Royal Commission on the Pike River Coal Mine Tragedy

Te Komihana a te Karauna mōte Parekura Ana Waro o te Awa o Pike

UNDER **THE COMMISSIONS OF INQUIRY ACT 1908**

IN THE MATTER OF **THE ROYAL COMMISSION ON THE PIKE RIVER COAL MINE TRAGEDY**

Before: The Honourable Justice G K Panckhurst
Judge of the High Court of New Zealand

Commissioner D R Henry

Commissioner S L Bell
Commissioner for Mine Safety and Health, Queensland

Appearances: K Beaton, S Mount and J Wilding as Counsel Assisting

S Moore SC, K Anderson and K Lummis for the New Zealand Police

N Davidson QC, R Raymond and J Mills for the Families of the Deceased

S Shortall, D MacKenzie, R Schmidt-McCleave and P Radich for certain managers, directors and officers of Pike River Coal Limited (in receivership)

C Stevens and A Holloway for Solid Energy New Zealand

K McDonald QC, C Mander, A Williams and A Boadita-Cormican for the Department of Labour, Department of Conservation, Ministry of Economic Development and Ministry for the Environment

G Nicholson and S Stead for McConnell Dowell Constructors

G Gallaway, J Forsey and E Whiteside for NZ Mines Rescue Service

N Hampton QC and R Anderson for Amalgamated Engineering, Printing and Manufacturing Union Inc

J Haigh QC and B Smith for Douglas White

J Rapley for Neville Rockhouse

T Stephens and N Blomfield for New Zealand Oil and Gas

P Mabey QC for Pieter van Rooyen

TRANSCRIPT OF PHASE THREE HEARING
HELD ON 13 FEBRUARY 2012 AT GREYMOUTH

COMMISSION RESUMES ON MONDAY 13 FEBRUARY 2012 AT 10.01 AM

MS MCDONALD CALLS

ANTHONY ARTHUR RECZEK (SWORN)

Q. Mr Reczek, do you confirm that your full name is Anthony Arthur Reczek?

A. Yes.

Q. And you're from New South Wales, Australia?

A. Yes.

Q. And you're a consultant?

A. Yes.

Q. A copy of your CV is attached to your brief of evidence, but could I just get you to confirm in a high level way please, that you are an electrical engineer, having qualified from the University of New South Wales?

A. Yes I am.

Q. And a systems safety specialist with 50 years' experience in engineering discipline?

A. Yes.

Q. I think you also hold the New South Wales statutory qualifications as an electrical engineer in charge for coal mines and have worked in that capacity for many years?

A. Yes.

Q. In 1978 you were appointed I think as a senior inspector of electrical engineering for coal mines in the New South Wales Department of Mineral Resources?

A. Yes I was.

Q. And you held that position for 18 years?

A. Eighteen years, yes.

Q. Can you confirm also that in your brief of evidence you state that you have particular experience in mining risk management systems and protection for hazardous areas with explosive and toxic gas atmospheres?

A. Yes.

Q. And you also have experience in mining accidents and safety environment and have experience investigating major incidents?

A. Yes. Yep.

Q. Now your brief of evidence covers an overview and an evaluation of the electrical system at Pike River and possible electrical sources of ignition doesn't it?

A. It does.

Q. Can you just, perhaps coming then to paragraph 11 of your brief of evidence. You've expressed that paragraph in terms of possible electrical sources of ignition?

WITNESS REFERRED TO BRIEF OF EVIDENCE

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A. Yes I have.

Q. Can you just comment please on how conclusive your findings are?

A. It's not possible to be deterministic in the sense that we know exactly what happened. The available evidence gives us some indications to what could have happened in the sense of providing ignition sources and there are a number of conclusions that I've reached in that regard.

Q. You've come on in the next few paragraphs to provide an overview and evaluation of the electrical system at the Pike River Mine, going through those paragraphs can you start please by explaining whether, and if so, why electrical systems in underground mines differ from surface electrical systems?

A. Yes, there are a number of differences. Primarily of course there is the fact that they're operating in a what's designated to be a hazardous environment by way of the possible presence of methane, but in the direct electrical sense they have differing types of earthing systems to what are commonly used on the surface. Earthing systems are normally dealt with on the surface locally whereas in coal mines they are distributed. There are various applications of insulations and protection on cables that are important for the high temperatures that might be achieved. There is over current protection for overloads and earth-fault detection and also there is earth-fault limitation which is very important.

Coal mines have distributed electrical systems in the sense that the cables radiate out from a single source of supply and as a result of that there is a need to provide different types of earthing arrangements and different types of protection from the symmetry of cables. The use of flexible trailing cable is also significantly different to other industries and the voltages of which equipment is utilised also tends to be higher, rising to 3.3 kV and up to and including 11 kV.

Q. Well, we'll perhaps come back to some of those concepts in more detail later. You say at paragraph 13, "That an important feature of electrical systems in underground mines is the inclusion of measures to control the risk of ignition of methane"?

A. Yes.

Q. Can you just elaborate on that please?

A. Well, methane is very easily ignited. It has an extremely low ignition energy and it has a relatively wide distribution in coal mines. It tends to appear wherever electrical equipment is in use particularly in production environment and of course in other areas of the mine so it's important to have recognition of the possibility that methane can be ignited and for it to be protected against.

Q. Is it also important to control the risk of ignition of layered coal dust through overheating?

A. Yes it is. There are particular measures in place, typically, to limit the temperature, the surface temperature that equipment can attain to exclude coal dust as far as is reasonably practicable from any electrical equipment particularly in enclosures but also to maintain dust-free surfaces on any machinery that could reach a high temperature.

Q. And you've said in paragraph 14, "That coal dust will ignite at temperatures in the range of 110 degrees Celsius to 160." Care to comment on those temperatures or the research in general terms that has led you to that view?

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A. Yes, there's been research done by scientific officers in the Department of Mineral Resources that goes back to, I think, about 1984, perhaps

earlier indicating that coal dust can be ignited at temperatures between 110 degrees C and up to 160 degrees C. Evidently if you get temperatures higher than that, then it will certainly ignite.

Q. Are you aware of some research or studies in the US context that put the temperatures higher than that?

A. Yes, the US, I think they've had measurements in the order of 250 degrees for methane igniting. There is a lot of factors that influence the actual temperature. There are a lot of variables involved such as the thickness of the deposit, the type of coal dust, in other words the seam in which it's being mined, the time that it's exposed too; there are a lot of factors that are involved in determining those temperatures. Now the ones that I've based mine on is the research done in New South Wales.

Q. Now paragraphs 15 and 17, you go on to talk about the levels of control that you believe are required to prevent electrical ignition of methane in an underground mine. I'd just like to take you through just those briefly. So, the first there you've identified as sufficient ventilation in the mine, in the mine workings?

A. Ventilation is always considered as the primary means of diluting any methane that might be present, so that's the first level of protection. If there is the possibility that methane will be present then it is required that you have electrical equipment either suitably enclosed so that it cannot ignite an external atmosphere of methane around electrical equipment, and other than that it has to be of a sufficiently low energy that makes it impossible for it to ignite methane.

Q. So you've got sufficient ventilation as your first level, layer of control, second one's the containment of the electrical ignition, is that right?

A. Yes.

Q. And then paragraph 17 you come down to talk about methane detection devices?

A. Methane detection devices are a backup to those other devices. It can't provide a means of protection in its own right.

Q. Okay, now we'll leave paragraph 16 at this stage and I'm going to take you later on to talk about flameproof enclosures and restricted and non-restricted areas. Paragraph 18 of your brief you talk there about the typical features of an electrical system of an underground mine. I'd like you just to identify the headings there in the sub-paragraphs for us and then come back if you would and identify which of those relate to the Pike River situation and are relevant for our purposes?

1012

A. In relation to the earthing system?

Q. Well –

A. There is typically an earth electrode located on the surface with the main substation that supplies the underground part of the mine. That earth electrode provides the source of earthing for all other items of equipment in the mine, in other words everything that exists in the mine electrically is eventually connected to that earth.

Q. So I'll just stop you there. So what you're saying there is there's an interconnected earth system which is connected to the surface?

A. Yes.

Q. Throughout the whole mine?

A. Yes.

Q. And that's relevant in the Pike River situation?

A. Yes it is.

Q. Do you want to say anything more about that at this stage?

A. It's different to what you would normally find in other industries or installations because there is no local earth provided where electricity is being consumed. Typically in other installations there would be an earth electrode or earthing system locally to the equipment, but in coalmining it's all reticulated.

Q. Back to the surface?

A. Back to the surface.

Q. The second one, "appropriate installation for high temperature machines." Is that a matter of significance here?

A. It's significant in the sense that machinery is designed to operate at higher temperatures typically. It's not to be expected that they would be hotter than the temperatures that we have identified for surface temperatures, but internal temperatures of explosion protected equipment can get quite high before the temperature actually conducts through to the surface. So installation and the types of materials used can be particular to coal mines.

Q. The next one is "appropriate explosion protected joints and connections in power cables?"

A. Yes, all reticulated cables such as trailing cables or power cables that are being extended to distribution centres join with mechanical couplers that are bolted together. Those mechanical couplers allow cables to be extended by having them in links and you can add links or take links out by bolting or unbolting the couplers.

Q. Next one, "protection from excess electrical currents and fault currents?"

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A. Yes, in electrical systems in coal mines there is, or in the power circuits, there is always a restriction placed on the amount of earth current that can flow in the event of a fault. That earth current is determined by the voltage at which it's being operated and will vary depending on where it is in the circuit. Also –

Q. So just stop you there Mr Reczek. So, that would be what would lead to a trip, or a short-circuit, or a fuse, is that right?

A. Yes, if you get a fault occurring either as an earth fault or as a short-circuit then the switchgear would interrupt the fault.

Q. The next one there is, "earth fault current limitations on all power circuits"?

A. Yes. That's designed to protect people against an electric shock. Because of the use of trailing cables to machinery, the voltage that's possibly conducted to items of equipment which are connected to the earthing system and which people may be in contact with are protected by having earth fault limitation.

Q. "18.6 Symmetrically designed earth screened and armoured cables"?

A. Yes, these are essential for the type of earthing systems that occur in coal mines because they neutralise the potential for voltages to appear between the ends of cables. They're symmetrically designed to coincide with the electrical characteristics of the power supply which are symmetrical and therefore the power conductors are also symmetrical and the earthing conducting and the pilot circuits within those cables have to be placed symmetrically within the cable.

Q. And, presumably, it follows from that, the correct connection of such cabling ensures proper functioning?

A. Indeed.

Q. Now you're going to come back to this later, but just while we're at this point, if access to pit bottom in stone were able to be obtained, is there some benefit in your view, from an electrical point of view, in being able to look at this issue of symmetry in the cabling?

A. Yes, there would be a number of issues to review. The way that the cables were connected is one. Primarily looking at the way the earth connections were made, whether or not they were symmetrically connected or not, whether pilot circuits were being used and what the protection settings were on the various relays that were protecting those electrical systems.

Q. Okay, might come back to that. The next one is "flexible trailing cables to mobile machinery." Is there anything more you need to say about that?

A. Flexible training cables are the primary means of supplying mobile machinery. Some of them are reeling cables and in particular cases they have different types of insulation, such as semi-conductive material.

Q. And the next one, "high voltage mobile machinery up to 3.3kV and higher?

A. It's, again, in common use. A lot of equipment operates at 3300 volts and some of it now operates at 11,000 volts.

Q. And then finally, "appropriate use of explosion-proof or flameproof enclosures on electrical equipment."

A. The difference with explosion protection generically and flameproof is that flameproof enclosures are a particular case of explosion protection, so there are a number of types of explosion protection that can be applied in addition to flameproof equipment, but typically you would have to have explosion-proof or flameproof equipment on all equipment that's in a place where you could be exposed to methane.

Q. Now what you've just been going through are the typical features of an electrical system in an underground mine, can you just identify from that list which are particularly relevant in this context?

A. I think the explosion-proof technique of increased safety is important –

Q. Sorry, which one are you referring to, what number?

A. Increased safety in 18, it's the –

Q. Which sub-paragraph number?

A. 8.9.

Q. 18.9?

A. 18.9, increased safety and protection by ventilation.

Q. So just going back to relate those comments to the paragraph numbers, or sub-paragraphs, I think you earlier identified 18.1, the interconnected earth system as being relevant?

A. Yes.

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Q. 18.6, the symmetrically designed cabling?

A. Yes, yep.

Q. And 18.9, the appropriate use of flameproof enclosures?

A. I think they're the most relevant paragraphs, yes.

Q. Now just in terms of the information you had and the material, the facts that you had to work with, you've set those out in paragraph 19 and following. Can I just get you also to confirm that you had some dialogue or discussion with a former Pike employee in the electrical area, Mr Mike Scott was it?

A. Yes I did. I had a conversation with Mike Scott primarily seeking to understand the disposition and type of cables that were being used for

the main fan located underground. That was my primary interest in talking to him. I didn't have any other contact with him.

Q. Now coming on then, paragraph 21.2 you just confirm there that methane is naturally present in the mine. Paragraph 21.3, you go on there to talk about non-restricted zone and I think it might be appropriate to put up the map at this point. I think its number 34, exhibit 34 Ms Basher?

WITNESS REFERRED TO EXHIBIT 34

A. I don't have anything on my screen.

Q. No, no, it will come up in a moment, and it's above you on the, behind you?

A. Oh there it is.

Q. If you turn around the other way Mr Reczek? Up there?

A. That way, yes.

Q. And you've probably got a pointer have you, there with a –

A. Yes I have.

Q. I might get you to identify areas as you talk through this?

A. Okay.

Q. So can you point out then the non-restricted zone and the areas where you believe there would have been methane and the relevant areas of the mine, from your point of view?

A. Okay. There's a dotted line located here.

Q. Yes.

A. And that is what I understand to have been designated as a non-restricted zone. There is a – the main fan is located there.

Q. Now when you say "there" and "here," that's got to be recorded into the transcript so we might just need you to describe what you're looking at. So you're identifying the main ventilation fan marked on the map?

A. Yes I am. It's the, just trying to read it, main ventilation fan, yes. FA001. And is the dotted line needing to be described?

Q. No, I think we all know where that is and we can see that on the map, that's fine.

A. So I would expect anywhere on the return airway side of that main fan to be a potential source of methane and I would consider anywhere inbye of, by "inbye," I mean the intake side of the air flow to potentially have methane present. It would be particularly present where there were machines working in sections. They'd be the main areas where I'd expect that you would say yes methane could be present.

Q. And I think you have some knowledge of where there were methane sensors in that area?

A. Yes, there were methane centres located within this non-restricted zone, but exactly where they were I don't know. It's got it marked on the map, CH4 sensor bank located here in the intake airstream, which would put it very close to the main fan.

Q. So what comment could you make about the fact that there were methane sensors in a non-restricted area? What does that suggest to you?

A. Well it indicates to me that the people who designated the non-restricted zone considered that methane could be present there.

Q. And the significance of that, given the equipment that was in that area?

A. The equipment was not explosion protective and it would appear to me that they relying on the methane protectors to provide the means of protection if methane were to be present.

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Q. And given what you told us a few minutes ago about the various levels of control and the methane detection being at that backup level, as you put it, what comment do you make about that?

A. Yes, I would designate that whole area to be an explosion-risk area, possibly about a zone 2 designation.

Q. Now, just coming back to your brief of evidence for a moment then please, at paragraph 21.4, you talk there about having viewed email correspondence, or correspondence and paragraph 21.5, the material provided by Rockwell?

A. Yes.

Q. And that I think is attached to your brief of evidence and if you need to you'll come to that later?

A. I'll refer to that if necessary.

Q. Now, moving on then to potential sources of ignition in the Pike River Mine electrical system, you refer there to two features that you consider are of particular interest. The variable speed drives, or VSDs?

A. Yes.

Q. And the electrical power supply issue?

A. Yes.

Q. So those two areas in particular?

A. Yes.

Q. And it's clear from your statement that your view is that the VSD devices were evidentially causing harmonic currents?

A. Yes they were.

Q. Now, can you just comment on harmonic currents in a very general way, we're going to come to the specifics later, but are they expected, unexpected, normal, what?

A. In the case of the variable speed drives, they would be expected because they are created by the process of providing the speed variation. What would be undesirable is for those harmonic currents to find themselves outside of the immediate area where they are created. At this stage, I'll leave it at that.

Q. Right, we'll perhaps just read paragraphs 23 and 24 if you would, just summarises your position before we get into the detail.

A. "I was particularly interested to note that VSD devices were used in the mine and were evidentially causing harmonic currents to circulate in the power supplies. The harmonic currents are a normal feature resulting from the use of VSDs. They can cause currents to be induced or transmitted in earth circuits and therefore need to be properly controlled." 24. "There also appeared to have been issues related to the Pike River electrical supply as evidenced by the apparent overheating of certain electrical plant. This could in itself create

potential sources of ignition and could exasperate the effects of harmonic currents produced by VSDs."

Q. Coming then to VSDs. Am I right that VSDs are used to control the speed of most large motors?

A. Yes.

Q. What else can you say at a high-level generic sense about a VSD that will assist us?

A. It is a significant advantage to be able to control the speed of motors using VSDs.

Q. Why is that?

A. Because it gives you continuous control over the speed and you can set the speed to be at a value that's desirable. Particularly on items of plant, for example, traction motors where you are varying the speed that the vehicle might travel at, or in this case the Pike River. The case of the main fan where they apparently wanted to be able to vary the speed of the main fan.

Q. So that would assist, where necessary, in reducing the load on the mines' power supply or impact on the wear and tear of machinery as you say?

A. Yes it can reduce wear and tear, the main advantage I think is in being able to control the volume of air that is circulating in the mine and also to reduce the amount of energy that's being consumed by the fan.

Q. So they have the effect, or can have the effect of saving energy?

A. Yes.

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Q. Paragraph 30 and following, you talk there about how a VSD works. Without getting too technical about it, Mr Reczek, does the VSD vary the frequency of the output wave?

A. Yes it does, that's its function. The input wave form is fixed at 50 Hz and to vary the speed of the type of motor that we are talking about the way to vary the speed is to vary the frequency applied to it and that allows a continuous variation between 0 Hz and 50 Hz.

Q. Can I get you please to have a look at just a generic diagram here, it's AA4, the DOL number is the usual DOL reference ending in 0007, it's in tab 5 of the bundle. It will come up in a moment Mr Reczek. Thank you Ms Basher.

WITNESS REFERRED TO DOL DOCUMENT – TAB 5 OF BUNDLE

A. Yes.

Q. Now, again Mr Reczek, bearing in mind that we're not all electrical engineers in the room. Could you just take us through that diagram in a fairly high level way?

A. This is the input wave form.

Q. Now you're talking, "there," you need to identify what you're looking at for the record?

A. Sine wave power.

Q. Sine wave power. So that's the input wave form, yes.

A. The input wave form coming from the substation or transformer providing energy to the variable frequency controller.

Q. Okay, I'll just stop you there. You might need to come a little bit closer to the microphone. I know it's awkward, but we have to also record what you say. So the sine wave power comes in?

A. Yes and this is in a fixed frequency of 50 Hz.

Q. And goes to the?

A. It goes through the variable frequency controller and it comes out at a continuously variable frequency but with the sine wave only approximated.

Q. So the wave form has changed at that point?

A. Yes it's changed to a square wave form typically. That's diagrammatically being shown by these sharp edges.

Q. Yes.

A. But it approximates the sine wave like that.

Q. And then it goes to the motor?

A. Then it goes to the motor. At this stage before the motor that frequency is infinitely variable between 0 Hz and 50 Hz, generally starting at a low frequency of about two but then rising as the frequency is controlled up

to its full speed. The motor would respond to the frequency and it would rotate at a speed that relates to the frequency that's been applied.

Q. I think that's clear, thank you. Now VSDs can cause, as you indicated earlier, harmonic distortions of electrical currents, is that right?

A. Yes.

Q. You've also referred in your brief of evidence to them causing secondary currents induced by harmonic distortions?

A. Yes.

Q. And thirdly, induced voltages in earth systems?

A. Yes.

Q. Now we're going to come to some of those things in a little more detail later, but in a very high level way can you just identify what the differences are, what those three things are and just so that we can have some sense of the differences between...

A. Okay, so the first instance that you mentioned is –

Q. Harmonic distortions?

A. Harmonic distortion. Harmonic distortion is a feature of the process of doing the frequency conversion. It is a square wave form and a square wave form in theory contains an infinite number of sine waves of different frequency. So what that means is that you have a large number potentially of different frequency voltages and currents being generated by the square wave form.

Q. So you're getting high frequency wave form that matters?

A. Yes. You get a high frequency wave form, many of them, in theory an infinite number of them.

Q. Now we'll come back to that if we need to. Now the next one was secondary currents induced by harmonic distortions?

A. Secondary currents result from asymmetry but, that's like non-symmetrical induction and conductors that may be running parallel adjacent to conductors that are carrying these harmonic currents. So where the current or the voltage is distorted and if there's asymmetry in the cables, then there will be voltages induced in adjacent conductors.

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Q. So, “voltages induced in adjacent conductors” –

A. Adjacent conductors, yes, which –

Q. What does that mean, in real terms?

A. It means that you would get voltages and currents induced in the earth circuits.

Q. And then the third one was, “Induced voltages in earth systems” is that different, or –

A. Yes, no, that’s the same really.

Q. Right, so is –

A. It’s just that the earth systems are interconnected, therefore the voltages and currents that appear in the adjacent conductors would also appear in all of the earth circuits attached to it.

Q. So there’s really two things there, the second of them is broken into two parts?

A. Yes.

Q. Okay, coming back then to harmonic distortions caused by these VSDs, you said earlier that that was a known feature?

A. It’s an expected feature of it. In fact it’s how they work. It’s essential to create a square wave form in order that the frequency conversion can take place, so it’s actually a function of the variable speed drive to do that.

Q. And would you say that that is a disadvantage of the use of a VSD or not?

A. Yes, it’s a disadvantage in the sense that it can cause interference and it can – that’s with other electrical systems, and it can affect other electrical installations that are connected to the same power supplies.

Q. I’m going to get you to go to what’s tab 7 in your documents, AAR6, but the second diagram, which is Ms Basher, DOL number ending 0009/2?

WITNESS REFERRED TO DOCUMENT DOL ENDING 0009/2

Q. That one there, thank you.

A. Yes.

Q. Now, by reference to that diagram Mr Reczek, can you use that to again at a high level way explain to us these harmonic distortions?

A. Okay. The dotted line on the right hand ledger called "designated first," is what's called the first harmonic or fundamental. That's represented in this diagram by the fundamental sine wave that is being supplied from the power supply, and these voltages where they are harmonic – where the same voltage has harmonic content –

Q. So you're referring there though, just for the record, as the fifth –

A. To the heavy line.

Q. The heavy line, yes.

A. The heavy line which is following the sine wave, is showing, it's actually a sine wave that's distorted due to the presence of this harmonic here, which is being added to this one and causing this.

Q. All right, again, just to translate that for the record, you're referring to the frequent shorter harmonic shown at –

A. Yes, so harmonic is a frequency which is varying in tune if you like, so this, you've got three complete cycles compared with the fundamental.

Q. And –

A. Or five in the case of the fifth harmonic. So, if this is the fifth harmonic, that's one, two, three, four, five. That's the fifth harmonic and the heavier line is the summation of the fifth and the first.

Q. And just to bring that back and make it relevant to what we're talking about here, what's the effect, you say, of those harmonics, those increased – the increase in frequency there?

A. The higher the frequency, the greater is the level of induced voltage and current in the adjacent conductors. The frequency and the amount of current or voltage that's induced are basically proportional. The higher the frequency, the higher will be the induced voltage.

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Q. Now, you've identified at paragraph 38 in your brief of evidence, two potential problems that can result from the existence of currents with frequencies in that high range. Can you just summarise what those two problems are in lay terms?

A. Yes. The high frequency currents, or voltages, are not restricted by the normal earth-fault current restriction device located in the transformers.

Q. So just stop there. So what you're saying is one problem is they're not limited by the earth system?

A. That's correct.

Q. They're not caught?

A. The higher the frequency the more likely they're just to bypass the impedance. So the currents are no longer restricted.

Q. And the second problem?

A. Because they are induced in the earth circuit, normally the earth leakage device would detect earth-fault currents, but in the case of harmonics they don't pass through that device and they flow undetected. So no protection devices will trip.

Q. Now, you've referred I think somewhere in your brief of evidence to these currents will follow the path of least resistance?

A. Yes.

Q. Just expand on that?

A. Because the voltages and currents are being induced in the earth circuit and the earth circuit is interconnected basically everywhere in the mine and also through the equipment, electrical equipment sitting on the ground itself, it means that the earth currents have multiple parts available to them to flow and they will flow whichever has the least impedance to their flow. So they will basically flow wherever the easiest path is for them to follow.

Q. And in the Pike River Mine situation, what's your view about?

A. At Pike River they would be able to flow in the earth conductors that were connecting the variable speed drive and the main fan and also any other equipment which would include the substations supplying the variable speed drive, the variable speed drive itself and the main fan motor installation, they would also provide earth return paths for those stray currents.

Q. So potentially, how far into the mine?

A. The whole mine is interconnected so there would be no limit to where those currents could find themselves. They would flow through the

earth circuits, depending on which was the least impedance to their path.

Q. And again, we're going to come to the detail by just what's the potential consequence of that?

A. Well, it means that everywhere where there's a joint that could experience an earth current flowing through it is a potential source of sparking and basically that would include every joint in the earthing system in the mine.

Q. Can you comment on the position on the distance between a VSD and the motor, a piece of equipment and the significance of that distance?

A. Yes. There are VSDs used throughout the mining industry on machines such as shuttle cars and continuous miners. These can be on trailing cables, as being supplied through trailing cables, but the VSD itself, it's source of supply and the motor where the supply is consumed all are located on the machine so what that means is that there is a solid electrical connection onboard a machine which will allow these harmonic currents to flow without them being transmitted off the machine itself, so they're contained within the frames of the machinery, they don't get off. In the case of Pike River there was quite a distance between the variable speed drive's location and the motor where the –

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Q. In which piece of equipment are you particularly talking about?

A. The main fan. My understanding is that there was a cable of about 90 metres long between the VSD and the main fan and that meant that the currents that were – the harmonic currents were flowing in the earth circuit would be being conducted along that earth, the earth path, within the trailing cables or within the cables and are being conducted into the mine earthing system via the motor earth and via the substation earth.

Q. So, ideally what you want then is the current to what, to come back to the VSD?

A. Yes, the VSD is the source of the harmonic currents. It's basically a DC voltage with zero in the middle of the sine wave and all the harmonics

will try and circulate through external earth connections back to the VSD through the earthing system.

Q. So, the ideal is for the current to come back to the VSD. Does it follow that if you've got a significant distance between the VSD and the motor, there's less chance that the current will come back to the home base?

A. No, it will always come back to the VSD because that's the circuit that's provided, but it will do so via any other earthing circuit that's available to it.

Q. So it'll go walkabout in the meantime?

A. Yes.

Q. Right. Now how do you fix that problem? What would you do?

A. Well, typically it's a installation and design issue. You would want normally to keep the two devices as close together as possible, ideally connected together so that the currents circulate within the devices themselves, but there are external means of limiting the possibility that the harmonics will stray or be present in the power system. That's done by filtering and that, filters can be designed for the particular harmonic frequency that you are interested in. One of the problems with that is that you can never be certain what the particular harmonic frequencies are that you have to deal with so typically you would be required to take measurements and to design filters and specialised electrical equipment to conduct those harmonic frequencies safely. So, I didn't see any evidence of that at Pike River.

Q. Okay, perhaps we'll come to some of those matters again. Now, moving on then to secondary currents induced by harmonics, which you mentioned very briefly a moment or two ago, quite a dense topic and a difficult one, but for our purposes, can you just explain what you believe was happening as a result of the secondary currents?

A. Yes, well, the primary current first of all is in the power circuit. That's in the power conductor supplying the motor and the secondary currents are the currents that are induced or conducted through capacitance to adjacent conductors. And what that was doing in effect was causing the high frequency currents to circulate in the normal earthing circuits.

Q. So, you're talking about transference by capacity are you, rather than by connection, is that right?

A. Yes, there's no direct connection. The capacitance is typically on the insulation between the power conductor and the earth conductor. The insulation between those two conductors provides capacitance and at high frequencies, or higher frequencies, that capacitance becomes conductive and the higher the frequency, the more conductive it becomes. So, you are transmitting the currents almost directly across the insulation of cables or in fact between windings on machinery as well where that capacitance exists.

1050

Q. And is that on the output side or the supply side or both?

A. It would be on both.

Q. And if it is occurring on the output side, is that a problem?

A. Yes, on the output side you have the potential for sparking anywhere where there is a mechanical joint on the earth conductors.

Q. So really the matters that you've covered in paragraphs 40 through to 44 and summarised in 45, reduce down, don't they Mr Reczek, to the risk of arcing from this process?

A. Yes.

Q. Could you read paragraph 45 then please?

A. "These harmonically reduced phenomena have been detected in many underground coal mines and have resulted in arcs being observed to pass between machines as they make contact and to cause electric shocks to personnel who have been simultaneously in contact with mobile machinery, such as shuttle cars and the ground."

Q. Now, we're coming onto induced voltages in mine earthing systems, I'd like to take a moment now and ask you if you could to just, again in a general way, explain earth limiting systems?

A. Yes. If you took a normal industrial or domestic situation, what happens is that electrical appliances are connected directly to earth through an earth wire that passes through the conductors and is connected to what's called a local earth connection. In the case of a restricted – and

in those sorts of systems if you get a fault on an appliance or on any of the wiring, the earth current flows in an unrestricted way and it is intended to either trip a circuit breaker or to blow a fuse or some such device.

Q. So it's like our fuse box at home when it clicks out?

A. Yes, essentially. So you try and raise as much current as possible by having a good earth circuit and then it will trip the circuit breaker. Typically in modern domestic installations there is a, what's called, a residual current detector which makes sure that if an earth current flows then it will trip off very, very quickly before people who are exposed to it receive a shock. Now, the difference in a coal mine or a restricted system such as we're talking about at Pike River, is the potential to provide a dedicated earthing system at the point of consumption is virtually impossible and we are using trailing cables to supply energy from substations through distribution centres to the mobile machines. So in order to guard against people receiving an electrical shock, if an earth-fault or a defect occurs, the earth-fault current is limited to a nominal value at the source of supply and it's the limitation of that current that prevents people from receiving electrical shocks. The detection of the current is done in the same way, in other words, when an earth current flows the fact that it is flowing causes the circuit breaker to open.

Q. So just, it may be a little bit repetitive but it's probably nonetheless important, the harmonics that you've been talking about can they be detected by a normal earth limiting process at Pike River?

A. No, they're not present in the power circuit in the same sense that electrical currents coming from the power supply are because they're being generated internally within the VSD themselves. So they don't flow as a result of the power circuit and it's only the power circuit that is protected.

Q. Now, coming on then to induced voltages. What's the significance of that in this context?

A. The induced voltages in the earth conductors as a result of the harmonics would not be detected and there is no means of tripping the source of supply if they are at a dangerous level or indeed if they're occurring at all.

1055

Q. And that in turn, as I understand what you've been saying, can cause arcing?

A. Yes.

Q. And the higher the frequencies the bigger the problem, is that right?

A. The higher frequency, well two factors. The higher the frequency and the higher the current. So the two things go hand in hand.

Q. Now do you think that adequately covers what you've set out in paragraphs 46 through 50 or is there anything else that you want to comment on?

A. There is another feature there which is probably worthwhile mentioning, in 48. At higher frequencies there is a phenomenon called transient voltage fronts. So the higher the frequency the more liable the system is to that phenomenon and at times when you have power being switched on or switched off, you can get transient voltages flowing along the lines, the power lines, and that can have the effect of doubling the voltage that is being induced.

Q. And you say, don't you at paragraph 49, what that means in simple terms, and perhaps if you just read that paragraph?

A. Okay. “In simpler terms, what this means is that when VSD motors are starting the amplitude of the higher frequency harmonics would be much greater than when the motors were running at full speed. Accordingly during start-up where would be commensurately larger travelling waves being conducted along power system cables including earth conductors.”

Q. And that in turn increases does it, the risk of –

A. It increases the intensity and the energy of any sparking or arcing.

Q. Now coming then to paragraph 52 and VSDs at Pike River, I'm going to take you first please to the DOL reference ending 60010/1. It’s a

photograph of some VSDs. It's actually at tab 8 of your bundle Mr Reczek?

A. Okay.

WITNESS REFERRED TO DOL DOCUMENT – TAB 8 OF BUNDLE

Q. Now, just looking at that photograph, just to be clear, these are some VSDs aren't they?

A. Yes.

Q. Above ground?

A. Yes.

Q. Are they Pike River VSDs?

A. Sorry, what was that question again?

Q. Do you know these are photos of Pike River VSDs?

A. To the best of my knowledge they are, and it says that it's the make-up water station. They're supplying liquid-cooled variable speed drives. These are manually operated circuit breakers. They're about two metres high, perhaps about a metre a wide, and it's typical of the sort of installation that we're talking about.

Q. And just to be clear, there's actually four of them there which you can tell from the four handles that are shown?

A. From the number of the handles, yes. And it's sitting on a frame which is fairly typical. It would be designed to sit on the ground and the cables providing energy or power to these cubicles would be connected to the substations or to a substation.

Q. So is it your understanding that they're of a similar type of VSD to those that would have been at pit bottom south area?

A. Yes, it's typical of the sort of equipment that we're talking about.

Q. Now you mentioned earlier that VSDs used on mobile machines at underground mines are usually integrated into the machines themselves?

A. Yes, they form an integral part of the machine frame. So the, typically the motor is bolted to a gearbox and the gearbox is connected to the drive train, to the wheels of a piece of equipment and the whole

assembly is bolted onto the frame or the chassis of the machine. So it's a totally integrated system.

1100

Q. Because these ones aren't integrated?

A. No these ones aren't and they are connected by cables going off the VSD and going to a remote location for the motor.

Q. Now, I'll just take you, in your brief of evidence, to paragraph 55 and following. Without getting into the detail of some of that material, I'll just lead you through that, confirm that you've looked at some of the correspondence, an email correspondence in particular that's been provided to you and did that identify that there had been some problems with the VSDs at Pike River?

A. Yes, they were experiencing quite a number of issues. First of all the harmonics were measured to be present and they were measured to be present in areas which they reasonably shouldn't have been.

Q. Such as?

A. Such as the circuit breakers on the power's supply systems. CB4 is one.

Q. We're just looking at the map again, just to be complete where that is. If we can go back please to exhibit 34?

WITNESS REFERRED TO EXHIBIT 34

A. We're talking about the main fan primarily here in the Spaghetti Junction area. There is a substation located there which has an 11 kV cable coming down the drift and into the high voltage side of the transformer then there is a cable supplying this other cubicle which is the variable speed drive and then there would be a cable transmitting the output of the variable speed drive up to this location where the main fan's located. The harmonics in the power supplies were being measured up in this area here which I think is called pit bottom at a location called CB4.

Q. So it's pit bottom stone at the location CB4, to the far right of the diagram?

A. Yes. Now the other, apart from the measurements that were being taken, there was also evidence of overheating both on the variable

speed drive itself but also in the motor to the extent that they were needing to leave the cubicle doors open.

Q. So you're looking in the area of the fan?

A. No this is this area here, where the variable speed drive is.

Q. Can we just get that described for the record please? A heading cross-cut two I understand. Yes.

A. And they were experiencing difficulties in trying to get the fan motor up to its full rotored speed.

THE COMMISSION ADDRESSES MS MCDONALD – IMPORTANCE OF EVIDENCE OF MAP NUMBERS

THE COMMISSION:

Can you just repeat that process for us?

MS MCDONALD ADDRESSES THE COURT – DISCUSS LOCATION ON MAP

EXAMINATION CONTINUES: MS MCDONALD

Q. If we can go to another plan it might be easier to identify. It's the DOL number 150008/1.

WITNESS REFERRED TO DOL150008/1

Q. It's a fuller plan. Can you expand that area at the far right Ms Basher? I'm struggling to read it. So if you could just try, Mr Reczek, when you are pointing to that because the record needs to be able to just define the area you're talking about, if you could give us a description that's marked on the map?

A. I'm referring to the pit bottom switchboard, SB1001.

Q. SB001 actually.

A. Yes.

Q. Yes and that's what?

A. And they would've had a circuit breaker designated as CB4. And that should've been one of these switches. So this is a number. This is 1, it's designating the switches collectively, but they would –

1105

Q. And you're pointing there to the black mark?

A. Yeah, this black rectangle and there would be cables coming out of these individual switches and they would be being transmitted down the shaft, variously to the main fan. There was a cable going to the main fan and my understanding was that it was fed from CB4.

Q. And when you say, "CB4", that's what you're talking about there?

A. It would be one of these, yes.

Q. Right, it's at SB001 on the diagram?

A. Yes.

Q. And that's where the measurements were taken from?

A. As far as I know, yes.

Q. Just pause there please. Is that sufficient sir?

THE COMMISSION:

Well, can we go back as well to Spaghetti Junction area where Mr Reczek gave us a description of cables going to the main fan from a substation?

EXAMINATION CONTINUES: MS MACDONALD

Q. Ms Basher, if we can go to the Spaghetti Junction area and enlarge that? And again, Mr Reczek, the same process if you could, go back over what you said a moment or two ago but by reference to descriptions that are shown on that diagram?

A. So, this is a drift, coming down to Spaghetti Junction from pit bottom. There was an 11,000 volt cable coming down there, coming along this cut-through and into the back of this black rectangle –

Q. And that's marked –

A. – which is the substation and that's marked substation SS601.

Q. Just stop there. That's fine, thank you. So that's your cable?

A. That's the high voltage cable.

Q. Yes.

A. And then from the substation there is a low voltage cable going from the output of the substation into the VSD drive and that's designated FA001VS601, drive for the fan.

Q. Yes.

A. And then there is a cable coming out of the VSD travelling along here, this designated – I'm not sure what that cut-through's called – to the main fan motor located there.

Q. So going straight ahead to the main fan, it looks like –

A. Located there. There's, now there's a bulkhead shown there, with the black rectangle on that side, my understanding of that is that the, this is the fan itself and the motor is on this side of it.

Q. Hang on, we just have to get all of that for the record. So you're cable's coming up from the substation SS601?

A. Yes. It goes into FA001, which is the drive for the fan.

Q. Yes, just stop there. And then where does it go from there?

A. And then it goes along the cut-through –

THE COMMISSION:

Due north?

EXAMINATION CONTINUES: MS MACDONALD

Q. Due north and along the cut-through to?

A. To the main fan.

Q. To the main fan?

A. Motor.

Q. And the motor of the main fan is shown?

A. Yeah, I don't think the motor is shown on this diagram. I think that that black rectangle represents the rotor of the fan itself, so my understanding is that the motor would be on this side –

Q. On the left-hand side of that?

A. On the left-hand side of that stopping. It looks like a bulkhead to me. So that bulkhead is intended to separate the non-flameproof motor from the return airway in which the fan motor's located. So in terms of what we've been talking about, we're talking about the harmonic content being generated in the variable frequency drive, being conducted from the earth circuit on the variable frequency drive to the motor –

Q. And you're talking there about going from FA001?

A. Yes, FA001 to the main fan motor and because those two components are connected to the main earth for the entire mine, any voltage, harmonic voltage that'd appeared between that location and this location would spread out through the entire mine.

Q. So any voltage between those two locations, between the –

1110

THE COMMISSION:

Q. Well, between the variable speed drive or variable frequency (inaudible 11:10:07) drive and the fan itself.

A. And the fan itself, yes.

EXAMINATION CONTINUES: MS MCDONALD

Q. Now you were telling us that you had become aware of the problems with the harmonics for Pike River because you've been through the relevant correspondence. You've also, I think, viewed the communications from Rockwell?

A. Yes I have.

Q. And have you got any particular comment to make about that or?

A. Yes, they report a number of what I would call anomalies in the operation of the fan, and not the fan alone, also the monitor pump, but specifically in this case for the fan, of evident heating of components, electrical components to the extent where they've had to leave the doors open on cubicles to allow them to cool and also some instability in the speed of the motors. So they were having instability problems, heating and evidence of harmonics where they were taking measurements. There was quite a degree of confusion in my view as to what was causing all of this and they were in the process of trying to understand whether or not the harmonics were being caused by some other external source causing the fan to trip off on protection relays and whether or not the instability was being created by the harmonics themselves which are normally generated in the VSD. So there was no clear-cut understanding in my view of how to tackle these issues.

Q. Now, you talk at paragraph 58 again about capacitively coupled paths to the machine frames?

A. Yes.

Q. You've mentioned this earlier, but again just to be clear, you're talking there as I understand it about not an electrical connection, an actual connection, but a capacity connection, is that right?

A. Yes. In transformers, large power transformers and large motors the windings themselves have a small capacitance between each turn. Now that capacitance is an inherent feature of all electrical coils or circuits but abnormal power supply frequency is negligible so it doesn't have any influence on the system, but what happens when the frequency goes higher, then the inter-turn capacitance becomes important and you get currents being conducted through the inter-turn capacitance to the earth circuit of the machines and that includes the transformers, the VSDs and the motors.

Q. So you're talking about currents going between machines?

A. Between conductors on machines to the earth circuit on that machine.

Q. And what's the risk there?

A. Well the risk is that you'll get incendive sparking being conducted through the capacity coupling to the earth circuit and being transmitted into the more general earth circuit.

Q. And would that be high enough to ignite methane through arcing?

A. It would indeed.

Q. And just generally, can you comment on what level would be high enough to ignite methane? What's the...

A. Well, methane it has a number of ignition points, which is like the most easily ignited mixture, the most explosive mixture. In general it's between 5% and 15% of a mixture, but the amount of energy for the most easily ignited mixture is about .29 millijoules, which is a very, very small fraction of the sorts of energies that not only have we seen but would be conducted by inductive coupling and capacity coupling.

1115

Q. And can you relate that to something that we could relate to? How much? You've given an example I think of the typical battery in your brief?

A. Yes, if you had a watch battery it would have many, many times the amount of energy that's required to ignite methane. Watch batteries are not permitted underground for that very reason.

Q. Could you perhaps just read for us paragraphs 59 to 62?

A. "These current flows would almost certainly exceed the capability to deliver sufficient energy to ignite methane through arcing across mechanical connections and would therefore represent an extreme risk for the ignition of methane at any location in the mine where electrical equipment had been connected to the mains. 60. Essentially, the harmonic current flowing in the earth circuits of the underground power supply would be capable of generating incendive sparking across any mechanical surface connected in the connection in the earth circuit. Then 61. The information provided to me by the Department of Labour indicates that at some time between 1545 and 14 seconds and 1545, 18 seconds, GPS time, on the 19th of the 11th 2010, the loop cooling pump of PG212, had started and the cooling system was pressurised. This loop cooling pump had to commence operation and pressurise the system before the start signal was given to the variable speed drive powering the number 1 fluming pump. Allowing for a pre-programme five second delay after the system was pressurised, the VSD would have started and begun supplying power to the number 1 fluming pump between 1545 and 19 seconds and 1545 and 23 seconds, GPS time. At 1545 and 26 seconds, GPS time, the circuit breakers at the portal's sub-station tripped. Therefore the VSD drive would've been in operation for a maximum of seven seconds and a minimum of three seconds before all power was lost to the mine. The implication is that at or very near the time the explosion took place when FP1 was starting, harmonic voltages, and in particular the higher order frequency harmonics creating travelling wave effects during start-up would've been present in

earth conductors making it much more likely that ignition sources at terminals or discontinuities in the conductors would appear."

Q. So you're saying from that that that start of that fluming pump could've resulted in the transmission of these harmonic currents and in term arcing?

A. Yes the fluming pump was a significantly larger machine than the main fan.

THE COMMISSION ADDRESSES MS MCDONALD

THE COMMISSION:

Q. Can we do a similar exercise, Mr Reczek to that which you did a moment ago in relation to the main fan, but on this occasion relating it to the pump we are concerned with and hence the power supply, position of VSD which is relevant, are you able to do that?

A. Yes.

THE COMMISSION ADDRESSES MS MCDONALD – SAME EXERCISE DISCUSSED

EXAMINATION CONTINUES: MS MCDONALD

A. We need to have a look at the pit bottom area.

Q. This is the, just for the record, 0008/1.

WITNESS REFERRED TO DOCUMENT 0008/1

Q. And can you identify Mr Reczek first which area you want?

A. Yes, that area there.

Q. Pit bottom and stone?

A. Yes. Now I'm looking for the pump that we're referring to as starting.

COMMISSION ADJOURNS: 11.20 AM

COMMISSION RESUMES: 11.37 AM

EXAMINATION CONTINUES: MS MCDONALD

Q. Now Mr Reczek, can I take you to the plan that we've got up there, DOL150008/1, and we have the pit bottom in stone area enlarged, and I'll come to the Department of Labour report in a moment which assists us with this identification, but could you just now see if you can explain where you believe the fluming pump was?

WITNESS REFERRED TO DOL150008/1

A. Yes. Well the best description is that it would most likely be this pump here.

Q. Now are you talking at the top black –

A. This is at the top pump on –

Q. Let me get it for the record. To the top –

A. Top pump on a bank of pumps listed as PU201 to PU205. So there are five pumps there and this would be number 1.

Q. And if you can just come down still by reference to that diagram and point out where the variable speed drives were for those pumps?

A. Yes, the variable speed drives are here.

Q. And you're pointing to the three –

A. And the –

Q. Just let me get it in the record. Three black rectangles immediately below those pumps on the map. They are marked variable speed drives VS201 to 205?

A. Yes. So VS201 would be the one supplying PU201.

Q. And you believe the top pump is the fluming pump?

A. It's the most likely one based on the description.

Q. And so can you just explain then the cabling and the supply into that pump and out of it please?

A. Yes. The cabling would be an 11,000 volt cable coming down the drift into the pit bottom switchboard. One of the switches in this bank would be a switch supplying substation SS201, and then the substation 201 would supply the variable speed drives and there's a bank of them –

1140

Q. Which are marked on the map as you've indicated?

A. Yes.

Q. Yes.

A. Those there, and then each one of these would supply one of these pumps.

Q. And then from the pump, what happens, so the cabling from the pump?

A. Well the cabling's coming from the variable speed drive to the pump.

Q. Yes.

A. So they've got the same situation here as exists with the fan, in other words, when that, the variable speed drive starts, you would generate the harmonics between the variable speed drive and the pump that was starting, and those harmonics would appear at the substation and at the pump and through the interconnections with the earthing system both to the surface and into the mine through the other high voltage cables –

Q. Which are running down the drift?

A. Running down the drift, to the other installations at Spaghetti Junction.

Q. I'll just get the rest of the map shown up, Ms Basher if you could come out to show us Spaghetti Junction as well now?

A. Okay.

Q. In fact could perhaps go to the full size if we can.

A. So they would be coming from this location there –

Q. Which is the pumps in pit bottom stone.

A. – pumps it there, the 11 kV cable is feeding this bank of switches, and cables that are connected to that would then continue on down the mine.

Q. Down the drift to Spaghetti Junction?

A. Down the drift, yes.

Q. And further in?

A. And further in.

Q. And when the pump was switched on, what do you believe the consequence of that would be?

A. Well, when the pump was switched on, when you look at the relative size between the pump and the fan, the pump is essentially a, nominally a 3.4 megawatt pump compared with the fan of about .3 megawatt –

Q. So, much bigger?

A. It's about 10 times the size, so the ignition potential with the arcing coming as a result of the harmonics, would basically light the entire electrical system up like a Christmas tree.

Q. And the – can you comment on the evidence that we've heard about the miners having seen the flash?

A. Yes.

Q. And what significance you believe that – the white flash I think it was described as?

1143

A. Okay, my understanding with I think the gentleman's name was Rockhouse?

Q. That's right.

A. Reported seeing a white flash from the area around the bottom of the drift or up at the top of the drift I can see in this case.

Q. I'll just get it marked.

A. And he reported seeing a bright flash which, and it was at the time that the pump started. When you look at the SCADA results.

Q. Yes.

A. Given the differences in polling times which there are some gaps in the timing, but it looks like there was a coincidence between or very close coincidence between the pump starting and the flash appearing. Now, I can't make a judgement as to the cause of the flash other than to say for a flash of that magnitude it was most likely a high voltage flash and I think it would be more a consequence of the explosion rather than the cause of it. So, I think that the sort of flash that's been described sounds like a high voltage fault and it was the high voltage, the currents of the high voltage fault that tripped the surface circuit breakers.

Q. Are you able to make any comment about where in the mine the ignition might have been?

A. My general sense of it in terms of likelihoods centres around the area around the fan and perhaps inbye of that, up in this direction. I think that any sort of presence of methane around this open equipment would have been ready to ignite but, of course, anywhere in any sort of power circuit inbye where there was methane present, it would find its ignition source.

Q. I was going to take you to the DOL report but I think Mr Mount might do that, so I don't think I will need to now. Just one thing that's probably very obvious but just for completeness. We talk about arcing. Is arcing simply big sparking?

A. Yes, sparking is usually used to describe low energy arcing. Typically one, two joules. You can get sparking of nylon underwear, but arcing is always associated with large power systems and you are talking about megawatts of energy so there's a big difference between the two concepts. Essentially they're the same but one is much greater intensity.

Q. Now coming then, if I can take you back to your brief of evidence, paragraph 63. In addition to the correspondence that you've talked about that you reviewed, I understand that you also observed some physical evidence that you believe could support your conclusions?

A. Yes.

Q. And that is perhaps best described by references to photographs at your tab 11, and they start with DOL reference ending 160013/1.

WITNESS REFERRED TO DOL DOCUMENT ENDING 160013/1

A. This item of equipment was located on the surface near the upcast shaft and the particular piece of equipment that we're interested in is this green device, which is an interface between the non-intrinsically safe power supply to the gas guard and the detector located in the upcast shaft and its function is to ensure that the electrical power going to the methane detector head is intrinsically safe.

Q. There's an arrow there shown on the photograph, but just to be clear can you use your pointer and just identify what you're talking about, and it is the Zener barrier isn't it?

1148

A. That's called the zener barrier.

Q. And is it that green?

A. That green strip and there's a power supply. The power supply is located here and here.

Q. Just stop there, here and here we need some descriptions.

A. Sorry.

Q. So you're talking about the power supply to the right of the zener barrier?

A. The power supply is to the right of the zener barrier yes.

Q. That's the blue?

A. Supplying the zener barrier and then the zener barrier carries power to the detector head sensing mechanism and interpretation mechanism. In other words it's the measuring mechanism for the gas in the upper car shaft.

Q. Now I just want to take you to another photograph next. If we go to the same number but it's 13/3?

A. This is the underside of the zener barrier.

Q. So it's that same green?

A. It's the same green thing but it's much bigger now because of the photograph and these are the terminals by which it is connected to the earth circuit inside the frame of the housing.

Q. And that's shown by the two arrows?

A. No these two arrows are showing the connection that's made to the frame. And the issue here is the erosion and the evidence of sparking at this location. Both on the right and on the left.

Q. So the two arrows mark the area of sparking?

A. Sparking, yes.

Q. And the next photograph which is 13/4.

A. This is the rail, the earthed rail that the zener barrier was bolted to.

Q. So it's the mounting rail?

A. The mounting rail, yes, and the zener barrier was, those two earth terminals that have the arcing evident were showing equivalent

evidence of arcing on the rail both on the upper side there and on the bottom side there corresponding to the locations on the zener barrier itself.

Q. And this is all in the equipment at the top of the vent shaft?

A. Yes, this is in a, my understanding is that it was in a shed-type housing which housed the cubicle for the gas detector and the cables went from that gas detector, the gas guard, to the sensor located in the shaft.

Q. So this equipment's on the surface but is it nonetheless connected to the mine's earthing system?

A. It's connected directly to the mine's earthing system because the cable supplying this came up from the mine via a shaft. Now, they actually had a cable bringing electricity from within the mine to the gas guard on the surface so the two earths were directly connected.

Q. So that evidence of sparking and scorching that you refer to does that suggest to you that the harmonics, the harmonic phenomenon that you've talked about and consequent arcing was occurring?

A. Yes and under any circumstances you should not have arcing on a piece of intrinsically safe equipment. It's just not acceptable under any circumstances. So the sheer fact that it was there is an issue in itself but the fact that it was connected to the underground earthing system, indicates to me that there was certainly the possibility that the same harmonics that were present underground were present on this device. In fact I can't think of any other source.

Q. Well, if we come then to the Pike River electrical supply, paragraph 69 and following, and you say at paragraph – well, perhaps first, I'll just get you to identify again in a very high level way, I don't think we need to go through these, but – find the DOL reference. The DOL number ending 0015.

1153

WITNESS REFERRED TO DOCUMENT DOL3000160015

A. 00160015?

Q. That one there that's up on the screen now?

A. Yes.

Q. What's that?

A. This is really just a diagrammatic layout of what the Pike River system looked like from an electrical reticulation point of view. It shows the switch gear that we've been referring to earlier.

Q. So the top left hand –

A. At the top left-hand side, supply 11,000 volts. Now these, this switchgear would itself be supplied with 11,000 volts from the surface, but here it's being passed through these switches to the various components which are doing the frequency conversion and are to the equipment that's being operated by the variable speed drives. It also shows more cables going to the underground, further underground down the drift, supplying other mining machinery, in green, this is at a lower voltage now, probably at 1000 volts I think in that case, but it just shows generically how the reticulation system distributes itself through the mine.

Q. Now, I think we can – really your point, and correct me if I'm not interpreting this properly, but your point is that the power comes in at –

A. 11,000 volts.

Q. – 11,000 volts, and then gets transformed into lower voltages as it goes through?

A. Yes, depending on the voltage that it's required to be consumed at, typically that's 3300 volts for the fluming pumps. It's 690 volts for the main fan and it's 1000 volts, typically, maybe 1100 volts for the mining machinery and 415 volts for other types of machines such as pumps and …

Q. And that occurs through I think three principle transformers, is it?

A. No, there would be a – it does occur in the sense that you have on the surface, there is in the Pike River system, there is a mains transformer at 110,000 volts that provides surface power at 33,000 volts to the Pike River substation located on the surface. That transforms from 33,000 volts to 11,000 volts and then the 11,000 volts is brought down underground to these switches and that then is transformed locally wherever there is a machine, such these machines here for example on

the lower right-hand side have a transformer that transforms the voltage to suit that application.

1157

Q. Well perhaps just again, just quickly, diagram 15/2?

A. Yeah, this diagram shows the surface installation primarily. This is the 110,000 volts supply.

Q. So that's Logburn?

A. That's Logburn.

Q. Logburn substation. It's marked on there?

A. Yes, it's coming at, it transforms from 110,000 volts on the left-hand side to 33,000 volts on the right-hand side going to the Pike River substation.

Q. Which is marked on the right-hand side of the diagram?

A. Which is marked on the right-hand side. There is another tertiary winding, as it's called, on the substation, supplying power at 11,000 volts to the coal handling preparation plant on the surface. But the main issue for this is the Pike River substation which has power at 11,000 volts, 33 kV on the primary to 11,000 volts on the secondary, which is then distributed underground to each one of these transformers. The circles represent a transformer.

Q. So each of the circles shown on that diagram is a transformer, and again that mirrors what you just said a moment ago about the voltage dropping down as it's going on to the equipment?

A. As it comes down into the mine, the further it comes down then it's then transformed to its consumption voltage.

Q. Just pause there please. Now, low flow studies. You've done some work in relation to that and it's again quite a complex issue, but I just want to really get you to focus in on the relevance of it for our discussion. You say in paragraph 71 of your brief of evidence effectively that you believe there was an assumption made by Pike River of an infinite supply of power coming into the mine and that was not correct, is that the position?

A. Yes. I don't know what the designers of the electrical system for the mine were asked to do, but their load flow studies were based on the

nature of the installation underground and they only appeared to have considered sizing of cables, loads that were going to be attached and the voltage profile throughout the mine based on the assumption that there was no restriction on the surface to the amount of energy that could be delivered.

Q. And again you've done some mathematical calculations about load flow and supply to the mine haven't you?

A. Yes.

Q. And just have a look at a load flow analysis please. It's DOL reference 0160016?

WITNESS REFERRED TO DOL DOCUMENT

A. Okay, this entire representation in the sheet represents the entire load of the mine.

Q. And this is the Pike River's load flow document is it?

A. Yeah. This is the loads flow study that was done for Pike River. It shows point of connection to the supply here.

Q. At the top?

A. At the top, and it shows the voltage profile throughout the mine, which could be expected – this is a computer model, bear in mind, so this is what could reasonably be expected for the sorts of loads that are connected. And it indicates that the voltage throughout the system is satisfactory for the sorts of loads that have been considered and I wouldn't dispute that, given the situation at the top which is the point of supply hasn't really taken into account any limitations on its capacity to deliver.

1202

Q. And if I can take you to another document 16/2, this is the fault level analysis

WITNESS REFERRED TO FAULT LEVEL ANALYSIS DOCUMENT 16/2

Q. And again I think this is a Pike River analysis, is that right?

A. Yes it is.

Q. And again, just in a very high level way confirm first that you have reviewed this document?

A. Yes I have.

Q. And what is it attempting to show?

A. Well, once the load flow study is done depending on the voltage profile that you find going into the mine and the fault level is evident, this is how they calculate it, you're able to determine what settings to make for these protection relays to trip on the transformers. So for example, depending on the amount of maximum energy that can be delivered at this location, at the point of supply, then that determines how you set the protection relays to protect that transformer and of course every other transformer in the system. So it's used to provide a basis for setting protection relays.

Q. Now if we come to DOL reference 160017/1 please?

WITNESS REFERRED TO DOL 160017/1

Q. Which I think is your analysis is that right?

A. Yes, I've expanded the charts.

Q. And we'd like you to blow that one up if we could Ms Basher please. The top one Mr Reczek?

A. Yes. Okay, this is showing the external grid which is essentially the point at which energy is delivered and it's showing that there is a potential load here of 10.205 kVa which is about 10.2 mVa so that's megavolt amps. So that's the sort of load that they're considering and below it is the voltage that they expect at that load and it shows that it's 1.05, which means that it's about 5% higher than 11,000 volts at that load.

Q. And the diagram below that? If we can just get that one up if we could please?

WITNESS REFERRED TO DIAGRAM OF FAN

A. That deals with the fan and its showing that at the fan they're expecting 730 volts. On the secondary of the fan transformer, so this is at the variable speed drive and that's representing 1.06, in other words 6% higher than the nominal voltage that would appear there. So, that's essentially the purpose of the load flow studies to determine what those voltages are going to look like when the projected load is connected.

Q. So do I take from your comments that it is important for a mine to have a good understanding of its power supply and load flow?

A. Yes, if you don't understand it then it's very difficult to do two things. The first thing is to set the protection correctly for short circuits to cause the relays to trip and for overload protection to make sure that motors switch off at the appropriate time. So the protection aspect, it is very important, but the other issue that is very important is the performance of the machines themselves. Machines like fans and pumps are very sensitive to the voltage at their terminals. In fact they won't deliver their rated output unless they are supplied with their rated voltage.

Q. So the results of your analysis, what do they indicate in terms of the reliability of the load flow studies that Pike had prepared and that you looked at?

A. Based on the information provided from Westpower, it seems to me that the supply was reaching pretty much the extent of its capacity with just the fluming pumps and the main fan running.

Q. So again, just to take that again to a higher level. So not enough power coming in for the capacity?

1207

A. There's insufficient capacity of the power supply to provide the energy stability that's required for the motors.

Q. So can you comment on, given all of that, with the pumps going would the mine have been – what level of power supply would've been used? Would it have been capacity, or under capacity?

A. Okay, with the – I mentioned that the projected load when the load flow study was done was 10 mVa. Typically with the fan running and with the pump running, it would've been approximately 4 mVa and at 4 mVa that's like say two-thirds or thereabouts of the nominal calculated power supply, so the voltage should've been okay according to their studies, but the evidence available indicates that the voltage was below what was being expected when the machines were being run and that was evidenced by the information provided by Rockwell and the evidence of over-heating.

Q. And what does that suggest?

A. It suggests that the voltage is too low.

Q. Now perhaps we'll come back to that. So does that take us really through to paragraph 79? I don't want to skim over anything else there that you think you need to highlight, but…

A. Okay, I've –

Q. In terms of the low flow issues?

A. Yeah, if you have, basically if you have a drop of voltage of in the order of 10% which seems to be, that's below the nominal value that they've calculated, you can expect to have about 80% of the rated output of the motors. That's the maximum that they could attain. When I did the calculations based on the information I was given, I was seeing outputs in the order of 76% of their available power output and what that means is that the motors would be running very largely in the overload range. They would be subject to heating and it would be very likely that they'd have instability on the drives themselves, because they are very sensitive to voltage and I would suspect that the instrumentation would be unreliable as well.

1210

Q. And a consequence of that for ignition?

A. It means that where you've got increased loading due to – where you've got low voltage, you get higher currents to compensate and those higher currents cause increased harmonics where the variable speed drives are concerned.

Q. Which in turn will lead to (inaudible 12:10:25)?

A. In turn leads to the sorts of arcing that we've been discussing.

Q. Well paragraph 79, really I think that's just the point that you've just made. The machinery, the motors are getting hotter?

A. Yes, they're getting hotter, so are the conductors that are supplying them, primarily because they're drawing higher currents that would reasonably be expected.

Q. And paragraph 80, there I think your point is, isn't it, that you saw some evidence of that from your review of the documentation where the emails show that some of the machinery was getting hot?

A. Yes. Yes, there are, there's evidence, first of all there's burning out of capacitor pre-charge resistors. Now just exactly why that was occurring hasn't been determined, but they were reaching temperatures where solder could melt. Solder melts at about 190 degrees C, so that's quite high and there is other correspondence indicating that there is high temperatures on contactors.

Q. And if we look at some photographs please, DOL number 160019/1?

WITNESS REFERRED TO DOCUMENT DOL ENDING 160019/1

Q. This is the BFD capacitor pre-charge resistor?

A. Yeah, these – this is what is called the pre-charge resistors. They're mounted on what looks like a heat sink, in other words –

Q. Just pause there Mr Reczek. I'll just ask Ms Basher to – can we make that any larger, perhaps the first photo and then move to the second one? Thank you.

A. So these are the pre-charge resistors and they're sitting on a heat sink here which is intended to keep the temperature low and you can see the solder has melted out from within this device which means that the temperature inside or around this device is sufficient to melt solder and this happened on a number of occasions.

Q. And if we could just go to the second photograph which is a close-up of the melted solder?

A. Yeah. There it is there.

Q. Now, where there is evidence of overheating does that increase the possibility of degradation over time of power connectors and that in turn leading to hot joints?

A. Yes.

Q. Please explain that?

A. In any set of circumstances where the power conductors are getting hot, for any reason and continuous over-current is usually one of those

reasons, any mechanical join in a power conductor can be subject to oxidisation and eventually it will fail, just by overheating and melting.

Q. Now the evidence before the Commission has been that on the 19th of November there was very little power connected that day, it wasn't a normal day?

A. Yes.

Q. What comment can you make about that, given what you've been talking about?

A. Yeah, I reviewed the graphs of the Logburn power supply, which was where the power was being metered and it appears that the measurements were being taken at 30 minute intervals in one case and that the actual events which would be a hallmark of the actual explosion would've been first of all the fluming pump starting. The graph should've show evidence of that fluming pump starting, because it represents something like four or five times the amount of power that was otherwise being used at the time and there's no evidence in the graph that you see the pump starting.

1215

A. The other thing is that there was evidently a flash which would've been equatable to a fault on either the 11,000 volt system or on a lower voltage system that was reflected in the 11,000 volt system. Either way, the power tripped off and that event wasn't recorded on the power supply charts either, so the absence of those two events makes me question the value of the actual power supply being metered.

Q. The arcing that you've talked about, can that occur even when there is very little load on the system?

A. Yes it can. It can heat up all the time that a piece of equipment is running if the equipment is under voltaged, in particular, and drawing a higher than expected current. The conductors would automatically be hotter than what you would normally expect, certainly if that was happening continuously. The most likely time for such a failure to occur though is when a piece of equipment starts.

Q. Now, perhaps just read paragraph 85?

A. "A related issue is that wide swings in system voltage can cause unreliability of voltage-sensitive electronic systems, such as variable speed drives and measuring instruments, such as methane detectors. Such systems as variable speed drives connected to the effected mains could potentially become unstable and unreliable as a result of varying load conditions and this seems to have been the case at Pike River. Again, it seems to be evidenced by the issues referred to in the emails that I've read from Rockwell and others."

Q. Now, your next sub-heading is, "Possible indirect consequences on the configuration of the Pike River electrical system." Do I take it from those first couple of paragraphs under that section that you're really saying that if you get things wrong at the load flow analysis stage, there is then trouble determining when to turn machines off and when these short circuits might occur in such (inaudible 12:18:02)

A. It creates a climate, if you like, of unreliability and instability. The system would look okay so long as there was no load connected to it or if the load was very light, but then it could well become unstable when a threshold of load is reached and that threshold of load seems to be well outside of the range that was expected at Pike River.

Q. And does it follow from that, really what you've said by way of summary at paragraph 96, that there would've been a challenge for Pike in establishing.

A. Which paragraph are you referring to sorry?

Q. Ninety six.

A. Ninety six.

Q. The optimal protection settings.

A. Yes it would be very difficult to get the protection settings correct. That actually does lead to some lack of understanding about why it was that in the event of a short circuit at the bottom of the drift or at the top of the drift, the circuit breakers at pit bottom didn't trip rather than the surface breaker on the surface tripping because it means that any fault that occurred would be experiencing the sort of fault level that would be

required to trip the surface circuit breaker, in other words, there was no differentiation available apparently.

Q. Now, I might get you to just read some of the next section of your brief. If you could start reading please from paragraph 97 and I'll …

1220

A. Possible source of electrical ignition? "In my view the two most likely potential sources of electrical ignition at Pike River Mine relate to the likely existence of arcing caused by the effects of harmonic currents in the mine's earth system, resulting from the use of VSDs and/or arcing caused by the effects of overheating leading to hot joints due to the electric power supply issues I have noted above. These potential sources could also potentially combine so as to exacerbate the effects independently produced by either. 98. Based on the available information and physical evidence, the harmonic current circulating in the Pike River earthing circuits could provide potential ignition sources throughout the mine where power cables are present and VSD produced harmonic currents are circulating. The coincidence of a VSD powered main pump starting and the increased ignition source potential on either explosion protected or non-explosion protected electrical apparatus at the time of the explosion is compelling. A mine earth system is interconnected throughout the mine and directly connected to the surface earth electrode through the power supply cables. Uncontrolled earth currents would, as a result, have the capacity to circulate through connected sections of the mine electrical systems. Normally, such currents are limited in magnitude and would be detected by protection devices resulting in the power immediately being cut off. However, in the case of harmonic currents induced in the earthing circuits there is no such device installed to detect them and the currents would circulate undetected, unrestricted and unprotected. This means that wherever the energy being dissipated by harmonic currents exceeds the energy required to ignite methane, then an ignition source would be present in earth conductors but particularly at any mechanical interface in the earth circuit. Such mechanical interfaces are evident in

the earth circuit of the zener barrier located between the safe zone and the hazardous zone of the upcast shaft methane detector but would typically also be present on the adjacent surfaces of bolted or screwed coupling devices on power cables and other mechanically joined surfaces on machines." 101?

Q. Yes, just keep reading please.

A. "Arcing caused by the effects of power supply issues. Of itself the relatively low capacity of supply side energy supply infrastructure would represent a significant hurdle to overcome for the load supply energy distribution system to be reliable, resulting in potential sources of ignition. The magnitude of the problem can perhaps best be illustrated by observing that with a projected load in the order of 10 mVa, a supply side fault level in the order of 200 mVa would be required at the 11,000 volt terminals on the surface transformer at Pike River. As the power system calculations have illustrated, the actual 11 kV fault level would be in the order of 70 mVa, actually 69 as given by the Westpower documents. The low fault level, the load level impacts on all motors in the mine and would prevent them from operating effectively thus potentially leading to overheating. Because the induction motor outward torque is directly proportionate to the square of the voltage applied to its terminals this condition alone would restrict the capability of all induction motors in the mine to some fraction of their nominal output torque ratings. These conditions foreshadow motors operating in overload and at reduced speeds as they draw increased currents to compensate for reduced terminal voltages and cause excessive temperature rises in power conductors. Such temperature rises increase the likelihood of series conductor mechanical connectors overheating and burning, leading to other ignition sources on power conductors and switch gear. In addition, due to the attendant current surges that can occur when induction motors start and stop, the consequential swings in system voltage could adversely affect the consistent operation and accuracy of electronic or measuring devices connected to the mains including the variable speed drives themselves. When the energy supply situation is

combined with significant levels of harmonic currents being generated in the mine's electrical earth system, the situation becomes unreliable, unpredictable and potentially dangerous.

1225

A. My conclusions, therefore, are that higher than usual load currents were most likely being drawn by induction motors on variable speed drives as a result of inadequate energy supply. This condition if combined with the harmonic earth currents, earth circuit currents continuously circulating and coincidentally likely to be at their maximum when seconds prior to the explosion the VSD driving fluming pump number 1 was started, could possibly have compromised the restrictive zone electrical protection at the mine by distributing ignition sources throughout the mine."

Q. I'll just stop you there. Earlier you touched on the issue of what benefit you may be able to gain from access to pit bottom and stone?

A. Yes.

Q. Could you just talk about that in a little more detail? Put – what potentially may be there of assistance from an electrical point of view?

A. It would be good to get some access to the mechanical connections between conductors, earth conductors, the, on power cables supplying the VSDs and the motors that they're driving, to look for evidence of sparking or arcing on the surfaces.

Q. And if you found that evidence that would do what? Confirm your conclusions, or?

A. Yes, it would indicate that those arcs were occurring in the mine itself. The other issue is the settings on the protection devices, to be able to understand how they were being set, what the values were and if there was any other issues associated with short-circuit faults.

THE COMMISSION ADDRESSES COUNSEL – APPLICATIONS FOR CROSS-EXAMINATION OF WITNESS – ALL GRANTED

CROSS-EXAMINATION: MR MOUNT

Q. Mr Reczek, you will appreciate, of course, that the issues you have raised place the events in the minute prior to the explosion and indeed the seconds prior to the explosion into some focus. I wonder if you could just help us to try to have as accurate a possible understanding of the sequence in those critical seconds before the explosion?

1230

THE COMMISSION ADDRESSES MR MOUNT – USE MICROPHONE

CROSS-EXAMINATION CONTINUES: MR MOUNT

Q. Mr Reczek I was wanting to ask about the events in the seconds leading up to the explosion, perhaps if we could have DOL30001400/01 on the screen alongside the map 3000130008?

WITNESS REFERRED TO DOL3000140001

WITNESS REFERRED TO MAP DOL3000130008

Q. What we have on the left-hand side of the screen is a diagram from a report produced by Energy New Zealand which is a report into the electrical systems at Pike, you've seen that I take it?

A. Yes.

Q. On the right, of course, we have the map that we're familiar with of pit bottom in stone. First of all, the diagram on the left, do you understand that to be a flowchart of the sequence leading to the starting of the pump?

A. Yes I do.

Q. There's one thing you could just help us with. We see at the beginning that the first event is a start signal from the control room. Where in that sequence does that VSD start?

A. I think it's after the five second timer delay. So I don't think it's actually shown in that diagram. I think it should be here but it would start as soon as that time second delay was complete and the signal was given to this fluming motor to start. So I would understand the VSD and the motor to be represented by this block.

Q. So just reading that into the record, the VSD would start immediately before the box labelled, “Stage 4,” is that right?

A. I think they’re integral, yes. So there would be no delay between the end of the five seconds and the motor starting. There’d be no additional delay.

Q. The first thing we see under stage 2 is PG201 gland pump number 1 starting?

A. Yes.

Q. If we just flick over to the diagram on the right-hand side, confusingly there seem to be two references to PG201. Are you able to help us at all with those two references, and where I'm looking is towards the top of the diagram.

A. This one here, this one here?

Q. That’s right. Towards the top of the diagram it says, “Gland pumps, PG201 to 205.”

A. Yes.

Q. At the bottom it says, “Gland water pump PG201 to 205.”

A. Yes.

Q. Are you able to help us with that at all?

A. I can't help you with that sorry. I don’t know how that numbering’s been carried out.

Q. Do you have any sense who would be best placed to understand the relationship between these two diagrams?

A. I think the people who are the author of the report would be.

Q. The next thing we have in stage 2 is PG212 loop cooling pump. We don’t see that on the diagram. Do you know where that pump would be?

A. No I don’t.

Q. And again, PG211 cooling water pump, do you know where that is?

A. No I don’t.

Q. And I think you’ve already explained that the starting of the VSD that you described as being immediately after the five second delay, are you

able to help us with whether that is variable speed drive VS201 or do you know which one of those variable speed drives would have started?

A. I don't know categorically but given the numbering system where we've got VS201 to VS205, I'd expect that those numbers – because of the correspondence between this number and that number, I would expect that that would be associated.

1235

Q. That's the correspondence between VS201 and PU201?

A. Yes. Yeah, I would suspect that that number in any sort of rational numbering system you'd use the same numbers for the gland pump to be associated with the pump that it's associated with.

Q. Earlier in your evidence you referred to some evidence of harmonic distortions being found on CB4, circuit breaker 4?

A. Yes.

Q. While we have the map on the screen, where is CB4?

A. I think it's one of these here.

Q. That's pit bottom switchboard SB001?

A. Yeah, that's the back. So there would be a row of switches there.

Q. So in terms of the source of the harmonic currents resulting from the switching on of the VSD device seconds before the explosion, they would all be generated in this area we can see on the plan on the right-hand side at pit bottom in stone?

A. They're not generated there in the sense that they are going to occur on the variable speed drive feeding that pump. So it's going to be generated between that pump and whichever one of these variable speed drives was supplying it.

Q. Between PU201?

A. 201 and PU201. So they are actually generated in the drive itself and they would circulate to the pump and then back to the variable speed drive itself and then they would be appearing wherever the optimal earth circuit impedance sent them.

Q. You used a phrase earlier in your evidence that the system would "light up like a Christmas tree"?

A. Mmm.

Q. I wonder if you could just expand on that a little. What were you meaning to convey with that expression?

A. When you look at a Christmas tree you've got little lights all over the tree and the tree as a power source, it comes from the power point, and when you turn it on all the lights light up. In the sense that I'm using it I think that each of the mechanical connections that are between the surface transformer and all of the machinery located underground potentially could experience arcing across those connections. So in that sense every mechanical connection could have a spark and that would last as long as the harmonic currents were present. It would be unpredictable. You couldn't say exactly where they would flow, but notionally everywhere in the mine.

Q. Now I appreciate that the answer to this may be that it would depend, but to what extent would you expect that arcing to be visible to the naked eye?

A. I wouldn't expect it to be visible. It would only be visible if it occurred very close to the surface, if you like, of where the mechanical joint was. In fact, it would be unlikely to be visible.

Q. But nonetheless, sufficient to ignite methane in the right quantities?

A. Yes.

Q. To what extent were there mechanical connections or aspects of the mine's electrical system in the return of the ventilation system that may have experienced this arcing?

1240

A. My expectation is there'd be none. It's not the – it's not allowed and I don't think it was the case at Pike that they had any electrical equipment, like power equipment, located in the return.

Q. Earlier we looked at photographs of a device retrieved from the surface of the mine where you showed us some arcing visible on a zener barrier?

A. Yes.

Q. Was that device connected to a methane detector in the top of the ventilation shaft?

A. Yes, it was.

Q. In your opinion, to what extent is it possible that the type of arcing you've described would have been encountered in that methane detector in the ventilation shaft?

A. I'd say you would have to suspect that if arcing's taking place on that zener barrier, then there would be arcing taking place across the terminals of the detection device itself.

Q. And if we think about the main ventilation fan for a moment, to what extent would you expect that this arcing you have described would have been encountered on that main ventilation fan?

A. Yes, I think it would be present on the fan motor. It could be evidenced on the footings, for example where the motor is mounted to the frame, whatever it was mounted on and it could cause currents to circulate along the shaft for example of the motor, and that could find itself on the rotor of the fan itself and on its bearings.

Q. We understand of course that the main fan motor was located on the intake side of the ventilation system?

A. Yes.

Q. So ought to have been in fresh air, is that right?

A. Yes, that's right.

Q. Whereas the parts of the fan that actually contained the blades and the operating part of the fan, if you like, were located on the return side, is that right?

A. Yes.

Q. To what extent are you saying that arcing caused by harmonic distortions could've been present on the return side of the main fan?

A. Yes, it's certainly possible.

Q. In terms of understanding the precise sequence leading up to the explosion, the first explosion, there are a number of sources of, if you like, electronic or mechanical time records including, as I understand it, the Westpower SCADA system – which is S-C-A-D-A?

A. Yes.

Q. Pike's own SCADA system, sometimes recorded on an audio recording of DAK communications underground –

A. Yes.

Q. – and including to the surface as well as times that are recorded on the picture of the portal video?

A. Yes.

Q. Are you aware of any work that has been done to try and reconcile those, if you like, objective records of timing to create a time sequence immediately leading up to the explosion?

1245

A. Yes, DOL has undertaken that work and I did see a table of their results as late as Friday last. There still seems to be some uncertainty, if you like, trying to line up the exact timing of the events because of the polling time differences, like there's a four second polling time difference and particularly with the surface equipment which is quite a long time in polling so they're relying on other physical indicators to give some indication of when events took place. Not all of them electrical.

Q. If it becomes necessary to ask for further evidence to establish that time sequence as precisely as possible, would you be willing and able to assist with that process?

A. Yes I believe so.

THE COMMISSION:

Q. Did you say, "Polling time difference," Mr Reczek?

A. Yes.

Q. Polling time is the instrument that takes a measurement and then it waits for four seconds and then takes another measurement. So the polling time is the gap between sequential measurements. In the case of the Logburn power transformers for example, that was as long as 30 minutes. In the case of the SCADA, it's four seconds. So it means there could always be a four second error.

CROSS-EXAMINATION CONTINUES: MR MOUNT

Q. I'll move onto a new topic now. Unless there's anything else you can tell us to assist with that exercise of precisely identifying the timeline leading up to the explosion?

A. No I don't think I can add anything at the moment because I don't have enough information to. I think it warrants a closer look and try to be more definitive about the timing, but I don't have enough information before me to add anything at the moment.

Q. In your evidence, at paragraph 57, you referred to harmonic currents having been measured at circuit breaker 4?

A. Yes.

Q. And other locations in the VSD systems at Pike?

A. Yes.

Q. To what extent does it appear to you from the material you've seen that the issue of harmonic currents was understood at Pike River?

A. I'm not comfortable that it was well understood at all. There seemed to be a knowledge on behalf of the contracting people, or the suppliers, that harmonic currents would occur. That's not that they're unexpected, they are expected but in the context of the Pike River fan, I don't think anybody would've been expecting the magnitude of the harmonics and the extent of them. Based on previous experience, for example, I'm not aware of any installation of that nature anywhere in the world in an underground coal mine so I can't see that there would be historical information or practical data, experimental information, if you like, or information from a testing authority that could definitively say how that installation was going to react to the harmonics. I think, nevertheless from my perspective, that testing in the very least should've been carried out.

Q. You say you're not aware of another installation like this in the world?

A. Yes.

Q. What was it about the Pike installation that made it so different?

A. Well, there's two. The first thing is that it's located underground. I mean, I feel very uncomfortable about a main fan being located

underground and I feel more uncomfortable when it's connected to a variable speed drive that is quite a large unit and has never been connected in that configuration before. It would be, in my views, warrant further investigation in terms of how the harmonic currents were going to distribute even if the fan was located on the surface, let alone in the situation it was in, in Pike River.

1250

Q. You explained earlier that variable speed drives, come in different sizes and explained earlier that variable speed drives come in different sizes and configurations and I take it it's quite common to have smaller VSDs, perhaps machine mounted VSDs, underground, is that right?

A. It is, it's almost universal.

Q. But if I can just pick up on your comment that it's unusual to have VSDs of this type underground. If I understood that correctly that it is unusual to have this type of VSD underground?

A. All of the other VSDs that I'm aware of are explosion protected. They're in flameproof enclosures and they're confined to the body of machinery. So in the sense of the configuration at Pike River, I don't think there's an equivalent. I've never seen one like that.

Q. There was some mention of this by Mr Nishioka, the Japanese mining consultant when he gave evidence. At page 3494 of the transcript the question was asked, "In your view is there any concern about locating VSDs underground?" And he said, "Yes, VSDs, as you know, are a good system to control," and the word wasn't picked up. "But that VSD system has to be placed in very clean environment and a consistent temperature and dry dust free, but it's not so easy to find that environment underground. So, you know, if we could avoid using a VSD system I like to go that way." So I think he was expressing some concern from an environment impact perspective. Would you agree with those views expressed by Mr Nishioka?

A. Indeed I would. There were comments in fact made by Rockwell about the installation and the dust and water that were evident both in the cubicles and around them, and it's well known that they are sensitive to

environmental issues. So I'd be – and underground to the coal mine, unless you have a totally enclosed room which is dust free and filtered and separately ventilated, I don't think you could provide a satisfactory environment for their operation.

Q. What were the potential implications of the way in which these were installed at Pike with potential vulnerability to dust, moisture and so on?

A. There's a number of issues with the environmental concerns but they go to reliability. The electronics are sensitive. They're required to be kept clean and they are required to be kept dry. They haven't got to be overheated and the voltage has got to be very steady. So the environmental restrictions on their use, you know, they're very, very tight so it makes them sensitive to anything in the environment that's adverse, and an underground coal mine is probably one of the most adverse environments you could find for that type of equipment.

Q. When I asked you a moment ago about whether there was a "proper understanding about the harmonic issues, you referred to contractors who were dealing with them at Pike. Do you know from the material you have seen, who the primary contractors were dealing with the VSDs at Pike?

A. Yeah, my understanding is it was Rockwell International. They're the supplier, and they were doing the commissioning and troubleshooting.

Q. Were there other contractors involved in working on the VSDs?

A. Not that I'm aware of.

Q. If I could refer you to a couple of references in a work record kept by Mr Nishioka which we've had in evidence at the Commission. First of all, if we could have NISH0002 page 34 please?

WITNESS REFERRED TO NISH0002

Q. And if we zoom in on the record for the 14th of October, .3, you'll see that Mr Nishioka's record for 14 October said, "The capacity of the VSD could go up higher once currently having harmonic noise problem is solved according to Colin from Rockwell.

1255

Q. It is not clear how long it will take to solve harmonic noise. And then if we turn over to the next page, Mr Nishioka's record for the 15th of October, there's reference again in the bullet point that has been highlighted at the top of the page to the harmonic problems with the VSD. I'll give you a moment to read that paragraph.

THE COMMISSION ADDRESSES MR MOUNT – DATED 15 OCTOBER

CROSS-EXAMINATION CONTINUES: MR MOUNT

A. I'd agree with that. I think that they were experiencing under-voltage problems and I formed the opinion that Rockwell were aware of this. In fact there were some measurements – oh, some measures taken to try and address the problem of low voltage such as adjusting transformer taps and other activities like that, trying to take measurements. But yeah, in the general sentiment there, I would agree with that.

Q. Can you just help us to understand what Mr Nishioka's record is referring to when he talks about the harmonic problem with VSD?

A. Yeah. First of all the harmonics are larger than you would expect and they are evident away from the units, away from the VSDs themselves, so it seems evident that they were aware that these harmonic currents and voltages were appearing elsewhere. There was no consensus, if you like, between the mine personnel and the Rockwell personnel as to what was the cause of this and the comments made by Rockwell is that in their opinion it was too low a supply of voltage, so – now the issue is that they need more than 3300 volts, in fact from the information I've read they needed around 3450 volts to have an adequate voltage at the VSD itself, because of the voltage drop that was going to occur through the VSD to get the 3300 volts that they needed to operate the plant and they weren't achieving that.

1258

A. So, what that would mean is that whilst the equipment was running at a lower voltage and a lower speed then they would be drawing heavier

currents and they would be experiencing over temperatures and potential overload trips and general unreliability of that sort.

Q. And I think you referred earlier to having seen some correspondence with Rockwell?

A. Yes.

Q. Is there anything you have seen to indicate that this issue had been resolved or satisfactorily or at all?

A. No there isn't. In fact I still don't, I'm of the view that it still hadn't been correctly understood at the end of the correspondence that I saw which was, I think, late in October.

Q. When Mr Murray gave evidence last week for the Department of Labour he referred to, I think, some material being received from Rockwell in January of this year. Have you seen that material?

A. Yes I have.

Q. In your view, to what extent are there questions that remain unanswered having seen that material?

A. Having seen the material I think it throws the whole issue of what was going on with the power supplies and the demands required for the VSDs into another open question. I just don't think it's been properly understood.

Q. Now in fairness to Rockwell who are not presently represented in this room, a memorandum has been filed by their counsel, indeed, it was filed on Friday. Have you seen that memorandum?

A. No.

Q. It among other things makes the comment that your evidence, they'd seen a copy of your statement, discusses VSD technology in a general way but does not account for the actual VSDs that had been installed at Pike River. Now, I appreciate that you're just hearing that comment for the first time now but –

THE COMMISSION ADDRESSES MR MOUNT – MR RECZEK TO HAVE TIME TO REVIEW DOCUMENT

COMMISSION ADJOURNS: 1.01 PM

COMMISSION RESUMES: 2.02 PM

CROSS-EXAMINATION CONTINUES: MR MOUNT

Q. Mr Reczek, have you had an opportunity to see the memorandum filed by Rockwell on Friday?

A. Yes, I have.

Q. Now this is just quite a preliminary indication as I understand it of the response of Rockwell to your statement, but in fairness to them and in fairness with you, I want to just summarise what they have said and invite your reply. Paragraph 7 of their memorandum says that, what you have described as a possible source of ignition might apply if the VSDs were early generation VSDs, but they say that the conclusions drawn are overly simplistic and do not account for more current technology and they also say that the conclusions related to VSD technology in a general way but don't take account of the actual VSDs installed at Pike. Do you have a response to that?

A. I guess the - in terms of being over simplistic, one of the objectives is to try and present the simplest version possible of what's essentially quite a complex technical problem so if that's a criticism I'd be comfortable to learn how you would do it in any other way and it would always be good to hear from experts the sorts of things that they think are ameliorated by newer generations of technology. In general I haven't referred to Rockwell Technology directly. What I've been alluding to is the measurements that they took and the evidence that is available, rather than commenting on the specific technical features that VSDs have.

Q. I understand that it is intended for Rockwell to file evidence with the Commission in the near future. Can I take it that you will be willing to look at any further material filed and give us the benefit of any further opinions you may wish to express?

A. Indeed, of course, I'd be more than happy to look at anything that gets produced that can shed light on, particularly on the harmonic currents that were pretty evident.

1405

Q. Can I ask you about any matters that may operate as limitations on your investigations and your opinion? First, the lack of access to the actual VSD units inside the mine. Is that a factor in any sense?

A. Yes, it does. It limits the first-hand evidence that could be collected particularly in relation to the way the cables were wired, to look for any evidence of heating on conductors and to look for any evidence of arcing on any of the mechanical connections. I think all of those things really would benefit from a first-hand inspection of the equipment.

Q. You've already referred to potential assistance that might come if and when there is access to that pit bottom in stone area. I realise this may, to some extent, be speculative but what would your expectation be about the effects of the explosions on the physical evidence that might be located at pit bottom in stone?

A. I wouldn't expect there'd be any physical damage at all from the first explosion certainly. Subsequent explosions they were evidently more severe and they appear to be dust explosions so there would be some damage but most of the equipment was located, like, adjacent to the main drift and I wouldn't expect that there'd be devastating damage at that location even after the explosions.

Q. So I take it that you would still be optimistic that some useful information may be derived?

A. Yes and quite often even in major explosions if there is electrical damage then it can be pretty evident after an explosion of that. Because the electrical damage itself can be significant and very identifiable.

Q. Another potential factor in terms of limitations on your opinion, access to the manner in which equipment was installed, is that at all relevant?

A. Yes it is. In fact it's very relevant. Its location and the way that the equipment has been installed particularly the cables and the mountings, those sorts of issues I think are very important.

1408

Q. Another potential limiting factor is the degree of access that you have had to information from the manufacturers, suppliers and installers of the drives. Has that been a factor?

A. Well I haven't really had any information from them except recently from Rockwell on their inspections and the comments that they made during those inspections. So most of my opinions are based on the evidence that I had and inspecting the equipment as it was discovered at the time after the explosion and on the reports, that's emails that were circulating by officials and others regarding the problems that they're experiencing, and on the evidence associated with the diagrams and protection system settings that were provided, but in terms of the manufacturers or the providers or the commissioners, I haven't seen anything.

Q. Would you expect that there will be information in the possession of those bodies that might be relevant to your enquiries?

A. I would have thought so. Typically for an installation as sensitive as the one that was, particularly in the case of the fan, I would have expected reasonably that there would be a minimum of a risk assessment, hazard identification process, perhaps even a design risk assessment for the configuration of the equipment. I would reasonably expect the provider to do that, so perhaps that sort of information is available.

Q. It hasn't been provided to you?

A. No.

Q. There is reference in the Energy New Zealand report, DOL3000140001 at page 27 to certain failed VSD units having been sent to the United States for forensic analysis. Are you aware of that issue?

A. Only to the extent that I believe it was the pre-charge resistors that were sent. I've no knowledge of any other components that were filed and sent.

Q. Have you had access to any of the results of any testing done?

A. No I haven't.

Q. And are there, in your view, any other limitations on the conclusions or the investigations you've been able to make?

A. I think primarily it's the lack of first-hand evidence, particularly in relation to the source of ignition and the potential sources of failure. I think it's very important to try and get that sort of information if possible, would, it potentially can remove any speculation.

1411

Q. Earlier I asked you to what extent it appears to you that the issue of harmonic currents was understood at Pike, and your answer was that there seemed to be knowledge on behalf of contracting people or suppliers that harmonic currents would occur. Can I just ask you to expand a little? Was it evident that there was an understanding by Pike River employees or others at the mine itself about this issue?

A. They seem to be in a multiple frame of mind from the correspondence. At one stage they're dealing with instability of machines, trying to get them to run up to speed, and in another issue they were dealing with tripping of protection relays, not associated with the VSDs themselves, but with the power supplies to them and it appeared that they were concerned about overloads and the tripping of overloads. They were concerned about not being able to get the machines, the motors, up to full speed and of them being overloaded at that speed, so there seemed to be quite a range of issues that in some way were being attributed to harmonics but which you could reasonably say were a consequence of other things than the harmonics, might be getting larger harmonics because of other issues. So, I don't think they'd actually put together a comprehensive picture or understanding of how the whole thing worked together. There was a suggestion even that because they were getting power relay trips at consistent times of the day that a signalling harmonic from a supply authority was causing the VSDs to trip off, and they were investigating that. So it seems fairly clear that they didn't really know what was causing the problems that they had and I suppose you could ask after that whether or not it was reasonable to ask those questions. I think it was, but I don't know that they'd actually reached any sort of definitive answer.

Q. Is there any evidence that you've seen that either contractors or Pike staff turned their minds to the potential safety implications of this phenomenon?

A. I think indirectly, yes. They had made observations that cubicle doors were left open; that there was dust accumulating; that there was water ingress; that the environmental conditions were less than satisfactory and that they would have to be made satisfactory before the equipment could be commissioned and that has safety consequences. There are other issues such as being able to keep the temperature of components down and they did actually go to the extent of measuring some of the voltage drops in the system and the currents, to try and perhaps identify what the problem was but did they have some direct course of action to alleviate those issues? I don't believe so.

1415

Q. Are there measures that can be taken to reduce or eliminate the arcing caused by harmonic currents that you've described?

A. Yes there are. The way to go about that is to eliminate the potential for harmonics to circulate in the earth circuits. If you were to take systems other than mining, for example, in high-rise buildings or other installations where they use variable speed drives, then they often have a concern with harmonics impact or effects on communication systems because communication systems are affected by way of having noise and unreliability imposed on the communication systems. So they are always concerned about the effects of harmonics and there are ways of dealing with it whereby you don't allow the harmonic currents to flow by having deliberate open circuit in the earth system or it's possible to connect the equipment in such a way that the harmonics circulate freely but never get out of the equipment and then there's the opportunity to provide filters on the power circuits so that the harmonics that are being produced can be filtered and short-circuited to ground, basically. All of those things require a good earthing system which is of a low value, either in providing a very low impeding circuit for them to travel or a good earth connection so that you get a very low voltage generated.

Now, all of those circumstances are very difficult in an underground coal mine. So, yes there are opportunities and measures that can be adopted but the measures that you would adopt might look quite different to what they would look like on the surface or in a surface installation and I haven't seen any evidence that those sorts of measures were adopted or even foreshadowed.

Q. The measures you've described, how well-known orthodox are they within the industry?

A. I'd say within the industries providing variable speed drives, they're well known, in fact there was a lot of information published, technical information, both from the Internet and then technical documents provided by suppliers. But I think the sort of information as it would apply into a coal mine, I don't think is well-known at all. In fact I don't think the problem has really arisen to the extent that it did at Pike River on other than relatively small plant, so I don't think the problem is well understood. It has been recognised but I don't think it's well understood.

Q. To what extent was the location of these particular VSDs underground relevant to that?

A. I think it's crucial to it. In fact just the location of devices of that size and in the environment that they were going into and with the type of earthing system that is inherent in a coal mine, would have meant that you would have to do a lot of, not so much research, but, if you like, testing and examination of the systems that you are proposing in order to be confident that the normal safety measures used in coal mines could be applied and I don't see that that's been done.

Q. Given the nature of the installations at Pike, in your view what would it have been reasonable to do in order to try and address this issue?

1420

A. Well, there's two aspects to that. One of them is the, it's in the nature of the ventilation system itself. Locating the main fan underground is, I think, at the very least an innovative path to take. So then to put a variable speed drive in the configuration that they did really compounds

the innovation and because you're doing something which is novel and new, then I think it warrants quite a degree of examination particularly by way of hazard identification, risk assessments and documentation of the sorts of controls that are going to be put in place to make sure that the system is as safe as is required and that's what I would expect.

Q. In the material that you have seen, have you been made aware of any risk assessment or planning document specifically looking at these electrical issues?

A. No, I have heard that there's been risk assessments carried out by way of emails that were transmitted. I'm not aware of what they were and I don't know that they applied specifically to the sorts of issues that I'm alluding to, that's the electrical issues of harmonics, earthing systems and arcing.

Q. I take it, in your view that should have been done?

A. I do think so, yes.

Q. In your view, what level of attention should be given to this type of installation by the inspectorate?

A. By its very nature and the fact that it's in a hazardous area in a coal mine and it is novel, I would have thought that there would be a significant amount of attention warranted by a regulator. In that sense I don't mean that they would regulate, but I think you would be interested to know what measures were being taken by the proposers of the design as to how they were going to assure themselves that it was as safe as would normally be required, and I think that you could be fairly objective of that as a regulator.

Q. In your view, are the issues that you have described at Pike matters that should have been picked up in an electrical inspection?

A. By an electrical inspection by a regulator or?

Q. By a regulator?

A. I think if you're a regulator you need to have some form of documentation which allows you to compare what you see installed with what you expect to have been installed and I don't think that documentation was readily available. So what would happen is that you

would fall back on your experience of let's say practical coalmining, and trying to make some judgements about how it compared with what you were used to seeing and I think that's about as far as an electrical inspector would be able to go. It's not the sort of thing that you can go into manually to open covers or to check values or do tests in an underground environment that will alert you to the problems that were in existence. The only way an electrical inspector would be able to become aware of those sorts of issues would be if he was present and could physically appraise himself of the sorts of things that were happening and perhaps raise the sorts of questions that the contractors and the mining people were raising themselves and try to understand it. So I think it would be very difficult to foreshadow what an electrical inspector might go to look for.

1425

Q. Thinking about the organisational structure of the mine, what position or what role would you expect to be filled by a person who had overall responsibility for the electrical system?

A. I would expect an electrical engineer in charge, who has an overview of the way the electrical equipment is to be managed. That would be via some form of electrical management plan. That would be formed, or formulated as part of the mine management plan and I would expect that there would be a very close relationship between the electrical engineer in charge and the mine manager. Now that goes to operational issues, not design, installation and commissioning, so although the mine management should have some insights into what's transpiring during installation and commissioning, I think that they would be formulating their management plans on what the providers of the equipment and the risk management team had identified as issues that needed to be specifically included in their normal mine management plan. So, I would expect the electrical engineer in charge to have perhaps an overview of how the equipment is to be operated safely and what sorts of deviations he could look for, for it to be operating unsafely

or unsatisfactorily. Now, I think they were finding that out as they went along.

Q. In your experience, what level of authority, or how would the electrical engineer in charge sit within the organisation? What would you expect them to be able to do?

A. Well, it's different organisations have different reporting structures, and reporting structures are often quite different to the way that the actual relationships work, but if you are an electrical engineer in charge and you became aware that there was some deficiency in the way that the electrical system was operating, then I would expect the electrical engineer to have the authority and the capacity to shut that down either directly if it was a direct danger, or by reporting through the system to his superiors that he was not comfortable or happy with the way the system was working.

Q. You referred earlier to the desirability of a risk assessment, flowing from the unusual nature of the Pike installation, would the electrical engineer have a role in that risk assessment process?

A. Not necessarily. I think he needs to be aware of the outcomes of it and he needs to be aware of what sorts of controls the risk assessment team envisaged and his role would be to ensure that those controls were implemented as part of his electrical management plan. I don't know that a typical electrical engineer would have the necessary technical knowledge to have input to a risk assessment, as dealing with the design, perhaps the commissioning even of that sort of plant. He might be able to provide some of the practical input whereby you deal with how to run cables, what's the best ventilating location for the rooms that the equipment's going to be installed in, purely practical aspects of how you install it rather than the technological aspects of how we are going to deal with any potential harmonics, or arcing that results from it, so they're quite different. I wouldn't think the electrical engineer would get involved in the upstream or design part.

Q. Would you expect the electrical engineer to insist on that risk assessment process happening?

A. I would have. I think yes, and it wouldn't naturally be the electrical engineer who's doing the insisting. I would've thought that the people who were involved in deciding to use that type of plant and to purchase it and then to implement it would be the proper client, if you like, of those risk assessment processes just to know that they are purchasing the appropriate sort of equipment for the job.

1430

Q. I think a moment ago you referred to an electrical plan for the mine or is it an electrical management plan?

A. Mmm.

Q. Did you see such a document for Pike or are you aware?

A. No I haven't, I haven't seen one and I'm not aware that one exists.

Q. If we can briefly look at the organisational structure at Pike, PW23, and if we zoom in under the engineering manager role?

WITNESS REFERRED TO ORGANISATIONAL STRUCTURE CHART – PW23

Q. This is the structure at 19 November. From your investigations into the situation at Pike, could you see whether any of the roles identified on that chart were taking some responsibility for the overall electrical system?

A. Well, I would expect that the engineering manager would be the first in line for that role because he is the line manager of the electrical engineer and the mechanical engineer and it appears to be vacant on this diagram but that would be the line management role. Quite often the electrical engineer in charge has a primarily statutory responsibility and isn't involved with the actual operational activities which more fall under production line management. So it's not really quite clear that the electrical engineer in this sense has an active role in making sure that the equipment is operating satisfactorily. It seems to me that it's more like a consultancy type role. Perhaps directed by the engineering manager. I think that the electrical engineer probably should more properly answer to the line manager and it should be a very tight relationship because of the combination of the risk management

associated with ventilation and methane management and hazardous area protection. So I think that needs to have a very strong relationship. Whether or not that structure provides that, it would depend on the individuals I would suggest.

Q. I want to move on now to ask you about the definition of the restricted zone at Pike that you have already mentioned. If we could have the map back up on the screen, DOL3000130008?

WITNESS REFERRED TO MAP DOL3000130008

Q. And if we zoom in on Spaghetti Junction area. You've already been referred to the dotted red line which defined the restricted zone?

A. Yes.

Q. Are you able to see any logical basis for that definition of the restricted zone?

A. I can't. In fact it seems to me to be quite arbitrary. In hindsight they have been detecting methane there, they have had methane trips within that area.

Q. Now you've just pointed on screen to the area, sorry Mr Reczek.

A. That's the restricted zone there. The unrestricted zone.

Q. You've pointed to the area right around the dotted line on the chart?

A. Yes. That one there. I mean, it's a serial ventilation system, in other words, there's only one source of intake air, not two. I would quite normally expect equipment like the main fan, if you have to have it there for any reason and you have to have VSDs and transformers in this location feeding it, I would expect these components to be in their own room separately ventilated so that a proportion of the air coming through the drift here is passed over this equipment and –

1435

Q. Now just pausing there Mr Reczek. You've just described the drive for the fan and the substation?

A. Yes the VSD drive and substation and the fan motor, and I would expect them to be separately ventilated by their own dedicated supply of air, fresh air coming down the drift. In the configuration that you've got or this here, any changes to the ventilation in the mine by way of re-routing

some of the air or by disturbance for any reason of stoppings being opened or a change in the pressure differentials through these roadways meant that you're going to change the way that air was flowing over this equipment. So it could never be 100% guaranteed to have a steady supply of fresh air. Always going to be subject to other factors. The fact that they had methane detectors, I'm not sure exactly where it is in the unrestricted area but there is records of the methane detectors actually tripping off, there are records of methane drainage pipes leaking and as a result methane detectors are tripping off. So to have those sorts of occurrences means that this entire area should be designated as a hazardous zone.

Q. Sorry, when you say “this entire area,” where –

A. The whole of the unrestricted zone in my view back up into the intake airway.

Q. So everything inbye of the –

A. Somewhere in this area here.

Q. You've indicated just to the left of the grizzly on the plan?

A. Yeah.

Q. When you discussed the restricted area earlier today, you made a reference to a zone 2 designation?

A. Yes.

Q. I just wonder if you could explain that for us please?

A. Zone 2 allows for multiple methods of explosion protection other than flameproof enclosures and it gives some flexibility to people who are designing and installing equipment in a hazardous area as to the sort of construction that they can use. Generally speaking, there's a technique called “non-sparking” or “increased safety,” which is appropriate to use in a zone 2 environment. It’s more readily designed, it’s more readily installed and it’s cheaper than flameproof equipment is. The other technique would be called ventilation, like explosion protection by ventilation. Now what you do in that technique is ensure that you have a reliable source of fresh air. That reliable source of fresh air is passed constantly over the equipment and it is monitored for its volume and for

its contact, for the, whether or not there is any contamination. It essentially means that you can't contaminate the room where the electrical equipment is installed with methane and there's a number of ways of doing that. It can be done by pressurisation so that the room is actually at a higher pressure than the surrounding environment. That can be done with seals, special doors and those sorts of techniques. So the upshot is that there are multiple techniques that aren't necessarily flameproof techniques that you can apply and still achieve satisfactory explosion protection in an area like that.

Q. The reference to different zones, is that something that is tied to a particular jurisdiction or is that industry-wide?

A. Typically it comes from the Australia and New Zealand standards but they are included in some regulatory documents like coalmining regulations, but is based on a standard initially which looks at three zones for methane, group one gases, as they're called, and it's zone 0, for intrinsic safety, zone 1 for flameproof equipment and zone 2 for these other types of techniques.

1440

A. And it's based on the likelihood that methane could be present, so the amount of reliability, the amount of security that you require is commensurate to the likelihood that methane could be present at that location, but it's an Australian standard and New Zealand standard.

Q. Given this particular mine design with a main fan underground and all of the features we see of what's been termed "Spaghetti Junction," in your view was there a way to make that electrical equipment safe?

A. Safe in the sense that it was satisfactorily explosion protected?

Q. Yes.

A. No, I don't believe there was. I think it was too late once the installation had been done. It's a big call once you've actually purchased the equipment to then proceed to try and modify the installation or the equipment. It would be hugely expensive and inconvenient, let's put it. If anybody was to suggest, I think, after the installation's been done that it should be re-done and made a zone 2 for protection, they'd be pretty

much unemployable, I'd suggest. You'd want to find somebody who wasn't going to find that.

Q. Why is that?

A. Well, I've had a number of instances over the years where we've had a debate in a regulatory environment about the difference between gassy and non-gassy mines and non-gassy mines essentially are cheaper to install and operate than gassy mines, because obviously you don't have to worry about methane exploding. The natural fact is that non-gassy mines explode too and what tends to happen when you look at the investigations into why that happens is that once you have done an installation and you've declared the mine to be non-gassy, there is a huge amount of pressure not to find methane, so people don't want to find methane because they know that if they do, all of the infrastructure has to be replaced and inevitably people are reluctant to either voice their concerns or in fact to make a determination that we have to shut the mine down until we do reconfigure it, so it is a very, it ends up being a very big call for anybody to do such a thing. And I think that that would be the magnitude of the decision that you would be being called upon to make in this case. I mean, you're talking about closing the mine down until you get the equipment properly configured.

Q. Do I understand you to say that with that design underground fan, single intake, there may have been no way to have made the electrical equipment comply with the restricted zone requirements?

A. It seems to me that it would be very, very difficult. I mean, I wouldn't call the absolute and say it's impossible, but you'd have to give very, very stringent consideration to how the area was going to be ventilated; how the equipment was going to be relocated and if you like grouped together, and that would have to be done in accordance with a risk assessment that included the sorts of issues that we've discussed.

Q. So if the mine was to continue and not be shut down, are you saying in effect the restricted zone would have to be defined outside that equipment?

1445

A. Mmm, I think so yes. I'd be moving that non-restricted zone out to here and I'd be dealing with the rest of the mine as potentially a hazardous area.

Q. A couple of specific points. The main fan motor. There's reference in Mr Nishioka's notes to the fact that on the 4th of October, and this is at NISH0002, page 27.

WITNESS REFERRED TO NOTES OF MR NISHIOKA - NISH0002, PAGE 27

Q. "On the 4th of October the main fan was test run and sparks came out from the shaft." Are you aware of that occurrence?

A. Yes I'm aware that that observation's been made yes.

Q. And Mr Nishioka's note was that this was going to be repaired. To your understanding how was the issue addressed?

A. Well, my understanding of the original issue is that it was related to a bush that was located between the fan motor and the fan blades, that's the rotor and the bush was around the drive shaft.

Q. Pause there, for the non-technical among us, what is a bush?

A. A bush is a round annulus, like a ring.

Q. Like a donut?

A. Like a donut yes, except that it's got a rectangular cross-section not a circular cross-section so it's designed for a shaft to pass through it and for the rim of the bush to fit into a slot that's the same size as the diameter. So, essentially it's a thin annulus, relatively thin annulus through which the motor drive shaft fits, in order that it can drive the fan in the return airway from a motor located in the fresh air. Now, my understanding of what happened is that there was a mechanical failure of some sort, not really detailed. Must've caused interference between the bush and the drive shaft and the upshot of that was that the bush melted in parts due to the friction and sparking could inevitably result from steel being heated or by some contamination causing sparks to come off the shaft during the period that the bush is melting. So that's my understanding of what happened.

Q. What do you understand was the repair or solution to this?

A. To remove the bush and make a bigger hole, which of course meant that the outer hole directly between the fresh air and the fan side on the motor side and the fan rotor, which effectively connected the fresh air base to the return.

Q. Does that mean that if ever the fan stopped there would be a direct connection between the return and the intake?

A. It does indeed. It means that you would get, if there was any methane in the return around where the fan was, the fan rotor, then it would seep into the area where the fan motor was.

Q. From your perspective, is that a satisfactory situation?

A. No it's not.

Q. In your view is it one that might've been picked up on in an inspection?

A. I find it remarkable that when the initial problem was discovered that it wasn't corrected at that stage in the way that it was intended to be corrected, or intended to be operated. I mean, I don't think that even a bush is sufficient protection in that situation. Normally you would have the type of gland which is termed a labyrinth gland between a location where flammable gas could be ignited and the ignition source and they're a particular design that applies to either flameproof motors or increased safety motors, but that certainly wasn't the case there.

1450

Q. Can I turn to ask you now about two communications from the inspectorate in New Zealand and in New South Wales and Queensland? Firstly, if we look at CAC0146, which is a letter dated 21 December 2011 from the Department of Labour, and I understand sent to various mines in New Zealand. Have you seen this letter?

WITNESS REFERRED TO CAC0146

A. Yes I have.

Q. Are you able to help us with what this communication from the Department of Labour is drawing to the attention of the industry?

A. Well, yeah. I think they're alerting the industry to the issue of there being potential ignition sources associated with variable speed drives in hazardous areas. I think that's the essential element of the letter.

Q. Does it address the very issue that you have been discussing today?

A. It does indeed. It addresses it in a generic way and suggests that sufficiently expert advice and research be conducted to make sure that the ignition sources are dealt with if there are any indeed. I would think that's the purpose of the communication.

Q. In your view, is there anything else that ought reasonably to be done to address the issues you've been raising with us today?

A. It seems to me that there is probably a need to have higher level oversight of what's going on with these particular types of issues. In terms of the technology itself, I think the technology can be made safe. It's really only a matter of having the correct technology installed and correct protective systems installed and using the traditional or the expected risk assessments during design, installation and commissioning. So from the engineering side of it, I think it's relatively straight forward. From the oversight and management side of it, I think it becomes more problematical because what you're looking for is being able to assure yourself as a operator or as a manager that you have in fact satisfactorily met these requirements. So, it says seek expert advice and competent person, so how do you know that you've got expert advice or a competent person? It's more the management issues that get called into question.

Q. So when you refer to high level oversight, that's by mine management is it?

A. Yes, yeah. Usually with these sorts of things there are three elements that you need to consider. The first one is that the equipment is technically fit for the purpose to which you're going to put it. The second thing is that you have adequate oversight to ensure that it is installed and maintained in the condition where it remains fit for purpose. And then the third thing is that you have a system in place that tests that both of those things are in place and working. So I think it's that overall process of making sure that these systems are in place adequately that you need to ensure.

Q. What role do you ideally see for the inspectorate on this topic?

1455

A. I see the inspectorate as a, not as oversighting this type of an issue because this is properly in the area of mine management and people who are proposing to operate, but I see an inspectorate as testing that mining management is in fact looking at the appropriate measures and perhaps comparing what they're doing with what would reasonably be expected in other areas, so it's more like an external audit function for a regulator whereby it, don't become directly involved in saying that the equipment is satisfactory or that the management systems are appropriate, or that there is correct management oversight, but that you do have a look and see that that process and those processes are in fact being followed and perhaps be comfortable that they are being followed satisfactorily.

Q. Can I refer also for the record to a safety bulletin, as I understand it, put out by New South Wales with the concurrence of the Queensland inspectorate – this is CAC0150?

WITNESS REFERRED TO DOCUMENT CAC0150

Q. Are you familiar with this safety bulletin?

A. Yes, I am.

Q. Are you able to summarise it's affect for us?

A. It's pretty much the same. They're talking in relation to relatively large capacity of couple of currents, which is what we've been talking about earlier. They're also referring to EMI mitigation and the fact that we've got a neutral earthing resistor, so the issues that I've alluded to earlier, are all raised in this document and what they're saying is that they need to take sufficient measures to manage them, without actually saying what they are.

Q. Now, I should note for the record this document is dated 21 December 2011, the same date as it happens as the New Zealand letter.

A. Oh, okay, yeah.

Q. Given how recent these notices are in both New Zealand and Australia, should it be concluded that this issue was one that could not have been foreseen or is an issue that's come out of the blue, if you like?

A. I think it's probably an order of magnitude greater than what the industry has been dealing with to date. I know that – well, I personally have been involved in investigations where people have received shocks from equipment being operated with VSDs on board, and we've been able to identify directly that the cause of that was the presence of harmonics in the earthing circuits and we're also able to determine directly and this was in conjunction with the departments that there was sufficient energy there to ignite methane had there been an explosive mixture present. So, I don't think the issue itself has been unknown, it's been sort of recognised for a number of years to be a problem. It's an order of magnitude different at Pike. The sorts of issues that had arisen previously were associated with equipment that was on board, mining machines with trailing cables supplying them, and with the failure of the trailing cable earthing system in such a way that capacitive and induced voltages were present in the cables, which is basically the same mechanism that we've described at Pike River and that would've been known in formal investigations probably going back four to five years. So, to suggest that the issue isn't known, wouldn't be correct. To say that the issue would be recognised to be as big a problem as it was at Pike River, I think that wouldn't have been recognised.

Q. Can I ask you something perhaps just to rule it out, but if we could have DOL3000160013, which is the series of photographs from the installation at the top of the ventilation shaft.

1500

WITNESS REFERRED TO DOCUMENT DOL3000160013 – SERIES OF PHOTOGRAPHS

Q. If we turn to page 2, we can see that there is what is marked as a disconnected earthing connector.

A. Yes.

Q. Sorry, disconnected earthing conductor?

A. Yes.

Q. Are you able to help us with what you know about that and what it's significance, if any, is?

A. Well, the photograph is taken, I took the photograph, and it was of the equipment as I found it, so the sheer fact that the earth conductor was disconnected means that the equipment would not be in an intrinsically safe condition because you are required to have the earth conductor connected just so that the zener barrier can work. Now, that's how I found it so I'm just making the observation that in that condition it was not in intrinsically safe condition.

Q. And the short and perhaps obvious point is you don't know when that was disconnected or by whom if indeed it was by someone deliberately?

A. That's right, I don't know. There's all sorts of speculative reasons why it could've been disconnected but I don't know that it helps to speculate.

Q. If it had been disconnected before the explosion would that have any impact on the arcing that you have noted on the zener barrier? In other words, does it effect your conclusions on that topic?

A. No it doesn't because the earthing system itself still persists through the frame of the housing and it's connection to the hut, I think it would be called, in which it was housed and I'm not quite sure what the earthing arrangement was for the housing itself but my expectation would be that it would be connected to the earth cable coming up from underground. So even though it was disconnected I think the earth connection from underground would still be present through to the housing. So it's more to do with a standard. It's like, you do expect there to be a direct earthing conductor for it to be in accordance with the standard.

CROSS-EXAMINATION: MR RAYMOND

Q. Mr Reczek, if we could just clarify in terms of the expert panel, you were the only electrical engineer working on the panel of experts for the Department of Labour?

A. No there was an electrical engineer, I just forget the name of the company that he was working for, but I think it was Energy New Zealand. A gentleman called Andy Logue.

Q. Andy Low?

A. Logue.

Q. Logue and was he on the panel of experts that we've had referred to us by Mr Reece?

A. No. As far as I know he was assisting the Department of Labour as part of their investigation too.

Q. So I was referring a moment ago to the expert report which is attached as appendix 6, I think it is, to the Department of Labour report, in paragraph 13 of Mr Reece's brief he refers to the five experts on that panel and the one discipline of electrical engineering.

A. Yes and that was me.

Q. And that was you?

A. Myself yes.

Q. So in the context of the opinions which you have now expressed to the Commission, have you had those peer reviewed by anybody else?

A. No.

Q. Why is that?

A. Well, I haven't had the opportunity to peer review them and to have peer review I would need to know somebody who would be able to do that.

Q. You, in your CV attached to your brief of evidence, refer to your professional memberships?

A. Yes.

Q. And one is as a charted professional engineer?

A. Yes.

Q. And that's under the umbrella group Engineers Australia?

A. Yes.

Q. And they publish a code of ethics?

A. Yes.

Q. Which you'd be familiar with?

A. Mhm.

1505

Q. And you lecture at University in New South Wales to final year –

A. Engineering students.

Q. – engineering students? And you touch on that subject of?

A. No I don't.

Q. The code of ethics refers to obviously practising competently and on the basis of adequate knowledge and in the guidelines which support that it states as a guideline that engineers in this area should seek peer review. You've indicated you haven't done that?

A. Yes.

Q. Are you going to seek that peer review?

A. Well I haven't thought of doing that to be frank. At this stage the information that I have got I think needs to be more properly clarified and perhaps better described to go to a peer review and give them the opportunity to review the same information and documentation.

Q. Better clarified by whom?

A. The peer reviewer.

Q. No, you said before it goes before the reviewer?

A. Yes.

Q. Does it need to be better clarified?

A. I would think so, yes.

Q. By whom?

A. By myself.

Q. So is your report then incomplete?

A. Yes I would think that it's incomplete because there are too many unknown factors. What we're doing is drawing conclusions or inferences, if you like, based on information which is available that isn't conclusive.

Q. As a member of Engineers Australia and I think another body you're a member of, the Institution of Engineers, and that's through your corporate membership of the Institution of Engineers Australia, they also have a code, correct?

A. Yes.

Q. Under those codes as within New Zealand under the guidelines for engineers, when someone in your position is embarking on an exercise which effectively is critiquing the work of another engineer, is it a requirement of your code that you advise that engineer of the work that you're about to undertake as a matter of professional courtesy?

A. It would be, yes.

Q. And did you do that in this case?

A. Well I don't believe that I've critiqued any other engineers.

Q. Well those who've designed this installation and installed it might think otherwise in light of some of your conclusions don't you think?

A. Well they might, but that would be their conclusions. I'm not attempting to address the designs that have been or haven't been done. What I'm saying is that I'm not aware of any.

Q. Well you've heard of the company iPower?

A. Yes I have.

Q. And you've mentioned Rockwell?

A. Yes.

Q. And Rockwell prepared a tender or a quote for iPower for the construction and installation of the VSDs, amongst other things, for the electrical installations to iPower's design?

A. I haven't seen that. Not aware of them either.

Q. Well that's my point. What steps have you taken if any, and you may have just answered it, to source the critical core data and information available from iPower and from Rockwell which would give you, I would have thought, basic platform for you to then go on and draw your conclusions?

A. Well the conclusions that I am drawing such as they are, are based on the information provided by Rockwell and by, I don't think it's iPower, I think it's Westpower, other than the load flow analysis which I think was done by iPower which in itself isn't a design document. It's just like a circuit diagram with results on it and I did suggest that I don't really know what their brief was when they were preparing that.

Q. Well have you sought the specification that Rockwell must have been working to in order to construct the VSDs for the mine?

A. Sorry, what was the question? Have I seen?

Q. Well in order to construct this installation, to build the VSDs and have them installed?

A. Mmm.

Q. You accept that Rockwell as a subcontractor would have been working to a specification provided by the installation designer?

A. I would expect that, yes.

Q. Have you sought that specification?

A. No I haven't.

1510

Q. Why not?

A. Well, I didn't see myself as competent to comment on the design of VSDs or on their application. I'm primarily looking at the nature of the installation and the results that I was made aware of there from. I wasn't actually trying to seek or comment on any designs.

Q. When you say, the results you were made aware of, what results are you referring to?

A. Well, they were the inspections from the equipment as it was retrieved at the time after the mine exploded, on documentation that was provided to me by the Department of Labour, on an interview that I conducted with Mike Scott, and on questions and information provided by the investigation team.

Q. Have you listed anywhere in your work what information you specifically considered in respect of the installation and commissioning of the electrical system?

A. No.

Q. Do you think that you should have?

A. I wouldn't have thought so as part of my brief, I hadn't been asked to review the nature of the installation or its commissioning and certainly if I was asked to do that I would want to see the documentation, yes.

Q. Isn't doing that part and parcel of looking at the electrical installation and assisting in drawing your conclusions?

A. I don't believe so, no.

Q. Okay. We discussed in evidence this – or last week and I think it was touched on this morning about the coincidence of pumps from the control room with the almost simultaneous release of a large volume of methane from the goaf. You understand that coincidence?

A. Well, I've – I don't accept the coincidence. To me, that's part of the conclusions that the investigation team is making on the way that methane was emitted. From my perspective, I believe that you only had to have the presence of methane anywhere in the mine. It didn't rely on a sudden presence of methane as a result of a fall, or some other agency and I don't know where the methane could've accumulated. The fact it did, how it got accumulated, I don't know.

Q. We've heard evidence, and I'm not sure if I follow you, and if you could maybe expand on that a little, we've heard evidence about a large plug of methane potentially being released from the goaf –

A. Yes.

Q. – and we've heard evidence which you've supported again about the pumps being turned on and the effect that that would've had –

A. Yes.

Q. – and it would appear that the turning on, at least on your analysis of the pumps, coincided broadly with the goaf collapse?

A. It seemed so, yes. Well, if that's what it says. I mean the goaf collapse is a potential source of a concentration of methane being ejected into the workings, but I don't know that that is a pre-requisite for the pump to start and cause an ignition source. I think that the ignition source as being pervasive as it would've been, then methane could've been collected anywhere.

Q. Okay, that's straying outside your field of expertise, is it not?

A. Yes, it is.

Q. The main fan was, of course, on prior to the explosion?

A. Yes.

Q. And the fire prior to the pumps being turned on?

A. Yes.

Q. And it was drawing its energy from the same cables which run down the drift and into the pit bottom south area which you've referred to in your evidence?

A. No, it wasn't. It had a dedicated cable. It was on its own supply for the main fan.

Q. And was that then fed through a substation to the main fan motor?

A. Yes. Yes.

Q. If we could just put up please Ms Basher, 3000130008, I think it was?

WITNESS REFERRED TO DOCUMENT 3000130008

1515

Q. If we could just blow up please the area around Spaghetti Junction and the fan. Is the substation which supplies the power feed to the motor what we can see in the cross-cut between, well, I'm not sure what it's called, but it's got substation SS601?

A. That one?

Q. Yes. Is that the substation which feeds the motor?

A. It feeds the variable speed drive, in that sense it feeds the motor.

Q. And you described it earlier, and His Honour Justice Panckhurst, referred to due north going up through, what I think is, cross-cut two.

A. Going up through here?

Q. Between A and B heading?

A. Yes, from there to there.

Q. That power circuit was going in the mine regardless of anything which Mr Duggan may or may not have done in the control room by turning on the pumps?

A. Yes it was indeed.

Q. And the problem with harmonics, which you've identified, could, on your evidence, have existed within that circuit for the vent shaft motor?

A. It certainly did, I'm sure it would've as well, yes.

Q. In which case the coincidence which we were just discussing about turning on the pumps doesn't come into play?

A. Well, not necessarily, that's correct. I mean there would be sufficient harmonics here being generated to ignite methane and they would've been being injected into the earthing system without the pump starting. I think the point that I was making about the pump starting is that the pump is about eight to 10 times the size of the fan motor so what that means is that you would have a lot more energetic harmonics coming from the pump than you would have from the transformer.

Q. Substation.

A. Sorry from the main fan.

Q. Just pause there and where is that extra energy which you just referred to turning on the pumps going to?

A. Well, if you go back now to the pit bottom in stone, yes. So we've got substation here which is the one that we think is starting this pump. I think that's the pump that was starting?

Q. Yes.

A. And this is pit bottom switchboard so the high voltage cable would've been coming from that switchboard to that substation and then the low voltage output, which this time is at 3300 volts, not 690, it would be feeding that variable speed drive and then from that variable speed drive it would go up to that pump. So, the essential circuit is very similar. Now, the difference is that this is shorter, right. I don't think that looks like 90 metres, but it's like 10 times more energetic and it's at 3300 volts instead of 690. Now, the way the harmonics would've existed between this drive and that pump would've been via the earthing circuit from the pump back to the variable speed drive, so they would be being generated here and they would be appearing between that pump and that substation.

Q. So if we go to the larger diagram please, into AF5 cross-cut three one west main I think. Do you know where I'm referring to Ms Basher? In front of the panel 1, the goaf. That area which is the third cross-cut from the right. There's an arrow going into it and there's a rectangle there with a stopping?

1520

A. This one, is that the one you're referring to?

Q. Yes.

A. Yeah.

Q. The problem which you just identified with the harmonics in pit bottom in stone?

A. Mmm.

Q. Has the effect of transferring that problem so far into the mine that it affects the auxiliary fan AF005?

A. It would affect every item of equipment that's connected to the earth circuit, yes.

Q. And the question is, is AF005 a piece of equipment connected to that earth circuit?

A. It would be connected to the earthing circuit, yes.

Q. Mr Reece has indicated what I understood the expert panel view to be, that that was the likely position or source of the explosion, AF5 or in that vicinity?

A. Mhm.

Q. Were you familiar with that?

A. Not really.

Q. Because your preference is, if we could go back to the map Ms Basher, near, and blow up around the fan. Could you indicate with your light, exactly where you say your preferred source of ignition is for the explosion?

A. No, I haven't made a decision on what I think is the preferred source of ignition. I'm not saying that. All I'm saying is that the harmonics being generated between those points would be distributed uniformly throughout the mine on the earthing circuit. Therefore anywhere where there is an accumulation of methane of an explosive mixture and there was electrical equipment installed, would present an opportunity for an ignition source.

Q. So you're not saying the ignition source is necessarily in that area?

A. No.

Q. But it's the harmonics in that area –

A. Yes.

Q. – which as with, you've just described, can be –

A. They can be transmitted.

Q. – transmitted through the earthing structure?

A. Yeah, and the reality is it just doesn't have to be the earthing circuit either. It can be other metal work such as pipes or other metallic equipment that's perhaps in some form of connection with the electrical equipment.

Q. Just finally on the cables that were used. Is it your evidence that the cabling between the installations was a trailing cable, the sort of cable which is also used behind the machinery?

A. No. My understanding of it, and I'm not certain about this, is that it is a distribution type cable. A distribution type cable isn't necessarily wired in the same way as a trailing cable is. Trailing cables are uniformly wired to be symmetrical in the way that the earth conductors are terminated. With a distribution cable that's not necessarily the case. They do usually have three earth conductors and what you do is have the option of how you terminate them. So one of the things that is of interest would be how the cable running from the variable speed drive to the motor was in fact terminated, how the conductors were disposed, and I haven't been able to determine that.

Q. Does the cable all have to be armoured or screen cable?

A. It doesn't have to be but my understanding in this case is that it was.

Q. And that would be the correct cabling to use, screened?

A. Yes. Screen cabling certainly, armoured not necessarily.

Q. Can you explain the distinction between screened and armoured?

A. Yes, with screen you have a copper braid around each of the power conductors on the outside of the installation. So you've got three power conductors and in each one of those power conductors is a braided copper continuously woven along its entire length. Armouring then goes around the entire cable and it's usually steel wire and it's interlaced so that it provides a very strong mechanical barrier from the outside. So that the functioning of the screen is that if the cable is crushed by any

means, then you preferentially get an earth fault before you get a short-circuit. That's the function of the screens.

1525

Q. And the function of the armour is extra protection from mechanical damage?

A. Typically the armour is earthed as well at each end and it's just for mechanical protection.

Q. And the cabling between substation SS601 heading due north to the motor through cross-cut two between A heading and B heading, would've been what sort of cabling?

A. I think it would've been a distribution cable and I wouldn't have expected it to be armoured, necessarily. It may have been, I don't know.

Q. What should it have been in your view?

A. It should be at least screened.

Q. You say, "At least screened?"

A. Yes. Armoured would be an advantage, it adds an order of protection. If you have other reasons why you want to increase the security, you've got vehicles passing or any other mechanical activities taking place and you have a critical cable like a fan cable, then it would reasonably be expected to be armoured.

Q. It would be running up to the roof though, wouldn't it?

A. Yes, yes, ideally it would –

Q. So less likely to be mechanically damaged?

A. They get mechanically damaged, even on the roof.

Q. And in terms of the length of the cable between substation SS601 and the fan motor have you been able to ascertain whether that exceeds 50 metres?

A. Well, my understanding is about 95 metres, but it could be longer. There's no –

Q. And is that too long, that distance?

A. Well, ideally you wouldn't have any cable between those locations. They would be this, that's the VSD and the motor ideally would be bolted together without any cable between them.

Q. Just pause on that. Is there any reason why in terms of space and the design of the motor at the foot of the fan that that couldn't have been built like that?

A. Well, I can't see why you wouldn't, no. But it goes to the convenience of the room here, and I think the VSD should have been in all reasonableness incorporated into a properly constructed room which was suitable for its installation and I would've thought that that room, the room here where the motor is might be an appropriate place to do that but it hasn't been done that way.

1528

Q. Just before we break for afternoon tea, you mentioned the electrical inspectorate which operates in Australia?

A. Yes.

Q. And there's no equivalent electrical inspector regime in New Zealand, you obviously understand that?

A. Well, I've been told that, yes.

Q. If there was such an inspectorate regime, and if that regime was operating in a manner similar to that which it operates in Australia, are the sort of shortcomings which you've identified with the electrical installation layout be the sort of shortcomings that you would expect an inspector to pick up on a routine electrical inspector regime?

A. Are you referring specifically to this type of an installation?

Q. Yes.

A. I wouldn't expect that to be picked up no. I think that the only way that a regulator would become involved in that would be if there was some reason to investigate it, some mishap of some sort, or if there was some form of regulatory sanction required.

Q. What about at the front end, the consenting stage prior to installation? Does the electrical inspectorate in Australia have a role at that juncture?

A. No they don't.

Q. It's always further down the track on routine inspections?

A. Yes.

Q. So it may or may not have been picked up had it been operated under a similar regime?

A. Yes that's right.

COMMISSION ADJOURNS: 3.30 PM

5

COMMISSION RESUMES: 3.46 PM

MR HAIGH ADDRESSES THE COMMISSION

THE COMMISSION ADDRESSES MR HAMPTON

THE COMMISSION ADDRESSES MS SHORTALL

CROSS-EXAMINATION: MR HAMPTON

Q. Mr Reczek, your statement of evidence at paragraph 53 and the DOL reference is at /15, and in that paragraph you say, "Although VSDs are in use on many mobile machines in underground coal mines, they are usually integrated into the machines themselves. At Pike several very large VSDs were used and were separated by cables from the equipment (inaudible 15:48:35). I am not aware of the use of VSDs to the same extent, size and configuration in any other underground coal mine." Over what geographic spread have you made your enquiries about other VSDs in underground coal mines?

A. New South Wales and Queensland.

1549

Q. And VSDs underground in those two states would be alongside, immediately alongside the machine that they are driving?

A. No typically they're onboard. They are part of the machine, so it's like, typically they're used on traction motors, or shuttle cars, which means that they are actually onboard the machine and being used to control the speed of the traction motors. So they move with the machine.

Q. In that sense you said, "… to the same extent, size and configuration." Dealing with first with the word "extent," in New South Wales and Victoria have you come across any single machine underground where the VSD is separate from the machine it's driving?

A. No I haven't,

Q. Size, what's the importance of size?

A. It's the amount of energy that's being consumed and thereby the amount of currents that are being drawn on the power circuits, and thereby the magnitude of the harmonics that get generated.

Q. And the size of the VSDs underground in Pike, first, were they all uniform size?

A. I can't answer that, I don't know. The best of my awareness is the cubicles that we saw indicated some uniformity but I can't, I don't know. My expectation is that there would be differences because the fan motor was operating at 690 volts and the fluming pumps or the monitor pumps were operating at 3300 volts, so that necessarily and also the order of magnitude difference in the size so from 450 kilowatts to 3.3 megawatts so there would be a difference in size just from the drives.

Q. The equipment they were driving. Okay dealing with the fan one, the smaller of the two?

A. Yes.

Q. Underground in Victoria or New South Wales, have you seen one that size?

A. No, the typical size on the mobile machine might be 100 kilowatts, so that would be a third to a half of the size and it would be flameproof.

Q. And certainly then it follows that you haven't seen anything the size of the one that was driving the pumps?

A. No.

Q. If you, I know it's difficult and it's got a degree of hindsight in it, but to go back to, first your experience as an electrical inspector in New South Wales, your 18 years was it?

A. Yes.

Q. As an electrical inspector and a mines inspectorate, if per chance you'd come across the proposal to install something like this underground in a gassy mine which you were inspecting, what would you have done about that?

A. It certainly would've sparked my interest.

Q. Sparks probably an interesting word to use. It would've sparked your interest to what extent?

A. To the extent that I'd want to know how the configuration, the installation was going to be managed, if you like, in the sense of it's explosion risks, the way that it's being operated and from a point of view of its maintenance and how it would be integrated into the electrical engineering management plan. It would be quite a significant departure from what would normally be in place and that would, you know, draw my interest and perhaps I'd certainly scrutinise what was being done.

Q. So it depends on attitude of management and what you were told, I suppose, we can't say whether it would be the subject of what in New Zealand we call improvement notices?

A. There'd be no approval.

Q. No approval, right.

A. No there'd be no intention to even indicate that I was satisfied with what they had done.

Q. Wearing your other hat for a moment because you've also been, in terms of mine management, up there as an engineering manager in effect haven't you?

A. Mmm.

Q. Would you have contemplated, or even as a consultant now, would you contemplate putting such a system as was in Pike in any mine that you're responsible for?

1555

A. The short answer is, I'd be very, very careful, very cautious about it. I'd want a lot of information and if possible experiential knowledge about how they have performed in other similar environments and if this was the first installation or the first of its kind, then I'd be wanting design risk assessments; I'd be wanting a whole range of assurances about performance and sensitivity to mining environments.

Q. And just going back a step, so back to wearing your inspector's hat, one of your concerns as well would be what zone this sort of non-flameproof equipment was going to be sitting in, I imagine?

A. Oh, absolutely.

Q. In that paragraph at the bottom you refer to AAR8, which is a DOL number and I wonder Ms Basher if we could have it up? DOL3000160011.

WITNESS REFERRED TO DOCUMENT DOL3000160011

Q. And it's an email from Mr White, Doug White to Mr Whittall on the 22nd of March 2010. If you could blow it up as much as you can Ms Basher, under, starting with recommendations at the bottom of the page. Oh, that's good. Why do you reference that in your statement, can you explain please Mr Reczek?

A. Yeah, was, it's saying in the background area, "The VSD is the only one of its kind on this site, and we are led to believe it's the only one of its kind in the southern hemisphere." So to me, that's indicating that you would take extreme care in deciding how you were going to implement that sort of technology.

Q. The red flag's up?

A. Yes.

Q. Okay, thank you. Well, just to turn from the VSDs to the fan, the main underground fan. In your experience, going back over your 50 years starting out as a boy as an electrical apprentice, I think, electrician's apprentice, you ever come across an underground fan like this as the main ventilation system of a –

A. Never.

Q. – underground coal mine?

A. No.

Q. Your reaction to that when you first heard or read about that?

A. I was slightly incredulous.

Q. Why?

A. The main fan is probably the most important feature of keeping an underground coal mine safe. You want to make sure that it is reliable to the highest extent that is possible. You don't want any doubts about being able to maintain it, to access it, to have anything that could be detrimental to effective inspection, testing or maintenance. To have a fan like that located underground means essentially that you have to

stop it to do those sorts of things. To carry out normal inspections, and routine maintenance, you actually have to have the fan stopped –

Q. So you stop the main lungs in the mine?

A. Yes, and you're in it, so it's not an optimal sort of a situation to be in when you're wanting to carry out electrical maintenance.

Q. Wearing, and again it's with a degree of hindsight I know, but wearing your electrical inspector's hat, if you'd come across such a proposal in your 18 years, what would you have done about that?

A. Well, I would've, it would've been subject to very close scrutiny, primarily from the explosion hazard risk. I'd be wanting to know about what type of explosion protection techniques were being proposed. That could be almost, in spite of the fact that it was going to be located in fresh air, because –

Q. So even if it was in that sealed off room that you were talking about earlier on?

A. Yes, I'd still want, I'd still be looking at it being explosion protected. I mean, let me express it another way. If you have an auxiliary fan in a section which is helping the main fan if you like, to ventilate an area, they are always explosion protected even though they're always located in fresh air, and the basic reason for that is that they will be drawing flammable mixtures of methane through their fan impellor. Now the same sort of principle can apply to the main fan located as it was at Pike River and in my experience it even happens on the surface. So I've had situations where a surface fan has had unacceptable quantities of methane.

1600

Q. So the main fan underground at Pike wasn't explosion-proof from your point of view?

A. No it wasn't.

Q. Did you look at the fan at the top of the ventilation shaft?

A. No I didn't get to have a look at that.

Q. Just going back then to the main fan wearing your other hat and your experiences of mine ventilation engineering management, did you contemplate putting such a structure underground?

A. You mean a room?

Q. A main fan underground?

A. I wouldn't have, no. I don't think it's an acceptable thing to do mainly from a reliability and access perspective and being able to be confident that it is going to be able to be maintained correctly.

Q. You spoke to Mr Mount about where the drive shaft from the motor for the fan goes through into the fan itself?

A. Through the bulkhead through to the fan rotor?

Q. And I asked Mr Reece about that on Friday and he described that sealing where the drive shaft goes through the wall as it were as a gland?

A. Yes.

Q. But we're talking about the same thing as what you're speaking about?

A. We're talking about the same object. For it to be a proper gland and for it to be an explosion protected gland, which is what I would expect there, it has a particular design and it's called a labyrinth seal. It has flame paths and all of the attributes that go with such a design. My understanding of what was at Pike River was that it was a brass bush. Didn't represent any form of explosion protection at all.

Q. And then as you've told us, because of sparking they took it out anyhow?

A. Yes.

Q. Just one other thing about the electrics, and I wonder Ms Basher if we could have DOL3000150019 and I think hopefully it's a photograph of Spaghetti Junction and some of the things in Spaghetti Junction?

WITNESS REFERRED TO DOL3000150019

Q. Mr Reece made some comment about the fact that we had a, it really is a mess of spaghetti up there on the top of the roof?

A. Sure is.

Q. Including a whole series of pipe, some of which are methane drainage?

A. Yeah that's a methane drainage pipe.

Q. And some high voltage cabling?

A. These are high voltage cables, yes.

Q. Those orangey-red ones?

A. Mmm.

Q. Your thoughts about the sensibleness of that?

A. The gas drainage pipes shouldn't be there.

Q. Why not?

A. Because you've got methane running through it. If anything happens to that pipe you've got energised high voltage cables in very close proximity to it and if there is any form of damage, then you'll ignite the methane.

Q. Have you ever seen such an arrangement in all your years underground?

A. No I haven't.

Q. If you'd come across it as an electrical inspector?

A. I'd want it fixed.

Q. And how would you do it? Would you shut down part of the mine or you shut down the whole mine (inaudible 16:04:48)?

A. No, no I wouldn't shut it down, but I'd want a plan drafted for how they are going to separate these various pipes and how they are going to make these cables more secure and separated from the pipe work. So you might reasonably give them a period of time to do that.

1605

Q. But in theory it shouldn't have happened in the first place?

A. Shouldn't have started like that, that's right.

Q. Not sensible mining practice by any manner of means?

A. Certainly isn't.

Q. You told us about the need for any mining company to have a dedicated electrical engineer?

A. Mhm.

Q. What about any regulator, any mines inspectorate, should it have a dedicated electrical inspector such as the role that you performed over in New South Wales for 18 years?

A. I don't know how otherwise you'd get the sort of authority and knowledge and experience in order to be able to bring some practical knowledge to what the electrical engineer in charge of the mine may be confronting. You can of course hire experts in the sense that you can hire consultants, but inevitably they're dependent on themselves being paid by somebody, they need a client so there's nothing really replaces somebody in authority, with powers who's able to require that things be done.

Q. And working under and reporting to directly the chief mine's inspector?

A. Yes.

Q. Would that be the hierarchy?

A. Yes I think so. It's typically how it's being done, let me put it that way.

Q. And with some degree of success?

A. Well, it works.

Q. Last subject then and it's one that I continually ask every witness, your view about check inspectors under your 15 years of underground mining in New South Wales, mainly in New South Wales or always in New South Wales?

A. I've been elsewhere as well.

Q. Their utility, their usefulness?

A. Yes, I find them very useful, I always have. They bring to any form of senior management discussion for enquiries a perspective of the workforce and what that provides is for people who perhaps normally wouldn't be able to give voice to their concerns, a voice that can be articulated in a management setting fearlessly, let's say. My experience with them has always been that providing you are transparent, they are always of assistance and it's a very rare situation for any sort of conflict to arise. So from my point of view it's always been helpful to have check inspectors.

Q. And is that from just a mines management perspective or is it from –

A. It's mainly from a regulatory inspector perspective but in some cases it can be helpful for management as well. I mean if people tend to try and run the mine via the check inspector then that can become a problem for management but if there is a realistic transparent relationship and people are expressing their views in a reasonable way then I think it can be very helpful to management.

Q. In terms of relationship check inspector to you when you are the electrical inspector doing your inspection of a mine, were you helped by the presence of a check inspector?

A. Yes I was.

Q. In what way?

A. They always had a more intimate knowledge of what was happening with the workforce, if there was any discussions, let's put it, or discontent on behalf of the workforce, then the check inspector was able to represent that to me as an electrical inspector and then we were both able to make judgements as to whether or not it was a genuine complaint or if there was some other underlying problem and you can make a decision together whether or not it needs to be taken forward. I think to a large extent it depends on the nature of the relationship as much as the position.

1610

CROSS-EXAMINATION: MS SHORTALL

Q. Mr Reczek, I'm just going to work through some of the theories that you've described to us earlier today just to clarify some of my own understanding. As I understand your theory, it's that electrical harmonics in an underground coal mine are caused to flow through interconnected earth circuits via the process of either electromagnetic induction or capacitive coupling between parallel adjunct conductors, is that right?

A. Yes.

Q. And you say that these currents could then circulate throughout the interconnected earth networks of the entire Pike Mine, is that right?

A. Yes.

Q. And you say there then could've been an incendive sparking on interfaces and thus arcing, could be an ignition source created, is that right?

A. Yes.

Q. Okay. Now, you would accept wouldn't you that the production of currents in the earth circuit from harmonics is not universally supported by experts?

A. I don't know what other people think.

Q. So you're not familiar with the fact that there may be other experts who have a different view around that topic?

A. Oh, I'm comfortable with the notion that other people might have different views, yes. I don't know what they are.

Q. Well, are you aware that some experts take the position that harmonics are generated by the VSD rectifier circuit on the input side of the VSD and will be limited to the supply side of the electricity system?

A. There has to be a circuit for the current to circulate within. They can't just exist on the supply side. It has to be generated somewhere. It has to go somewhere and it has to return, so you require a circuit for that to happen. If you look at other installations done in coal mines for example, it is practice to actually have open circuits placed in the earthing circuit just so that those currents don't circulate. Another way of dealing with it is to have very low values of earth connections, relay resistance earth connections, so that the currents are dissipated and don't generate harmonic transmissions. So, there has to be a circuit somewhere to circulate.

Q. Have you reviewed the Department of Labour's investigative report, Mr Reczek?

A. Yes.

Q. And do you recall that there's actually a statement in that report, it's at 151, and I'll just read it briefly to see if it refreshes your recollection. "The production of currents in the earth circuit from harmonics is not universally supported by other experts…" and just as a pre-cursor,

there'd been discussion about your theory before the section I'm reading and then the report continues to say, "An alternate view is that harmonics are generated by the VSD rectifier circuit on the input side of the VSD and will be limited the supply side of the electricity system."

MS MACDONALD ADDRESSES THE COMMISSION – IDENTIFY PARAGRAPH

CROSS-EXAMINATION CONTINUES: MS SHORTALL

Q. If I had a version that had the paragraph numbers I would, let me just see if I can find one. It's at page 151, so I just identify it. Let me see if I can find it. I can come back to it afterwards if that would assist Your Honour. I don't have a version that's stamped with paragraph numbers. Oh, thank you. Excuse me, Mr Reczek we're just tidying this up. Do you recall reading that section I've just read to you, when you looked at the -

1615

CROSS-EXAMINATION CONTINUES: MS SHORTALL

A. I cannot really recall that, no.

Q. Well, the section that I'm reading to you, Mr Reczek, also provides and I'll just continue reading from the section so we can orientate ourselves. "Therefore while they will interfere with other equipment in the same supply system they [and this is the harmonics as I understand this part of the report] will not be coupled into the shared air circuit and circulate through the mine," and there's a citation there to M Empson 21 October 2011 email. Does that refresh your recollection at all around this alternate expert view?

A. I'm not really sure that I can understand what they're saying there.

Q. Well, let's just see if I can work this through with you and accepting that you don't agree with this alternate expert view –

THE COMMISSION ADDRESSES MS SHORTALL

MS MCDONALD ADDRESSES THE COMMISSION – CAN IDENTIFY PARAGRAPH NUMBER

THE COMMISSION:

3.37.7.4?

MS MCDONALD:

Yes sir, that was...

THE COMMISSION:

Q. Have you got that Mr Reczek, 3.37.7.4 and its page 154 in the...

A. Department of Labour investigation report?

Q. Yes.

CROSS-EXAMINATION CONTINUES: MS SHORTALL

A. Okay, where are we at?

Q. So I've just been working you through –

THE COMMISSION:

It's paragraph 3.37.7.4?

CROSS-EXAMINATION CONTINUES: MS SHORTALL

A. Okay, yes.

Q. If you just want to take your time perhaps sir just to read that, orientate yourself?

A. Okay.

Q. And in fullness you'll see in that paragraph of the report Mr Reczek, the Department of Labour investigative report notes that if these harmonics are described as HF currents, there is more common ground between experts. Do you see that?

A. Yes.

Q. And would you agree with that statement?

A. Depends what they mean by HF.

Q. I was going to ask you if you knew. Do you know sir?

A. Well I'd regard HF as being radio frequencies rather than power frequencies, but I don't know.

Q. Well let me just see if we can work through this. If the Commission were to lend some weight to the alternate view of the experts, then harmonics would not have been circulating throughout Pike's mine, right? And I accept your view is different to that and I just want to explore this alternate view for a moment. If the Commission were to lend weight to that we wouldn't have harmonics circulating throughout Pike's mine would we? You'd agree with that?

A. Yes.

Q. And so with that alternate expert view in mind, I'd like to turn to the timing coincidence between the start-up of the VSD for the number 1 fluming pump at pit bottom in stone and the explosion on the 19th of November 2010 and I understand from your answers to Mr Raymond before that the coincidental nature of this is largely irrelevant to your analysis, is that right?

A. Yes.

Q. So if I just work through this coincidence theory because there's been quite a bit of evidence about this. As I understand your evidence, if harmonics or stray currents were present in the earthing system, arcing and the ignition of methane could have occurred at any point on the interconnected earth circuit in Pike's mine, right?

A. Yes.

Q. But if we accept for one moment the view of the other experts that harmonics would not circulate throughout the earthing system in Pike's mine and with the exception of this HF current point, which I think you're not able to help us with today, we're left with needing to look to other potential paths for any stray voltage from the number 1 fluming pump to travel from the motor aren't we? Do you agree with that?

A. Well, or the fan.

1620

Q. And I'll come to that too. The Department of Labour's investigation has identified three potential paths. The motor frame, the pump frame and the connected pipe work, are you familiar with that?

A. Sorry, what was the last one?

Q. The connected pipe work?

A. Yes.

Q. And because the number 1 fluming pump and VSD were located in pit bottom in stone where the Department of Labour concludes in its report at page 158, it is almost certain the explosion did not initiate. The report looks just to the pipe work on this point. Do you understand that to be the way the analysis works?

A. Yes.

Q. Now, if we take out of the equation harmonics and the interconnected earth circuit in Pike's mine which some experts say we should, we're left looking to the current flow in the pipe work as the only potential ignition source that could tie together the coincident timing of the start-up of the number 1 fluming pump, right?

A. Mmm.

Q. Sorry, you have to say yes or no for the record.

A. Yes.

Q. Thank you. And in that respect you would agree with me that the fluming pipe work ran up the main return C heading to the ABM at B heading, one west two right, didn't it?

A. To the best of my knowledge I'm not that familiar with the pipe work.

Q. Well, just for the sake of the record I can refer to page 158 of the report and I'll get the specific paragraph number for counsel assisting after we finish. So it follows doesn't it that for any possible arcing and thus ignition to have occurred as a result of the start-up of the number 1 fluming pump, assuming for these purposes the alternate expert view that harmonics would not have been travelling in Pike's interconnected earth circuit, we would need earthed metalwork in contact but with not well, but well bonded with the pipe. Is that your understanding?

A. Earths metalwork not bonded with the pipe?

Q. It needs to have earthed metalwork and contact but not well bonded with the pipe. Do you recall reading that in the Department of Labour's report?

A. No.

Q. Let me see if I can take you to that paragraph. It's 3.37.11.4.

WITNESS REFERRED TO DOL REPORT PARAGRAPH 3.37.11.4

A. 3.37…

Q. Its page 162 of the version you have. It's the end of the second to last paragraph.

A. Sixty two? Okay. '

Q. So would you agree as reflected in the Department of Labour's report that absent harmonics travelling in Pike's interconnected earth circuit, that's what we need? This earthed metalwork in contact but not well bonded with the pipe to explain the coincidental timing?

A. When I read this it seems to me that it's really referring to the motor itself and the winding there and the potential for the rotor on the motor to provide a circulating current rather than the variable speed drive itself. On the diagram it's sort of showing the motor itself as the source, so what I would understand that to be is that they're talking about the rotor of the motor being the source of harmonics and circulating within the motor and potentially getting to the earth circuit.

Q. And just putting that aside for a moment, do you read this paragraph to say that the arcing and hence the ignition on this theory, could've occurred at any point where there was this earthed metalwork in contact but not well bonded with the pipe?

1625

A. Yeah, I would agree with that. If you've got, if you have harmonics and you have current circulating and it's in contact with pipe work, yes.

Q. And my point perhaps on this is just if we, in the interest of time move on, it's just that to clarify with you that the panel's not seen any actual evidence of this particular pipe and the likelihood of earthed metalwork not being well bonded to it, right?

A. Yeah, I haven't seen any.

Q. And it's possible that any metalwork in contact with the fluming pipe work was in fact well bonded with the pipe, isn't it?

A. It depends what you mean by "well bonded". Well bonded to me means you've actually got a direct connection, which is bolted to it, like an earth strap, or some such thing. Just being in contact with it isn't being well bonded, so it depends a little bit on what they mean by that.

Q. Now, the panel accepts, doesn't it, that at the time of the 19 November explosion, the exact nature, cause and consequences of certain issues with the underground plant at Pike, like the main ventilation fan and the underground pumping equipment had not become apparent? Do you accept that?

A. Yes.

Q. And the department has found that remedial activities were being undertaken by Pike staff and contractors prior to the explosion in an effort to improve performance, right?

A. Yes.

Q. So Pike was trying to figure out what the problem was, right?

A. Yes, they were.

Q. And so I'd like to come back to your theory that harmonics could have been travelling through the earth's networks at Pike's Mine and you've already mentioned, haven't you that, while currents flowing in the earth circuits of the mines electrical system would have been detected by protection devices on the power conductors and power shut off –

A. Yes.

Q. – there's no device able to detect harmonics currents induced in earth circuits, and so those currents circulate undetected and unprotected, right?

A. Well, that's by the protection system, but all you have to do is put an instrument in the earth circuit and you'll detect them. In fact that's usually what's done.

Q. Now, if as you suggest here at Pike these undetectable harmonic currents were circulating, there could've been a risk of the ignition of methane in a number of places in the mine, right?

A. Sorry, I'm not saying they're undetectable.

Q. No, I understand but at Pike you understand they weren't being detected, is that right?

A. Yes, they weren't being detected by the electrical protection system. They were being detected in terms of measurements, so the fact that the, they were measuring these harmonic voltages means that you have harmonics present.

Q. And just on this point about the possibility of the harmonics circulating underground, we can agree can't we that that means there could have been the risk of ignition in a number of places underground in the mine –

A. Oh, absolutely, yes.

Q. And the panel, and as your work particularly on the panel, hasn't given you any reason to believe that any of Pike's directors or officers knew about this potential issue, has it?

A. No.

Q. And you've reviewed at least some of the correspondence from the consultants and experts that Pike had engaged to assist in connection with this underground electrical system, haven't you?

A. Yes.

Q. Now I understand you're constrained by what's been made available to you, but you've not seen anything recorded in what you've seen where any of these consultants or experts explicitly or clearly brought this risk to the attention of Pike's directors and officers, have you?

A. No, I haven't. The only thing that I can say about that is that the reports that I have read were to their client, and my understanding is that the client for the reports was Pike River management. I don't know who else it could be.

Q. And I just want to explore a little further your theory about these possible harmonic currents being continuously present.

A. Yeah.

Q. Now, if that's under your theory anywhere there was an accumulation of methane in the explosive range and electrical equipment installed, there's opportunity for ignition, right?

A. So long as there's mechanical connections and electrical equipment, yes.

Q. So that follows, it follows then doesn't it, that there was a potential explosive event every time those two factors combined, right?

A. Yes.

Q. Now, the Department of Labour report concludes and I'm not accepting this, but it concludes that there were accumulations of gas in the explosive range in the mine on a number of occasions prior to the 19th of November 2010 and especially during the panel move the weekend before the explosion. Were you aware of that conclusion?

1630

A. I've heard of it so I'm aware of it yes.

Q. And you would agree with me wouldn't you, in those circumstances on the Department of Labour's conclusion, if your theory was right about harmonics being continuously present, an explosion could have occurred, in fact would have occurred before the 19th of November would it have?

A. If there was an accumulation of methane it would certainly be possible.

Q. Well in fact it would be more than possible wouldn't it? Under your theory if the harmonics are continuous and we have an explosive, according to the Department of Labour, there's explosive mixes of gas in the mine before the 19th of November, there would have been an explosion wouldn't there?

A. If you have an ignition source beside the methane yes. What it means is that you've got to have the fan running and the accumulation of methane at the same time. So...

Q. So we're agreeing aren't we?

A. Well I, if you're understanding what I'm saying, we are, because the fan's got to be running. Normally a fan running would be causing the methane to be ventilated so you wouldn't then get an accumulation of

methane. The fact is though that if the fan stopped for any reason and the methane accumulated because the fan wasn't running and then you started it, certainly then you've got the conditions.

Q. Well let me just take the fan out of it for a moment. I maybe misunderstanding so please correct me if I'm getting this wrong. But if we take the fan out, as I understand your theory harmonics are continuously circulating in the earth circuit in Pike's mine and there's the potential for a sparking anywhere there's an electrical installation, right?

A. The harmonics are circulating whilst the variable speed drives are operating, yes.

Q. Okay, and –

A. And if there is an accumulation of methane anywhere where there are those circulating currents able to manifest themselves as a spark, yes, you could get an explosion.

Q. So my point is that to the extent the Department of Labour has concluded and without – I'm not accepting that but to the extent that they have concluded that there were explosive mixes of gas in the mine prior to the 19th of November 2010, under your theory doesn't it follow if you're right that there would have been an explosion?

A. I don't think you can be conclusive, certain. I think that the possibility is always there, let me put it that way. It becomes a likelihood issue.

Q. Well the fact that there wasn't an explosion prior, based on the fact that the department concludes that there were these heightened gas levels, would make your theory as to harmonics being continuously present less likely wouldn't it?

A. Depending on where the methane was accumulating. I mean my understanding of it is that it was accumulating in the returns or in the goaf, in which case there would be no electrical equipment there. So certainly wouldn't be an electrical ignition source because the methane has to accumulate where there is electrical equipment installed and normally if methane is accumulating in more than 1.25% concentrations you have to switch the electricity off. So I mean you've got a number of

things that have to coincide for an accumulation of methane to reach an ignition source.

Q. I'd just like to stay on this point because there's been some evidence from witnesses last week and I think it may be of assistance to the Commission to understand this. Maybe I could have brought up please Ms Basher DAO.031.00002, and Ms Basher if we could perhaps just highlight the top left-hand corner of this map.

1635

WITNESS REFERRED TO DOCUMENT DAO.031.00002

Q. Mr Reczek this is a map that shows the layout of the mine on the 19th of November. You'd be generally familiar with this, is that right?

A. Yes.

Q. Now, I've asked Ms Basher to highlight a section of the map that shows not only the hydro-panel but also where the ABM continuous miner was working.

A. Yes.

Q. And in evidence last week Mr Reece gave some statements around potential, and I think it was in questioning from counsel assisting, the potential for there to be an accumulation of methane in that top left-hand corner where there are, for example, auxiliary fans identified as having been located. Do you see that?

A. Yes, I see the auxiliary fan. By auxiliary fan you're referring to this one?

Q. AF003 which is on A heading.

A. Yes, that one there.

Q. So just so that we're clear on this point, if there had been accumulations of methane in the explosive range prior to the 19th of November in the location on this map that we're looking at where, for example, there is the auxiliary fan at AF003 located, under your theory about the continuously circulating harmonics, there would have been an explosion wouldn't there?

A. No. This auxiliary fan is exhausting methane from this location.

Q. From the ABM continuous miner spot, yes?

A. Yes, so you've got air going up here.

Q. Up the B heading.

A. And down the tubes and being exhausted into the return. For that to be the case you can't have an explosive mixture there. The way you would accumulate an explosive mixture at that location is if that fan was stopped for any reason. Now, if that fan was stopped then you'd be asking the question, "Was the other equipment stopped, such as the main fan?"

Q. Well, let me just run one other potential theory past you then we might move on in the interests of time, Mr Reczek, there's another auxiliary fan noted in this part of the map at AF004. So, if we just follow through your theory that AF003 wasn't working which may have permitted an accumulation of gas.

A. If it wasn't working?

Q. Yes. I think that's what you just suggested to me, is that right?

A. Yes.

Q. So if that was the case and there had been a build-up of methane in the area, is it possible, under your theory, that the auxiliary fan at AF004 could have provided the ignition source?

A. So let me see, 004, that's?

Q. It's cross-cut six, if you find B heading it's just under that.

A. 004, that's that one there?

Q. Yes.

A. So that's exhausting into the return there, correct and this is ventilating from, looks like two areas, is that correct?

Q. Yes.

A. And that fan is running?

Q. Let's assume it's running for purposes of this scenario, yes.

A. You wouldn't have an explosive mixture in these areas because that fan would be exhausting them into the return.

Q. We'll move on, Mr Reczek, that's helpful thank you. Now another potential issue noted by the panel in its report, involves arcing due to electrical discharge machining, right?

A. Yes.

Q. And the idea being that there might've been arcing due to this electrical discharge machining at the main fan bearings, right?

A. Yes

Q. And you're aware, aren't you, that the underground fan at Pike was designed by Flakt Woods fan?

A. Yes.

Q. And the Flakt Woods' website states that it's a leading global supplier of energy efficient air solutions for industries including underground coal mines. Is that consistent with your understanding?

A. Yes.

Q. You're familiar with Flakt Woods?

A. Yes I am.

Q. They have a good reputation in the industry?

A. Yes they do.

Q. Now, Pike worked closely with the engineering business manager at Flakt Woods and a mechanical engineer there on all aspects of the design manufacture, installation and commissioning of the underground fan, are you familiar with that as well?

A. Yes.

1640

Q. Now the panel accepts, doesn't it, that Pike had put in place protection mechanisms to protect against the effects of electrical discharge machining on the main ventilation fan?

A. My understanding is that they did, yes.

Q. But the panel notes in its report that arcing at the fan bearings, shaft and impellor remained a possibility, right?

A. It's a possibility.

Q. But only if the shaft grounding brush was not correctly installed or functioning properly right?

A. That's right.

Q. And there's no actual hard evidence of the brush being installed incorrectly or not functioning properly is there?

A. No, there's not.

Q. It's quite possible that the brush was installed correctly and functioning?

A. Indeed, and it could be that everything in that regard is okay.

Q. Now, you've also suggested that ignition at Pike may have arisen by arcing caused by the effects of overheating leading to hot joints?

A. Yes.

Q. Due to the electrical power supply issues –

A. Yes.

Q. – that you described earlier, right? Sorry, I just need a yes or no?

A. Yes, sorry.

Q. But the panel has no actual hard evidence of this suggestion also being the actual ignition source, does it?

A. Not as an ignition source, no, but of the heating yes.

Q. I just wanted to raise with you another note in the Department of Labour's report – I just want to get the paragraph number so there's no confusion.

A. Okay.

Q. We're just going to get the correct paragraph number pulled up Mr Reczek – 3.37.9.9, bottom of page 159. Just once you've perhaps found that location, I'd ask you to read that paragraph.

A. 151 is it?

Q. 159.

WITNESS REFERRED TO DEPARTMENT OF LABOUR REPORT PAGE 159 PARAGRAPH 3.37.9.9

Q. Have you found it there Mr Reczek?

A. Yes.

Q. And you see there that the Department of Labour's report, and I'll just read this sentence so that everyone is familiar with what's written here. "Energy NZ has pointed out that the undersupply of power to the mine was ruled out by Electronet Services, after a load flow study conducted by Electronet concluded that the minimum voltage level for actual load was 99.04% at the hydro-monitor bus (LV) which is well above the minimum limit of 94% to 106% as stated in the Electricity Safety Regulations 2010 and AS/NZ 3000, 2007 Standard." And there's a cite

there in the report, and then in completeness I'll just read the remainder of the paragraph. "However it is unclear whether meeting the regulations and standard would necessary be proof of sufficient voltage to Pike as this is not a site specific measure of sufficiency but a broad brush standard." And my question to you, Mr Reczek is you've talked about electrical supply issues and here we have in the Department of Labour's report a place where it is noted that undersupply of power to the mine had been ruled out and so would you accept that there is at least an issue of dispute as to whether there was an undersupply issue at Pike's Mine?

A. I'm not sure what the people who did the low flow study were asked to do. If they were asked to do a low flow study of the installation of the mine alone then what they have done and what they have said is correct and I wouldn't dispute that. My issue is that I don't think that they have been asked or that they have taken into account the limitations imposed by the external source of supply, so what they're saying in terms of their results are completely consistent with what they've done, but if you look at the actual measurements, apart from when you re-do the calculations, look at the measurements, there is evidence that there was under-voltage and that's contained in the Rockwell information.

1645

Q. Well you yourself in your evidence note at paragraph 78 of your brief, "that further detailed study is required to more closely model the mine power supply system," right?

A. Absolutely. That's my, the point that I was making is that if you rely on the load flow study you don't have to do anything, but there is sufficient uncertainty about what the people who did the study were asked to do and the information that's been provided subsequently in trying to uncover what the problems were with the fan and the monitor pump. That's a flag to say we need to look at this much more closely.

Q. If I could just turn to another topic briefly, Mr Reczek. You've said earlier that you're uncomfortable about the fact that the fan was located underground and also connected to a VSD. Recall that evidence?

A. Yes.

Q. And you would agree with me that in the course of your investigative work you've seen that many consultants and experts knew about this installation though, right?

A. Yes.

Q. And had been involved in its design?

A. I presume so. I don't know but I would presume so.

Q. You don't have any reason to believe that Pike hadn't sought expert advice in relation to the design of that, sir?

A. No, no.

Q. And you're aware that Department of Labour mines inspectors had been underground at Pike aren't you?

A. Yes I'm aware.

Q. So it was no secret that this was Pike's design and installation was it?

A. To the best of my knowledge, no.

Q. Now I just want to ask you about the explosions that you've been involved in, in investigating in underground coal mines?

A. Yes.

Q. In how many of those have you or others working alongside you determine that induced harmonic currents arcing in electrical or metallic installations provided the ignition source?

A. In explosions?

Q. Yes.

A. None.

Q. Well in how many of the investigations that you've been involved with have you perhaps theorised that induced harmonic currents arcing in electrical or metallic installations provided the ignition source?

A. Well, we're capable of providing an ignition source because if you're tying it to explosions only, then the coincidence of an ignition source and an explosion are quite rare, but there are plenty of investigations where people have received electric shocks for example from equipment that has variable speed drives in use on them and that's as recently as last year.

Q. But none of those have found that the induced harmonic current arcing in electrical or metallic installations provided the ignition source for an explosion have they?

A. It wasn't an ignition source, it was an electric shock but the finding was that there was sufficient energy to ignite methane had it been present. So we've got the situation where the electric shock occurred at the time that a variable speed drive was being started, and as a result of that a person received an electric shock and we're able to measure the magnitude of the voltage and the magnitude of the currents and the problem that was causing that and determine the amount of energy was sufficient to ignite methane had it been present.

Q. And on how many occasions has that analysis reached the finding that you've just described?

A. Sorry, the finding?

Q. How many times has there been that conclusion reached that you've just described?

A. Well I personally have reached the conclusion twice in the last 18 months.

Q. Are you aware of anyone beyond yourself reaching a similar conclusion?

A. No, not formally in terms of a report, that’s a documented report that's formalised and submitted, but I have had other anecdotal evidence which I wouldn't repeat. It’s people like saying that those sorts of things aren't uncommon.

Q. Now the expert panel accepts doesn't it, that electrical systems in underground coal mines are complex?

A. Yes.

Q. And you'd agree with me wouldn't you that the design and installation of an electrical system in an underground coal mine is a difficult task?

A. Sure is.

Q. Not the sort of thing that you'd go into without having specialist expertise and skill is it?

1650

1650

A. I agree.

Q. Not the sort of thing that you'd expect company directors or officers to carry out without expert assistance is it?

A. Yes.

Q. Now, you would agree that it's reasonable for an underground coalmining company to engage people with appropriate expertise and skill to design and install its electrical system wouldn't you?

A. Yes I do.

Q. Now, do you, and it's not clear from the evidence that's been provided so far, Mr Reczek, but do you recall being provided in the course of your work with any information about how the design and supply of Pike's underground electrical system was subject to tender processes?

A. Well, I haven't asked for a tendering document but I did ask for any information that was available regarding designs or specifications and I haven't seen any.

Q. So you've not been provided with information showing that, from right back in 2006, Pike brought in expert assistance to assist with its design and installation of the electrical system?

A. No I haven't seen that.

Q. You're not familiar that the tender process was handled by Pike's engineering manager at the time, Tony Goodwin?

A. No.

Q. So you've not, just to be clear, you've not seen any of the tender documentation from 2006 or 2007 where there were requests for tenders for the design and supply of electrical equipment?

A. I haven't seen any of that no.

Q. You're not aware that Ampcontrol was the successful party in the first tender process which related to –

A. Ampcontrol, Ampcontrol.

Q. Ampcontrol, sorry, Ampcontrol for the supply of substation, DCBs and section isolators?

A. No I haven't seen that.

Q. Would this sort of information have been of assistance to you in doing your work?

A. I don't think so not in the brief that I was given.

Q. Because you weren't asked to look at design and installation?

A. I wasn't asked to look at that. I was asked to identify potential ignition sources and look at the evidence that was available that was being drawn from the mine.

Q. Would you agree that, in the evidence that you've provided to the Commission, it could be gleaned that you are being critical of the design of the electrical system at Pike's underground coal mine?

A. I think it's reasonable to divine that I don't accept that having the fan underground is an appropriate thing to do or that having VSDs installed without a very detailed design analysis and risk management plan for them would be an appropriate thing to do. I think if you're getting that impression then that would be correct.

1653

Q. And to the extent that we may also be getting the impression that in addition to that criticism to the extent that it even can be divorced from the overall design, installation, planning of Pike's electrical system in its underground coal mine, you're not intending to criticise the latter, you're just focussed around the underground fan, is that right?

A. That's correct; and the pump.

Q. So we should not construe your report more generally is providing criticism?

A. I don't construe it as being a critique at all. To me it's like what is the accepted practise? What normally do you find? It's certainly not beyond the realm of possibility that it could be done safely, but I'm not aware of anything that's been done that would, in my view, satisfy myself that all precautions had been taken.

Q. And I guess on that score I'm doing Mr Reczek is trying to identify the limits of what information may have been made available to you and from which you've formed those conclusions. So, just coming back to Ampcontrol, you're familiar with their reputation in the industry, right?

A. I sure am.

Q. Yeah, in fact you were an engineering mager at Ampcontrol?

A. Yes.

Q. And so you know it's an international supplier of electrical products to the mining industry, don't you?

A. Yes.

Q. And because I had some questions around the tender documents , but you won't have seen these, where Ampcontrol gave representations about its equipment being suitable for the arduous conditions of underground coal mines and complying with relevant Australian standards and coal mining regulations, you've not seen any of those documents have you?

A. I haven't, but I am familiar with the processes that they undertake, but those processes and the equipment they supply is mainly transformer substations. I don't know that they've had any prior experience or knowledge of the use of variable speed drives.

Q. You don't know one way or the other?

A. I don't know.

Q. Yeah, you would agree with me, wouldn't you, that in utilising amp control to supply electrical equipment to its underground coal mine, Pike made a good choice in consultant and provider?

A. I would think so, yes.

Q. And again, just to be clear, you've not seen any of the tender documentation where iPower Solutions were successful in the tender for other aspects of Pike's underground electrical system?

A. No, I haven't seen that.

Q. You're familiar with iPower Solutions though?

A. Not really familiar. I know of them.

Q. Are you familiar with their reputation in the industry?

A. No, not really.

Q. So you don't know that their clients include the likes of BHP Billiton, Rio Tinto and Xstrata?

A. No. I was trying to recall if I actually had any interaction with them recently, and I can't recall.

1656

Q. So you've not seen the contract that was entered between Pike and iPower in June of 2007?

A. No.

Q. You're not familiar with any of the tender documentation in which iPower states that it had extensive experience in delivery of this type of product and –

A. I'm not familiar with that.

Q. Any of that. You are familiar, does the name Conneq mean anything to you?

A. Sorry?

Q. Conneq, C-O-N-N-E-Q?

A. No.

Q. Just for the record I'll note that it appears that on the 1st of June 2011 iPower Solutions changed its name to Conneq, so I was just seeing if that assisted your recollection. You are familiar with Rockwell Automation though aren't you?

A. I'm not familiar with them other than I know that they're a multinational company.

Q. With a global reputation?

A. Indeed.

Q. As provider of industrial products and services, right?

A. Yep.

Q. And included amongst Rockwell's vast customer base are underground coal mines in Australia, you know that?

A. As I understand it yes they do.

Q. And you've given evidence that the VSDs at Pike were manufactured by Rockwell haven't you?

A. I didn't say that.

Q. I think if –

A. My knowledge was that they were the people who were engaged and were doing the work on the VSD drives. Like they were contracted to commission and install them. Whether they actually manufactured them I didn't know.

Q. I'll just turn you to paragraph 56 of your brief if you have it there Mr Reczek?

A. Mmm.

Q. Just if you take a look at that, I want to confirm whether I may have misread your brief. I took that paragraph to indicate that you understood that Rockwell were the manufacturers of the VSDs used at Pike?

A. Sorry, which one is that?

Q. It's at paragraph 56?

A. Well I'm taking that that's the Department of Labour say that.

Q. So it's your evidence at paragraph 56 around who manufactured the VSDs is based upon what the Department of Labour has told you?

A. Yes.

Q. You have any reason to believe that's inaccurate?

A. No I don't, but I haven't seen the manufacture. Very often in mining circumstances, coalmining circumstances there are multiple providers and they work together.

MS SHORTALL ADDRESSES THE COMMISSION – TIMING

1700

THE COMMISSION ADDRESSES MR RECZEK – DISCUSSION RE TIMING

CROSS-EXAMINATION CONTINUES: MS SHORTALL

Q. Just putting aside this manufacture versus supply point for the sake of convenience and time, do you understand, Mr Reczek, that Pike used Rockwell supplied VSDs to run its pumping systems for the hydro-monitor, fluming and slurry pipelines and for the motor of the main fan?

A. Yes I understand that they did.

Q. And that 12 of the 16 Rockwell supplied, or manufactured VSDs were located underground at Pike?

A. Well, yes.

Q. And based on your review of the correspondence between Rockwell and Pike that you described earlier to Mr Mount, does that correspondence that show that Rockwell was well aware of the installation and design of the VSDs?

A. They were certainly well aware of them. They were the ones doing the work and reporting on it.

Q. And we have iPower Solutions don't we also directly involved in this installation and design work?

A. I would imagine so, yes.

Q. Would you agree with me that in utilising iPower and the likes of Rockwell to design, install or commission, it may be a combination of some of those, I understand you don't have access to all the information, but to the extent that Pike was using those types of outfits to assist with its underground electrical system, it was making a good choice in consultant and provider?

A. Yes I don't think there's anything I'd say about the reputation of either company.

Q. And you'd be aware from the service records, some of which are annexed to your evidence, that representatives from Rockwell were onsite at Pike River on a frequent basis between June 2009 and November 2010?

A. Yes, they were, yes.

Q. And you're aware from those risk assessments that are attached to the service records that on at least, at least on my count, seven occasions a Rockwell representative signed a pre-job safety assessment certifying that the work environment was safe to start work, do you recall that?

A. I haven't seen those, no. But it wouldn't surprise me, I mean, that's a standard practice.

Q. Do you recognise the name Comlec?

A. I recognise it from having read about it.

1703

Q. Read about it in connection with Pike?

A. Just on the reports, yes.

Q. So you understand that Comlec was another consultant or expert that was advising Pike in relation to its underground electrical system?

A. Yes.

Q. And Comlec is an Australian electrical engineering company, isn't it?

A. Yes.

Q. And their clients include the likes of SIMTARS, don't they?

A. Yes.

Q. Would you agree that in utilising Comlec as another external expert or consultant to assist with its underground electrical system Pike made a good choice in consultant and provider?

A. Yes, I've got no reason to doubt that.

Q. Now, if I could just change topics just for one moment. Mr Mount showed you a letter or a bulletin earlier dated from December of last year. Ms Basher, if I can just pull up CAC0146/1 please?

WITNESS REFERRED TO DOCUMENT CAC0146/1

Q. I just have one quick question on this. I've got CAC0146/1, it's the letter, I believe, that was sent by the Department of Labour dated the 21st of December 2011. Do you see that on your screen there Mr Reczek?

A. Yes, I do.

Q. And I just wanted to draw your attention to one part of this letter because I hadn't see it until now when Mr Mount used it earlier, but on this first page, as I read it, the Department of Labour is recommending certain steps be undertaken immediately to address the potential hazard involving VSDs used in underground mining. Is that how you understand this letter?

A. Yes.

Q. Now at the first bullet point there – thank you Ms Basher, just reading from the document, it says, this is the Department's recommendation to employers and managers of underground mines, "You should seek expert advice from a competent person during the design, installation and commissioning and ongoing monitoring and maintenance of any

electrical systems that incorporate VSDs. This competent person should have knowledge and experience in the use of VSDs and underground environments where there is a potential for an explosive atmosphere." Now, you would agree with me, wouldn't you Mr Reczek, that Pike did just that in seeking expert assistance from the likes of iPower Solutions, Ampcontrol, Comlec, Rockwell, regarding its underground electrical system?

A. The underground electrical system, yes; I'm not quite so sure about the use of VSDs.

Q. I was going to come to that. You've seen correspondence with Rockwell regarding the VSDs –

A. Yes.

Q. – and you've accepted, haven't you that Rockwell has a reputation –

A. They have a reputation and they manufacture the equipment, so it should be – they are a credible company to provide that sort of expertise, yes.

Q. So given the use of Rockwell by Pike River, would you agree with me that Pike acted consistently with the first recommendation provided by the Department of Labour here?

A. I'd ask whether or not they had experience with the use of VSDs in an underground environment. That would seem to me to be quite an onerous requirement and whether or not they had that, I don't know, they may have.

Q. You don't know one way or another, do you?

A. No.

Q. And you don't know what if any representations Rockwell may have made to Pike River in the event that they didn't –

A. No, I don't.

Q. – regarding how that expertise could be filled, do you?

A. In fact, it would be good to uncover that and to explore it.

Q. Is that the sort of information you've been trying to get from Rockwell?

A. It would be, yes.

Q. Now, Mr Mount, this is my last couple of questions for you Mr Reczek, Mr Mount noted for you earlier how Rockwell has filed a memorandum, or through their lawyers have filed a memorandum with this Commission and I think he put to you some of the more specific criticism of your evidence and you've responded to that, but I just wanted to note for you that in this memorandum filed by counsel, that Rockwell identifies that their own experts are reviewing your work. Are you familiar with that?

A. Yes.

Q. And they have considered and it's reflected just for the record at paragraph 10 of their memorandum that your report, and I'm just reading from it. These are not my words, this is Rockwell's counsel's words, "Lacks sufficient detail to form any conclusions and the best that can be said about it is it raises other areas of investigation to which Rockwell can contribute." And as I understand your evidence, you would welcome that type of contribution?

A. Absolutely.

1708

Q. And to the extent that the contribution from Rockwell caused any of the conclusions in your report to change, that would be because you hadn't had that information from Rockwell beforehand?

A. That's correct.

Q. Now, in the memorandum submitted by Rockwell's counsel they also note at paragraph 12, "In summary, therefore," sorry just let me step back. The memorandum notes that Rockwell's experts are doing their work and they intend with the lead of the Commission to file an institutional brief and then it is stated in the memorandum at paragraph 12, "In summary, therefore, there is a real concern that the Commission may be misled into reaching a wrong conclusion as to the cause of the explosion and further in doing so severely damage the commercial reputation of Rockwell." And I think that's because they want the opportunity to respond further. And I just want to put to you whether you would accept, Mr Reczek, that absent full information from Rockwell and acknowledging you yourself hadn't had it to date, there is such a risk?

A. Well it's always possible to draw wrong conclusions if you don't have conclusive evidence and unfortunately we don't have that. So any input that can clarify or inform the information that we have would evidently contribute to getting a better outcome.

QUESTIONS FROM COMMISSIONER BELL:

Q. Mr Reczek, I've just got a couple of questions for you. Did you look at any of the flameproof boxes on any of the equipment on the surface at Pike?

A. No.

Q. So you've no opinion on the status or the condition?

A. No I don't. The only information I have had on status has been an audit report that I was provided with, which gave some reports as to the condition of equipment underground, including cables.

Q. What about portable gas monitors. Did you have a look at any of the ones that were available on the surface?

A. I haven't seen any of the technology other than the gas guard and the zener diode.

Q. And tell me about the gas guard and the zener barrier. Should that have been picked up do you think by maintenance people when they were maintaining that equipment?

A. It was certainly my expectation that it would have been. The explanation that was provided is that it was a difficult location to get to and because it's at the top of a shaft and they have to climb up a ladder and perhaps even stop the fan so I did ask the question, "Well, how frequently was the gas guard calibrated?" And I haven't had a response to that yet.

1711

Q. I'm just going to paragraph 59 of your statement where you say, "These current flows would almost certainly exceed the capability to deliver sufficient energy." What is your preference with the word "almost" because based on what you said before there seemed to be ample amounts of energy there?

A. Yes, I think there is ample. That's why I've said, "Almost certain." With these things I'm not comfortable to say it's certain unless you have an actual measurement. I would like to see some measurements taken, in a testing laboratory of what in fact was happening.

Q. We've had a lot of discussion about VSDs in underground coal mines and why they're there, why they're not there. What I'm trying to understand is why would you have them there in that set up, in that way when you could actually put them together and avoid the problem altogether?

A. Well, I think that's a question really for the designer. It seems self-evident to me as well that you would put them close together and bond them.

Q. So is there a benefit of having them the way they were separated by…

A. I can't understand what it is. In fact there are significant disadvantages in doing what they did. One of them is the increased voltage drop along the cable. So, I would need to understand what drove them to configure it the way they did. It may well have been convenience for the mine, I don't know.

QUESTIONS FROM THE COMMISSION:

Q. Mr Reczek, Mr Mount showed you a diagram, I haven't got the correct reference to it, from the Energy New Zealand report which shows the start-up process cycle for the number 1 fluming pump?

A. Yes.

Q. And can we have that on screen please?

WITNESS REFERRED TO DOCUMENT DOL3000140001/25

Q. You've explained to us there's this five second delay after stage 3 and before the VSD and the fluming pump cut in and are powered up?

A. My understanding is that all it's there for is to ensure that the cooling pump water is circulating through the system.

Q. Right.

1714

A. So it just allows a period of time for the pressure to build up and that pressure transducer would essentially say when that was correct and then there was roughly a five second delay just to allow that to circulate before the main drive started.

Q. Well, I'm afraid I haven't got past stage 2, all right. Can you just tell me what's the gland pump, the loop cooling pump and the cooling water pump. Are they all familiar to you?

A. No they're not. But I mean, to some extent they're a little bit self-explanatory in the sense that in the mechanical setup it's likely that they have friction-type bindings around the glands for the water, to prevent water leakage in which case you might have a pump circulating to ensure that that's cooled. Similarly, for the loop cooling. I don't know what they mean by loop cooling. And the cooling water pump, no I don't know.

Q. You've taken them to be ancillary pumps which have to be activated.

A. To enable the main pump.

Q. With a then delay to enable this very powerful main pump to be powered up by the VSD?

A. Yes.

Q. I'm intrigued by the name "harmonics" does that convey that these altered wavelengths which are no longer asymmetrical, as you have told us, do they create a sound?

A. They can indeed create a sound but it manifests itself in the windings and in the magnetic cores of transformers and in motors and it can manifest itself as a high-pitched whine if you can hear it. Usually the frequencies are much higher than that, than what you can hear or they might be dampened by other things such as oil or intervening material. But the harmonics, it's really a mathematical term which is used to explain that you need an infinite number of sine waves to create a square wave. They don't really exist as discrete frequencies, although they measure like that on an instrument.

Q. So that is the derivation not from my association with sound?

1717

A. No, I think, yeah, I think that it is, it does derive from sound in the sense that if you look at vibrating strings, and in a musical context you get one string vibrating with one, like at one node, and then you get the next string vibrating at a double node, so that would be a second harmonic or twice the frequency and then you can have another string vibrating at five nodes and that happens in a violin or in music generally, guitars, so I think the harmonics comes from the linkage between what we're looking at with the frequencies, and their coincidence with the driving frequency or the fundamental.

Q. I just want to be clear about something that arose when Ms Shortall was questioning you a moment ago. She put to you that the normal protection systems in the mine earth system do not pick up harmonic frequencies?

A. That's correct.

Q. Right, and you said that is so, but that these harmonics were being tested for and indeed identified within Pike?

A. Yes.

Q. How was that being done?

A. They have a special harmonic detecting instrument that you can connect to the, around the conductors of the power conductors, not in the earth circuit. It's in the power conductors and when you put a loop measuring device around the power conductor, then it induces a current or a voltage in that coil and it registers on an instrument what frequencies are present and what magnitude currents are present. It's a specialised harmonics detector.

Q. But if the detector is not used in relation to the earth system itself, how can you know that they, the harmonics are in that system?

A. Because you can see the distortion on the wave form, it has a screen on it and you can see the distorted wave form and it gives you a read out of the magnitude and the frequency of the waves that are present.

Q. Well, does that enable you to infer or deduce that the waves are within the earth system?

A. I think the way to detect them would be to open circuit the earth and put an instrument in the circuit, or go to a location in an earth conductor where you could put a instrument around the earth conductor. Now, they weren't concerned to do that, because at Pike they didn't see that there was a problem with currents in the earth circuit. They were more concerned with whether or not those harmonics were affecting the performance of the drives, so they weren't looking for the consequences to the earthing system.

Q. Right, so are you saying this device that was used in the way that you've described, could have been used in direct relationship to the earthing system?

A. Yes, it could.

Q. But wasn't in fact?

A. Yes.

Q. Finally, and this may not make a lot of sense to you, but I just need to ask the question, what degree of connection is necessary between a fuel source, explosive methane in this case, and an ignition source as you postulate here, arcing. In other words, is there some distance, connection or –

A. No. They have to be intimately engaged. The arcing source has to be within the explosive mixture.

Q. Thank you, so it wasn't an entirely silly question?

A. No.

RE-EXAMINATION: MS MCDONALD

Q. Mr Reczek, I'd just like to come back to one or two matters that counsel have asked you about, dealing first with one or two questions from Ms Shortall. If you have the Department of Labour investigation report with you, I want to take you to a couple of paragraphs there.

WITNESS REFERRED TO DOCUMENT DEPARTMENT OF LABOUR INVESTIGATION REPORT

Q. You were taken by Ms Shortall to page 162, paragraph 3.37. –

A. This is the Department's –

Q. Yes.

A. Sorry, what page was it?

Q. 162.

A. Yes.

Q. And Ms Shortall took you to paragraph 3.37.11.4?

A. Yes.

1722

Q. And I think she was suggesting the pathway of pipe work wasn't it?

A. Yes.

Q. I want to just take you back a paragraph, to the paragraph immediately above that because that puts the paragraph Ms Shortall put to you in context doesn't it?

A. Yes.

Q. And it starts doesn't it by saying, "As well as the interconnected earthing circuit the figure below shows a number of other potential paths."

A. Yes.

Q. And one of those other potential paths was the pipes.

A. Is the piping.

Q. And the interconnecting earthing circuit, is that what you have been talking about in your evidence?

A. Yes, it's the interconnected earths rather than the pipes or other metalwork.

Q. Still dealing with that report, you were taken by Ms Shortall to page 154, paragraph 3.37.7.4.

A. Yes.

Q. Now, I'll just give you a minute to read that paragraph in its entirety and then I want to take you to some other paragraph.

A. Okay. Yes.

Q. And you were asked by Ms Shortall about HF currents and I think you said that you didn't really know what they were but you thought they might be radio currents?

A. Yes, high frequency.

Q. And indeed if you look back a page to page 152, the HF term is defined in paragraph 3.37.5.5, as, "High frequency components generated by the VSD."

A. Yes.

Q. So coming back then to the paragraph on page 154, the last sentence of that paragraph says, doesn't it, that, "As evident below," and that's referring to the following paragraphs.

A. Sorry which one are you on now?

Q. 3.37.7.4.

A. Yes, sorry.

Q. The last sentence, "As evident below, if these harmonics are described as high frequency currents, there is much more common ground between experts."

A. Yes.

1725

Q. What you have been describing in your evidence today, in part you've been talking about high frequency currents, haven't you?

A. Yes.

Q. So and if you turn over the page to page 156, top two paragraphs 7.9 and 7.10, the first of those 7.9, "As discussed above, common mode voltages and stray voltages generated by high frequency components of the PWM waves can become capacitively coupled to the motor frame."

A. Yes.

Q. Is that what you were talking about earlier?

A. Yes.

Q. Last sentence on that paragraph, "This is another potential path for currents to travel throughout the mine environment."

A. Yes.

Q. The next paragraph, "Current from the high frequency components may also flow in other parts and enter other electrical circuits including the earth circuit."

A. Yes.

Q. And that's something you've told us about?

A. Yes.

Q. Now viewed in context with those other paragraphs, is in fact what Ms Shortall put to you a rejection of your theory or is it simply a description of the high frequency current?

A. I'm at a bit of a loss to know either. The other experts can be the people who normally work with high frequency components from VSDs and typically they're concerned with communication systems. In fact that's where most of the regulatory procedures are applied and they deal with noise and radio systems, telephone networks and those sorts of cases. All of those things are high frequency components generated by harmonics. In the context that I'm using it, they are lower than communication frequencies and they are in the order of the, the ones that have been measured or 350 Hz and up. So they are not radio frequencies, they are high frequency power frequencies. So, although they're the same thing, it's just that the – there is a difference in what the experts may or may not agree with.

Q. So effectively is this a distinction without a difference really?

A. I think so.

Q. Now just a couple of other matters, briefly, you were asked some questions by Mr Raymond and I want to take you while you've got the report in front of you to paragraph 3.37, it's page 150, 3.37.1.

A. Is this on outburst potential?

Q. No, no, page 150.

A. 150, sorry what was the number again?

Q. The first, paragraph 3.37.1.

A. Oh, yes, okay.

Q. And that paragraph confirms, doesn't it, that the Department of Labour report in relation to the underground electrical systems at Pike River remains incomplete at this stage?

A. Yes.

Q. And that's your understanding?

A. Yeah.

Q. So you, I think, are still working with the Department of Labour in relation to the electrical matters and in fact have not finalised your report yet?

A. Indeed.

Q. And your role in this matter was to determine the electrical source of ignition Mr Reczek wasn't it, not to assign blame?

A. Potential sources of ignition, yes. Not to be definitively defined the source, just to look for sources.

Q. And you were dependent on the information that was available to you at the time?

A. Yes.

Q. Now just one other discrete matter, you were asked some questions by Mr Mount about zoning.

A. Yes.

Q. And I think you made reference to the fact that the definition of zoning within the mine comes from the Australian standards, or New Zealand/Australian standards?

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A. They have zoning standards, yes.

Q. And I just want to be very clear about this. Those standards – and I just ask you to confirm that this is correct, if you agree with me – don't themselves apply to mining, in fact mining is specifically excluded in them –

A. Yes, they are.

Q. – but in Australia, those standards have been specifically adopted through gazetting or something in Queensland and New South Wales, I think?

A. Yes, but not that way, what – they don't apply. It's generally best practise that you refer to the standards for, particularly in the coalmining context because usually the zoning provisions aren't allowed to apply. You use the legislation and how it's defined.

Q. I just wanted to be clear about that for the record, but it doesn't alter your evidence which has been based on best practise standards?

A. Yes.

THE COMMISSION ADDRESSES WITNESS

WITNESS EXCUSED

COMMISSION ADJOURNS: 5.32 PM

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