Tuesday, 27 November 2018
(10.00 am)
SIR MARTIN MOORE-BICK: Good morning, everyone. Welcome to today's hearing.
We are going to hear some more expert evidence today from the person who has been instructed to look into the electrical aspects of this matter.
Yes, Mr Kinnier.
MR KINNIER: Thank you, sir.
May I call Dr Duncan Glover.
SIR MARTIN MOORE-BICK: Thank you.
DR J DUNCAN GLOVER (sworn)
Questions by MR KINNIER
SIR MARTIN MOORE-BICK: Thank you very much, Dr Glover. Sit down and make yourself comfortable.
THE WITNESS: Thank you, sir.
SIR MARTIN MOORE-BICK: Right. Yes, Mr Kinnier.
MR KINNIER: Thank you, sir.
First of all, would you mind confirming your name for the record.
A. Yes, my name is John Duncan Glover.
Q. Dr Glover, thank you very much for attending to give evidence today.
First of all, can you confirm that you provided a report dated 15 October of this year, a damage

assessment memorandum also dated 15 October of this year, and an addendum dated 16 November of this year; is that right?
A. Yes, three separate documents.
Q. For the avoidance of doubt, although headed "draft", both your report and the damage assessment memorandum are in fact the final versions; is that right?
A. That's correct.
Q. Do you confirm that the facts and matters set out in the report, the damage assessment memorandum and the addendum are true to the best of your knowledge and belief?
A. Yes, I do.
Q. Is it right that you have provided the report, the damage assessment memorandum and the addendum in the same way as you would've provided those documents to a court?
A. Yes, sir.
Q. Finally, does your report, damage assessment memorandum and addendum set out your opinions on the matters relevant to this inquiry?
A. Yes, that's correct.
Q. Thank you.
Dr Glover, the first issue I'd like to cover with you is your qualifications. You set out those

qualifications at section 1.3 of your report at page 4, and at appendix D of that report.
I'm not going to go through all of that, but I would like to pick out some key points.
First of all, is it right that you're a registered professional engineer in the Commonwealth of Massachusetts?
A. That's correct.
Q. Since 2004, you've been the president and principal engineer of Failure Electrical LLC.
A. Yes, sir.
Q. You hold a BS degree in electrical engineering from the University of Massachusetts.
A. Yes, in Amherst, Massachusetts, correct.
Q. You also hold an MS degree in electrical engineering from the Massachusetts Institute of Technology.
A. Yes, that was in 1968. That's correct.
Q. In addition, you were awarded a PhD in electrical engineering from MIT in 1971.
A. Yes, sir.
Q. Is it right that you're a life senior member of the Institute of Electrical and Electronic Engineers?
A. Yes, sir.
Q. You are also a member of the National Fire Protection Association.

A. I am.
Q. Between 1977 and 1990, you were a tenured associate professor in the Electrical and Computer Engineering Department of Northeastern University.
A. Yes, I started out as an assistant professor, but I worked myself up to a tenured associate professor.
Q. Finally, you were also a principal engineer at Exponent Analysis Associates for a period of time.
A. Yes, for 14 years, up to 1990, I was at Exponent.
Q. Thank you.
The next topic I'd like to discuss with you is the purpose of your report.
Is it right that the purpose of the report, the memorandum and the addendum is to assess the fire origin within an area that has already been established by other investigators retained by the inquiry?
A. Yes, that's correct.
Q. As set out in section 1.1 of your report at page 3, non-electrical fire origins are outside the scope of your expertise; is that right?
A. Yes, I'm not an expert in non-electrical fires, only electrical fires.
Q. In relation to the identification of the area of origin of the initial fire within flat 16, as set out in section 2 of your report, at pages 6 to 8, you've relied

upon the analyses of Professors Bisby and Nic Daeid; is that right?
A. Yes, I have.
Q. Accordingly, is it right to say that you've taken for the purpose of your report, the memorandum and the addendum, the area of origin to be the south-east end of the kitchen, between the kitchen window and the edge of the cooker?
A. Of flat 16, that's correct.
Q. Mindful of the limits of your expertise, have you seen any other evidence which casts doubt over their identification of the area of origin?
A. No, sir.
Q. Thank you.
The next topic I'd like to discuss with you is your examination of the physical evidence.
First of all, as set out in the damage assessment memorandum, is it correct you inspected 14 exhibits retrieved from flat 16?
A. I inspected many more exhibits than that, but there were 14 exhibits that are specially referred to in my damage assessment memo.
Q. In broad terms, the exhibits you examined were a variety of electrical components and wiring; is that a fair if broad summary?

A. Yes.
Q. Is it right that your examination also relied upon a range of technologies, including CT scans, scanning electron microscopy and energy dispersive X-ray spectroscopy?
A. Yes, as well as optical microscopy.
Q. The range of technologies you've relied upon are set out at section 1.1 of your memorandum; is that right?
A. The damage assessment memo, yes.
Q. The next topic I'd like to discuss with you is arc damage.
Is it fair to say that the principal object of examining the exhibits was to determine the existence of arc damage?
A. That was the principal. I did have some other side issues in terms of counting wire strands via the CT scan and looking at some wire connectors, but one of the primary objects was to evaluate the possibility of arc damage for the 14 exhibits.
Q. In that respect, could I ask you to turn to section 2.1 of the damage assessment memorandum. It's up on the screen, Dr Glover, which may be easier than trying to plough through the various files.
Before we go into the meat of that particular section, would you agree that the basic starting point

is that damage to electrical components can occur as a result of electrical and non-electrical events?
A. Yes.
Q. And that whether an event was electrical or non-electrical can indicate whether the damage was part of the cause or the result of a fire; is that a fair summary?
A. Two options, yes, two possibilities there.
Q. Is it right to say that electrical damage can indicate abnormal electrical activity?
A. That it would, yes.
Q. That was capable of causing a fire?
A. It's capable of causing a fire and also could be the result of a fire.
Q. Before we turn to the characteristics of arc damage, could you help us with an explanation of some basic technical terms that you refer to in your report and other documents.
First of all, and at its most basic, what's a short circuit?
A. A short circuit is an abnormal electrical condition where the electrical current becomes much higher than what is normally expected for the device that's carrying electrical current. It's usually caused by an insulation failure, a failure of the electrical

insulation that protects the wires and the components, and normally you would have a very high current that could possibly trip a circuit breaker, cause a circuit breaker to operate, or a fuse to blow.
Q. Thank you.
Secondly, what's a high-current ground fault?
A. Excuse me?
Q. What's a high-current ground fault?
A. Okay, that would be a short circuit that involves current flowing from an energised wire, a live wire, to a grounding wire or some metallic path to ground. It's out of the normal path of electricity. Normally electricity will flow down the live wire from a consumer unit or a fuse box, through an appliance or an electrical device, and then will return through a neutral wire. But when you have a problem, a short circuit involving ground, the current is diverted to another path, either the grounding wire or some electrical metallic path to ground.
Q. Thank you.
Finally, in your report you refer occasionally to an overcurrent; what's an overcurrent?
A. It would be not as severe as a short circuit, but it would be higher than the normal load current that a device carries.

Q. In relation to a short circuit, or a high-current ground fault, can we say that the energy released by these events is sufficient to melt metals, thereby creating a gap of sorts?
A. Yes, especially if there is an arc involved, where the electricity flows out of the wire, through insulation or through an air gap, and you have a luminous discharge. It becomes very, very hot, temperatures in thousands of degrees that are capable of melting metals such as aluminium, copper, even steel.
Q. It's that temperature and its consequences which are the primary consequences of what I've called the gap?
A. Yes.
Q. You note that abnormal electrical activity is often identifiable after a fire because it leads to arc damage; is that a fair if basic summary?
A. That is, yes.
Q. Again, I turned earlier on to section 2.1 of your damage assessment memorandum, and if I could ask you to look at the bottom of page 5, there you've identified nine of the characteristics of arc damage -- the ninth is overleaf -- at the bottom of that page. If we could just go through those.
First of all:
"(1) Sharp demarcation between damaged and undamaged

area of the energized copper conductor."
Again, can you give us a brief explanation of how that result is caused?
A. First, I would say that these nine items are taken from a document entitled the National Fire Protection Association, NFPA, document that covers a guide to fire explosions, and there is a chapter on electricity in that document. This is excerpted, these eight -- maybe there's a ninth one on the next page --
Q. There is.
A. -- items are excerpted from the NFPA guide.
Q. As I understand it, this list of nine characteristics is not exhaustive; it's illustrative only.
A. That's correct.
Q. Again, looking at the first characteristic, the sharp demarcation between the damage and undamaged area of the energised copper conductor, how does that happen in straightforward terms?
A. Yes. Well, as I mentioned, in the area of the arc, the temperatures can be very, very high, thousands of degrees centigrade/Celsius. But those temperatures are also very localised for a very small area in the vicinity of the arc, so that if you go perhaps a centimetre away from the arc location, you will not have the melting and the arc damage. So that's what we

call a sharp line of demarcation between the arc area where the melted or resolidified metal is observed, and yet a short distance way, a centimetre or less, no damage.
Q. Can we take it from the fact that the sharp demarcation is the first of these characteristics that it's the principal or most important characteristic of arc damage?
A. It's the one that I look for. It's the most readily recognisable characteristic.
Q. As we go through the list, number (2) is:
" (2) Round, smooth shape of artifact."
Can you explain in layman's terms what that indicates?
A. Well, very often when you melt copper, say, from a wire, that will result in a round -- what we call a copper bead. The copper strands on the wire, if it happens to be a stranded wire, will melt, and then they will resolidify into a round copper bead.
Q. Indeed, later, when we come to look at photos of certain exhibits, we'll see illustrations of copper beading, I think; is that right?
A. We will, yes.
Q. Number (3) is:
"(3) Localized point of contact."

Again, that flows from the explanation you've previously given as to what arc damage is, I assume.
A. Yes, it's very localised.
Q. Again, number (4):
"(4) Identifiable corresponding area of damage on the opposing (neutral) conductor or opposing grounded metal surface."
Again, that flows from the elemental explanation you've given of arc damage?
A. That's mainly a fundamental concept of electric circuits, where when current flows, it always flows in closed paths. So normally current will flow from, say, a consumer unit or a fuse box down a live wire, and it will return, after it passes through the load, through a neutral wire, back to the consumer unit. So you have current flowing in a closed path.
When you have arcing, the current gets out of the bag, so to speak. It flows through an abnormal path. It may have a luminous discharge, the arc may be flowing through air or gas or tracking through some damaged insulation. That current still has to return to the consumer unit. That's why you will often see a corresponding identifiable area of arc damage on a return wire or some metallic path.
Q. Again, that point is relevant when we come to look at

the various appliances and remnants of wiring that you examined for the purposes of the memorandum?

A. Yes.

Q. "(5) Locally enlarged grain size.

"(6) Resolidification waves."

In respect of number (6), can you explain that for us in layman's terms, what that characteristic involves?

A. Normally I don't look at (6) too much, and that's described in some of the appendices and documents that are associated with the NFPA guide to fire explosions, but when there is a melting of -- in this case we're talking about copper, and then a resolidification, there would tend to be waves on the resolidified copper.

Q. Is it a characteristic that is relevant to your analysis set out in the report in the other documents?

A. I did not particularly look at any resolidification waves.

Q. Looking at number (7):

"(7) Copper drawing lines visible outside the damaged area."

Again, can you give us a brief explanation as to why that's looked for as a characteristic?

A. Yes. As I mentioned, when you're a short distance away from the arc damage, you don't have arc damage. You will have the copper wires, if they're stranded. When

copper wires are manufactured, often there will be visible lines on these copper wires as manufactured, and you can often see that close to the arc damage.

Again, it ties back to item 1. You get a fine line of demarcation. So if you look at the wires that are close, the copper wires that are close to the arc but not damaged, you can often see these lines that were part of the manufacturing process of the copper wires.

Q. Thank you.

In respect of (8):

"(8) Small beads and divots over a limited area."

Again, am I right in assuming that would be a consequence of the cause of the arc damage that you outlined when explaining the nature of arc damage previously?

A. Yes, and there are examples of that, photographs that I have taken from the NFPA guide, that show the copper beads and divots or notches in the wires as a result of arc damage.

Q. Thank you.

Paul, if we could turn over the page to the top of page 6, the ninth and final characteristic:

"(9) High internal porosity when viewed in cross-section."

Again, can you give us a brief explanation of why

that's looked for as a characteristic of arc damage?

A. This is a more recent phenomena in addition to the current edition of the NFPA guide, using, I believe, the 17th edition, and some researchers have looked at arc beads, copper beads that have arced, and they have cross-sectioned them in the laboratory and found that when you have arc beads caused by arc damage, the cross-section of those beads will show a high porosity, very porous, as opposed to fire damage.

In the NFPA guide, when they talk about a fire-damaged copper, they call it a globule as opposed to a bead. Still round, looks very much similar, but when you cross-section a fire-heated globule of copper, you don't get the high porosity that you get from an arc-damaged bead.

Q. Thank you, Dr Glover.

You adverted to the difference between the characteristics of arc damage and characteristics of fire damage, and if we could ask you to turn to section 2.2 of your memorandum, which is at JDGM0000003_0010, we can see in the top of that section, you say:

"Copper conductors may be damaged before or during a fire by other than electrical means and often these effects are distinguishable from arc damage ...

"When exposed to fire or glowing embers, copper conductors may melt (the melting temperature of pure copper is 1085°C/1984°F). At first, there is a blistering and distortion of the surface, as shown in Figure 8 ..."

If Paul could de-amplify that and amplify figure 8 for us.

It may be fairly obvious, Dr Glover, but see on the big screen behind your shoulder, would you mind identifying for us the blistering and distortion to which you refer in the preceding paragraph?

A. Yes, sir. Again, this is a figure that's taken right out of the NFPA guide to fire explosions, and you can see --

Q. Don't worry, there's a microphone there.

SIR MARTIN MOORE-BICK: They're quite good microphones, they'll pick you up. You don't have to get too close.

A. Thank you, sir.

So you see instead of a copper wire that's been fire-heated, you can see the blistering and surface deformations. These are copper that is just beginning to see the effects of a high fire-heated copper. Blistering along the surface of the copper conductor.

MR KINNIER: Thank you, Dr Glover.

After blistering and distortion, what happens next?

A. Then with additional fire-heating, you will get what is called a thinning of the wires, the wires diameter will become thinning, that's sometimes called necking, and you also see the formation -- we don't call them beads, we call them globules, but they're very similar. They're round globules of copper that has melted. You can see them in the figure here.

Q. Yes. I think if Paul first of all amplifies figure 9, and then if you could identify the globules for us.

A. Yes, you can see a globule here.

Q. Yes.

A. It's a round artefact of copper that has melted and then resolidified, and you can also see the thinning of the copper wire close to that globule as opposed to back further, where the wire maintains its original diameter.

Q. Thank you, Dr Glover.

Looking at how you've summarised the differences between electrical damage and non-electrical damage, is it fair to say the most important characteristic of non-electrical fire damage is that, in contrast to arc damage, the damage is spread over a larger area and there is no sharp line of demarcation; is that a fair if general summary?

A. That's correct. If you can imagine a fire attacking a copper wire, it wouldn't be as localised as an arc,

which is very localised.

Q. When you've determined that electrical arc damage has occurred to a segment of copper wire, is it right that your next step is to identify the origin of the segment by determining whether the following features of the wire match features at each possible location of origin, such as strands?

A. Yes.

Q. Is that right?

A. Yes.

Q. The first stage of that appears to be, on the basis of your report, a simple counting of the number of strands; is that right?

A. That's one method, yes.

Q. The next stage appears to be measuring the diameter of those strands.

A. Yes, sir.

Q. In addition to examining the exhibits themselves for physical damage, is it right that you've also looked at other sources of evidence that have helped you?

A. Yes.

Q. First and foremost, you've looked at the witness evidence of the former occupants of flat 16; is that right?

A. Yes.

Q. You've also looked at what evidence can be deduced from the associated circuit breakers in the fuse box; is that right?

A. Yes, I call it the consumer unit, but that would be the fuse box.

Q. You've also looked at whether the fuse in a relevant appliance or device's plug is intact or blown.

A. Yes, the fuses were looked at and examined for the various appliances to determine whether they were intact, as you say, or blown.

Q. Finally, you've looked at the extent and pattern of any heat damage to a particular appliance or device.

A. Yes, to all of the devices that were in the area of fire origin that were established by the other investigators, Professors Bisby and Nic Daeid.

Q. Thank you.

Dr Glover, when we come onto it, we're going to have much discussion of the relevant circuit breakers and the main switch on the fuse box itself.

But before we come on to that, can you help us, in relation to the fuse box consumer unit, why is it relevant whether a particular circuit breaker was found in the off position or not?

A. Now, it's a very interesting event that occurred, that the occupant of flat 16, Mr Kebede -- I hope that I'm

pronouncing that correctly -- before he vacated the apartment, he turned off the main switch at the consumer unit, so that any other device at that consumer unit that was found in the off position would've had to have operated before Mr Kebede turned off the main switch. When he turns off the main switch, the consumer unit is now de-energised and there's no way that a circuit breaker could operate automatically after he does that.

Q. So it provides us with a snapshot of the circuits that had been tripped before the fuse box was turned off, and that's its importance; is that a fair summary?

A. That's correct. When you say the word "tripped", I mean, that would be a circuit breaker that operates to the off position automatically. We say in the engineering lingo that that means the circuit breaker tripped.

Q. Thank you.

Finally, in relation to setting out the basics, in section 10.3 of your report -- we don't need to go to it unless you want to -- you refer to evidence of "other abnormal electrical activity", which appears to be evidence above and beyond arc damage.

What evidence are you referring to here? What particular class of evidence are you thinking of here?

A. I'm sorry, are we in my report --

Q. In your report --
A. -- or the damage assessment memo?
Q. It's in section 10.3 of your report, page 39, and the reference is JDGR0000001_0039. It's point (3):
"(3) There is no evidence of arc damage or other abnormal electrical activity ..."
Do you have it there on the screen, Dr Glover? It's easier if you look at it on the screen, I think.
A. Okay.
Q. You see there 10.3?
A. Yes, sir.
Q. In subparagraph (3), you say:
"(3) There is no evidence of arc damage or other abnormal electrical activity ..."
Can you help us, it's just a general question, what other abnormal electrical activity are you referring to there above and beyond evidence of arc damage?
A. The main thing is the arc damage, in this case the copper wires that have melted in locations and that have been determined to be arc damage as opposed to fire damage.
There are other abnormal electrical events. If you have, for example, printed circuit boards in the device, you could look at components on the board, capacitors or other electrical components, and look for arc damage or

other types of abnormal electrical activity. Perhaps, for example, if the capacitor is punctured, that there was an internal event that caused a puncture that you could observe in that component.
You could also look for something called electrical tracking, along a printed circuit board.
So it would be a matter of examining the electrical components in addition to the wires.
Q. That's very clear, thank you.
SIR MARTIN MOORE-BICK: Dr Glover, forgive me, I think you're getting a bit too close to the microphone. It will work very well at this sort of range. And will save you leaning forward as well. All right?
A. Thank you, sir.
SIR MARTIN MOORE-BICK: Thank you.
MR KINNIER: Dr Glover, thank you.
The next topic I'd like to come on to is evidence of electrical arc damage itself.
We'll now turn to the principal points of the analysis which you've summarised in the memorandum.
Starting at the outset, correct me if I'm wrong, but your essential conclusion is that only two of the exhibits that you examined showed evidence of electrical arc damage; is that correct?
A. Yes. There were two exhibits, MJS/1 and JDG/1, that

I concluded suffered arc damage. All of the other remaining 12 exhibits did not suffer arc damage.
Q. Thank you.
Turning to exhibit MJS/1, starting with the most basic question, what is MJS/1?
A. Okay, MJS/1 is -- first I'll go to it. Perhaps I could show a photograph of it.
Q. Yes, probably the easiest reference is that one which has just come up on the screen.
A. In my damage assessment memo, you will see MJS/1, which are basically two copper wires. There is one segment that is approximately 10 centimetres in length -- there is a scale there, the yellow scale that shows one of the wire segments. There is a separate wire segment, but the interesting one is the 10-centimetre length wire that has a fused area. What I mean by "fused" is there is melted copper between the two wires that is to be examined, and once I examined that, I determined that it was arc damage.
Q. Stopping there, might I invite you to do this in the old-fashioned way. Pointing on the big screen above you, can you identify for all of us the area which you consider to be fused?
A. Yes. So here is this approximately 10-centimetre length of two wires (Indicates). Both of them are stranded, by

the way, each wire has 24 strands in it. But approximately 1.5 centimetres from this end (Indicates) -- it's kind of blurry here, so there will be other microscopic photos that will show the fused area -- the two wires are affixed to each other, and there is melted and then resolidified copper that fuses the two wires together.
Q. Thank you. Apologies for asking you to get up and down, but sometimes it's easier just to point on the screen.
Can you remember from where MJS/1 was recovered within flat 16?
A. Yes, it was recovered in one of the bedrooms, and it was recovered some 27 days after the 14 June 2017 fire.
Q. Looking at the composition of MJS/1 itself, you've adverted to some of this, but you describe it as consisting of two stranded copper wire segments of approximately 10/11 centimetres length, with a separate stranded copper wire segment approximately 5 centimetres in length. Is that a fair summary of its composition?
A. Yes, and that's shown in the photo here on the screen.
Q. Am I right in saying that approximately 15 millimetres from the end of one segment, there's the fused area of 3 millimetres in length to which you've just referred?
A. Yes, 15 millimetres or 1.5 centimetres away from the right end as shown in this screen.

Q. The precise dimensions of the fused area is 3 millimetres or thereabouts.
A. The width of the fused area, yes.
Q. Can we now turn to exhibit JDG/1.
In respect of that, can you give us a basic explanation. What is JDG/1, first of all?
A. Okay, and you've gone to figure A2?
Q. Yes.
A. Actually, is this out of my report or out of my damage assessment memo?
Q. This is the report.
A. Okay. So, again, we have copper wires, and there is a close-up of it.
Q. Looking at its composition, is it right to say that it consists of stranded copper wire segments of approximately 4 centimetres in length?
A. Yes. And you can see them along -- there's actually two wires on the outside and there are segments of wire, a third wire, in between, and then there is a cross-wire here, with a -- now you can see a copper bead, resolidified copper bead, at one end of JDG/1.
Q. The site of the copper bead, is that the evidence of arc damage upon which you rely?
A. It is, yes.
Q. Thank you.

Can I turn to the question of strand counts in respect of both these exhibits.
First of all, am I right in understanding that you've measured both the strand count and the diameter of both of these exhibits?
A. Yes.
Q. If I ask you to turn to section 4.4 of your report, and the penultimate paragraph on page 20 of your report -- Paul, the reference you have, but is JDGR0000001_0020.
I think what you set out there in the penultimate and final paragraph are the strand count, first of all, and the dimensions of the two exhibits; is that right?
A. Are you referring to the last paragraph on page 20?
Q. The penultimate, first of all.
A. The penultimate, the next to last.
Q. Yes.
A. Okay. Yes, both MJS/1, which we looked at previously, and now JDG/1, both of them, each wire in those two exhibits, each one has 24 strands. Those are 24-stranded wires. We also measured the wire diameter two different ways using calipers in the laboratory and using the calliper tool at the CT scanner at Nikon up in Tring. We measured the wire diameter two ways, and there's some variability in diameter depending on how tight you push your calipers against the copper, or how

you set the cursor on the CT calliper tool.
But we were measuring diameters approximately 0.16 up to 0.18 millimetres for not only MJS/1 but JDG/1.
Q. Thank you.
Turning now to the final paragraph on that page:
"As noted in Section 8.2 of this report, Exhibit MJD/38, the medium sized freezer includes wires with 24 strands and strand diameter of 0.16 — 0.18 m. Also, as noted in Section 12.9, Exhibits BPS/3 and BPS/4, components of the fridge freezer, include wires with 24 strands and strand diameter of 0.16 [and] 0.18 m."
Can you help us as to why you've set out that information there, why you consider it to be relevant?
A. Well, the question is: where do we find wires with 24 strands?
As I said, MJS/1 was found lying on the floor in the bedroom some 27 days after the fire, and JDG/1, by the way, was found inside -- I found that in one of my April inspections at Bureau Veritas down in the Bermondsey area of London. I found that inside of the medium-sized freezer. Okay?
So now I was interested in where you might find other wires, particularly in the area of fire origin within flat 16, that have 24 strands like these two arc-damaged exhibits, and I found them in two locations.

I found them in the medium-sized freezer, for example the power supply cord, or what you might call the main supply flex, as well as other wires within the medium-sized freezer. I also found 24-strand wires within the fridge freezer of flat 16.
Q. Thank you.
The next topic I'm going to come on to is the consumer unit and the circuit breakers.
If I could ask Paul to bring up a photograph, which is at JDGR0000016_0001. If I could ask Paul to turn the page.
Dr Glover, it's probably easier if I ask you to talk us through these photographs. You can identify those features which you consider to be pertinent.
First of all, what does figure A1-1 show us?
A. Yes, both of these figures, A1-1, show the consumer unit, you might call it the fuse box, from flat 16.
These are not my photos; these are photos that were in the file.
On the left side is the main switch, this red switch here, and that's the switch that Mr Kebede turned off as he vacated flat 16 on the night of the fire.
Then there are various circuit breakers to the right of the main switch. There are better photographs as we moved on, but two of them in particular were found in

the off position, two of these circuit breakers. One was the circuit breaker for what we call circuit 7, which fed the sockets in the kitchen of flat 16. There will be better photos of that. Circuit 7 is just to the right of this what we call an RCCB circuit breaker.

Q. Is circuit 7 that (Indicates)?

A. Yes.

Q. The penultimate from the right-hand side?

A. Yes. The last one is circuit 8, which was not off. Circuit 8 was in the on position.

The second circuit breaker that was found in the off position was just to the left of the circuit 7 breaker, and that is a special breaker. It's called an RCCB, a residual current circuit breaker. It's designed to detect small ground currents that get out of the normal path of flow of electricity.

Q. If I can take a step back and ask you a question about circuit 7.

You mentioned that it served the sockets in the kitchen. Is it right to say that the pertinent feature of circuit 7 for our purposes is that was the circuit upon which the large fridge freezer was plugged into?

A. I'm sorry, that was the circuit that what?

Q. The large fridge freezer was plugged into.

A. Yes, it was. The fridge freezer was plugged into

circuit 7 within the kitchen of flat 16.

Q. Okay.

If I can ask you now to go to -- over the page is probably easier, now. Again, the top photograph, figure A1-3, gives a close-up shot of the main switch in the off position; is that right?

A. That's correct, that's the red one.

Q. If we can remove that, Paul.

Then if we can amplify figure A1-4, and we see the second in from the right-hand side is the circuit breaker for circuit 7; is that right?

A. Yes, and it's in the off position.

Q. Again, moving leftwards, we see the RCCB also in the off position.

A. Correct.

Q. Thank you.

Paul, if we can put those photographs down, and if I may ask you, Paul, now to turn to section 3.4 of Dr Glover's report, which is JDGR0000001_0010.

It's section 3.4, which is the bottom of that page. Paul, could I ask you to amplify that.

Under the heading "Circuit Breaker Operation, Timing & Sequence", you say this:

"It is most likely that the two circuit breakers (6th and 7th circuit breakers to the right of the Main

Switch) found in the OFF position operated automatically ('tripped') as a result or a short circuit/over current, rather than being manually operated to the OFF position, as follows. First, Mr. Kcbede stated that he turned off the main red electricity switch; his interview statements do not state that be turned off any other circuit breaker. Second there is no record that any fire brigade personnel, fire investigator or other person manually timed off these two circuit breakers. Third, evidence of arc damages to Exhibits MJS/1 and JDG/1 provides an indication of a short circuit sufficient to trip the 32A MCB for Circuit No.7 (See Section 4)."

"After Mr. Kebede turned off the Main Switch, all electrical circuits in Flat 16 were disconnected from the electric utility power source. No circuit breaker could have tripped after the Main Switch was turned off. That is, both of the circuit breakers that tripped had to have tripped OFF during the initiation or early stages of the lire before Mr. Kebede turned off the Main Switch."

Stopping there, does that remain your view?

A. Yes, and that's a key element of my conclusions. That was a clue that was very important to me, that we have two circuit breakers that tripped early on in the fire,

or in the initiation of the fire, and those would provide a clue to find out what caused those circuit breakers to trip and would lead me to the fire origin.

Q. Flowing from that, you set out on page 11 the two possible sequences for the tripping of the two circuit breakers.

If you could just talk us through, first of all, sequence 1.

A. Okay, so we've got two tripped circuit breakers: the RCCB and circuit 7 for the kitchen, and they could have both tripped simultaneously for one event in the kitchen affecting circuit 7, a short circuit that would involve a live wire shorting to ground or arcing to ground. It would have to involve ground or some metallic path to ground in order for the RCCB circuit breaker to trip simultaneously with the circuit breaker for circuit 7.

So that's option 1. You could have one event affecting circuit 7, those are the sockets in the kitchen and devices connected to those sockets, that tripped both breakers at the same time.

Q. Thank you. Then compare and contrast sequence 2. Could you talk us through the hypothesis there.

A. The second option is you would first have -- I'm going to say first would be a short circuit in circuit 7 that did not involve ground, it involved a live wire arcing

to the neutral wire, not to a ground path. So that would not trip the RCCB that's only looking at ground.

So that would be the first event. You could have a short circuit, again in the kitchen, circuit 7, affecting the sockets in the kitchen, that did not involve ground, that would cause the circuit 7 MCB to trip.

But then how does the second breaker, the RCCB, trip? That would be a later event. Now circuit 7 is de-energised. The RCCB is looking at two circuits, circuit 7 and circuit 8. So circuit 7 has now de-energised, so the second event would happen in circuit 8. Circuit 8 are the flat sockets, the sockets in the remaining portion of the flat, not involving the kitchen. So that would be the second one.

I do say that that RCCB would have to have occurred after circuit 7 trips; it could not have been before.

Q. Flowing from that point, of these two hypotheses, which one do you consider to be more likely?

A. At this point, I'd have to fast forward to other evidence that I looked at. It's more likely now that I've looked at all of the evidence that there were two separate events, that circuit 7 tripped first for a line to neutral fault, affecting that circuit, or some device connected to circuit 7 in the kitchen, and then the

second event occurred at a later time. That's my opinion now. At this point in the report, I just leave the two options, there are two possibilities.

Q. So cutting to the chase, you consider sequence 2 to be more likely?

A. I do, yes.

Q. Okay.

Having regard to the evidence, in the final paragraph of page 11 of your report, so staying on that page, you say this:

"Based on the above analysis of the timing and sequencing of the two circuit breakers that tripped, it is probable that the fire origin is: (1) within the area of fire origin; and (2) at the electrical component that caused the circuit breaker for Circuit No.7 to trip."

First of all, does that remain your view?

A. It does, yes.

Q. Putting it somewhat differently, to what extent does identifying the circuit breakers which did not trip provide useful evidence in ruling out certain appliances in relation to origin?

A. Could you repeat that?

Q. Of course.

Looking at the alternative analysis, to what extent does looking at the circuit breakers which did not trip

help you in identifying origin?

A. Well, that would be looking at the circuit breakers that did not trip would be very helpful to rule out items as a probable fire origin.

Just to give you an example, there is a cooker in the kitchen. The cooker is adjacent to the fridge freezer -- we may look at that later -- and that cooker was supplied by a dedicated circuit, actually circuit number 1. So the cooker in the kitchen was not supplied by circuit 7.

So that would allow me, just from that, along with many other things, pieces of evidence, to rule out the cooker as a probable fire origin.

Then you could go on to other devices that were not connected to circuit 7 that could also be ruled out.

Q. Dr Glover, that's useful. We will come on to the individual appliances. As you say, that point becomes more vividly illustrated there.

Before we leave the issue of the consumer unit and circuit breakers, one point has arisen in relation to which it would be very useful to have your help and guidance, and that's understanding the role of circuit breakers in the prevention of an electrical fire.

First of all, can you help us with the most basic question: what's the purpose of a circuit breaker?

A. It is a safety device.

Q. Being more specific about it, is the aim to prevent I think what you've described elsewhere as a violent event, or, alternatively, is it to cut the violent event, or is it both?

A. It is both. You would hope that a circuit breaker would trip when there is an abnormal electrical event, a short circuit or an overload, and you would hope that it would trip before a fire occurs, but that's not always the case.

Q. One question that's arisen that your views would be sought on is: is there a reason why the circuit breakers were not able to prevent the fire starting in the first place?

A. Circuit breakers take time. They have to detect the short circuit and then, after they detect the short circuit, it takes time for them to open their contacts, to de-energise the circuit. So there is a time delay involved. Again, if the short circuit is not too violent, or it doesn't immediately ignite combustibles in the area of the short circuit, then the circuit breaker is successful in de-energising the circuit before a fire.

However, it's possible that if you have combustibles in proximity to the short circuit, to the arcing, that

those would ignite very quickly before the circuit breaker or a fuse has an opportunity to de-energise the circuit.

Q. I don't know whether you're able to express a view on this, given what you've seen, but are you able to help as to whether you think the circuit breaker operated sufficiently quickly here or insufficiently quickly?

A. I didn't notice any defects in the circuit breaker. It did its job. But circuit breakers are not perfect. They can't pre-predict a fire; they have to wait until the short circuit occurs, until the arcing occurs, until there's enough overcurrent sufficient to trip the breaker.

Q. Do you have any cause to believe there was any fault or defect of any sort in the consumer unit?

A. No, I have no reason to see any defects in the consumer unit.

Q. Thank you.

Dr Glover, I now want to turn on to the analysis you conducted of the various electrical appliances and other electrical items.

The first electrical appliance I'd be grateful for your help in relation to is the kitchen extractor fan.

For that purpose, first of all, it would probably be useful if, Paul, you could draw up section 11.7 of

Dr Glover's report.

First of all, Dr Glover, that sets out the summary of your views in relation to the examination of the extractor fan; is that right?

A. Yes.

Q. Can you confirm whether the extractor fan formed part of circuit 7 or not?

A. Yes, the extractor fan is located in the window on the east side of the kitchen, and the wires that supply the extractor fan come from circuit 7. There's a spur that taps off of a socket behind the fridge freezer that supplies power to the extractor fan.

Q. Am I right in understanding you examined five exhibits originally forming part of that fan for the purposes of your report?

A. Five exhibits? This is all related to the extractor fan?

Q. All related to the extractor fan. Can you remember now?

A. I'd have to count them.

Q. Don't worry. But you certainly examined components and wiring relating to the extractor fan?

A. Yes, I examined all the exhibits that were associated with the extractor fan, and they were in different categories. The fan motor, for example, is MJS/6. There was debris found in the window below the extractor

fan. Various other items were collected and I examined all of them.

Q. That's useful. If we look at 11.7 itself, you say this:

"The following observation supports a fire origin at the extractor Pan in Flat 16:

"(1) Most of the components are missing from the control board, including a (rectangular shaped) capacitor from the ... power supply section of the control hoard."

Can you help us, why does that support a fire origin at the extractor fan? To the lay reader, it looks neutral at best.

A. Sometimes when you have a fire that initiates on a control board, a printed circuit board, you will see components missing, and you also see, perhaps, non-uniform fire damage. One section of that control board, that printed circuit board, would be more heavily fire damaged than another section. So that's the type of things you look for.

Missing components. If you have missing components, you have no way to evaluate them for abnormal electrical activity. For example, if you have a capacitor where there's been an internal short circuit within the capacitor and it's been a catastrophic failure that punctures the enclosure of the capacitor, you would only

be able to determine that if you had the capacitor to examine.

So when you have missing components or if you have non-uniform fire damage, that would be a possibility of a fire origin there.

Q. Understood.

You then go on to say:

"Conversely, the following observations do not support a fire origin at either the extractor fan or the wiring and switches from the spur to the extractor fan.

"(1) No arc damage or abnormal electrical activity is observed on any of the following Exhibits related to the extractor fan ..."

You referred earlier on to MJS/6 in particular:

"(2) The short eh-cult/overload that caused the circuit breaker for Circuit No. 7 - Kitchen in Flat 16 to trip on the night of the fire did not occur in the extractor fan or any wire or electrical/electronic component downstream of the isolator switch. If it had, the 3A fuse in the isolator switch would have blown more quickly than the circuit breaker, which did not occur."

Does that remain your view there?

A. Yes. That's a long sentence, but that was actually a key component of my analysis for the extractor fan.

The extractor fan is protected by a fuse that's

located below the extractor fan. The extractor fan itself is in the window, but the wires run through an isolator switch, and within that isolator switch that feeds the extractor fan there is a 3-ampere fuse.

Earlier on in my report, I discuss the timing of fuses versus circuit breakers, and I show that the 3-amp fuse will always blow more quickly than the 32-amp circuit breaker for circuit 7.

This is one of the main reasons I ruled out the extractor fan, because that 3-ampere fuse, which always would've tripped first, which would've blown first before the 32-amp circuit breaker for circuit 7, was not blown.

So that was a key element of my analysis for the extractor fan.

Q. That's clear, thank you.

Looking at subparagraph (3), you say:

"(3) Arc-damaged Exhibits MJS/1 and JDG/1 are not associated with the extractor fan from Flat 16 or any of the wiring associated with that extractor fan."

Again, you're able to say that because you examined, first of all, the number of strands within the wires that form part of MJS/1 and JDG/1, and they weren't the type of wiring you found in relation to the extractor fan.

A. Yes. So we looked, by the way, at an exemplar extractor fan from flat 13. The fire was in flat 16, but one of the items of exhibits that I looked at was an exemplar fan from flat 13, and then we looked at the remains of the extractor fan from flat 16. We looked at all the wires in both of those exhibits, we counted the strands, and I found, as well as my other investigators, no wires associated with the extractor fan that had 24 strands.

Remember, those two arc-damaged exhibits, MJS/1 and JDG/1, both have 24 strands. Those were not associated with the extractor fan.

Q. Thank you.

The final point you set out at subparagraph (4), and then you set out the basic point that Nuaire, the manufacturer of the fan, had received no report confirming that a Cyfan/Cyfan-C was the source of a fire. That's your final observation there: the absence of previous instance of fire.

A. Correct. As you see, Nuaire is the company that manufactures the extractor fan, Cyfan, and they had sold some 113,000 of them since, I believe, 2013, none of which -- there were no reported fires for any of those fans.

Q. Just to help us, what weight do you attach to the absence of previous incidents generally compared to the

specific analyses set out in subparagraphs (1) to (3)?

A. It's just another key element. I think when you look at the possibility of a component having failed, it's important to look at the history of failures of the component, the history of any fires, the history of any recalls, the history of any legal suits, to see if there had been any prior incidents.

So that is a component. I don't know if I'd attach more weight to that than the actual evidence that I did look at.

Q. It's simply a relevant factor; is that fair?

A. It is relevant, yes.

MR KINNIER: Sir, it's 11 o'clock. We've been going for an hour. Would that be a convenient place for a brief break?

SIR MARTIN MOORE-BICK: It is convenient to you, I take it?

MR KINNIER: It is, yes, thank you.

SIR MARTIN MOORE-BICK: Well, Dr Glover, we have a short break roughly once an hour, so we're going to take one now.

I have to ask you not to talk about your evidence while you're out of the room, if you don't mind.

We'll come back at 11.10.

If you go with the usher, she'll look after you.

THE WITNESS: Thank you, sir.

SIR MARTIN MOORE-BICK: All right? Thank you very much. Yes, you can go now.

Right, 11.10, please. Thank you.

(11.00 am)

(A short break)

(11.10 am)

SIR MARTIN MOORE-BICK: All right, Dr Glover, ready to carry on?

THE WITNESS: Thank you, sir.

SIR MARTIN MOORE-BICK: Good.

Yes, Mr Kinnier.

MR KINNIER: Dr Glover, welcome back.

We were covering in this particular part of the examination analysis of the electrical appliances and relevant electrical items in the kitchen.

The next one I want to talk to is the cooker, which you were adverting to earlier on in the evidence.

First question, to be clear, the cooker was serviced by circuit 7; is that right?

A. The cooker was served by circuit 1, not circuit 7, circuit 1.

Q. Apologies, circuit 1.

If we could identify where the cooker was. Paul, if you could bring up figure 2 at JDGR0000001_0008.

Just so that we can orientate ourselves, that is

a sketch plan produced by Mr Kebede upon which you relied; is that right?
A. Yes, this is Mr Kebede's figure, yes.
Q. If we look at the top left-hand side we see "mop & bucket", then "A", which is the large fridge freezer, and next to it is "B", which is partially obscured by the four rings.
A. Correct.
Q. The B there is the cooker.
A. It is.
Q. Thank you. As you said correctly, it's served by circuit 1.
A. Yes.
Q. If we remove that and, Paul, if I could ask you to go to section 5.5 of Dr Glover's report, which is at page 23 of that report, and if you could amplify 5.5, here you set out a summary of your observations:
"The following observations do not support a fire origin at the Cooker or Circuit No.1 Cooker in Flat 16.
"(1) The Cooker is supplied by Circuit No. 1 at the Consumer Unit in Flat 16. The circuit breaker for Circuit No.1 was bound in the ON position, confirming that there was no short circuit or overcurrent sufficient to trip the 32A breaker for the Cooker circuit.

"(2) The circuit breakers that did trip at the time of the fire, the circuit breaker for Circuit No.7-Kitchen and the RCCB Circuit Breaker for the RCD-protected circuits, are unrelated to the Cooker circuit.
"(3) Arc-damaged Exhibits MJS/1 and JDG/1 are not associated with the Cooker Circuit wiring."
They're the first three. Are those the principal observations upon which you rely, first of all?
A. Those are the first three or four of eight observations.
Q. Are those the principal ones? I know there are others that follow, but are those the primary matters you rely upon?
A. I would point to (6), the possibility that someone was cooking on top of the cook top and that a fire could've started from non-electrical means by cooking oil or something. But I did examine the switches for the four hobs on the cook top and found those were all in the off position, verifying that, in my opinion, there was no cooking going on on the night of the fire. There were also no cooking pans found on top of the cook top.
Q. Thank you.
Looking at (8), you say:
"(8) There is only superficial heat/fire damage to the front, sides and rear of the Cooker."

To the lay reader, that looks like an important feature. Is that a fair observation to make?
A. Yes, it is. There's no arc damage to the wires that supply the cooker located behind the cooker, and if you look at the sides and the front of the cooker, they are fire damaged only. There's also no foodstuffs found in the cooker, in the oven, for example.
Q. Would you have expected foodstuffs to have survived the fire?
A. In the oven, possibly, yes.
Q. Turning to a new and separate appliance, the bread maker, the "m'tad", and you deal with this at section 10 of your report, which at pages 37 to 39.
Paul, could I ask you to turn to page 39 in particular.
Just to get some context, Dr Glover.
First of all, the bread maker was found on the kitchen floor next to the large fridge freezer; is that right?
A. Yes.
Q. You set out your conclusions here at paragraph 10.3:
"The following observations do not support a fire origin at the bread maker in Flat 16:
"(1) Mr. Kebede states that the Bread Maker ("M'tad") was not plugged in. Ms. Afeworki states that

she never used the bread maker ("injera pan") and never saw it used.
"(2) There is no evidence that the bread maker had been plugged into any socket at the time of the fire.
"(3) There is no evidence of arc damage or other abnormal electrical activity to the bread maker power supply cord/mains supply flex internal wiring, or heating coil.
"(4) Arc-damaged Exhibits MJS/1 and JDG/1 arc not consistent with the bread maker power supply cord and wiring.
"(5) The three wires of the bread maker power supply cord remain flexible (they are not brittle/not friable)."
Stopping there, can you help us -- it's probably a question that goes to the obvious -- why is the absence of brittle or friable material a useful consideration or a relevant consideration to have regard to here?
A. Yes, well, I tried to imagine this scenario where this bread maker would've been plugged in, and since its location is adjacent to the fridge freezer, the likely socket, if it had been plugged in, would've been a socket behind the fridge freezer. That would be the closest to where the bread maker was found on the day of

the fire.

Now, when you look at the other wires that were found behind the fridge freezer, those were quite friable, quite brittle segments of wires that had been broken off as a result of fire heat -- not arc damage, but fire heat.

I did not see that for the bread maker. The power supply cord, the main supply flex, was intact, including the plug and the fuse. And, as I said, the three wires were not brittle.

So I would conclude that this bread maker was not plugged in behind the fridge freezer.

Q. Thank you.

Finally, for completeness, you have:

"(6) The fuse in the plug for the bread maker power supply cord is intact/not blown."

A. Correct.

Q. Does that remain your view, as set out in section 10.3 of your report?

A. It does.

Q. Next, can we deal with the small fridge.

First of all, could I ask Paul to bring up the sketch, page 8 of your report.

Thank you.

If that could be amplified again, Paul.

I think the position of the small fridge is identified with capital letter "I" at the bottom left-hand corner; is that right?

A. Yes, and I would emphasise that this sketch was drawn by Mr Kebede. This was his memory of where these various items were located within the kitchen prior to the fire.

Q. And that's what you've relied upon, as you indicated earlier.

A. Yes, yes.

Q. If, Paul, we could de-amplify and go to page 30 internally.

Dr Glover, section 7.3, you set out again your summary in relation to the observations you make concerning the small fridge.

You say:

"The following observations do not support a fire origin at the small fridge or its power supply cord (mains supply flex) in flat 16:

"(1) Mr. Kebede and Ms. Afeworki both state that the small fridge was not in use and not plugged in.

"(2) Post-fire examination of Exhibit MJD/33, the four-gang extension lead that could have been used for the small fridge, showed that it had no plugs inserted into any of its four sockets (see Section 6).

"(3) There is no evidence that the small fridge had

been plugged into any socket at the time of the fire.

"(4) There is no arc-damage to the small fridge's power supply cord or to any internal wire or component within the small fridge.

"(5) The fuse in the plug associated with the power supply cord is intact/not blown.

"(6) There were no foodstuffs found in the small fridge.

"(7) The underside of the small fridge is largely intact/undamaged, including one of the plastic feet."

Does that remain your view?

A. Yes, sir.

Q. Thank you.

Could we now turn to the medium-sized freezer.

Paul, apologies for jumping around, could we go back to page 8 internally of this report. If we could amplify Mr Kebede's sketch plan.

The medium-sized freezer is identified by the capital letter "H" in the bottom left-hand corner; is that right?

A. Yes, the "H" is the medium freezer and the small fridge we just talked about is "I", which would've been on top of the medium freezer.

Q. Just to confirm evidence you gave earlier on, I think I'm right in understanding you accept the stranding

found in relation to the arc-damaged exhibits, MJS/1 and JDG/1, is consistent both in strand-count and diameter with the medium-sized freezer's power cord.

A. Yes, as well as a couple of other internal wires that had 24 strands.

Q. Paul, if we could de-amplify Mr Kebede's sketch plan and turn to page 33 internally.

Dr Glover, there we find the summary of your conclusions in relation to the medium-sized freezer.

First of all:

"The following observations support a fire origin at the medium sized freezer or its power supply cord (mains supply flex) in Flat 16:

"(1) Exhibit JDG/1, which I found inside the medium sized freezer during my 27 April 2018 examination at Bureau Veritas, consists of stranded copper wire segments with arc-damaged copper beads at one end. Each wire segment for JDG/1 has 24 strands, with an approximate strand diameter of 0.16 mm (See Section 4.31).

"(2) The medium sized freezer's power supply cord as well as other cords within the medium sized freezer, include wires with 24 strands and an approximate strand diameter 0.16 [to] 0.18mm. This stranding is consistent with arc damaged Exhibits JDG/1 and MJS/1."

Then you set out factors which do not support a fire origin at the medium-sized freezer:

"(1) Mr. Kebede and Ms. Afeworki both state that the medium sized freezer was not in use and not plugged in at the time of the fire."

You note the support provided by the Bureau Veritas report:

"(2) In his witness statement, Mr. Kebede states that the medium sized freezer stopped working about nine years ago so it was unplugged. He had not bought it long before it stopped working so called in a fridge technician from the Yellow Pages who told him the fuse had gone (see Section 7).

"(3) Post-fire examination of Exhibit MJD/33, the four-gang extension lead that could have been used for the medium sized freezer, showed that it had no plugs inserted into any of its four sockets (see Section 6.1).

"(4) There is no evidence that the medium sized freezer had been plugged into any socket at the time of the fire.

"(5) There were no traces of foodstuffs found in the medium sized freezer.

"(6) Other than Exhibit JDG/1, there is no arc damage to any component or any other internal wire within the Medium Sized Freezer. Either JDG/1 arced at

a prior time unrelated to the fire or it was relocated into the medium sized freezer during or after firefighting efforts.

"(7) There is no arc-damage to the remains of the Medium Sized Freezer's power supply cord.

"(8) The medium sized freezer's plug was initially found attached to the power supply cord, but later became separated from the cord.

"(9) In my opinion Exhibit MJD/34, the remnants of a plug, is the medium freezer plug that became separated (See Section 9).

"(10) The fuse in Exhibit MJD/34 is intact/not blown (See Section 9).

"(11) A paper label on the compressor and the plastic enclosure of an electrical junction box, both located within the medium sized freezer remain largely intact. It is implausible that the fire origin could be within the medium sized freezer with a paper label and a plastic junction box enclosure largely intact."

Then you go on in the final paragraph:

"In my opinion observations (1) [to] (11) above strongly support a conclusion that the medium sized. Freezer was not plugged in at the time of the fire. As such, it is probable that arcing to Exhibit JDG/1 occurred either: (1) during the initiation or early

stages of the fire when it was located in the area of fire origin, electrically connected to Circuit No.7 — Kitchen; or (2) at a prior time unrelated to the fire (Mr. Kebede reported that the freezer stopped working nine years ago and a bad fuse was found)."

Does that remain your view?

A. Yes. I have further concluded, if you go to my addendum later, that in my opinion the JDG/1 arced at a prior time unrelated to the fire.

Q. We'll come on to that, but essentially your view remains the same in terms of excluding --

A. Yes.

Q. -- the freezer. Thank you.

The penultimate appliance or wiring that I would like to take you to, the extension lead, this is dealt with at section 6 of your report.

First of all, before we go to the summary at page 27, could I ask Paul to go to figures A4-8, there we go.

First of all, this is the extension lead with which you're concerned in section 6 of your report; is that right?

A. Yes, sir.

Q. Can you help us as to where the extension lead was found, can you remember?

A. Yes, the extension lead was found -- and there are some

photos in that I could refer to, A4-1 and 2 perhaps -- on the east side of the kitchen, very close to the living room, okay? There were wooden sliding doors that separated the kitchen from the living room. Those panel doors were consumed during the fire, but this extension lead was found by fire investigators on the day of the fire, right in that vicinity where the wooden panel doors separated the living room from the kitchen on the east side.

Q. Thank you, Dr Glover.

Paul, if we could put down these photographs and return to Dr Glover's report, and page 27 within that report.

Dr Glover, there you set out the observations that led you to conclude that they don't support fire origin at the extension lead of its power supply cord:

"(1) No plug was round in any o I the Four sockets of the extension lead. If there were no devices plugged into the extension lead at the time of the fire, the extension lead delivered zero load current with no heat dissipation due to load current. Further, with no connected devices, the extension lead would not have delivered any short-circuit current or any overcurrent to such a device.

"(2) There is no arc damage to the internal

current-carrying components of the extension lead, and there is no arc damage to the remains of the power supply cord (mains supply flex) for the extension lead.

"(3) Arc-damaged Exhibits MJS/1 and JDG/1 are not associated with extension lead's power supply cord/mains supply flex.

"(4) There is a missing portion of the power supply cord and a missing plug for the extension lead. Therefore, it is unknown whether the extension lead was plugged into an electrical socket at the time of the fire.

"(5) If at the time of the fire the extension lead had been plugged into a socket, the most likely socket would have been the one on the living room east wall approximately 18 inches from the sliding door panels that separated the kitchen from the living room. As shown in Figure A4-3, taken on 14 June 2017 in flat 16, the severed end of the extension lead power supply cord is near that living room socket.

"(6) That living room socket is supplied by Circuit No.8 — Flat Sockets, not Circuit No.7. If at the time of the fire the extension lead had been plugged into that living room socket, then it is unrelated to the one event or the first of two events that caused the circuit breaker For Circuit. No.7 - Kitchen to trip.

"(7) If at the time of the fire the extension lead had been plugged into that living room socket, the missing portion of the power supply cord and missing plug would then have been located in the living room, which is outside the area of fire origin as established by fire investigators.

"(8) In my opinion it is implausible that a fire could begin in the living room where Mr. Kebede was sleeping at the time, then progress through the sliding door panels into the kitchen, and not awaken him until the kitchen smoke detector alarmed."

Dr Glover, does that remain your view?

A. Yes.

Q. Thank you.

The final element of wiring that I'd like to discuss with you before we get on to the large fridge freezer is the fluorescent light and wiring from the ceiling of the kitchen. You deal with this in section 13 of your report. That's at pages 63 to 64.

I think it's right to say that you've examined four exhibits comprising the wiring from the ceiling above the kitchen counter and near the window, as well as a fluorescent light; is that right?

A. Yes, sir.

Q. If, Paul, I might ask you to turn to page 64, and

section 13.5. If you could amplify that Paul, please.

You there set out again the summary of your observations:

"The following observations do not support a fire origin at any of the following items in the ceiling of the kitchen in Flat 16 ...

"(1) Lighting was supplied by Circuit Nos. 2 and 3 at the Consumer Unit in Flat 16. Both of the circuit breakers for Circuit Nos. 2 and 3 were found in the ON positions, confirming that there was no short circuit or overcurrent sufficient to trip either of the 6A breakers for these lighting circuits.

"(2) The circuit breakers that did trip at the time of the fire, the circuit breaker for Circuit No.7-Kitchen and the RCCB Circuit Breaker lot the RCD-protected circuits (Circuit Nos. 7 and 8), are unrelated to the lighting circuits and these exhibits.

"(3) No arc damage or other abnormal electrical activity is observed for any of the wiring in Exhibits MJD/49, MJD/63, and MJD/64.

"(4) Arc-damaged Exhibits MJS/1 and are not associated with any of the wiring for Exhibits MJD/49, MJD/63 and MJD/64."

Does that remain your view?

A. Yes, sir.

Q. Thank you.

Dr Glover, I'd like to turn to the question of the large fridge freezer which is considered at section 12 of your report.

Just so that we can orientate ourselves as to what you looked at, is it right to say that you examined the remains of the large fridge freezer, which was a Hotpoint FF175BP, which you understood to be manufactured in or about October 2008?

A. October 2008, yes.

Q. Is it right that you also examined what's been describe as an exemplar?

A. Yes, I did.

Q. That exemplar was provided by Whirlpool, and it was a model number FF175BP, but manufactured in or about November 2006; is that right?

A. Yes.

Q. Can you help us, what differences were there between the large fridge freezer that was in flat 16 and the exemplar fridge that you also examined?

A. There were a number of differences. For example, within the fridge freezer is a device called a motor run capacitor, a capacitor.

Q. If I could stop you there, again asking a basic question: what's the motor run capacitor?

A. A capacitor is an electrical device that stores charge and is utilised in this case to help the refrigerator run more efficiently.

Q. Apologies, I interrupted you in full flow. You were identifying the differences between the exemplar and the large fridge freezer, and you referred to the motor run capacitor.

A. So in my understanding, reviewing the records and the documents, Whirlpool changed their capacitor from a so-called P0 capacitor to a P2. A P0 capacitor is one that is not protected against fire or against electrical shock. So for the earlier model, the exemplar that I looked at, which was manufactured in 2006, that had the unprotected motor run capacitor, the so-called P0 capacitor.

The subject fridge freezer that was in flat 16 was manufactured in October 2008, and according to the Whirlpool documents, by that time Whirlpool had switched over to a so-called P2 capacitor that is protected against fire, and it's designed and manufactured so that if there is a problem within the motor run capacitor, it will be a fail-safe device, whether it be it failing from a fire or from an electric shock point of view.

So that's one example.

Q. Is this difference material to your analysis of origin

and cause? The difference between the exemplar and the subject large fridge freezer, is it relevant, is it material, to your analysis of origin?

A. There was some relevance, but the exemplar fridge freezer that I looked at was very helpful to me in understanding the basic components within the fridge freezer, and then when I went to the subject fridge freezer, I was well aware of the differences. I've talked about one, the capacitor. There are other differences.

Q. Can you help us what the other principal differences are that are material?

A. Yes. Both fridge freezers have a compressor, that is the device that is used to compress the refrigerant, that is part of the refrigeration cycle for the fridge freezer. The compressor is located at the bottom rear of the fridge freezer, either one.

The compressor that I looked at for the exemplar was manufactured by a company called Tecumseh, whereas the subject fridge freezer from flat 16 had a compressor in manufactured by Embraco. That's the second difference.

The control boards were slightly different. The number of wires. There was a wiring harness within the exemplar fridge freezer and the remains of a wiring harness in the subject fridge freezer. Both of them had

five wires, but there were some differences. One of them all five wires were in a cord, so to speak, with an outer jacket, whereas in the other the wires were separate wires.

So those were three differences.

Q. And they're the principal material ones, you consider?

A. Yes.

Q. If I could turn to the conclusions in your report regarding the large fridge freezer.

Paul, could I ask you to turn up page 61 of Dr Glover's report and, in particular, section 12.10.

At the top of the page, you say this:

"Exhibits reviewed in this section are segregated into three possible fire origins: (1) within the fridge freezer, Exhibit BPS/1; (2) at the fridge freezer power supply cord (mains supply flex); and (3) components associated with the fixed wiring for Circuit No. 7 - Kitchen."

If we can start, first of all, with subsection 12.10.1 within BPS/1, that's the large fridge freezer, you found the following observations supported fire origin within BPS/1:

"(1) There is a missing run capacitor, which would have been mounted on the compressor mounting plate to the left of the compressor ..."

Stopping there, why does that support a fire origin internal to BPS/1, the large fridge freezer?

A. Well, whenever you have a missing electrical component, that's a concern. You can't evaluate a missing component, you can't look at the device to see if there was abnormal or electrical activity.

There had been some prior fires with these fridge freezers. It involved run capacitors. However, we do know that the subject fridge freezer had a P2, a fail-safe device in it.

But that's always a concern, when you have a missing component that is perhaps completely consumed during the fire that you cannot evaluate.

Q. Turning to (2):

"(2) Arc-damaged Exhibits MJS/1 and JDG/1 are consistent with the remains of two wires found within the relay compartment of the fridge freezer ..."

You give the reason next for that consistency. It's that:

"Each of these wires, which has 24 strands, is either a run capacitor wire or an internal jumper wire within the relay compartment."

Is that right?

A. Yes. We looked at the remains of the connectors within the compressor relay compartment. We found two

connectors that had 24 strand wires in them, and by process of elimination, concluded that those connectors served wires for either the missing run capacitor or for an internal wire within the compressor relay compartment.

Q. Looking at the third observation you make:

"(3) Arc-damaged Exhibits MJS/1 and JDG/1 are also consistent with Exhibit SLW/111, a wire segment with a soldered end from BPS/3."

Taking each element of that, first of all, what is exhibit BPS/3?

A. BPS/3 are wires that were found below the fridge freezer, basically, subject to review, and that should be BPS/3 and page 50. Conductors from fridge freezer base, that's what BPS/3 is.

One of those wires was SLW/111, basically a wire segment, that was found to have 24 strands.

Q. The fourth point, you mention the previous incidents involving a P0 run capacitor and also two reports of fire potentially involving a P2 run capacitor, and that's the reason you adverted to earlier on.

You then go on to set out observations that don't support fire origin within BPS/1. At number (1) you say:

"(1) No arc damage was observed within BPS/1."

To the lay reader, that looks like a significant factor pointing against the fire origin within the large fridge freezer.

What would be your response to that lay observation?

A. Yes. As I mentioned, we're particularly focused on MJS/1. That was found in the second bedroom. We looked at that earlier today, a wire segment approximately 10 centimetres in length with a fused section.

I concluded that MJS/1, there is no way that that could have arced in the second bedroom on the night of the fire for various reasons. There was a lady sleeping in the room, for one reason.

Number 2, the bedroom is served by circuit 8. Okay?

Q. Which didn't trip.

A. Circuit 8 didn't trip. Mr Kebede turned off the main switch -- which is very helpful in my analysis -- before he vacated, so that when the fire eventually got into the second bedroom later on, after he vacated, there was no energised facilities there, so you couldn't have had arc damage at that time.

So for a number of reasons, I concluded that MJS/1 could not have arced in the second bedroom.

So that means you have two possibilities: one is that it was electrically connected to circuit 7 in the kitchen, because that's the circuit breaker that

tripped, or it arced at some prior time and it has been there for months or years, some time unrelated to the fire.

Those are your two possibilities.

Q. Moving on to subparagraph (2), you say:

"(2) The [3-amp] fuse for the fridge freezer power supply cord is intact/not blown."

Again, to the layperson looking at this, that seems like a significant factor pointing against the large fridge freezer being the origin.

What would be your response to that lay observation.

A. Yes. I want to point out that that's a 13 ampere fuse, 1-3, not 3 amps. Earlier I had mentioned that there is no way the extractor fan could've been the origin of the fire because the 3-ampere fuse did not blow, the 3-amp fuse that protected the extractor fan.

Here, for the fridge freezer, we have a 13-ampere fuse. Earlier in my report, I compare the operating times of the 32-amp circuit breaker for circuit 7, compared that with the fuse blowing time for a 13-ampere fuse, and the analysis shows that either one could go first. It's possible that the 32-amp circuit breaker could trip before the 13-amp fuse in a wide range of currents, I believe, ranging from -- the numbers are in there -- 100 to a few hundred amperes. Either one could

go.

So the fact that a 13-amp fuse for the fridge freezer is intact, it's not blown, that doesn't mean that there was no short circuit within the fridge freezer, because the 32-amp circuit breaker quite likely could have tripped first, leaving that 13-ampere fuse intact.

Q. Thank you.

Finally, we have subparagraph (3):

"(3) Whirlpool has reported that there have been no recalls and no legal proceedings/claims against Whirlpool, Indesit, or its representatives involving a Hotpoint FF175BP or FF175BG."

Just for the sake of completeness, I note that.

Do the views you set out there at 12.10.1 remain your view?

A. Yes, sir.

Q. Paul, if we can turn over the page to section 12.10.2.

At this point, you go through the various observations you identified in relation to the fridge freezer power supply cord.

I won't read them out, but essentially your conclusion is that the evidence does not support a fire origin within the power supply cord for the reasons you've set out in subparagraphs (1) and (2); is that

right?
A. Yes, sir.
Q. That remains your view?
A. It does.
Q. Similarly, if we go on to subsection 12.10.3, which deals with fixed wiring for circuit number 7, the kitchen, you say this:
"The following observations do not support a fire origin at the fixed wiring for Circuit No.7-Kitchen in Flat 16:
"(1) No arc damage or abnormal electrical activity is observed on any of the following items related to the fixed wiring: (a) remains of a double-socket busbar with two receivers from MCL-06 ...
Again, for those of us less technically minded, what's a busbar?
A. A busbar is within a socket. If you remove the enclosure of a socket, you will see metal devices. They are basically current-carrying devices that carry the current from the consumer unit, through the socket, to the plug that it is plugged into.
Q. Thank you:
"... (b) remains of single-socket busbar
And double-socket busbar from BPS/5; and (3) wires on kitchen ring main side of spur ...

"(2) Arc-damaged Exhibits MJS/1 and JDG/1 are not consistent with the kitchen ring main wires (Circuit No. 7), each of which has 7 stands/wire.
"(3) The fixed wiring is protected from mechanical damage via wire trunking and socket/switch/spur enclosures."
Just looking at the third and final one, is that to say that you found no damage to the fixed wiring? Is that what subparagraph (3) is getting at?
A. No arc damage to the fixed wiring. There's certainly fire damage, the insulation is burned off, but there's no arc damage or evidence of abnormal electrical activity.
Q. Paul, would you mind turning to page 77 of the report.
This sets out your essential conclusions in relation to the large fridge freezer.
At 16.1, under the heading "Relationship Between Fire Origin and Circuit No.7-Kitchen", you say this:
"Within the area of fire origin, it is probable that the fire origin is at the electrical component that caused the circuit breaker for Circuit No.7-Kitchen to trip ..."
You refer back to section 15.1, which we don't need to go to, because it effectively replicates what we just looked at at section 12.10.

But then turning to subsection 16.2, under the heading "Devices in Area of Fire Origin Confirmed to Be Electronically Connected to Circuit No.7-Kitchen", you rehearse the analysis we've just undergone, and then by a process effectively of elimination, you conclude that the large fridge freezer is implicated or probably implicated in the origin of the fire.
Is that a fair if general summary?
A. Yes, I concluded that the internal large fridge freezer was the most probable fire origin.
Q. Following on from the use of the word "probability", can I ask you to turn to page 77, of your report, and you'll see in the preamble to section 16, the third line, you use the phrase "a reasonable degree of engineering certainty".
Can you help us, what does that phrase mean? Are you indicating there that you applied the balance of probabilities or some other standard?
A. When I say "reasonable degree or engineering certainty", nothing is 100 per cent certain, okay? But based on all my training and education and experience investigating electrical fires, my conclusions are to a reasonable degree of engineering certainty. Most probable.
Q. Most probable.
If I could turn to the addendum you prepared. Just

by way of context, on 16 November this year you provided an addendum to your report which reviewed a CT scan of exhibit JDG/6B, a wire connector recovered from the compressor relay compartment of the large fridge freezer.
Am I right thus far?
A. Yes, sir.
Q. In short, your conclusion is that the wire connector had a poor crimp which led to an overheated connection, which you posit as a hypothetical fire initiation scenario; is that a fair summary?
A. Yes.
Q. In relation to the addendum, Dr Glover, my questions will fall essentially into three parts, first of all dealing with basic factual matters relating to exhibit 6B; secondly, some contextual points in relation to that exhibit; finally, some specific questions relating to the analysis set out in the addendum.
So starting, first of all, with the first part, that's the basic factual matters, Paul, could I ask you to turn up the addendum, which is at JDGR0000019_0001.
That's the addendum; is that right, Dr Glover?
A. Yes.
Q. If I could ask Paul to turn to page 5, and if you could amplify figure 1, the exhibit with which we are

concerned is 6B, which is more precisely identified on the right-hand side; is that right?
A. Yes.
Q. And then we see it together with other exhibits on the left-hand side, and it's at the bottom left-hand corner of that photo.
A. Yes.
Q. Can you just help us, the other exhibits on the left-hand side, they are extracted from the large fridge freezer as well; is that right?
A. Yes. All of these exhibits marked JDG/6 were collected from within the compressor relay compartment that was attached to the compressor for the fridge freezer in flat 16.
Q. Can you help us, are you able to gives us a precise idea from where within the large fridge freezer exhibit 6B was recovered?
A. So at the rear of the fridge freezer, at the rear bottom, there is a compressor, and attached to that compressor is a small compartment that would've had a plastic enclosure for it, and that compartment is called the compressor relay compartment.
Within that compartment, the fire investigators recovered JDG/6.
Q. You outlined for us earlier on what the compressor was;

it compressed refrigerant; is that right?
A. Excuse me?
Q. You defined earlier on what the compressor is, and I think you said it compressed the refrigerant; is that correct?
A. The compressor compresses the refrigerant that provides the cooling, yes.
Q. Yes.
A. Was that your question?
Q. Yes.
A. Okay.
Q. Secondly, the relay compartment. Just so people understand at the outset, what is the relay compartment and what does it do?
A. Okay. It would be a small explanation.
The relay compartment is attached to the compressor, and basically the wires, the electrical wires, that provide electricity to the compressor motor run through this relay compartment.
Within that compartment are therefore wires. You're seeing some of the remains in JDG/6 here, wire connectors. There are also two what we call relays. Those are switching devices that are used to control the operation of the compressor.
I could spend a little time on that just to be more

helpful.
The two relays, one of them is a so-called PTC relay, and that relay is used to start the compressor motor, so that when the compressor is first turned on, when the control board within the refrigerator decides that it's time to provide some cooling, the electrical current flows through this PTC relay to a start winding within the motor that gets the compressor motors started.
Then as the compressor motor comes up to speed and draws the full load current, this PTC relay switches the current over to a second relay, which is an overload relay. So there are two relays within the compressor relay compartment. The second one is an overload relay. It has a trade name Klixon. You are going to find Klixon relays in thousands of refrigerators and other appliances throughout the world.
So once the motor is up to speed, the electricity will flow through the overload relay, the Klixon overload relay, and if there is any short circuit or electrical problem within the compressor motor, that Klixon relay will disconnect power and safely remove any overload current.
So what you're talking about is wires, wire connectors, and two relays or switching devices in this

compressor relay compartment that is affixed to the compressor itself.
Q. That's useful context. We'll be coming on to the particular operation of these wires and the various components when we come to look at figure 7.
A. Okay.
Q. But dealing with basic matters at this stage, am I right in understanding that exhibit 6B was a wire connector?
A. Not only a wire connector, but a small section of wire -- actually, two wires -- that are affixed, that are connected, to that connector.
Q. What purpose does that serve?
A. Those two wires are part of the wiring harness that comes from the internal part of the refrigerator up where the control -- the control board is higher up in the refrigerator, but the wiring harness comes down. There are five wires. Two of them are associated with JDG/6B, what we're focusing on here.
Those would be live wires when the compressor calls for power, when it's time to energise the compressor, JDG/6B would be energised wires.
Q. That's useful, thank you.
Looking at its composition, as you've adverted to, 6B consists of two wires, and each with a strand diameter of 0.17 millimetres; is that right?

A. Yes.
Q. But one consisting of 23 strands and another of 14 strands; is that right?
A. Yes, sir.
Q. I now move to the second part of my questioning in relation to the addendum, and that's really in respect of certain contextual points.
Looking at how you've set out the reasoning in the at addendum, a central element of the hypothesis you advance is the poor crimp connection.
Is that a fair summary, before we proceed any further?
A. Yes.
Q. It may be useful if we go to page 6 of the addendum.
Can you help us, first of all, with what figure 2 shows?
A. Yes. Could you blow that up a bit?
Q. Paul, could you amplify it. Thank you.
A. So this is a result of a CT scan that was performed at Nikon Tring, at their computer tomography facilities up in the Tring area. We did that in September 2018. This is the resulting CT scan of that connector, JDG/6B. The top part of that is actually the connector.
Q. If you could return to your former role as a professor and identify where on the photograph that connector is?

A. So you can see two wires, they're entering the connector, and this area of the connector is called the wire barrel (Indicates).
Q. That is, for the stenographer's purposes, the two barrels which are alongside each other in the middle of that scan.
A. Correct. This is where the connector is crimped. It's a pressure connection, a tool or a machine that provides a compression force to that wire barrel. That basically grips the wire strands and keeps them inside of the barrel.
Q. If I can stop you there, the essential purpose of a crimp connection is to keep the wires within the barrel; is that it?
A. Tightly affixed within the barrel, yes.
Q. It has to be tight within the barrel -- apologies, it's a question to the obvious -- why do the wires have to be kept tight within the barrel?
A. Because you could have a problem. If they're loose within the barrel, you could get some overheating, which I have concluded happened for this JDG/6B.
Q. We can come on to that.
A. Yes.
Q. What we have set in the bottom half of this figure is what you've described as cross-sectional slices; is that

right?
A. Yes.
Q. There are five identified there; is that right?
A. One, two, three, four, five -- these are cross-sections taken by the computer tomography, the CT scan, that I observed.
Q. How many cross-sectional slices did you examine in total?
A. Okay, so the CT scan starting from the left-hand of the barrel to the right-hand of the barrel goes at approximately 0.03-millimetre intervals, and if you count them up from the left-hand side to the right-hand side of the barrel, there were approximately 80, 8-0, slices, five of which I am showing here.
Q. To what extent are the five slices set out there exemplars of the other cross-sectional slices you reviewed?
A. Well, you would have to look at all 80, which I did, but basically what I found was a lot of void spaces, an indication of a loose crimp that has not been properly crimped when the compression was applied during the application of this wire.
What I also mention, there is a space up here (Indicates). If you blow this up, you can probably see it a little bit better on this figure. But there is

a space, and it's a tapered space that tapers down to no space on the right side, and that's another indication that the crimp was not nice and tight. It wasn't a good compression crimp.
Q. If I could just stop you there. When you said there is a space there, you are referring to a space in between the two wire barrels.
A. Yes, sir.
Q. If I can go back to the bottom half of this figure, figure 2 -- Paul, if you could go back to figure 2, please -- you've identified on four of the five what you've describe as voids.
A. Yes, and there are even voids here (Indicates), but it's somewhat blurry. There are actually voids in all five of these sections. In fact, I found voids in all 80 cross-sections.
Q. And --
A. Some of them much larger than the others. You have some very serious ones here on the left. Here it appears that the -- by the way, inside of this crimp of the connector are the wire strands, the individual strands.
Q. If I could stop you there. If we could take this stage by stage.
Reading from left to right, Dr Glover, looking at the slide on the furthest left-hand side, to the lay

eye, there appear to be voids not only between the wires themselves and the wire barrel, but also between the wires themselves.

Is that a correct observation?

A. Yes, and it's an important one too, because you need the wire strands to be in contact with each other so as to provide an easy way for the current to flow among all of the strands and to reduce the so-called resistance of this contact here. Resistance, if it's too high, can lead to overheating.

Q. Stopping there, if we just examine each of these slices.

The second slice from the left to the lay eye appears to show voids as between wires; is that correct?

A. Yes. It's somewhat blurry, but there are definitely voids between the wire strands.

Another feature here, you see the two ends of the barrel are not projecting down into the wire strands, another indication that we have a loose crimp, a loose compression force here.

Q. Is the consequence of there being voids as between wires the same as the consequences of there being voids between wires and the wire barrel itself?

A. Yes, because the electrical current that is flowing in these wire strands eventually has to get out through the connector. This connector then connects on to a spade

connection which provides current to the compressor motor.

So the current is coming from these wire strands, down the wire. It has to come through the wire strands, and through the contact surface of the barrel of the crimp connector, and then the current will flow through the connection, eventually getting to the motor.

So you want a nice tight connection, to prevent basically overheating. If you have poor contact, you will get overheating.

Q. Thank you.

Paul, if you can take down figure 2 and then put up figure 3.

This is essentially a compare and contrast exercise, Dr Glover, isn't it, because what you describe figure 3 as "a good crimp".

If we again move from left to right, even though you describe this as a good crimp, on the left-hand side, there still appear to be voids, certainly to this lay eye. Are there voids there?

A. There are, actually. If I were to change this, I would say it's a better crimp than 6B, and we're looking at 6A now, but I actually have some concerns about this crimp also.

Q. So it's relatively better than figure 2, but it's not

a "good" crimp?

A. That's my opinion, yes.

Q. The reason why you don't think it's a good one -- it may well be the middle slice, the third from the left, illustrates I think the point you want to make -- is that there are still voids as between the wires themselves and query between the wires and the wire barrel; is that a fair observation?

A. Yes, you can still see void spaces.

By the way, these barrel curvature are much better than if you looked up at 6B, you can see them projecting more into the wire strands, especially over here, but you still have some void spaces here that would be of some concern.

Q. Thank you.

Dr Glover, those are the points I want to draw out in respect of figures 2 and 3.

Could I ask you now to turn to page 7 of the addendum and, in particular, the third paragraph on that page, which starts "Poor crimping leads". I'll let you refresh your memory and read that paragraph to yourself, first of all.

(Pause)

A. Yes.

Q. You say there that there is a decrease in contact area

between the wire strands and the connector.

Is the connector the wire barrels you have annotated in figures 2 and 3?

A. Excuse me?

Q. You say there that there's a decrease in the contact area between the connector and wire strands.

A. Yes.

Q. My question is: what is the connector, essentially? Is it what we've just seen in figures 2 and 3?

A. Yes, JDG/6B is the connector.

Q. You go on to say in this paragraph that it is "accompanied by an increase in the associated contact resistance".

My first question, just to help us understand the analysis, is: can you explain, first of all, what contact resistance is?

A. Okay. You're talking about an electrical term, "resistance". Copper is a very good conductor. It can carry current quite easily. It has what we call low resistance.

Other devices are not very good conductors of electricity. For example, air. Air is a poor conductor of electricity, especially dry air. If you have voids, an electrical current has to pass through those void spaces, that means you have an increase in resistance.

It's obviously not as good as the copper itself.

So the more voids you have, the higher the resistance. The lower the contact area between the wire strands themselves and between the wire strands and the connector, the more voids you have, the higher the resistance, and that leads to power losses and overheating when you do have high resistance.

Q. When you say connector power loss, that's what you're just referring to now?

A. Yes, and there's a formula that I provide there that when you have current flowing through a resistance, electrical current, then there is a formula for the power loss at that connector, which is the square of the current times the contact resistance. So the higher the resistance, the more power loss, and when you have power losses at a connector, you have heat.

Q. Thank you.

Staying with this paragraph, you say this phenomenon can cause oxidisation of the connector itself, and presumably that oxidisation itself increases resistance and has the consequences you just outlined; is that a fair summary?

A. Yes. So when you have voids, you have the possibility of oxides. Voids around the strands themselves and also voids between the wire strands and the crimp. When you

have those voids, you have the possibility of oxide build-up. It's an electrochemical reaction, electrolysis, which creates oxides, which provides more resistance, that further increases the contact resistance, leading to additional power loss and higher heat.

Q. Is that a process -- I'm assuming it is, given the use of the word "build-up" -- a problem which gets worse with time?

A. Yes.

Q. Am I right in understanding that prolonged overheating can lead to the ignition of nearby wire installations? Is that a fair if general summary?

A. Yes. What you end up with in a loose connector like this is basically a glowing connection. It's hot, it's glowing, current is trying to pass through the voids, and any wire insulation in proximity to that is suspect to ignition, igniting in the insulation of the wires.

Q. It's the insulation around the wires, so here it would be the insulation which would've been around exhibit 6B; is that right?

A. The wires that enter the crimp, the connector, have insulation on them. The insulation is stripped off inside the barrel, but outside of the connector, you have the insulation on the wires, which is no longer

visible here because the fire has burned off all the wire insulations.

Q. Can you help us -- apologies, a further level of detail -- what material the insulation to the wire is made of?

A. It's basically typically a PVC-type of insulating material. Electrical insulation.

Q. What sorts of temperature can PVC withstand?

A. They have different ratings, but a typical one is 90 degrees C.

Q. Thank you.

Apologies, Dr Glover, are you able to keep on going until 1 o'clock or would you like a break?

A. At your pleasure, I can continue.

Q. You have been going for an hour. I just wonder whether you'd appreciate a break at this juncture.

A. It's your decision, sir.

SIR MARTIN MOORE-BICK: Can I suggest that if you are comfortable keeping going, we'll keep going and see how we get on. If necessary, we can stop for lunch a bit early. But if not, we can run until 1 o'clock. All right?

MR KINNIER: Thank you, sir.

Dr Glover, thank you for that.

If I may now turn to the topic of the short circuit

and the fridge freezer. If I could ask you to turn to page 13 of the addendum and, in particular, figure 7, which I referred to earlier on.

Again, just so that I can orientate myself and those listening at the outset, am I right to describe your new hypothesis thus: that there was a short circuit between an energised internal wire and a neutral wire?

A. I'm sorry, could you repeat that?

Q. Of course.

Is it right to characterise your hypothesis thus: there was a short circuit between an energised internal wire and a neutral wire, and that process is illustrated in figure 7?

A. Yes, sir.

Q. Thank you.

Apologies, could I ask you to turn back to page 12 of the addendum and the third paragraph on that page, which starts with the words "Figure 7".

If I may invite you just to read that to yourself, first of all.

(Pause)

A. Okay.

Q. There you refer to the Klixon overload relay, and that's the Klixon overload relay you referred to earlier on in your evidence when describing the relay?

A. Yes, sir.
Q. You also say in this paragraph on page 12 that the result of the short circuit you identify there is that the magnitude of current:
"... is not limited by the compressor motor or Klixon overload relay, would therefore be on the order of hundreds of amperes, sufficient to trip the 32-A miniature circuit breaker (MCB) for Circuit No.7 ..."
Now, I think it would be useful just at this juncture to understand again: how does the compressor motor and the Klixon overload relay serve to limit the magnitude of the current under normal operation?
A. Okay, if we could go to figure 7, I could explain that.
Q. Paul, could we go to page 13.
Dr Glover, before you take us through the process, the stenographer has to valiantly identify for the record that which is visible to all of us, so if you are able to describe each stage before you take us to it, that would greatly help the stenographer, I think.
A. Yes. So just to familiarise ourselves, this is the power supply wires, or two of them, that come from the power supply cord or the main supply flex that supplies power to the refrigerator. The energised wire goes up and connects to the control board, and if there were current going to the compressor -- by the way, here is

the compressor, it's CO (Indicates).
You can see the flow of electrical current goes up to the control board, and when the control board so chooses, it provides current that comes down through an energised wire, goes through the Klixon overload relay into the compressor motor, and then returns through that motor run capacitor, down here, that's the normal path of current. I'm showing a different path for a short circuit.
Now, before talking about the short circuit that I'm showing here, let's talk about a short circuit over at the motor capacitors. Suppose the motor run capacitor had a short circuit, then the current would flow through the Klixon relay, through the compressor and then through the shorted motor run capacitor wires.
However, you've got two limiting factors here: the overload relay would sense that and then shut off or switch down, and also the compressor itself is a large resistance that would limit the short circuit current, if you did have a short circuit over in this region, to a very small amount, perhaps a few amperes, that would not be sufficient to melt the wires or cause an arc problem. It would be limited.
Here, however, I'm showing a different short circuit. I'm showing a short circuit on the front end

of the compressor relay compartment between an energised wire and a neutral wire, and you can see that this short circuit path bypasses both of the Klixon relay, the overload relay, as well as the compressor itself and the run capacitor.
In that case, what do you have to limit the current? You have the wiring of circuit number 7, small fraction of an ohm. You have the power supply cord for the fridge freezer, again, small fraction of an ohm. You have the internal wiring harness, a small fraction of an ohm.
In fact, the majority of the resistance is in the arc itself, within the short circuit, typically about one ohm, much larger than all of those other limiting factors which are small fractions of an ohm.
So if you think of 1 ohm -- now I have to give you another formula: current is voltage divided by current. Ohms -- well, it's a pretty simple circuit. We're supplying this fridge freezer with 230/240 volts, the standard voltage in the United Kingdom, and if you think of 240 volts in one ohm, Ohm's law would give you 240 amperes, 240 volts by 1 ohm.
So this path, you're not limited by the compressor, you're not limited by the Klixon overload relay, you're going to have a large amount of current, and that's

either going to cause the 32-amp circuit breaker for circuit 7 to trip, or the fuse, the 13-ampere fuse, to blow. As I mentioned earlier, there are many cases where the 32-ampere circuit breaker will operate, will trip, before the fuse blows.
Q. Flowing on from that last answer, you say in the same paragraph on page 12 that the 32-amp circuit breaker would trip:
"... without a thirteen-ampere fuse in the plug for the fridge freezer mains supply flex."
Just to deal with it point by point, because these matters are quite technical, can you explain why you say you would expect this scenario not to result in a 13-amp fuse in the plug for the fridge freezer to blow?
A. It's very common when you have 13-ampere fuses for appliances not to blow, simply because the 32-amp circuit breaker operates faster. It's going to be a race. One of them is going to operate first. But in many cases, the circuit breaker will trip before the 13-ampere fuse blows. I did explain that in section 1 of my report, but that does bear some analysis.
Q. Thank you.
Can we now turn to the relationship between the scenario you've posited here and arc-damaged MJS/1.
In this short circuit scenario, where would you

expect to find the electrical arc damage?
A. So here is the run capacitor. We saw that the run capacitor in the exemplar fridge, as well is in the subject fridge from flat 16, the run capacitor wires had 24 strands. Okay? So they run along the neutral here. So when you have an arc here from the energised wire -- by the way, that was 23 strands and 14 strands, if you recall JDG/6B -- arcing to 24 strand wires.
As I mentioned before, MJS/1 was not found within the subject fridge freezer, it was found in the bedroom, but these wires that go with the fridge freezer for the run capacitor, are consistent with that MJS/1.
SIR MARTIN MOORE-BICK: So I understand this, you are postulating that the energised wire shown in your diagram is sufficiently close to the neutral wire in terms of physical proximity for an arc to occur between them?
A. Yes, no, this is a circuit diagram.
SIR MARTIN MOORE-BICK: Of course.
A. So you see what appears to be a large space, but all of these wires enter the relay compartment in close proximity to each other.
SIR MARTIN MOORE-BICK: Yes. Thank you.
MR KINNIER: Thank you.
That dealt with the next questions I was going to

ask, so could I ask you to turn to page 13 of the addendum, and it's the only paragraph on that page.
Here you note that, in your view, the short circuit scenario you've outlined on the previous page would not cause the RCCB to trip; is that a fair summary?
A. Yes, it is.
Q. Could you take us through your reasoning for coming to that conclusion?
A. Okay, once again --
Q. Would it help if we put up figure 7 for you again?
A. That's good. If you could blow figure 7 up, expand it.
You see the arc, which is that red short circuit that I've annotated in red. The blue and the red is my artwork, the rest of the diagram is a Whirlpool circuit diagram.
So I've annotated a short circuit from an energised wire to a neutral wire (Indicates).
And now I've lost track, what was your question?
Q. It's just really understanding your reasoning for concluding why, in the short circuit scenario, it wouldn't cause the RCCB to trip. It's just understanding why.
A. Thank you so much.
So here we have a short circuit from an energised wire to a neutral wire. RCCB circuit breakers do not

trip, do not operate, for what we call an energised line to neutral short circuit. They only trip when the grounding wire or some metallic path to ground is involved. So if electrical current leaves an energised wire and somehow flows to ground, or to a grounded metal plate, then the RCCB would pick that up, it would detect it, and it would trip.
But in this case, the RCCB would see current coming in, current coming out, even though it's a very high value, could be a short circuit, it's coming in the energised wire, going out the neutral wire, the RCCB sees a balance of 0, it doesn't see a net current flowing to a ground path, and so it does not trip.
Q. Understood.
I think I'm right in saying that your view is that the RCCB tripped later, but before Mr Kebede turned off the main switch; is that, again, a fair if general summary of your view?
A. Yes.
Q. You say it's probable that this was a result of essentially smoke and smoke particles attacking an energised socket; is that right?
A. Yes. So circuit 7 has tripped, so all of the sockets in the kitchen and the circuit 7 wiring are now de-energised, but the RCCB is looking at two circuits, 7

and 8.
Circuit 8 are the other flat sockets, so if those other flat sockets in circuit 8, if one or more of them were attacked by fire, by smoke, by smoke particles, then knowing that smoke, smoke particles, soot, are all electronically conductive, carbonaceous material, if a socket in circuit 8 which is still energised before Mr Kebede turns off that main red switch is attacked by smoke and smoke particles, then you can have a small current.
By the way, the RCCB circuit breaker operates for a very small threshold of current, 30 milliamperes. That would be 0.03 amperes. It doesn't take much for that RCCB circuit to trip. In my opinion, smoke and soot particles quite likely caused a socket in circuit 8 to trip at a later time, before Mr Kebede turns off the red main switch.
Q. Looking at that, Dr Glover, you've noted that smoke and smoke particles are conductive. What is less clear is how precisely smoke and smoke particles are likely to have led the current flow to the ground receiver. Could you help us understand that process?
A. So if you look within a socket, or if you think of when you plug your 3-pin, your 3-pronged plug into a socket, one of them is the ground prong. It's the single one

and above it are the energised prong, the live wire prong and the neutral prong. They're all in fairly close proximity, the receivers within the socket that accept those prongs. Okay?

So let's suppose you have a socket where nothing is plugged into it. Smoke gets into that socket, the holes for the three prongs of the plug, and the smoke deposits bridge the gap between the receiver for the energised portion to the ground. Then you have that ground path that would trip an RCCB.

Q. Are you able to give us an idea as to the quantity of smoke or smoke particles that would be necessary to produce this effect?

A. I don't think I could quantify it for you. All you need are smoke particles, soot, to get into the socket receivers and bridge that small gap distance. I guess I'll have to go back to the 30 milliamperes. It would have to be enough soot and smoke deposits to cause the conduction of at least 30 milliamperes.

But if you want milligrams, I would not be able to quantify that without doing some experiments.

Q. Staying with this question of the density of smoke.

Could I ask you, Paul, to turn to page 14 of the addendum. It is really the third line of the third paragraph on that page, and it's a point we've adverted

to earlier on. You say this:

"It is probable that smoke and smoke particles, having exited the kitchen ... attacked an energized socket ..."

Then you quote an extract from Ms Kinfu's witness statement.

At the bottom of page 14, at footnote 4, you acknowledge that the two other occupants of flat 16 didn't necessarily agree with Ms Kinfu's recollection that smoke was in the corridor.

Can you help us with this point: why have you placed greater weight on the evidence of Ms Kinfu as opposed to the two other former residents of flat 16?

A. Yes. So when I read Ms Kinfu's statement, she was very explicit in her perception that there was smoke in the corridor. She was awoken from her bedroom, and she says in her statement that she didn't smell or sense any smoke in the bedroom, but once she opened the bedroom door and entered the corridor within flat 16, then she sensed smoke. She sensed it in three ways: she smelled it, she said she even tasted it, if you read her statement, and she saw it. Okay? And all of this is going on.

So you can see:

"I opened the bedroom door and I could smell

something different, not normal air, different. It was like a burning smell and like a chemical smell and I could taste it. I could not smell it in my room when the door was closed. I went into the corridor of the flat and saw smoke. The smoke was near to the front door which is at the other end of the corridor from the kitchen. I could still see the front door. I was shocked and I can't recall if I could see the other end of the corridor near the kitchen. The lights in the flat were off but light was coming in through the front door and everything seemed cloudy."

So you have quite an explicit memory that she is recording here, three different ways that she observed smoke.

Now, the other two witnesses -- Mr Kebede, I remember he was preoccupied with waking up his fellow roommates, Ms Kinfu and Ms Afeworki, and also going outside to wake up the other occupants of the other flats on the 4th floor, and then going back into his apartment and getting dressed, picking up his cellphone, turning off the main red switch and then vacating. He was also calling -- it's not 911, what is it?

Q. 999.

A. 999 here. So there were other things on his mind.

Ms Kinfu, however, is very explicit in her recalling

the smoke in that corridor before she vacated.

Q. Following on from that point, if I could ask Paul to de-amplify that but amplify footnote 4.

In the second sentence, in respect of Mr Kebede, you say:

"He also states that he is not sure if he closed the kitchen door behind him or not ..."

Stopping there, were you aware of the thermal imaging camera footage taken by the firefighter first responders when they entered flat 16, and that it certainly appeared from that footage that the kitchen door was closed?

Were you aware of that footage is the first question?

A. I was, yes.

Q. Given that footage, what effect does that have on your analysis of the amount of smoke that could've escaped the kitchen and got into the hallway, thereby triggering the scenario which you've posited in the addendum?

A. Well, you have to consider the possibility -- certainly it was open at one time when Mr Kebede looked into the kitchen and observed the fire on the east end of the kitchen near the fridge freezer. He doesn't remember whether he closed it. Was it fully closed or was it ajar when the fire department came in?

So those are issues I have.
Could somehow, in some other means, that kitchen door have been left open by Mr Kebede, and then closed in some other way due to fire, heat, or someone else?
That's possibilities. I don't have an answer.
Q. Presumably it flows from that, you aren't able to assist us on the amount of smoke that may have escaped the kitchen into the hall between the time of Mr Kebede first identifying the fire and making the 999 call?
A. That's right. I'm not quantifying that, not able to.
Q. Equally, you're not able to give us any idea about the amount of smoke that would have escaped the kitchen into the hall between the first 999 call and Mr Kebede leaving the apartment?
A. No, I can't --
Q. Okay.
A. -- distinguish.
Q. Looking at trying to understand the mechanism by which the short circuit occurred, are you able to assist us with how long smoke would need to be at or in the area of the socket in order to penetrate the inner workings and trigger the scenario you've posited?
A. It's almost instantaneous. Once the smoke and soot particles enter the socket and bridge the gap between the ground receiver and the energised receiver, the RCCB

trips very rapidly, within milliseconds.
Q. Could we now come on to the separate topic of the role of 6B in your scenario.
You conclude -- we can turn to page 15 of the addendum just to orientate you in your conclusions -- that it's probable that the overheating of 6B caused the fire in flat 16. Is that a fair summary of the conclusion you reached in the addendum?
A. Yes, sir.
Q. Can you explain for us the relationship between the overheating of 6B and the short circuit you've set out in figure 7, or do you think you've covered it in the evidence you've already given?
A. Okay, so you have the overheating within the crimp for --
Q. Yes.
A. -- exhibit JDG/6B, and that becomes a glowing connection over time as the oxide builds up and the resistance builds up and the power losses increase. Once you get that glowing connection, you have the possibility of igniting the wire installations. Now you have a fire going on within the compressor relay compartment.
So now it's a matter of time to bridge that gap between the energised wire, that's JDG/6B, and the neutral wire, to cause a short circuit. And those wires

are in close proximity to each other within the relay compartment, and it's just a matter of time before the installations are burned off both of those wires, causing a line to neutral short circuit.
Q. Apologies for asking what might be a simple question, but is it the overheating which causes the ignition or is it the electrical arcing, or is that a false distinction?
A. The overheating in the crimp starts the fire. It overheats, it glows, it ignites. We don't have a short circuit yet. It's kind of what you call a series arcing through those voids. You have glowing electricity, luminous electricity, flowing through those voids. It creates heat that ignites the insulation on the wires before you have a short circuit that would trip the circuit breaker.
Q. Thank you very much, Dr Glover.
I now turn to part 3 of the questions that I'd like to ask you in respect of the addendum, and that's more specific questions regarding the reasoning.
Paul, if you could put down the addendum and return to Dr Glover's report, and page 57 of that report, if possible.
You say in the substantive paragraph underneath the halfway point, and I quote:

"It is concluded that arc-damaged Exhibits MJS/1 and JDG/1 are consistent with a wire from either the run capacitor or an internal jumper wire within the relay compartment of BPS/4."
I think this is an extract we looked at earlier when discussing your analysis of the large fridge freezer.
Having read that, could I ask you to turn back to your addendum, and page 9 of the addendum.
If we look at the top paragraph, it says this:
"Figure 6 shows arc-damaged Exhibit JDG/1, which I found within the medium-sized freezer during my 27 April 2018 inspection at Bureau Veritas. There are two possibilities for the location of JDG/1 at the time of the fire: either (1) JDG/1 remained within the medium sized freezer; or (2) JDG/1 was initially located outside the medium sized freezer at the time of the fire, and was (inadvertently) moved into the medium freezer during or after subsequent firefighting efforts."
To the lay reader, that suggests that you are less definite that JDG/1 formed part of the large fridge freezer.
What would be your response to that observation?
A. Okay, so at the time that I concluded my 15 October report, I hadn't focused on the crimp connector with the

voids JDG/6B. Once I saw the voids, when I was able to produce my addendum, I went back and considered the two arc-damaged exhibits that were found in flat 16: MJS/1, JDG/1.

JDG/1 I found in the medium-sized freezer, and we know that there was a problem, Mr Kebede had a problem; a fuse was blown many years before the 2017 fire. And putting that together, and now further looking at JDG/1, that arc-damaged wire which has really three wires with 24 strands in them, that would be not quite as consistent as MJS/1, which had only two wires.

Now, that goes back to the motor run capacitor in the fridge freezer that has two wires in it, and both of those have 24 strands.

So upon looking at JDG/1, which had two wires but then a third wire, segments in between, that to me made it less likely that that could've been in the fridge freezer, more likely that that came from the medium-sized freezer due to a prior event many years before the 2017 fire.

So I ended up concluding that the likelihood of arc damage would've been associated with MJS/1 within the fridge freezer.

Q. Thank you.

What would be your responses to the suggestion that

it's at least a possibility that MJS/1 was once part of the medium freezer?

A. First of all, go back to that basic clue. We have circuit 7 that tripped on the night of the fire, okay?

We only have two arc-damaged exhibits that would be sufficient to trip the circuit breaker for circuit number 7. We just have two: we have MJS/1 and JDG/1.

Now having excluded JDG/1 as having come from a prior event, we are only left with one arc-damaged exhibit from that flat, from flat 16, that could've tripped circuit number 7.

Q. Following on from that, is the wire you've identified as MJS/1 the only electrical component that you believe is from the fridge freezer that wasn't found near the large fridge freezer?

A. Yes.

Q. Yes.

A. First of all, it's the only arc-damaged one, excluding JDG/1, and all these other exhibits like JDG/6B, all those were found within the fridge freezer.

Q. Apologies for jumping around. We're at the addendum at the moment. If I could ask Paul to turn to page 10 of at the addendum.

You state there in the third paragraph on that page:

"With evidence that exhibit JDG/1 arced at a prior

time unrelated to the fire ..."

Stopping there, can you identify for us what the evidence is that you rely upon for concluding that JDG/1 arced before the fire?

A. This would be basically Mr Kebede's statement that he had a problem with the medium freezer many years before the fire. He called in a technician from the Yellow Pages and he had a specific memory that this technician told him there was a bad fuse. Mr Kebede didn't want to fix the problem at that time, but he continued to preserve the medium freezer. That would be the basic evidence we have that there was a prior event that caused a fuse to blow.

Q. Apologies for pressing the point, but given you've considered that JDG/1 arced before the fire, why do you exclude the possibility that the damage to MJS/1 was arc damage sustained before the fire?

A. What I'm saying is that, once again, we're left with one piece of arc damage that would've been sufficient to trip the circuit breaker for circuit 7. That's MJS/1. So that's how I conclude that it was somehow, at one point, connected to circuit 7, that it was energised from circuit 7 within the kitchen.

Now, I am assuming that this is an electrical fire. As I mentioned, I'm not a cause and origin expert.

I have no opinion on whether this was a non-electrical fire caused by a lit candle or a smouldering cigarette. I'm assuming we have an electrical fire here, and I'll leave it to the fire investigators to tell the inquiry whether this was a non-electrical fire.

So if we have an electrical fire, we're left with MJS/1, the only arc-damaged exhibit that in my opinion could've tripped circuit 7 for the kitchen.

That would happen before the fire, obviously. We have an abnormal electrical event, trips a circuit breaker, fire starts.

Q. Maybe I should've asked this question earlier on, but it flows from what you've just said.

Whilst we have the benefit of the guidance you identify in the damage assessment memo, we have the listing of the nine characteristics of arc damage, how straightforward is it to identify arc damage as a general proposition?

A. It does take experience. If it's someone who has experience in looking at arc-damaged wires, has reviewed the literature -- I've mentioned NFPA 921, the guide to fire investigations, and there are some very explicit -- we listed nine of them -- things look for. The fine line of demarcation between the localised damage and the undamaged, the copper beads, arc beads, the opposing

wire, you've got to have arc from one to another -- all of these things I saw are the clear evidence of arc damage to MJS/1.

Q. Can I move on to a separate topic, which is looking more particularly about MJS/1 again.

It may well assist if we put up a photo, Paul, which can be found at WPL000003234 and internal page 23.

SIR MARTIN MOORE-BICK: Can I just intervene, are you still happy going on?

THE WITNESS: Yes, sir.

SIR MARTIN MOORE-BICK: You don't need a break now?

MR KINNIER: It is a convenient place to stop if that helps.

SIR MARTIN MOORE-BICK: I just wanted to make sure that Dr Glover was not sitting there thinking he had had enough of the morning.

THE WITNESS: I'm fine.

SIR MARTIN MOORE-BICK: Are you fine with that? Whatever time suits you.

MR KINNIER: I think we're having some difficulties locating the photo at the moment.

(Pause)

Paul, do you have the reference? It's WPL000003234.

There we go.

If we could go to page 29, using the Relativity numbering.

If we can amplify figure 8.

Apologies, just for context, it's necessary to rehash a question I asked earlier, but is the design of the compressor in the exemplar which is shown there different to the one you found in the large fridge freezer in flat 16?

A. Yes, this is an exemplar, and the way you identify this particular compressor is there is a blue logo that's actually, in this company -- the logo of this company is -- the company is Tecumseh.

Q. Sorry to interrupt you, Dr Glover. There's the compressor unit which sits roughly in the middle of the photograph, there's two labels in the centre of the compressor.

A. Yes.

Q. We're looking at the top label, and there's a blue logo to the far left-hand side.

A. Correct. So this is the compressor. There are two labels on the compressor. There's a warning label below and there is a manufacturer's label. In the upper left corner, there is what I call a blue logo. That is the logo of Tecumseh, it's actually a native American headdress, Tecumseh is a Native American name.

So this is not the Embraco compressor that was within the subject fridge freezer from flat 16.

Q. Understood.

Is the design of the exemplar different to the design of the index fridge that was in the kitchen at flat 16?

A. Not significantly, no. I mean, you have the compressor. To the left of that you have what we've been calling the compressor relay compartment. This is a plastic enclosure that plugs into the compressor. Both of these features, there might be some small differences would be applied to the Tecumseh model that you see here as well as the Embraco, and you also have the run capacitor over here which runs into the compressor relay compartment.

These are all general. They would apply to both models.

Q. Would there be any difference in the wiring layout of the index fridge freezer and the exemplar fridge freezer?

A. There are some differences, as I mentioned. The wiring, harness with five wires that come down from within the freezer is slightly different from this exemplar. It's still five wires, but one of them, the wires are within a cord with an outer jacket, and for the other they're not.

The actual size of the compressor relay compartment might be different for both, but generally they're

similar.

Q. Are the components within the compressor relay compartment enclosed within the housing? I think the housing is to the left of the compressor.

A. Yes.

Q. That's a yes?

A. Yes. Those would be the two relays, the PTC relay and the Klixon relay, and the wires and wire connectors.

Q. Okay.

Paul, can you put away that photograph and put up a separate photograph, which is MET00009047.

I think and hope and expect this is a post-fire photograph of a compressor relay; is that right?

A. Yes. So this is not one of my photos, but this is the compressor.

Q. If I can stop you there, hopefully that also shows exhibit 6B; is that right?

A. On this front, as we're visualising here, if you looked at the rear of the refrigerator, it would be on the left, but we're facing the compressor relay compartment. The plastic enclosure is now missing, it's been consumed in the fire, and what you are looking at are -- up here I believe is the Klixon relay, up here, and down here is the PTC (Indicates), it's hard to see, and there are a number of wires with connectors on them. One of them

is JDG/6B, as well as JDG/6A and 6C, and all of those wires came from this area, which was exhibit BPS/4, the compressor from the fridge freezer fridge in flat 16.

Q. Thank you.

Just to flow from that, are you able to confirm that you examined all the wires that are illustrated in this photograph?

A. Okay, now, I never saw this as it is in this photo. This was then disassembled during laboratory investigations that I was not present at, and certain items were put into certain evidence bags, zip-locked bags, and labelled with different components. So I was looking at various components that were taken from this compressor relay compartment.

Were they all there? I looked at everything that was shown to me, and I carefully examined everything that was presented to me. Can I say that there's something here that I didn't look at? I can't say that.

Q. I suppose the next question is: did you find any arc damage on the wires that you believe to have come from the compressor relay?

A. No, there was no arc damage. The only arc damage was MJS/1 and JDG/1.

Q. Can I ask Paul to put away that photograph and return to your addendum, Dr Glover, and could I ask you to turn to

page 5 of that addendum.

If we now turn to some specific questions regarding the various exhibits illustrated there in figure 1.

First question is this: were 6A and 6C and the longest wire from 6F from the run capacitor as they're all 24 strand conductors?

A. Short answer to that is yes. If you look at JDG/6A in the lower right corner, that's a connector, and the CT scans that show that there were 24 strands of the wire within JDG/6A. Moving to the centre, JDG/6C is another connector with a wire in it, and the CT scans show there were 24 strands associated with that connector and wire. And then there is a third wire up here, JDG/6F, I believe it's this one (Indicates), one of the other wires that did not have a connector associated with it, it was just a wire segment, also had 24 strands.

By process of elimination, I concluded that those were basically run capacitor wires.

Q. Would those wires have been contained within the compressor relay compartment?

A. In my opinion, yes. JDG/6C and A are definitely right in the compressor relay compartment, and of course they're wire segments now. I would associate this 24-strand wire over here with this connector (Indicates) because it's simply -- there's nothing left. So there

had to be a wire here. It's most likely it was this F, which also has 24 strands.

This JDG/6C has a connector but also has a wire with 24 strands.

So I would put these definitely right within the compressor relay compartment.

Q. Tying this together with MJS/1 and previous answers, you've confirmed that the length of MJS/1 was 10 centimetres, or approximately thereabouts.

Do you think or have you concluded that MJS/1 was located within the compressor relay compartment?

A. I have concluded that it is most likely, it is probable, that the fused area of MJS/1 was located in the compressor relay compartment. To the left of that fused area are 7, 8, 9 centimetres that most likely projected out of the relay compartment and were headed toward the run capacitor.

Q. Would it help if we went back to look at some photos of MJS/1?

A. Yes.

Q. Paul, could you go back to JDGR0000006_0002.

If we could amplify I think the top figure, Dr Glover, is probably the most helpful; is that right?

A. I would take the bottom figure, simply because there is a scale on there.

Q. Okay, if we could amplify the bottom one, Paul.

Dr Glover, can you confirm for us the fuse section? I think you were saying -- correct me if I'm wrong -- the fuse section was contained, you think, within the relay?

A. Yes, here is the fuse section about 1.5 centimetres from this end of MJS/1 (Indicates). In my opinion, that was located within the compressor relay compartment of the fridge freezer.

Q. And the rest extruded.

A. At some point this would have exited the compressor relay compartment and continued on to the run capacitor, which is further over to the left at the lower rear of the fridge freezer.

Q. Paul, take away that photo and return to the addendum, and figure 1, at page 5.

A. May I ask a question: is it possible to have a split screen and show both of those figures at the same time?

Q. It is, he says optimistically!

(Pause)

A. Thank you.

Q. Thank you, Paul.

Given the analysis you've carried out, Paul, if I could ask you to amplify -- thank you -- figure 1 on the left-hand side, are you able to say whether MJS/1 is

the continuation of the capacitor wires 6C and 6F?
A. Basically, yes.
Q. Can you help us why you can say that, or why you think you can say that?
A. So, 6C and 6A, these are connectors, these are the crimp connectors. Those will plug in within the relay compressor compartment. These connectors had to be within the compressor relay compartment. That's to start.
Q. The next question, therefore, is which end of MJS/1, illustrated in the right-hand box, would've been closer to the broken wires 6C and 6F?
A. Okay, so here's my analysis. Let's take 6C. This is within the relay compartment. Here is the wire (Indicates), it's about 7 centimetres, if you look at this scale, about 7 centimetres of wire. That would've been connected, in my opinion, to the right end, which itself is 1.5 centimetres from the fused area of MJS/1.
So here is 6C (Indicates), this wire would connect to one of these wires, and here is 6A, which connects to this wire (Indicates), also with 24 strands, which then connects to the other wire on the right end of MJS/1.
Q. Understood.
A. So what you end up with is about 7 centimetres here, another 1.5 centimetres here, 8.5 centimetres, that's

about 3.2 inches.
3 inches of wire in my opinion would fit quite comfortably within the compressor relay compartment.
MR KINNIER: Dr Glover, thank you.
Sir, that is a very convenient point at which to break.
SIR MARTIN MOORE-BICK: Yes. All right. And you seem to be getting on quite rapidly.
MR KINNIER: We are. Not much further to go.
SIR MARTIN MOORE-BICK: Right, Dr Glover, we'll stop at that point so we can all have some lunch. There will be some more questions when we come back.
THE WITNESS: Thank you, sir.
SIR MARTIN MOORE-BICK: I'm going to ask you not to talk about your evidence over the break, and if you would like to go with the usher, we'll start again at 2 o'clock. All right?
THE WITNESS: Thank you, sir.
SIR MARTIN MOORE-BICK: Thank you very much.
Good, 2 o'clock, please. Thank you.
(1.00 pm)
(The short adjournment)
(2.00 pm)
SIR MARTIN MOORE-BICK: Do sit down, Dr Glover.
Yes, Mr Kinnier.

MR KINNIER: Thank you, sir.
Dr Glover, thank you very much for coming back.
We were discussing wire MJS/1 before the break. Can we return to that and, in particular, refer to a photo MET00009077.
Can you just confirm for us what this photograph shows?
A. This is the remains of the compressor from the fridge freezer in flat 16. On the front view, this would actually be the left side of the compressor if you were behind the fridge looking at it. You're looking at the compressor relay compartment, the remains of it and the components within it.
Q. As we're looking at it, is the wire on the left 6C?
A. I cannot answer that. Again, I was not present when the compressor components were still affixed to the compressor, I only saw them in separate bags, so I cannot tell you which is 6B or 6C. I don't have a scale to measure things there.
So I could try to do an analysis in the future, but I cannot identify which is 6B, which is 6C or --
Q. Understood.
If the one on the left is 6C for the purposes of a hypothesis, would the arc-damaged part of MJS/1 need to be located at the end of 6C?

It's a hypothetical question, given your previous answer.
A. Well, 6C is approximately 7 centimetres in length, and -- could you repeat that question?
Q. Yes, of course.
On the hypothesis that the wire on the left is 6C --
A. Okay.
Q. -- would the arc-damaged part of MJS/1 be located after the end of 6C?
A. Yes, it would.
Q. Can I ask you to turn back to your addendum and figure 7, which is at page 13.
The path of the short circuit is illustrated with the red zigzag in the bottom right-hand corner, I think; is that right?
A. Yes, sir.
Q. Are the wires that participate in the short circuit that you say was caused by the overheated crimp located inside the compressor relay or not?
A. Yes.
Q. Yes.
A. They were located inside the compressor relay compartment, yes.
Q. Looking at figure 7 itself, where would you place MJS/1?
A. Considering the number of wire strands in MJS/1, 24

strands per wire, okay, which is consistent with the run capacitor wires, here you have the run capacitor, okay? Here is one run capacitor wire here, another one here (Indicates).

Now, these look like short sections to you. Remember that the run capacitor is not within the relay compartment. It's over here (Indicates), okay?

Q. Yes.

A. So you pull this run capacitor out and bring these two wires -- here is one, here is two, both of which -- and here's a continuation of it (Indicates) -- bring these two wires out and then bring them into the compressor compartment then hook them up to these two locations.

Does that explain it?

Q. To an extent. Apologies, this may be me, but you have the path of the short circuit shown by the means of the zigzag on the left-hand side.

A. Yes.

Q. If you place MJS/1 in or near the run capacitor, which is what I understood you were saying --

A. Yes.

Q. -- why is the path of the short circuit not near the run capacitor?

A. Well, again, this is just a circuit diagram. These two wires, the run capacitor wires, extend out. So even

though I'm showing the short circuit here, if I could run this over here (Indicates) -- I'm just trying to illustrate here a short circuit that bypasses the Klixon overload relay in the compressor itself.

Now, again, these two wires for the run capacitor are running out of the relay compartment. So if you wanted to, I could bring this over here (Indicates), okay? And you get the same effect.

Q. I understand.

Could I now deal with the fire initiation scenario itself.

Looking at the mechanism of overheating, what testing have you done to ascertain the electric current that flows through 6B when the fridge freezer is running normally?

A. That would be the compressor load.

Now, we'll start with the power supply cord for the fridge freezer. It has a 13-ampere fuse on it. So we're talking about a normal load current for the entire fridge freezer of, let's say, 10 amperes, just to give you a rough number approximately.

When the compressor is on, I would estimate that -- and it's my estimate -- in the range of 5 to 10 amperes for the compressor load current, under normal conditions.

When it starts up, it's much higher. A compressor motor, when it starts, could be five or six times that. But after it gets into the normal running current, I would estimate the compressor load current in the range of 5 to 10 amperes.

Q. Were you able to measure the post-fire electrical resistance of the connection within 6B?

A. No, I did not do that.

Q. Would that be possible?

A. Well, you could certainly allow a device, an electronic meter, to try and measure resistance, but how meaningful that would be, I would question. You have a connector that has gone through a fire. It's heavily fire damaged, and then after the fire it was exposed to moisture and the possibility of additional corrosion, rust. So in my opinion, that would be -- it certainly could be tried, but I wouldn't find that too meaningful of a measurement.

Q. Thank you.

Turning now to the wire crimp, just understanding its basic design.

Does it include internal serrations?

A. On the barrel of the crimp?

Q. Yes.

A. I wouldn't call them serrations; I'd call them ribs,

perhaps.

Q. These are used to clamp the wire strands together in the electrical connector, just to understand?

A. Excuse me?

Q. The basic crimp design has serrations; is that right?

A. Yes.

Q. The purpose of those serrations is to clamp the wire strands together in the connector?

A. Yes, and clamp them to the wire barrel itself.

Q. Looking at 6A and 6B, are they two different crimp designs?

SIR MARTIN MOORE-BICK: Do you think we should see them?

MR KINNIER: Yes. Having said that, I am now trying to remember what the reference would be. It may well be that you don't need it just to deal with 6A and 6B.

A. The only difference -- 6B, as I mentioned, has 14 plus 23, that's 37 wire strands in it. 6A has 24 strands.

So whether they're the identical connectors, I can't answer that. They look very similar in design, but they may have different model numbers in order to accommodate different size wire strands.

But they are similar in design.

Q. If we go back in your addendum at page 6, does this provide any help -- it may not, actually -- to illustrate the point you've made?

A. Again, they look very similar. However, I would have to do a dimensional analysis, perhaps even look -- I don't know if you could find some model numbers on the remains of these crimps. They're very, very similar, but I can't say they're of the identical model.

Q. Staying with this page, and looking in particular at figure 2, the top suite of pictures, is it fair to say there are multiple points where the wires in 6B are tightly clamped, just looking at what we see in those cross-sectional slices there?

A. Okay, so we're looking within the wire barrel itself.

Q. Yes.

A. And now we have to look at cross-sections.

Q. Yes.

A. And that's where we're looking about the clamping.

My opinion, looking at the shape of the connector not projecting -- not the curved portion of the barrel projecting inwards, also looking at this space (Indicates) which is wide over here and then narrows down --

Q. Stopping there, the space you're referring to there, the space referred to earlier on, the space between the two wire barrels illustrated at the top of figure 2.

A. Yes. Yes, so I don't consider this a tight connection.

Now, what was your question exactly?

Q. Well, the question is really: are there multiple points illustrated by these cross-sectional slides where the wires are tightly clamped? Is that a proposition you would accept or not?

A. I would not use the words "tightly clamped". There are locations where wire strands are in contact with each other, and there are other locations where there are void spaces. I would not consider this a tight clamp. I would not consider any of these a tight clamp because of the lack of the curvature portion of this barrel projecting more into the strands, which you can compare with the lower figure for 3A.

Q. Going back to the top of figure 2, looking at the wire barrel itself, there appear to be, looking at the top wire, two or possibly three ribs. Is that a correct reading of that?

A. There are rib sections, yes.

Q. Are you able to say whether there is a correlation between the location of the ribs and the location of the voids illustrated in the cross-sectional slices below?

A. Well, considering that there are 80, 8-0, slices here that the CT scan gave us, and there are voids in every slice, you are going to have some slices in between ribs, some slices under ribs, both of which have voids. So I'd say there's no correlation there.

However, I would say that the slices that have large voids, such as the centre one, are likely correlated with the ribs.

Q. To some extent, can we draw any reassurance from the fact if we're looking at the centre cross-sectional slice, there's a green line, an arrow immediately above it, if we follow the line up, does that reach a rib in the lowest wire barrel?

A. It does. Now, I have to be careful here. I selected a cross-section more or less in the middle of the wire barrel, and then I drew a line from what I considered to be the middle of the wire barrel down to this. I can't say that that is aligned with a rib.

So even though I'm showing it like that, I did not specifically say: yes, this came from that rib.

This cross-section came from more or less the centre of the barrel, this cross-section came from the left end, this cross-section came from the right end (Indicates).

So when I drew this, I was not thinking of ribs; I was just picking five cross-sections that would broadly scan the entire length of the barrel.

Q. Understood.

Can I turn to the hypothesis on the initial fire spread insofar as it concerned MJS/1.

Is it a correct assumption that the scenario you've set out in the addendum report is based upon the fire starting within the relay compartment?

A. Of the fridge freezer, yes.

Q. If MJS/1 was located outside the relay compressor, how did overheating in JDG/6B cause arcing on MJS/1?

A. Did you say the fused section of MJS/1 is located outside the relay compartment?

Q. No, simply if MJS/1 was located -- I put it more generally than that.

A. The important part is the fused section of MJS/1.

Again, I have concluded that MJS/1 was associated with this fridge freezer and ran into the relay compartment, but a certain part of that 10 centimetres must have projected outside of the relay compartment, heading towards the run capacitor.

Q. Can you help us with how the fire would have travelled from within to without the compartment?

A. Before the short circuit or after --

Q. Yes, before, first of all.

A. So you're placing -- I just want to get your premise. You're assuming that the fused section is outside of the relay compartment.

Q. If we assume it's within.

A. Well, then, the fire doesn't need to travel outside.

The fused section is within the relay compartment, and that's my opinion, that's my conclusion, and the line to neutral short circuit that gives you the arc damage to MJS offence is all within the relay compartment.

Q. In relation to the scenario you've postulated in the addendum report, are you able to identify which two wires touched each other in the short circuit that you've set out, illustrated in figure 7?

A. One of them had to be an energised wire. That would be JDG/6B or an extension -- remember, we only have about 7 centimetres of it and then it ends. So you think of the end of that 6B bridging across the run capacitor wires and causing a line to neutral short circuit.

Q. This may follow from a question I asked before lunch, but are you able to assist us with what you think came first: was it the short circuit or the overheating connector?

A. The overheating connector, in my opinion, was the first event that started burning the insulation on the wires that led to a short circuit.

Q. If that's so, would the full path of the current through that connector during normal operations operate at a maximum of 0.4 amps or thereabouts?

A. 0.4 amperes?

Q. Yes.

A. I don't know where you got that number. Maybe I don't understand the question. Repeat that.

Q. Yes, of course.

If you say, which you do, that the overheating connector came first, do you accept that the full path of the current through that connector during normal operations would be at a maximum of 0.4 amps?

A. No.

Q. Can you give a reason why you don't accept that?

A. Well, we need to know what the compressor load is, and I have not calculated that, but I am assuming that it's more than that.

Q. Okay.

Would you agree with the proposition that there were additional wires in the exemplar compressor relay compartment that you reviewed compared to the flat 16 fridge freezer? By way of example, do you agree there was a jumper relay system in the exemplar but not in the flat 16 fridge freezer?

A. Okay, I think I understand your question, but if you could repeat that one more time.

Q. Of course.

Do you agree with the proposition that there were additional wires in the exemplar compressor relay compartment compared to the flat 16 fridge freezer? By

way of example, there was a jumper relay system in the exemplar but not in the flat 16 fridge freezer.

A. Yes, that's a possibility. The exemplar exact design and manufacture may have some differences, including, as you say, I observed some small jumper wires -- it's in one of my figures in the report -- within the relay compartment of the exemplar fridge freezer which may not be associated -- they may not have those jumper wires within the subject fridge freezer.

Q. Would that difference have any material impact on the reasoning you set out in your addendum on the hypothetical fire initiation scenario?

A. No.

Q. Can you help us why not?

A. Because I am associating the short circuit with 6B, that has 23 strands and 14 strands in it, and that would've been energised when the compressor is on, and that's where the overheating crimp is, and that is what would have arced to the run capacitor wires.

Q. Are you able to say whether the length of the wires in the flat 16 fridge freezer were longer or shorter than the wiring in the exemplar?

A. We have to take the wires one at a time.

Let's talk about the run capacitor wires. The run capacitor is not within the relay compartment. If

you're behind the refrigerator, it's over to the left. The run capacitor, as I understand it, would be a separate component, not necessarily supplied by the compressor manufacturer. That would be what the company that manufactured the fridge freezer would be connecting within the relay compartment.

I would assume that the run capacitor wires would be similar for an exemplar, whether it be an Embraco or Tecumseh.

Q. If they were shorter, for example, in the flat 16 fridge freezer, would that have any material impact on the reasoning you set out in the addendum?

A. No, but, again, they can't be shorter. They have to -- I know where the run capacitor is, on the left end of the mounting plate for the compressor, it's off to the left if you're behind, and then these wires run from the run capacitor to the relay compartment. They have to be a similar length, whether it be a Tecumseh or an Embraco.

Q. Dr Glover, thank you. I now come on to my final topic, which I'll deal with briefly.

Given your experience of electrical fires in the United States, can you help us with what protective measures are fixed at the back of domestic fridges so as to contain fire?

A. Yes. This is an area that I did not address in my report, but the one difference that I have seen is that in the United States, the back casing, the rear casing, of refrigerators are required by Underwriters Laboratory Standards to be manufactured of a metallic -- steel, let's say steel, not plastic, whereas here in the UK, and I think in Europe also, you are allowed to manufacture refrigerators with a back casing that is plastic.

Q. Are you able, on the basis of your experience, to give us any assistance as to how effective the metal casing is in America to containing fires that start within a fridge?

A. Just in a general view, again, you're starting to get outside of my area of expertise. I'm an electrical guy.

But you can imagine a fire starting within a refrigerator, and with a steel backing -- now, that backing does not span the entire length of the refrigerator. There is an open space down below where the compressor is located, but that steel backing would help to contain an internal fire, keep it within the refrigerator for a longer time, and you have less combustible now. Instead of a plastic casing on the rear which is combustible contributing to the fire, you have a steel casing that is not, but that's just in

layman's terms, again, because I'm not a cause and origin person.

MR KINNIER: Dr Glover, I'm grateful for your assistance.

Sir, may I ask for the usual 5 minutes or so just to see if there are any points which I ought to have covered?

SIR MARTIN MOORE-BICK: Yes.

Well, we usually have a little break at this point. Counsel thinks he has run out of ammunition, but he needs to check that that's the case.

We'll have just over a 5-minute break, and please don't talk to anyone, of course, about your evidence while you're out of the room.

If you would like to go with the usher, we'll come back at 2.35.

THE WITNESS: Thank you, sir.

SIR MARTIN MOORE-BICK: Thank you very much.

Right, 2.35, please.

MR KINNIER: Thank you, sir.

(2.25 pm)

(A short break)

(2.35 pm)

SIR MARTIN MOORE-BICK: Well, I haven't asked Mr Kinnier whether he has any more questions, but I would be surprised if he didn't have one or two, so shall we just

see?

Yes, Mr Kinnier.

MR KINNIER: Well, sir, there are two unique events which have happened today: one, we have finished before 5.00, and the second unique event is that there are no supplemental questions.

SIR MARTIN MOORE-BICK: No supplemental questions! That must be a first!

MR KINNIER: So it leaves me to simply say, Dr Glover, thank you very much for attending today to give evidence. It has been very helpful indeed.

SIR MARTIN MOORE-BICK: Dr Glover, can I thank you, please, on behalf of the inquiry as a whole. I found your evidence really interesting and very useful, and, if I may say so, very clearly put.

Thank you for giving us the benefit of your expertise. We're very grateful to you.

THE WITNESS: My pleasure, sir.

SIR MARTIN MOORE-BICK: Thank you very much indeed.

So that's it. If you would like to go with the usher, she'll look after you.

(The witness withdrew)

MR KINNIER: Sir, there are two final points before we rise today, the first one of which is to thank Mr Penfold, who has been the documents director for a significant

chunk of the inquiry. This is his last day assisting today.

If I may on behalf of the entire CTI team pass on our thanks to him. His patience has been exemplary, I think.

SIR MARTIN MOORE-BICK: I think we all owe him a great debt of gratitude. Thank you very much indeed.

MR PENFOLD: Thank you.

MR KINNIER: Sir, the final matter is that concludes the evidence today and we have Professor Nic Daeid at 10 o'clock tomorrow.

SIR MARTIN MOORE-BICK: Good, thank you very much.

Well, we all get an early afternoon, but I'm sure you can make good use of it. We'll break now and resume at 10 o'clock tomorrow with our next witness.

Good. Thank you very much.

(2.40 pm)

(The hearing adjourned until Wednesday, 28 November 2018 at 10.00 am)

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