Monday, 18 February 2013

(10.00 am)

(Proceedings delayed)

(10.10 am)

Housekeeping

THE CORONER: Thank you, do sit down. Are there any issues to raise before we ask the jurors to come in?

MR MAXWELL-SCOTT: Madam, just to point out there's going to be some new documents that will be handed out, some at the beginning and then some as we go along.

THE CORONER: Yes.

MR MAXWELL-SCOTT: I have four new documents at the beginning to go in the jury bundle.

THE CORONER: Yes.

MR MAXWELL-SCOTT: They are the home fire safety visit form --

THE CORONER: Thank you, yes.

MR MAXWELL-SCOTT: -- a chronology relating to the building --

THE CORONER: Yes.

MR MAXWELL-SCOTT: -- a glossary of terms relating to the building and a timeline from the fire reconstruction.

THE CORONER: Thank you very much.

MR MAXWELL-SCOTT: We'll do those, I suggest, immediately once the jury come in.

THE CORONER: Yes.

MR MAXWELL-SCOTT: Then, a little later on in the evidence, there will be a smoke diagram in A3, there will be a diagram showing the positions of cameras for the video footage from the fire reconstruction, and there will be an A3 sheet summarising the Met Office data.

THE CORONER: Thank you. That's very helpful. Thank you very much.

MR MAXWELL-SCOTT: Once the jury come in, we'll start handing out the first ones of those.

THE CORONER: Indeed, thank you very much. Thank you. Does anyone have any issues that they would like to raise before the jurors come in? Thank you. I know that Mr Walker's report was served at the end of last week. Has that given rise to any timing difficulties for anybody? Well if there are, please do raise them, all right? Thank you. Could we ask the jurors to come in that, thank you.

(In the presence of the Jury)

THE CORONER: Members of the jury, good morning. I'm sorry that we've had a slightly late start, but Mr Maxwell-Scott and Mr Atkins have been working very hard to prepare sets of documents which we're going to be giving to you, some shortly and some during the course of the day.

Until now, we've heard evidence from residents about their experiences and a lot of evidence from London Fire Brigade firefighters and officers about the tackling of the fire and search and rescue and so on. We're now going to shift the focus. Starting from now, we're going to have a look at the building, look at how the fire spread, and significant features of the building in that context. So that's the evidence that we're going to start to look at from now on, all right?

Yes, Mr Maxwell-Scott, thank you.

MR MAXWELL-SCOTT: So the witness today will be David Crowder. Before calling him forward, there are four new documents to be included in the jury bundle.

THE CORONER: Thank you. Yes. I think that Mr Graham has sets of those, thank you.

MR MAXWELL-SCOTT: So not the A3 ones at this stage, please. Once you all have them I'll very briefly explain what they are and where to file them.

You should have a home fire safety visit form which was referred to in evidence on Thursday. If that could be filed at tab 20 of your jury bundles.

There's then a one-page document headed "Chronology relating to the building". If you could file that at tab 21.

There's then a three-page document, "Glossary of

terms relating to the building". If you could file that at tab 22.

Finally, a one-page document, "Timeline from fire reconstruction". If you could file that at tab 23, please.

That's the home fire safety visit form at tab 20, the chronology relating to the building at tab 21, the glossary of terms relating to the building at tab 22 and the timeline from fire reconstruction at tab 23.

THE CORONER: Thank you very much. Yes, thank you.

Dr Crowder, would you like to come forward? Thank you.

DAVID CROWDER (affirmed)

THE CORONER: Dr Crowder, thank you very much. Please could you make sure that you keep your voice up so that everybody in the room can hear you. If you speak close to the microphone, that should help. Thank you very much.

A. Okay.

THE CORONER: Do help yourself to a glass of water.

Mr Maxwell-Scott will take you through your evidence initially on my behalf and then there are likely to be questions from others. Thank you.

Questions by MR MAXWELL-SCOTT

MR MAXWELL-SCOTT: Good morning. Can you give the court your full name, please?

A. Yes, good morning. My name is David Paul Bertram Crowder.

Q. You're here to give expert evidence to the court. Can you outline for the members of the jury your field of expertise and your qualifications?

A. Okay. I'll start with my qualifications. I have a bachelor of science with honours degree in forensic and investigative science, specialised in fire engineering and fire investigation, and I'm an associate of the Institution of Fire Engineers. My expertise is around the investigation of fires with respect to fire development and performance of building structures and components, particularly with respect to the building regulations in England and Wales.

Q. Can you outline for the jury your previous experience in summary in this field?

A. Okay. I have -- since I started working at BRE just over six years ago, I have investigated fires predominantly on behalf of the government, looking at the ways in which these fires have spread and developed and building performance, and that has been to inform government of the way in which the building regulations

are performing.

In addition to that activity for the government, which is the main proportion of my work, I also carry out investigations for other interested parties, such as fire and rescue services, police services, insurers and so on, informing them how buildings have performed and whether there are any implications in terms of responsibility for the ways in which these fires have occurred.

Q. You mentioned that you work for BRE and have done so for six years. Can you explain to the jury the nature of BRE Global and a little bit about its history so that they can understand its relationship with central government.

A. Yes. "BRE" stands for "Building Research Establishment". We were a government agency. BRE is now in its 91st year, so 1912 -- 1922, sorry, was when the Building Research Station originally formed. BRE has provided a fire investigation function to government since 1974, dedicated a team since that time, and has continued to do so since its privatisation in 1979. We're now wholly owned by a charity, so we are completely independent of government and any other commercial interests.

Q. Are there particular facilities that you have available

to you in relation to testing that can be carried out?
A. Yes. So within the BRE group structure, BRE Global is one of the group companies and it's a testing and certification body that is accredited by UKAS -- that's the UK Accreditation Service -- to carry out these standard tests, and it's recognised that those tests are carried out to the highest standards and are appropriate for use in terms of demonstrating the performance of products but also taking that forward into legal cases.

We also have a burn hall, which is -- imagine, if you will, a very tall warehouse with a large smoke extraction system in its roof. It allows us to build buildings and sections of buildings within that burn hall that we may have seen during investigations of incidents or if we're carrying out research projects. We can instrument those buildings and see how they perform in a laboratory setting so that we can learn lessons and try to apply that to the way -- normally to the way in which government drafts revisions to legislation and guidance.

THE CORONER: Please could you not speak too quickly. The shorthand writers need to keep up with you.

MR MAXWELL-SCOTT: You were involved in the writing of four reports by BRE Global, and what I'd like to do is simply to put up the first couple of pages of each of them so

that you can identify them.

Firstly, this is BRE report 259449, dated 17 December 2010. It's entitled "Lakanal House fire investigation computer modelling and reconstruction fire". Who commissioned this report from you?

A. This report was commissioned jointly by the Metropolitan Police Service and London Fire Brigade. The version that you see here states that it's prepared for the London Fire Brigade. There is an identical version that was issued for Metropolitan Police, and that's down to contractual issues. However, the body of the report itself relates to, as the title suggests, a reconstruction and modelling that was carried out in relation to the incident.

Q. If we turn over the page in it to page 2, we see that you are named as one of the authors. Were you the lead author on this report?

A. Yes, I was the lead author on this report.

Q. If I then take to you report number 266862. This one is entitled "Lakanal -- computer modelling to investigate smoke ingress into, and movement within, the common access stairway", version 2, dated 21 April 2011. Who was this report prepared for?

A. This report was prepared for the Office of the Chief Fire and Rescue Adviser. That's a department that sits

within the Department for Communities and Local Government and is concerned with overseeing fire and rescue services throughout the UK.

Q. I turn to page 2. What was your involvement in the writing of this report?

A. I was a co-author of this report. The lead author, Richard Chitty, is an expert specifically in computer modelling and the main part of this report was concerned with computer modelling. He's the lead author, but I'm happy to comment on this report and its implications for Lakanal.

Q. Thank you. If I turn then to report number 271805. This is called "Lakanal fire investigation -- expert witness report", dated 11 May 2012, prepared for the Metropolitan Police Service. If we turn to page 2, is it right that you're the sole author of this report?

A. Yes, that's correct.

Q. Finally, report number 278607, dated 30 April 2012, prepared for the Metropolitan Police Service and answering some questions. Is it right, looking at page 2, that you were the sole author of this report?

A. Yes, that's correct.

Q. As part of your role in preparing expert evidence, did you study and look into the history of Lakanal House and the changes made to its structure and fabric over the

50 years or so since it was built?

A. Yes, I did.

Q. What I'd like you to do now is to have a look at the chronology relating to the building, and that is at tab 21 of the jury bundle. (Handed)

I'm going to deal with this in three phases. Firstly, some features of the original building as constructed I'm going to ask you to identify for the jury, and then secondly I'm going to ask you about alterations made to the building between the date of original construction and the period 2006/2007, and then finally I will ask you about some changes made in 2006/2007.

Firstly, looking at the chronology, it states that the building was completed in around 1958. Is that your understanding?

A. Yes, that is my understanding.

Q. If I ask you then about some features of the building that the jury have heard about and we can look at in photographs. Firstly, the single central staircase, was that a feature from the original construction in the 1950s?

A. Yes. As I understand it, the original design was for a single staircase.

Q. Then if I ask you to turn within the jury bundle to

tab 13, where there are some photographs, and to turn to page 39, firstly. Does that show one of the ventilation grills at the end of a corridor?

A. Yes, it does.

Q. As far as you have been able to establish, were those ventilation grills part of the original building as constructed in the late 1950s?

A. Yes, they formed part of a cross-ventilation scheme that was originally designed into the building.

Q. Then if you turn over the page to page 40, we can see ventilation grills in one of the lobby areas off the central staircase; is that right?

A. Yes, that's right.

Q. Were those ventilation grills installed like that, as far as you're aware, at the time of original construction?

A. Yes, as far as I'm aware, those ventilation grills were as originally constructed.

Q. You mentioned something about a cross-ventilation scheme as part of the original construction. Can you explain what you mean by that?

A. Yes. At the time that Lakanal was constructed, there were two routes that were recognised for dealing with the spread of smoke throughout a building and trying to protect the occupants from that smoke. One was

compartmentation, which is still used today and is basically about separating off areas of the building so that smoke may fill one area but doesn't get to the next. At the time, there was also a belief that cross-ventilation would be a useful avenue for ensuring the safety of the occupants. This philosophy was based around the idea that if you have enough ventilation into the relevant parts of a building, then the fresh air that's introduced by the effect of wind and general air movements around the building will exceed the capacity of any fire to fill that space with smoke. So effectively you clear the area of smoke before the fire has had a chance to fill it.

Q. If you ask you then to look in the same tab at photograph 9, please. That shows a door from the central staircase on an even-numbered floor, in this case the first floor, leading to a lobby area. Have your researches looked into whether or not those doors would have been original features of the 1950s construction?

A. Not into those doors on the even floors, no.

Q. This is an odd-numbered floor.

A. Oh, sorry, on an odd-numbered floor. As we understand it, we think there were originally doors into the stairwell.

Q. If I could ask you then about what you found out about the nature of the original front doors to the flats within Lakanal House. If I ask you first in this way: were all the front doors that were found in Lakanal House after the fire identical or not?
A. No. No, there were different -- we identified four different kinds of front door in place at Lakanal after the fire.
Q. Was it possible to say whether any of them were original?
A. Not with any certainty. We thought it highly likely that some of the doors were original, and that it indeed was highly likely that some were not original, but it's not possible to say with any certainty whether all of them were original or not.
Q. Can you explain to the members of the jury what is meant by the phrase "smoke seals" on doors?
A. Yes, smoke seals -- so you have a door leaf that sits within a doorframe. Smoke seals are installed around the edge of a door leaf so that when you close the door there is effectively an air seal between the leaf and the frame so that no smoke can pass from one side to another.
Q. You've mentioned that there are four different types of doors found after the fire. Did any of those different

types have smoke seals?

A. Not of those that we saw, no.

Q. Did you conclude anything from that about whether or not it was likely that the original front doors to flats had smoke seals?

A. It was our understanding that the original front doors would not have had smoke seals.

Q. If I ask you then to turn in the same tab to photograph 26. Here we have a photograph which enables one to see the shape of a staircase within a flat and the way in which it turns through 90 degrees. If you turn over to 27, is it right that that shows boxing in and behind that one has the internal staircase of the flat?

A. Yes, that's correct.

Q. Can you help us with the extent to which these internal staircases in flats cut through or interacted with the central corridors on the odd-numbered floors?

A. Yes, I can do. The shape of the staircase was such that where it turned through 90 degrees to go to the upper floor within any given flat, that angled section had to cut through the wall and some part of the floor slab into the corridor to reach the flat above. It was our understanding that this was probably a design flaw in the original construction of Lakanal, and the reason that we came to that conclusion was there was some

evidence that the concrete around that opening -- there was evidence that it had been cut. So the concrete in the building was originally installed and when they came to put the staircases in, they found that they had to put this cut into it to actually achieve the fit that they wanted.

The result of that was that you had a timber staircase, a combustible element, passing through from the flats into the cross-section of the corridor, and by the time of the fire this was encased entirely within the suspended ceiling.

Q. If you bear with me a moment, I'm going to put up on the screen some images of the layout of flats. We're looking here at the layout of two flats on an odd-numbered floor with the central corridor and, on the lower floor of the flat, an odd-numbered floor, two bedrooms and a bathroom. Can you assist us with whether that layout is essentially the original layout from the 1950s construction?

A. Essentially, yes, that is the original layout.

Q. If I then show you the same for the upper floor, the even-numbered floor. So now there's no central corridor and one has a lounge and a kitchen for each flat extending the width of the building. Is that layout essentially the same as at the time of original

construction?

A. Yes, that is.

Q. If I then show just a typical west-facing flat showing both the lower floor and the upper floor. Does it follow that that is essentially the layout as originally constructed?

A. Yes, that is.

Q. For completeness, if I do the same for a typical east-facing flat. Again, that's the same as originally constructed?

A. Yes.

Q. I'm now going to ask you about the bathroom ventilation system in the flats. I've put up on the screen a graphic that is specific to flat 81 but also refers to other flats above and below. Can you help us with the nature of the original bathroom ventilation system?

A. Yes. The original bathroom ventilation system consisted of a series of vertical ducts which connected to all of the bathrooms that corresponded with that duct in terms of their being situated adjacent to that vertical column. The single duct, by its nature, allows communication of gasses between the various bathrooms, which I'll come onto in a minute, but that single duct is designed to allow the transfer of whatever atmosphere is extracted from the bathroom up to the roof level of

the building, where it connects to a horizontal duct and that then passes along to a pair of motors which were drawing on that extraction system.

As we understand it, the overall extract that was provided by the motor was designed to provide an air extract rate at each bathroom that was equal. There were flow control dampers at each bathroom that allowed for an engineer or a team of engineers to go round and balance the flows between all of the bathrooms. Had you not had that damper, then you would have had quite a lot of extraction going on at the top of any one of these ducts and that gradually decreasing as you go down the building, but these dampers allow that to be balanced and control that.

The other thing, which I alluded to earlier, is as -- by virtue of these bathrooms all being connected to the one single duct -- and I can tell that you there weren't any non-return dampers or non-return valves on these -- on the grills, the vent grills that connected the bathrooms to these ducts -- if, for any reason, the extract system should become overwhelmed by a quantity of gas or atmosphere that's entering at one of these bathrooms, then it's possible for that gas or atmosphere to reenter another bathroom that's connected to the same duct. In extreme cases, you could follow that all the

way up to the top of the building, and if the atmosphere or if the amount of material that was entering one of these vertical ducts was in extremely large quantity, then that could be such that it could then communicate with another downward duct and you might have smoke or an atmosphere or other gas entering bathrooms on other vertical ducts passing down the building.

Q. Focussing on what's shown on this diagram, then, a single vertical duct, is it right that there was a single vertical ventilation duct starting at flat 11 and then connecting it to flats 25, 39, 53, 67, 81 and 95?

A. Yes, that's correct.

Q. I'm going to move on then to ask about changes that were made to the original construction at periods in time after the original construction but before 2006. If I ask you to go back to the chronology relating to the building at tab 21 of the jury bundle, please.

Firstly, we see in that chronology the date 1979, and it says:

"Windows in the flats, central staircase and lift lobbies and end of corridor ventilation grills replaced."

Have you seen documents that support what is said there in the chronology?

A. Yes, I have seen those documents.
Q. If I then ask you about the installation of a suspended ceiling. I'm not concerned with precisely when in the 1980s this may have taken place, but is it right that at some point in the 1980s it appears that there were various works carried out in the building, as it says in the chronology, including the replacement of the heating system, the installation and subsequent replacement of the suspended ceilings in the corridors?
A. Yes, that's correct.
Q. If we just remind ourselves of the photographs of those. Go to tab 13 of the jury bundle at page 27. 17 would be better in fact.

At 17, we can see a ceiling in one of the corridors at Lakanal House as it was at the time of the fire in July 2009. That ceiling that we see in that photograph, was that original from the 1950s or was that installed later?
A. No, that was not original. That was installed some time during the 1980s.
Q. If you turn over the page to 18, does that indicate the nature of what was above the suspended ceiling?
A. Yes, that does.
Q. What is your understanding about the extent to which what we see above that suspended ceiling was added in

the 1980s, in broad terms?

A. Okay, my understanding is that as part of the original design and construction of Lakanal, there was a -- what's called a hot air heating system, so there are some pipes here which are an original feature. However, these, at the time of the fire, no longer carried through into the flats. They were stopped off at the point where they entered the flats.

A more conventional hot water central heating system was installed some time during the 1980s, and some of what you can see here is associated with that. There's also ducts and trunking of cables that runs through that suspended ceiling, and then you have the actual structure which is supporting the suspended ceiling panels, which appears to have been made of timber. Typical timber; probably pine.

THE CORONER: Sorry, could you just repeat that? We just missed you on the microphone.

A. Yes, sorry.

THE CORONER: The bit about the structure supporting the panels.

A. Yes. So the structure that you can see there is there to provide a support for the panels to be fixed to, and that appears to have been made of timber.

THE CORONER: I think you said probably pine, did you?

A. Yes, probably pine. Typical, ordinary timber, nothing particularly special. We don't think it was treated with any fire retardant materials or anything like that.

MR MAXWELL-SCOTT: If you go back to the photograph at 17, which shows the panels of the suspended ceiling in position. Are you able to assist us with what those panels are and when they were put in and whether they were changed at all at any time?

A. Yes. So a suspended ceiling was installed some time during the 1980s, and for whatever reason, the local authority decided that they were not appropriate, we believe, and they asked for them to be replaced with a panel which had a trade name of Panoflam. We don't know exactly what the fire performance of those panels were but we understand that they were designed to provide some level of fire performance that was in addition to those panels that were originally installed.

Q. In the same tab, if you could turn to page 11, please. We see there a door leading from a lobby of an odd-numbered floor onto a corridor, and then at 13, we see the equivalent door leading to the other corridor off the same lobby. Can you assist us with your understanding of whether those doors were original to the 1950s construction or if they were added later at some time before 2006?

A. It is my understanding that these doors were not original. Further to that, it's my understanding that originally there were no doors at this point and these doors were added -- well, there is some evidence to indicate that a decision was made to install doors during the 1980s, but we don't know when the doors were actually installed.

Q. If we go back to the chronology relating to the building at tab 21. In the box relating to the 1980s, I've read out the bit referring to the replacement of the heating system and the suspended ceiling, and then that box goes on to say that in the 1980s there was an installation of the doors leading from the lift lobby to each corridor, in other words the doors we've just looked at. From what you have seen, are you satisfied that those doors were probably installed after the original construction but before 2006?

A. Yes.

Q. And probably in the 1980s?

A. Probably in the 1980s.

Q. Then, staying with that chronology, we see that the next entry is 1994, modification of flat 79 by the tenant. If I show you on the screen some images relating to that.

THE CORONER: Before you get into the discussion of that,

could I just remind everyone I think there'll be a fire alarm test at 11 o'clock, so provided it doesn't sound for very long, we can just continue.

MR MAXWELL-SCOTT: We're looking at an image of flat 79 with areas of modifications highlighted in red. We're now looking at an image without those red areas, which shows a more open plan layout, and the image I'm showing you now, with an open plan area and the internal staircase leading off it, is that as it was at the time of the fire, as far as you understand?

A. As far as I understand, yes, it is.

Q. The modification from 1994 primarily being the removal of the internal wall between the bedroom and the internal staircase?

A. Yes, that's correct.

Q. So that's the removal of the large wall shown in red on the image that's on the screen at the moment?

A. Yes.

Q. And also of a smaller area. Is that a wall or a door?

A. That's a door. That's the first of two doors that led into the bathroom, the original feature.

Q. We'll come to the next aspect in more detail shortly, but is it right that in 2006/2007 there were further refurbishment works carried out to Lakanal House?

A. Yes.

Q. Those works were carried out under something called the "Decent homes and planned preventative maintenance programme"?
A. Yes, that's correct.
Q. What I'm going to ask you to do next -- and there's going to be an element of repetition about this -- is to identify for the members of the jury some of the potentially relevant features of the building, both the exterior and the interior. If we deal first with exterior features by looking at tab 18 of the jury bundle. On the first page of that, we have a photograph and a diagram showing the exterior of the odd-numbered floors, the floors which the bedrooms were on. We can see label 1, an area of glazing, and label 2, composite panels with insulation core. Can you assist the jury with whether the composite panels with insulation core were original or whether they were added at a later stage?
A. It is my understanding that these panels -- well, there were panels in the original design of Lakanal but that these composite panels with the insulation core were installed at a later date, specifically during the refurbishment in 2006/2007.
Q. So we've divided the building into three periods in time: original construction, events between original

construction and 2006, and then the 2006/2007 refurbishment. These composite panels, label 2, were installed in the 2006/2007 refurbishment?

A. Yes.

Q. What about item 1 then, the glazing? Are you able to help with us that?

A. The glazing -- I don't know what the original glazing was but I would believe it to be highly likely that it was single-glazed glazing, as Lakanal was originally constructed. The glazing at the time of the fire -- and we believe installed as part of the total replacement of these window assemblies -- was double-glazed, so two panes of glass within flames.

Q. So the glazing labelled 1 and the composite panels 2 were newly installed in 2006/2007?

A. Yes.

Q. What about the frames that we see?

A. The frames were also newly installed during the refurbishment of 2006/2007.

Q. Can you assist the jury with an expert opinion on what you think those frames were made of and why you think that?

A. Yes. It's my opinion that these frames were made principally of aluminium and they were coated with some sort of PVC/UPVC coating. The reason why I've reached

the opinion that the frames were primarily constructed of aluminium is their performance during the reconstruction. The frames --

(Disturbance)

The frames at the end of the reconstruction were found to have softened and melted in some places, and the temperatures that we achieved during the reconstruction, which you'll see later, I don't think they exceeded -- certainly not for any significant length of time -- I don't think they exceeded 1,000 degrees. For aluminium to have performed in that way under these temperature conditions is entirely to be expected. Had they been, for instance, steel frames, then we wouldn't have expected that to occur until the temperatures had reached around 1,500 degrees Celsius.

Q. So it's on the basis of the fire reconstruction, which we're going to talk a little bit about more later in your evidence, that you think these frames are more likely to have been aluminium than steel?

A. Yes.

Q. If we turn, then, to page 2, looking now at the kitchen on an even-numbered floor, a slightly more complicated diagram. The top diagram shows the exterior, not including the balcony panels, and the bottom diagram shows the balcony panels obscuring the view of, for

example, number 4, the block-work wall?
A. Yes.
Q. The photograph to the left shows what one sees in the bottom diagram; is that right?
A. That's right, yes.
Q. The glazing and the frames and the composite panels, we've seen reference to those in the previous diagram, and here they are labelled glazing "1", composite panels "2". One also sees the frames. Were those also all installed during the 2006/2007 refurbishment?
A. Yes, that's my understanding.
Q. Then item 4, the block-work wall, was that added in 2006/2007 or was that part of the original construction?
A. As I understand it, the block-work wall was part of the original construction.
Q. How about item 5, the balcony panels?
A. As I understand it, the balcony panels were -- the balcony panels that were in situ at the time of the fire were installed during the 2006/2007 refurbishment. There were other balcony panels in place as part of the original design and construction of Lakanal.
Q. Do we need to be concerned about the item labelled 3?
A. No, that didn't have any particular bearing on the way in which the fire developed and spread.
Q. Thank you. Then over the page, page 3, a similar set of

diagrams and a photograph of the lounge on an even-numbered floor. Were the glazing, number 1, the composite panels, number 2, the balcony panels, number 5, and the frames all installed in the 2006/2007 refurbishment?

A. Yes.

Q. And item 4, the block-work wall, was that part of the original 1950s construction?

A. As I understand it, yes.

Q. I'm next going to ask you to explain in general terms the nature of what is described in this as a composite panel with insulation core. Its name, "composite", indicates that it's made up of more than one thing, and we have a sample in court. I'm going to ask that you be passed the sample and that once you've had a look at it and identified it, it's then passed to the coroner and then onto the jury. (Handed)

THE CORONER: Could you just hand that back to the witness, please.

MR MAXWELL-SCOTT: Is that a sample of one of the composite panels with insulation core, labelled "2" on these diagrams?

A. Yes, it is.

Q. Where was that sample taken from?

A. That was taken from one of the window panel sets.

I can't recall from memory but I can refer to you the exhibit number if that helps.

Q. At Lakanal House?

A. At Lakanal House, yes.

Q. That's sufficient for our purposes, thank you. Without getting into very technical details like the chemical composition or the technical specification, can you explain to the members of the jury, who've all had an opportunity to hold and look at that, what it is?

A. Yes, it's a composite panel made up of three layers. There are two external layers, which I understand are both -- both have the same composition. In broad terms, that external layer is a pressed sheet that contains a mixture of cellular sort of paper-type materials and a resin that binds it all together. You can probably get more accurate information from the manufacturer, who I understand may be giving evidence later.

The core itself, between the two external layers, is some sort of blown or aerated foam core. We believe it's likely to be something similar to a polyurethane. The intention is that it provides a level of insulation. So this being the external area of the building, you have two hard-wearing outer surfaces that can withstand weather and mechanical knocks and so on, and then that inner layer isn't so resistant to those kind of shocks

but provides that thermal insulation so that you've got a comfortable environment within the building.

Q. Are composite panels sometimes referred to as sandwich panels?

A. Sometimes, yes. The term "sandwich panel" in the fire community tends to relate to panels that are used for the external cladding of large warehouse buildings. They tend to have metal outer sheets which might be painted or coated. In strict terms, this could be considered a sandwich panel, but you may hear people referring to sandwich panels when they're only referring to the types that are used on warehouses.

Q. What about the balcony panels that the members of the jury can see labelled "5" on pages 2 and 3 of tab 18 in the jury bundle? Are they the same as the sample you're holding? If not, what are the differences?

A. No. As I understand it, the balcony panels, they were somewhat thinner than the window panels. I believe the balcony panels were about 8 millimetres thick, from memory. They were composed entirely of the black material that you see as the outer layer of the composite panel, the reason being that their main function is to provide a mechanical barrier to people falling out of the building, as you would expect for a balcony panel, and there is no need for them to have

an insulation component, as with the window panels.

Q. Whilst we're on the exterior of the building, I'm just going to remind us about the two different ways in which the windows can be opened. I'm going to look at figure 90 from your fire reconstruction report. Figure 90 is on screen and it shows the windows in two different positions: on the left, the windows in tilt position, and on the right, windows in swing position.

A. Yes.

Q. The members of the jury had an opportunity to see this demonstrated during the visit to Lakanal House four weeks ago.

If we turn then to some potentially relevant features of the interior of the building and of the flats within it, and we go back firstly to look at the ventilation grills in the communal areas. If we just remind ourselves that these are shown in the photographs at pages 39 and 40 of tab 13.

You mentioned the cross-ventilation system from the original construction earlier. To what extent does that system depend upon the environment outside the building? In other words, whether it's a completely still day with no wind or a very windy day, what effect would that have?

A. Okay. Yes, the system is entirely dependent on the

weather conditions outside. If there are still air conditions, then there won't be any force sending fresh air through those grills and therefore dissipating any smoke that might be produced by a fire. If, however, you have a particularly windy day with a strong wind, then you might have -- if it's in the right detection direction, you might have a gale blowing down the corridors and that might even have some detrimental effects on the comfort of the environment within the individual flats, because you may have drafts coming in under the front doors and so on.

BRE actually did the research during the 1970s that led to recommendations being made that cross-ventilation should no longer be used as a ventilation scheme for blocks of flats such as Lakanal.

Sorry, just to elaborate on that, this led to that recommendation being phased out of all relevant guidance on construction of blocks of flats.

Q. If I ask you then to turn in the same bundle to page 27. The white coloured board that one can see above the line of the original suspended ceiling, which has been taken down for the purposes of these photographs for other investigations, is that what has been described by some as, "boxing in"?

A. Yes, that is.

Q. Then if one looks over the page to page 28, one can see another example of boxing in with a partially removed suspended ceiling, is that right?
A. Yes, that's right.
Q. Photograph 29 is a close-up of what we saw in photograph 28. Does that show the boxing in cutting into the area above the suspended ceiling?
A. Yes, it does.
Q. What were the white panels that formed the boxing in made of?
A. It's our understanding that they were made of a cementitious board, which is something which has been developed partly as a result of the phasing out of the use of asbestos, but the board in this diagram is effectively mineral fibres which are similar to asbestos but don't have its extremely hazardous effect on people's health when it becomes airborne, but you take mineral fibres, you mix it into a cement mix, along with other aggregates, and then that's rolled out and pressed into a board, and it provides a certain amount of fire resistance.
Q. When would that boxing in have been added?
A. It's difficult to say. As mentioned, the stairs cutting into the corridor was part of the original construction of the building, so I would expect that there were some

attempts made at that time to continue the compartmentation provided by the corridor walls and the corridor roof by adding some feature around the stairs to provide that protection. It's possible that these -- this boxing in that's seen here may have been repaired or may have been entirely replaced during the installation of the current suspended ceiling that was carried out during the 1980s, but I cannot say for certain whether these particular boxes are an original feature of Lakanal or whether they were replaced or repaired during the 1980s.

Q. Can you say with confidence that they were not something that was installed in the 2006/2007 refurbishment?

A. Yeah, as far as -- from all the evidence that I've seen regarding the 2006/2007 refurbishment, this boxing in was not installed as part of that refurbishment.

Q. Then if you look at photographs 19 and 20, they both show a panel above the front door of the flat, photograph 19 taken from the corridor, photograph 20 taken of the same panel but from inside the flat. Firstly, can you assist us with what they were made from?

A. The panels appeared to have been constructed simply from timber. I cannot recall the thickness, but typical, similar to pine, if not actually pine, sections of

timber.
Q. Were they original or were they added at some later date?
A. I haven't seen any information to indicate that they were not original, so it's my understanding that they were an original feature of Lakanal.
Q. If one looks at photograph 19, is it right that the top of that panel extends up into the suspended ceiling that was added in the 1980s and that the bottom of that panel is below the height of the suspended ceiling?
A. Yes, that's correct. Would you like me to comment on its likely relationship to the original construction of Lakanal?
Q. Yes.
A. So the evidence that I've seen indicates that if there was a suspended ceiling when Lakanal was originally built -- and there probably was, because images I've seen from that time do not show any pipework associated with the original hot air heating system -- however, this -- or whatever ceiling was present in the original construction was much higher up in the corridor than as was the case after the work carried out in the 1980s, and therefore the panel that you can see here, which is predominantly concealed by the suspended ceiling in this photograph, would originally have been visible from the

corridor and not communicating directly with a concealed space.

Q. So whatever suspended ceiling may have been there as part of the original construction would have been above the top of this panel?

A. That's my understanding, yes.

Q. There's no need to go back to the photographs of the images, but we've also already looked at the changes to the layout of flat 79 and the nature of the bathroom ventilation system.

A. Yes.

Q. What I'm going to ask you about now is a new topic, which is the fire reconstruction that was carried out at BRE in the burn hall that you mentioned to the jury at the beginning of your evidence. Firstly, who designed the fire reconstruction?

A. I designed the fire reconstruction.

Q. On the day of the fire reconstruction itself, what role did you play?

A. On the day, I was the officer in charge, which meant I was in overall control of achieving technical objectives for the reconstruction.

Q. In broad terms, what was the purpose of the reconstruction?

A. In -- in its broadest sense, the reconstruction was to

allow us to see the way in which the fire developed and spread, predominantly within bedroom 1 of flat 79 of Lakanal, and how that had implications for features of the building such as the doors, the panel above the front door, the boxing in underneath the stairs, and so on.

The reconstruction included some experimental features. Would you like me to elaborate on those?

Q. Yes?

A. The main portion of the reconstruction was this fire in bedroom 1. We decided to reconstruct the fire in bedroom 1 of flat 79 because at the time there was some concern about the amount of fuel that was present in bedroom 1 of flat 79. I'll come on to what was found later on, but the fire was intended to provide us with a heat source also for testing other features of Lakanal. So within the lobby of the reconstruction -- we didn't have a bathroom or bedroom 2 beyond the lobby but we did have the doors present on the relevant parts of the lobby, behind which were panels. So if the fire burnt through those doors then the fire wouldn't go anywhere else, but it allowed us to measure the performance of the doors in those locations, because it was our opinion that they would be subjected to conditions which were very similar to those to which the

front door of flat 79 in our reconstruction could be exposed. We therefore chose to install a chipboard front door and a hollow core front door at the locations to the entrances of bedroom 2 and the bathroom respectively.

We also, as another experimental aspect of the reconstruction, had an upper floor to our reconstruction rig. We didn't reconstruct the upper floor of flat 79; we added a second window facade set. So you'll see when we come onto it that the facade to bedroom 1 of flat 79 was installed.

Above that, and offset so that it was actually slightly in advance of the facade to the bedroom flat 79, we had another facade, the idea being that once we had a fully developed fire in our reconstruction rig within bedroom 1 of flat 79, we could see how flames that were emitting from that reconstruction may or may not impinge upon the facade in the situation directly above and what the performance of the panels in that situation would be.

THE CORONER: That's a lot to take in, but I think that's going to become more apparent when we actually see it. I just wonder whether we might try swapping the microphone.

A. Yes, I've been cutting out sometimes.

THE CORONER: Yes, so I wonder whether we could rob Mr Atkins of his. Thank you.

MR MAXWELL-SCOTT: What I'm going to ask you about next is the way in which the materials that were used in the reconstruction were chosen. If I could do that by asking you to look on the screen at figure 20. Does that show the staircase in the reconstructed flat in the burn hall at BRE?

A. Yes, that does.

Q. And that staircase, where did that come from?

A. That came from another flat within Lakanal itself. The Metropolitan Police Service and London Fire Brigade went -- we chose a couple of flats which were available for use and removed relevant features for inclusion in the reconstruction rig so that we could be as confident as possible that everything that was in the reconstruction rig and therefore produced data that we could use for our interpretation later on was as accurate a representation of what was in Lakanal as possible.

Q. If I show you one other example on the same point. If we look at figure 28, we see a doorframe being prepared for installation. Figure 29, doorframe. The materials that one sees here, where were they taken from? Can you assist with that?

A. They were also taken from flats in Lakanal. So this is the actual frame and panel taken from another flat in Lakanal for use in the reconstruction.

Q. If I take you back to figure 26, we see boxing in. Is that boxing in in the reconstructed corridor at the burn hall?

A. Yes, that is, and you can see from the writing on that panel that that section was taken from flat 23 in Lakanal.

Q. Were there any features of the fire on 3 July which you were conscious that you were either not able to create or did not attempt to create when designing the reconstruction?

A. Yes. First of all, whilst our burn hall is a very large facility, we don't have -- it's not large enough for us to reconstruct a 14 storey block of flats. We were -- we had to be very careful in selecting which part of the building we would reconstruct, but we were ultimately limited by scale to reconstructing bedroom 1, the lobby and a section of the corridor from Lakanal. This meant that we wouldn't be able to replicate what would happen when the fire spread into bedroom 2, and indeed when the fire spread into the bathroom and what effect that would have -- that might have in terms of further heat being introduced into the system and affecting the relevant

features of Lakanal that we'd -- we'd incorporated.

We also didn't have the capacity to reproduce the wind conditions as they were on the day during the fire. I think you've already heard that there was some unusual gusting and wind movement going on during the course of the incident, and we simply didn't have the capacity to try and reproduce that within the laboratory. We could have tried to wait until a day with suitable weather conditions. We had the front of the burn hall open during our reconstruction to allow a certain amount of air movement in, but had we tried to wait for a day when the wind conditions were perfect, then there's a good chance that they might have changed during the course of the reconstruction and that would have other effects which we wouldn't have controlled, so we decided as far as possible to go with still air conditions for our reconstruction with a small amount of inlet air being allowed through the front of the burn hall.

Q. If I ask you to look at figure 15. If everyone takes a moment to orientate themselves. The area that's outlined but not coloured in, does that represent the burn hall?

A. Yes.

Q. Then if you could explain to the members of the jury what they're seeing in the shaded-in blue areas.

A. The shaded-in blue areas correspond to the extraction system in the burn hall. So the entire rig -- the large blue area represents the area of our 9-metre calorimeter hood. That is very large collection hood, a bit like a massively oversized kitchen extract, which will collect all of the smoke which is produced by any experiments we conduct beneath it. It will measure things like oxygen content, carbon dioxide, carbon monoxide, temperatures, the obscuration, the optical density of the smoke -- so how thick it is and so on -- and it gives us information on the amount of energy that is being released by the fire at any given moment. So we have continuous data that you will see later on of the amount of energy which is expressed in kilowatts or megawatts that's released by the fire.

Q. Pausing there, we'll look at the different means of recording information a little later but we have a corridor with a single orange arrow at the end of it. Is that can a reconstruction of the corridor on the 11th floor?

A. Yes, that is.

Q. Then the rectangle where there are three orange arrows, is that bedroom 1 of flat 79?

A. Yes, the three arrows are actually passing through the facade of bedroom 1.

Q. What was your understanding on the direction of wind flow at the time of the incident on 3 July 2009 in relation to the areas we see here?
A. Okay. So on the day of the incident, we understand that in general terms, so looking at sort of a geographic level, looking at London as a whole, there was a wind that was generally approaching from the west towards Lakanal House, and that was therefore impacting directly on the west face of the building. So if you imagine you're looking out of a window on the west face of Lakanal. You would have had the wind coming directly towards you from the west.
Q. Pausing there, that wind would have been blowing onto the windows of the west side of Lakanal and therefore the bedrooms of flat 79. Was that something that you tried to replicate in this test?
A. No, we didn't specifically try to replicate the wind that was impacting on the front of flat 79.
Q. Then what about any wind effects on the corridor of the 11th floor?
A. We did try to replicate the wind effects in the corridor of the 11th floor. At the bottom right-hand end of the corridor, where you see the arrow leaving the corridor, that was connected into a duct which was also connected to our extraction system, which was drawing air and

smoke at a rate that would reproduce what we thought was the general speed of windflow passing through that corridor.

We also had a fan at the far end of the corridor which was intended to produce high velocity wind at a local area which would have been the same as the wind accelerating as it passed through the smaller ventilation grill through the security doors into the end of that corridor. However, that fan failed quite early on during the reconstruction, so we were only -- during the reconstruction, we were only using the main flow that was provided by our extraction system.

Q. So in summary, you were replicating some but not all of what you thought would have been the effects of wind on the day of the fire itself?

A. Yes, we were only controlling aspects -- we were only including aspects that we could control.

Q. As a result of replicating some but not all of the wind effects on the day of the fire, was the fire created in the reconstruction less severe than that which occurred on 3 July in your view?

A. Yes. In my view, it was less severe. We were aiming for a fire which gave conditions that were severe enough for us a make assessments on how Lakanal performed during the incident, but we didn't want to produce

a fire that might be considered to have been more severe than the incident that occurred, so we were definitely aiming to have a fire that was somewhat less severe than the fire that occurred on the day.

Q. And that aim of trying to create a fire that was less severe rather than more severe than the fire on 3 July, was that a principle that you carried through throughout the design of this reconstruction?

A. Yes.

Q. Looking back in hindsight after the reconstruction took place, would you, with the benefit of hindsight, have made any particular changes to the way that you designed that reconstruction?

A. No.

Q. This would be a convenient moment to hand out the Met Office report of weather data from 3 July. Just a single sheet, Mr Graham. (Handed) This can be filed in tab 24 of the jury bundle. Do you now have that in your jury bundle?

A. Yes.

Q. Thank you. Have you seen this information before today?

A. Yes, I have.

Q. Is it information that you used when designing your reconstruction, or if not, is it consistent with the information you used?

A. It is consistent. It is not the same information that we used but I'm happy that it's consistent with the information that we did use.

Q. Just to introduce it to the members of the jury whilst we have you in the witness box and we're producing this document for the first time, it shows data gathered at six moments in time on the afternoon and evening of 3 July 2009, those times being 1500 hours, 1600 hours, 1700 hours, 1800 hours, 1900 hours and 2000 hours. The data comes from four recording stations: St James' Park, Kew Gardens, East Malling and Kenley Airfield. Those recording stations are shown on the map.

A. Yes.

Q. Also on the map, one can see where Southwark and Lambeth are, so one gets a feel for the approximate location of Lakanal House.

A. Yes.

Q. The data available from three of the weather stations -- not St James' Park -- includes wind direction and wind speed, both in average and maximum gust.

A. Yes.

Q. Then for all four weather stations, there is a recording of temperature on the hour.

A. Yes.

Q. The highest recorded temperature at any of the weather

stations in that period was 25.2 degrees Celsius.
A. Yes, that's correct.
Q. Madam, that would be a convenient moment for a break?
THE CORONER: Yes.
So if we have a break for ten minutes, members of the jury. Do leave your papers behind if that's more convenient. Thank you very much.
Mr Crowder, because you're part way through giving your evidence, you must not talk to anyone during the break. So be back in ten minutes, please.
(11.40 am)
(A short break)
(11.52 am)
(In the presence of the Jury)
MR MAXWELL-SCOTT: What's being handed out are two A3 sheets to go into tab 25 of the jury bundle which indicate camera positions. We're going to be moving on now to look at the set up of the reconstruction, and as a first topic within that, the method of capturing and recording evidence.
THE CORONER: Yes.
MR MAXWELL-SCOTT: So looking at those sheets, the first sheet has slightly more information on it, is that right, because it has the dimensions of the rooms that were built for the reconstruction?

A. Yes, that's correct.
Q. The arrows on it, are they giving the numbers of specific cameras that were used?
A. Yes, they are.
Q. Then if one goes to the second sheet, the information is stripped down just to the camera position; is that right?
A. Yes, that's right.
Q. Whilst keeping that open, I'll put up on screen figure 47. If you could keep your voice up, please, when answering. We're looking here at a plan showing the same area as we see in the A3 diagrams; is that right?
A. Yes, that's right.
Q. But what we're seeing here is a different set of instruments to record evidence; is that right?
A. Yes, this shows the locations of instrumentation that was installed.
Q. If you take us slowly through the different types of instrumentation shown here. Firstly, we have some red triangles which are described as "thermocouple trees". Can you explain to the members of the jury what they are?
A. Yes, these are sets of thermocouples which are arranged in a vertical column, simply from floor to ceiling.

Q. What is a thermocouple?
A. A thermocouple is a -- it's a device which is used to measure temperature at a given point. It's -- they're generally constructed from a wire that has two conducting cores in it. The two conducting cores are made of different metals and the principle is that by virtue of these two metals, the point at which they connect, which is at the tip of the thermocouple, depending on the temperature, that will generate a voltage across the two metals which can be measured and will tell us the temperature at that point and at that time.
Q. So that's to record temperature. If I show you figure 44, do we see a thermocouple in that picture?
A. Yes. Well, we see a -- what's most obvious on the picture is that there is a section of metal and you can probably see there's some perforations in it, but up the length of that piece of metal we have attached a series of thermocouples from floor to ceiling so that they will tell us the temperatures throughout the duration of the reconstruction at those various heights at that location.
Q. If we go back to figure 47, there's reference to a heat flux meter, shown with a blue star. What does that measure?

A. Heat flux meters measure radiant heat flux. So an easy example of radiant heat is if you have an electric heater and you're stood some distance away from it and you can feel that heat, then that's radiant heat as opposed to convective heat, which would be, say, a hot plume rising above a hot object or a hot surface. Heat flux meters measure that radiant heat. Do you want me to explain the technology?

Q. No, just what it measures.

A. Okay.

Q. Then you told us already when we looked at an earlier plan about the 9-metrical calorimeter. Does that measure heat release rate?

A. Yes.

Q. Then if we go to figure 48, we can see a green arrow which is labelled "Gas sampling". Can you explain what that was measuring?

A. Yes, so there was -- at the top of this diagram, you will see the second facade that I mentioned, which was an experimental feature of this reconstruction. Within the box further down -- whilst I said we didn't reconstruct the upper floor of the flat, there was a smaller box which represented a head space. We know from the evidence from the building that the fire did not spread into the upper floor of flat 79 per se.

There was burning around the top of the stairs but there was no spread beyond that. What we did was recreate this -- well, we created this head space so that the fire could interact with the staircase as it did in Lakanal, and then off of that head space we are drawing gasses which enter that head space, and the gasses we were measuring that were drawn off at that point were oxygen, carbon dioxide, carbon monoxide, hydrogen cyanide, hydrogen bromide and hydrogen chloride.

Q. If we go back then to tab 25, I think it's most helpful to look at the second diagram for the camera positions. If we keep that open, what I'm going to do is play about three and a half minutes of video footage which is footage from the reconstruction up to the point of ignition, in order to show the different camera angles. What I'll do is I'll play it through once straight through, and then once we've gone through I'll go back to the beginning and go through it a second time so you can comment on it and ask me to pause where appropriate.

A. Okay.

(The video was played to the Court)

Q. So we've played it once through up to the point of ignition. What I'm going to do now is to play it through again, and if you can comment where you wish to do so.

(The video was played to the Court)

A. Right, so this is a view looking along the length of the corridor of the reconstruction. In the -- towards the middle of the image, you can see the escape door which has thermocouples attached to it, and in front of it there is a thermocouple column. Further along the corridor, you can see the front door to the flat and another thermocouple column, and at the end of the image, just against the right-hand side of the image, you can see the extract duct that was next to the end of the corridor and was drawing gasses and smoke from the end of that corridor.

Q. The front door has a letterbox; is that right?

A. The front door has a letterbox. We understood that the letterbox to flat 79 was not an original letterbox. We understood it had been replaced with a brass letterbox, and that is what was present in the reconstruction.

MR COMPTON: Madam, I'm sorry to interrupt. It's very difficult to hear Mr Crowder's voice at the back of the court, and I know that there are a number of people who simply can't hear. This is a plea from those at the back -- this is not a criticism, but if he could slow down and speak clearer.

THE CORONER: Right. I have on my desk -- oh, there's one there, another microphone. I don't know whether it

might be possible to use that. I don't know if it's switched on. No, it's not. Let's just continue and if you could just keep your voice up, Mr Crowder, and Mr Clark, would you mind just finding the facilities management people to see whether they could help us maybe swap a microphone and use a different one. Maybe ask them for a lapel microphone for Mr Crowder. Thank you.

MR MAXWELL-SCOTT: So we looked at camera position 1, and I'll start playing again.

(The video was played to the Court)

A. Right. Camera position 2 is located directly above camera position 1. It is in the suspended ceiling that was installed into the reconstruction, and you can see directly ahead the boxing in that was installed beneath the stairs and -- around the stairs, where they cut through into the corridor.

Q. I'll start playing again.

(The video was played to the Court)

A. Camera 3 is located in front of the front door to the flat. So here we have a clearer view of the brass letterbox that I mentioned. You can also see the thermocouples that were installed into the door. I should mention we had thermocouples on both sides of those doors in these corresponding positions, and again,

the thermocouple tree which is in front of the door.

THE CORONER: Do we see three different locks?

A. I believe we do. It was -- yes, I believe so.

Camera 4 is located at the far end of the corridor, so nearest the extraction point, up into the extraction system for the BRE burn hall, and again there's a thermocouple column directly in front of it. The first door you can see further down the corridor is the front door, with the escape door beyond that.

Camera 5 is located in the lobby of the flat, so to the left of the image you can see the inside of the front door and directly ahead you can see the stairs that were installed into the reconstruction rig. I should also point out at this point that we understood that as part of the modifications that were carried out to flat 79, we understood that the risers on the stairs had been removed so that you could see through the stairs into the -- what was intended as an escape route, which was being used as a storage area for materials beneath the staircase.

You can also see the door to bedroom 1, which was in place. When the camera comes round, you'll see that the door was not actually in use. There was a wardrobe partially obscuring the door and we understood that the occupants of flat 79 would step across over the stairs

to get into bedroom 1, and to the right of the image you can see the door that would have gone to bedroom 2. But behind that door, there is a panel so that when the door burns through the fire wouldn't spread beyond that, outside of our rig.

Camera 6 is looking across bedroom 1. So to the left again, we have the stairs and there's the escape door which is included, the dwarf door that leads to the main escape door which is beneath the stairs. You can actually also see the locations of a couple of cameras, one which is embedded in the red painted wall to the left beneath the stairs and there's another camera in the wall opposite.

What you can also see in this image is, although it's not desperately clear, the brown colour of the floor. We actually -- well, we loose-laid timber across the floor so that the effect of this timber on the fire growth could be included and factored in. However, I should point out that whilst the floor in flat 79 was understood to have been varnished, we did not attempt to varnish this timber as we knew that the time required for all of the volatile components of varnish would be quite extended, and we didn't want the floor to present any -- to have any chance of the floor presenting a more severe fire load than was the case in the building.

Camera 7 is back in the lobby, and that's adjacent to the door to bedroom 2 and is looking back towards the front door, with the stairs to the right and the unused door to bedroom 1 to the right of that.

Camera 8 is situated -- so when you're looking at the facade of flat 79, camera 8 would effectively be on the right hand wall. So immediately to the left of this image, you can see curtains and actually the window frames, as were present in flat 79, and then you have a fairly wide image of all of the contents in the room. I should point out that the -- the contents of the room were identified by London Fire Brigade and the Metropolitan Police based upon statements that they collected from the occupants of flat 79.

Q. It's being suggested we might put two microphones on the desk and see if that works any better.

THE CORONER: We'll give it a try, yes. Would you mind, Mr Atkins, just carrying that one round, thank you.

A. Right. Is that any better?

THE CORONER: Please just try keep your voice up as well, thank you.

A. Yes.

Right, camera 9 is the front of the reconstruction rig. A couple of points to note. One is that the cribs that you can see there -- would you like me to explain

those now or later?

MR MAXWELL-SCOTT: I'll ask about those later.

A. Okay. This camera view will be continuous throughout any images that you see. So at various points throughout the footage you'll either have a full screen or you'll have split screens where you have four screens visible. Camera 9 in that situation will always be in the top left hand corner.

Above the -- so you have the windows into bedroom 1 of flat 79 at ground level. Above that, we have the experiment that I referred to earlier, where we had a second set of window panels directly above. Now, these are bedroom -- this is a bedroom window set directly above, and as you know, in Lakanal itself we had bedroom windows, then we had the kitchen or living room and balcony arrangement, and then there would have been another bedroom arrangement. What we did here -- and that partly relates to the way in which the bedroom window is set back from the position of the upper floor bedroom windows -- was we were using the reconstruction purely as a heat source. So if you are considering what's going on on the upper floor, the fact that we've reconstructed bedroom 1 downstairs is irrelevant. What we're doing is creating a condition where he can have flames extending from a fully involved room fire in the

floor below and impinging onto a set of bedroom windows, as would have been the case from the kitchen of flat 65 up to the bedroom windows of flat 79.

THE CORONER: Could you just repeat that explanation of showing the passage of the fire from 65 up to 79?

A. Yes. So we know that the fire developed to a quite severe fire within flat 65, and at one stage the upper floor of flat 65 in particular was fully involved in fire and there were flames emitting from that flat and impinging upon the panels of bedroom 1 of flat 79. We haven't attempted to reconstruct the fire in the upper floor of flat 65. What we have assumed is that the heat and the severity of the flames that are extending from our reconstruction are equivalent to those which were extending from the upper floor of flat 65. The upper floor of our reconstruction is therefore flat 79 being exposed to flaming from flat 56, and the practical difference is treated as irrelevant.

THE CORONER: Thank you.

A. Camera 10 is looking back towards the windows that you just saw on camera 9. So again, we can see the kinds of materials that have been included in the room. As I mentioned, those were sourced for us by the London Fire Brigade and the Metropolitan Police based on statement evidence.

Camera 11 is actually quite close to camera 10, but that's looking straight back at the windows that you can see in camera 9.

Camera 12 is situated directly above camera 3, so what you can see here is the inside of the void above the suspended ceiling, and you're looking at the panel that's above the front door in flat 79. I should point out at this stage that we did not include all of the contents of the suspended ceiling void. The main reason -- although you'll see later this turned out not to be desperately successful -- we didn't want to obstruct the view of cameras that were looking at things like the panel above the front door and the boxing in under the stairs. We wanted a clear view of those, and also we didn't want to have a runaway fire extending down the length of this cavity within our reconstruction. So it's partly a practical consideration and prioritising the evidence we wanted to get, but there was also a safety consideration in terms of what severity of fire we might want to achieve.

Q. So my white arrow there is pointing to one of the timber panels above the front door; is that right?

A. Yes, that's correct.

Camera 13 is situated on the upper floor of the reconstruction rig. That's looking back at the windows

on the upper floor so that we could see whether and when any flames emitting from the reconstruction below would be long enough to actually be visible through the glazing on that upper window set. The green cables are thermocouple cables which are connected to that facade set.

Q. So that is view from inside, looking at the upper set of windows?

A. Yes. So this would be directly above the middle of bedroom 1, looking back towards the windows.

Q. If I pause there and ask you about the method of ignition before we see it.

A. Yes. So given that we were interested in flat 79 for this reconstruction and not flat 65, there was no prospect of realistically reproducing the ignition scenario as it occurred in flat 65. We therefore designed what you see in front of you, which is a set of three timber cribs. These are made of conditioned timber so we know what the humidity content is, and from that we can calculate what kind of a fire these timber cribs are going to produce. So they were designed specifically for the purpose of producing flames which were of the same length as the flames -- the length of the flames from flat 65 which would have overlapped onto flat 79.

So in practice, the flames from flat 65 would have extended from quite a long way back within flat 65 itself. What we wanted to do here was just represent the length equivalent of that which would be in front of flat 79.

Q. So you wanted the flames to reach the same height up the exterior of flat 79 as you believe the flames did from flat 65 in the real fire?

A. That's correct.

Q. In broad terms, on what did you base your analysis of how long those flames would have been?

A. That was based upon a combination of photographic evidence, some computer modelling that was carried out, and also engineering calculations that we have, which are -- fire-engineering tools used to work out how long a flame is going to be given a particular fuel load or fuel source.

Q. If, for any reason, you had under or overestimated the length of those flames, what impact would that have on the reconstruction?

A. Well, that would change the severity of the conditions to which the panels were exposed, and again, if the flames were longer or if the crib was hotter, then that would be a more severe condition, and if it was less so then the opposite would be true.

That was one of the ideas behind having this experiment at the upper floor level, was it allowed to us to validate that approach and confirm that actually the flames that we were getting from a fully involved room fire below would overlap to the same extent as the flame lengths that we produced from these wood cribs.

Q. So it might have an effect on the severity of the fire on the panels and frames and glazing; is that right?

A. That's right.

Q. But once the fire is established in the flat, the equivalent of flat 79, would it cease to have any bearing on what happened after that?

A. It would have a bearing but it would be insignificant.

Q. Insignificant?

A. Insignificant.

Q. Before I play this, because this relates to what happened to flat 79, I want to take us back in the chronology and look at the start of the fire in flat 65 and the spread of the fire in flat 65. It would probably be helpful for the members of the jury to have open their sequence of events at tab 12 of the jury bundle.

Just to be clear, the opinions that I'm going to ask you about now, is it right that they are not based on the fire reconstruction?

A. Yes, that's correct.

Q. Jade Spence, who was the occupant of flat 65, has given evidence in this court about discovering the fire and given an indication, by reference to mobile phone records, of when she discovered it. In statements that she gave to the police a few days after the fire, she gave some evidence that wasn't heard in this court about the extent to which bedroom doors and windows were open or shut, and because I think that's evidence that you rely upon for your views, I'll just summarise them to you.

She said that the bedroom door was open when she went in and saw a fire in the corner of bedroom 1. She said that she left that bedroom door open and ran upstairs, and she said that she opened the door in the front room to get to the other exit, and another door that got her to the main stairwell. So that was doors.

Then, in a statement given on 9 July 2009, she gave some evidence to the police about windows. She said it was hot in the bedroom, the right hand window of three was open only at the top, as was the middle window, and there came a point when she opened the window as far as it would open, which means it goes back flat against the wall, reaching in line. She said the third window was not open.

When you analysed this issue, did you have regard to statements that she had made about the positions in which she left doors and windows?

A. Yes, we did.

Q. Did you rely upon her evidence?

A. Yes, we did.

Q. Do you have the sequence of events open in the jury bundle?

A. Yes, I do.

Q. Thank you. So when you were looking at these issues, did you pick a particular point in time as one to work from for the time at which the fire started in flat 65?

A. Yes. Our initial starting point was the telephone call which she made to the London Fire Brigade. That was the only absolute fixed marker that we had with a time associated with it.

Q. Did you assume that the fire had started at that point or shortly before it?

A. Shortly before. We used -- so the actual analysis that was carried out here was after we had done the reconstruction. We used data from the reconstruction. We also used data that exists within British standard documents that are used for fire engineering and working out how quickly a fire will develop in types of rooms, given particular types of fuels, to back-calculate --

given the observations that she mentioned, I think, during her 999 call and in her statement, we back-calculated from the size of the fire at that time when the fire would have started, based on a fixed fire growth rate.

Q. Did you therefore work on a time between 16.15 and 16.18?

A. Yes.

Q. As I say, this evidence isn't based on the reconstruction, but can you give us your opinion on how the fire would have spread within flat 65?

A. Yes. So the fire originally established itself within, I think, an appliance, it's fair to say. From that point, the fire grew and started to involve the materials and the objects that were around it.

At approximately four and a half minutes, we would have expected windows to start breaking. Now, that's not particularly -- didn't have a particularly material effect because windows were already open, so the fire was well ventilated and able to develop unhindered from a ventilation point of view. If the room had been entirely closed, then it's possible that the fire might have snuffed itself out through lack of oxygen, but that wasn't the case as a result of the windows being open.

Approximately 6 minutes and 15 seconds after

ignition, then the partition wall separating bedroom 1 from the staircase within flat 65 would have been expected to fail, although fire would have already been spreading to a certain extent through the door to bedroom 1, round to the base of the stairs and up to the upper floor of flat 65.

The living room windows would have failed just under four minutes after that, so ten minutes from the point of ignition of --

Q. These are the windows on the upper floor of flat 65?

A. Yes, the windows of the living room on the upper floor of flat 65. Then, a further 30 seconds or so after the failure of those windows, then we would have expected a flashover or backdraft event in the upper floor of flat 65, that being rapid fire development and the involvement around that time of all of the combustible products and surfaces within that area.

Q. So what you've just said to the jury was that around ten minutes or so after the fire started in flat 65, two events would have occurred: firstly, some of the windows would have failed, and secondly, there would have been a flashover or backdraft in the living room/kitchen of flat 65?

A. Yes.

Q. How does that evidence and the events described there

relate to the time of ignition in the reconstruction?
A. So the time of ignition of the reconstruction relates to when we would have expected to have significant flaming outside of flat 79 as a result of the fire in flat 65. That therefore coincides with the time of flashover or backdraft, because you would have needed full involvement of those materials within flat 65 to have flames that were long enough to impinge upon the windows and window panels in flat 79 above.
Q. So in terms of sequence, we have fire spreading from bedroom 1 in flat 65 internally upstairs --
A. Yes.
Q. -- to involve the lounge and the kitchen, progressing to a flashover, backdraft, and to windows failing?
A. Yes, that's correct.
Q. And it's that point of windows failing that creates flames on the exterior of the building that then impinge on flat 79; is that right?
A. Yes, it's the windows failing and there being enough fuel burning all at once to produce the energy that's required for those flame lengths.
Q. And that sequence, is that based only on computer modelling or also on your understanding of fire development principles?
A. Yes, that's based on the experience of myself and

colleagues as well as computer modelling. I won't go into the detail, but we carried out a number of calculation -- pen and paper calculations as well as some more intermediate calculations before we did computer modelling, so that we were as confident as we could be that the sequence we had developed was robust and reflected reality. And it was also confirmed against photographic evidence and witness testimony -- statement evidence, I should say -- from the incident.

Q. Then the estimate of approximately ten minutes that you gave the jury from ignition in flat 65 to flashover and flames emerging through windows to impinge on flat 79, is that based on computer modelling?

A. Yes.

Q. That fire growth that you've described within flat 65, is it right that in the industry you use terminology to describe fire growth such as slow or medium or fast or ultra-fast?

A. Yes, that's correct. That comes from a British standard.

Q. How would you describe the fire growth within flat 65 itself?

A. That would roughly correlate with a medium growth fire, which is entirely typical of the kind of fire growth rate you would have in a building such as Lakanal.

Q. So there's nothing unusual about the fire growth within flat 65?
A. No, nothing unusual.
Q. It represents a standard internal flat fire?
A. Yes.
Q. So we then get ready for the fire reconstruction. We are now, as I understand it, looking at events approximately ten minutes after the fire started in flat 65; is that right?
A. Yes, that's right.
Q. So when we look at times and think about how they relate to times of the afternoon of 3 July 2009, your expert evidence to us would be that we should be adding ten minutes on to the time when the fire started in flat 65?
A. Yes, that's correct.
Q. So the reconstruction shows ignition at approximately 16.25?
A. Yes, approximately.
Q. What I would ask the members of the jury to do now is to have open tab 23 of the jury bundle. This shows a timeline of selected events evidenced in the reconstruction.
A. Yes.
Q. The first of which is shown at one minute and 27 seconds after ignition. So on the basis of the evidence you've

already given to this court, one might think of that as being 16.26.27 on the afternoon of 3 July 2005; is that right?

A. Yes, approximately.

Q. Approximately. What I'm going to do is play the video through for approximately five and a half minutes, and what I would ask you to do is comment where you consider it desirable to do so, and if you want me to pause at any stage then I will.

A. Okay.

(The video was played to the Court)

Q. We're starting it now, and it's counting down, 3, 2, 1, to ignition, and now the clock has started. So we're now four seconds after ignition, according to the internal clock, and that will remain playing.

A. Yes. So as the fire starts to develop within these wood cribs, you immediately start to get radiant heat being emitted out onto the panels. As the fire gets well developed within the cribs, then you will start to get direct flame impingement onto the panels. We can see that the cribs produce a certain amount of smoke but nothing that's too significant in relation to what you'll see later. (Pause)

Can we pause it there? The material that you can see falling off the underside of the upper level, that

is the plaster screed which was applied predominantly in relation to the inside of the rig. You can see it here because it was applied continuously up to the underside of the -- well, up to the edge of the underside of the first floor slab, but the location and the fact they're falling off isn't relevant to this fire. You wouldn't have had that going on during the actual incident.

(The video was played to the Court)

A. We can see the frames are starting to have soot deposits on them, just behind the flames, and the panels are just about catching alight. You can just start to see flames that -- the base of the flames are actually on the panel, indicating that the panel surface itself is alight.

Q. I've stopped it at one minute and 28 seconds, so that's one second after the time indicated on your timeline, which is based on your expert report. So your evidence here is that the panels, the composite panels, underneath the windows are alight by this stage?

A. Yes.

Q. And that represents the panels on the exterior of bedroom 1 of 79?

A. Yes, that's correct.

Q. And they've come alight because of the effect of flames coming out of the windows of flat 65?

A. Yes. What we just start to see at this stage -- and it's quite faint initially, but you'll just start to see some smoke drift across the top of the image in the -- there's a tiny gap there between the top of the frame and the ceiling, and air gaps just generally around these things which allow a certain amount of smoke to enter. We can see now the fire is well established on the panels, and those panels will continue to burn. (Pause)

So the flames -- at this stage, we can see that the flames are readily impinging on the glazing as well as the panels themselves. Later on, you'll see that the glazing itself will fracture and fail, although not until after the fire has spread in through the panels to ignite curtains.

What you might just be able to start to see -- and it may be worth pausing, although whether we'll find an appropriate spot or not I don't know -- on the right-hand edge of the panels you can start to see flames developing on what appears to be an edge. Now that indicates that the panel is starting to deform and distort and actually pull forward in the frame so that gaps are emerging around which flames can propagate, until eventually you get burning around to the other side of the panel, which will lead to ignition of the

curtains within the room. As time goes on, that's becoming steadily -- a little bit more apparent. Again, if you keep an eye on the panel on the right-hand side, you can see the flames effectively demarking the edge of that panel, indicating the way in which the fire's developing around that panel.

Q. We are approaching the time of four minutes and five second, where --

A. Is it worth pausing there just to explain the angles again?

Q. Yes.

A. So just to remind everyone, camera 9 is our front view. Camera 8 is looking across the windows, so on the left-hand side of that camera view you can see the flames and the window frames themselves, and the amount of smoke that's starting to enter the room, and cameras 9 and 10 are looking back at that fire. What you will see in a few seconds is flaming start on the bottom left edge of the curtains.

(The video was played to the Court)

A. There we can see the first licks of flame just inside the flat, and the curtains are about to ignite. That's ignition of the curtains.

Q. So we're now at four minutes and 24 seconds, so a couple of seconds after, according to your report, the fire has

begun to involve the curtains?

A. Yes. (Pause)

So as the fire develops within the room you start seeing an increased amount of smoke, and what you'd eventually see is the development of a smoke layer in the upper half of the room. Camera 8, being somewhat higher than the other two cameras, is becoming obscured by the smoke in the upper half of the room.

Q. Just pausing, because we're getting towards five minutes and 26 seconds. What should we be looking out for at that point?

A. Okay, in the middle of the view that you currently see in camera 9, you have a dark region. That is actually glazing that's still in place but you can't see through it because it's become covered in soot. So the blackening is the result of soot formed by the fire just sticking to the glass. What you will see is a section of that black fall away. That's the glass falling out of the frame and that allows more ventilation into the room and further development of the fire. (Pause) There we can see a section of glass that's just fallen out on the right.

Q. What we saw just there was what we see in the timeline as "First bedroom window failed"?

A. Yes.

Q. I'm not going to take you to it, but the next event on the timeline is "Third bedroom window failed", at nine minutes, 18 seconds, and that means the third and final bedroom window; is that correct?
A. Yes, that's correct.
Q. You mentioned earlier about smoke at the top of the room?
A. Yes.
Q. And it having an effect initially on camera 8, because that was higher, but not elsewhere. What would you say now, at just before five and a half minutes, about the smoke generally in the room?
A. Yes, so the smoke is continuing to increase within the room, and as -- at this stage, the increase in the smoke is causing that layer to come further down into the room. What -- if we went on further, what you would see is that at some stage there will be a total failure of the facade set, which increases the ventilation and takes us back to the situation I mentioned earlier, where we have a smoke layer and some relatively clear air underneath. During this stage, you have a lot of smoke being produced by the fire in the facade but not enough ventilation as a result of the components of that facade actually being removed by the fire that it allows free ventilation of the compartment, so as a result the

compartment is filled, as we can see, with the smoke produced by the fire.

Q. We've seen here the first bedroom window fail after five and a half minutes, in circumstances where the composite panels beneath were already alight some four minutes earlier. If the composite panels, or whatever was in that position under the windows, had not been alight at this time, can you help us in general terms with how long you would have expected the glazing to remain intact before it failed? Would it firstly have been a different period of time to the five and a half minutes that one sees the first window fail in this video?

A. Yeah, it could. The -- by virtue of the panels igniting, you have heat that's being generated by the burning of those panels directly beneath the glazing, and therefore the heat is in as close contact with the glazing as it could be, being produced directly below and passing up past the glazing. There is a difficulty in estimating times when glazing will fail because it's a very unpredictable phenomenon. Glazing fails in fires as a result of thermal stress. So you have a hot side of a piece of glass and you have a cold side of a piece of glass, and any sudden change in that in a fire condition can lead to expansion, which -- because glass

is very brittle, as we all know from experience, it simply cannot withstand the stress that that change in temperature across its material causes, and therefore it cracks and breaks away.

So I couldn't put an exact time on how much longer, but it's reasonable to state that the glazing would have failed some time later, but not significantly so.

I wouldn't have thought so. And even in the scenario here, when we have what appears to be relatively consistent flaming across the facade, we can see that we have a four-minute interval between one section of glazing completely failing and falling away and another, and again, that's reflective of the unpredictability in terms of how glass will respond to a fire.

Q. I understand what you say about the unpredictable reaction of glazing to a fire, and you well illustrate that by reference to the fact that the first window failed after five and a half minutes and the third one failed approximately four minutes later. I think the significance or otherwise will have to be for others to judge, but firstly the short point: would you have expected the glazing to survive intact longer if the material immediately beneath them had not been on fire itself?

A. Yes.

Q. How much longer is difficult to estimate; is that right?
A. Yes, very.
Q. Based on your experience working for BRE and some of the work that you told the jury it was involved in, can you answer this just in very general terms: would you have expected the glazing to fail before whatever happened to be beneath it?
A. If what had been beneath it had been non-combustible or -- in relation to what?
Q. In broad terms, if you're looking at the set up of a flat in a block of flats and you're envisaging an area underneath some windows, which is solid, and then windows immediately above -- what we've seen here is that the area underneath, which in this instance was composite panels, failed before the glazing failed. Is that, in broad terms, without going into precise time estimates, something that would surprise you?
A. Yes. In broad terms, yes, you would expect -- if I can just take a step back. In normal circumstances, you would expect a fire such as in flat 65 to occur as it did. Flames would emit from the window and if they were long enough they would impinge upon the glass of the storey above. That glass would eventually fail, and the fire would spread to the next storey and involve the flat above. In the normal scheme of things, we would

expect that it's the fire going out of one set of windows and in another set of windows that would be the root of fire spread when it occurs externally, and there would be a certain amount of time required for it to happen.

Q. Thank you. That's sufficient to answer that question for today's purposes.

I'm going to ask you then about some other points that one can see on the video. I'm going to move it forwards to shortly before 20 minutes and 37 seconds, where, according to the timeline based on your expert report, we will see the internal staircase within flat 79 alight.

(The video was played to the Court)

A. Okay. Shall I start by explaining the camera views we have here?

Q. Yes, please.

A. So camera 9 is still looking in the front of the reconstruction, as before. Camera 1 is looking at the escape door and further along you can see the front door. Camera 5, which is the crucial camera here, is looking through the lobby.

What you can see -- sorry, if you can pause there a second. You have got two vertical lines of glowing that you can see in that image. Those are either side

of the door to bedroom 1. So what you could see earlier was a painted red door in a blue frame. To the left of that, which is currently dark, is the staircase, and what you will see in this is the staircase becoming involved in fire, which corresponds to a -- an increase in the amount of burning, the amount of energy that's being released by this fire in the flat overall. Camera 13 is the upper floor of the rig but it's not relevant to what we're about to see.

Q. So we should be looking at camera 5?

A. Camera 5 is the most important camera for this.

(The video was played to the Court)

A. So as the flames start to involve the staircase, you start just to be able to see the silhouette of the stair treads and the removed risers at the backs of the stairs. So the flames that you see are actually involving a sofa that was located at the base of the wall that ran alongside the stairs, which had been largely removed, as we previously heard, and the fire is just now starting to properly involve the staircase.

Sorry, if we just -- what you can also see, actually, which is worth noting, is in the top left corner in camera 9, it looks as though a lot of the fuel that's in the room has been burn away, and that is actually the case. Just prior to the staircase

igniting, the severity of the fire has, to a certain extent, diminished from what originally occurred when all these combustible contents were originally involved. The involvement of the staircase increases the severity of the fire at that point quite dramatically, and that has an impact on the conditions to which things like the doors, the panel above the front door, and the boxing in are exposed.

Q. What I'm going to do now, while we're sticking with the video, is move us forward to approximately 38 minutes into the video, as in 38 minutes after ignition, to look out for the panel above the front door failing.

(The video was played to the Court)

Q. I'll pause. Do you want to just tell us what we're looking at with these different views.

A. Yes, so at the moment camera 9 is, as ever, the front view into the reconstruction rig. Camera 1 is looking at the escape door, and we can see glowing from beneath the escape door and a certain amount of smoke that's passing around the leaf of the escape door, although it's actually holding up quite well.

Camera 3 is the front door of the flat, and we can see that fire has managed to get around the gaps around the door. The door leaf is still in place, but the heat is such that the fire has been able to establish itself

on the surface of the corridor side of the front door, and camera 4 is looking back along the corridor towards the front door, and I think that's about to change to a camera in the suspended ceiling.

Q. Which camera should we be looking out for?

A. One of these is going to change, so if we can pause it when it changes. There we go. So camera 12 is now the camera of interest. That is situated directly above camera 3 and is looking at the panel. So because the two cameras are directly above each other, the location of the panel within the view that you can see in camera 12 is actually, relevant to the location of the door, in camera 3 directly below. So within the view of camera 12, you're looking at the region directly above the door in camera 3, where flaming's going to become apparent, and we have visual confirmation that the panel here has failed, although the temperature measurements that we were taking indicated that there was failure of this some time before this occurred.

Q. After the break, we'll come back to some of the temperature measurements, but what I will do before the break is complete the relevant evidence from the video footage.

Just before I play it, I'll point out that we are here about 16 minutes before the front door itself

collapses, which is the second piece of footage we're going to see, but one can see flames and smoke emerging from rounds the side of the door; is that right?

A. Yes, that's right.

Q. And the absence of smoke seals on those doors would be relevant to that; is that right?

A. Yes, yes, to a certain extent. I mean, smoke seals won't provide the same level of fire resistance as the door itself, but they would provide some -- their intention is to provide, as their name suggests, a barrier to smoke but they would provide some additional hindrance to fire spread around the edge of the door as well.

Also worth noting that with the introduction of smoke seals around doors, there are controls or tighter controls, I should say, around the gap that can exist between a door leaf and a doorframe. That's become relevant particularly to the performance of the seal. If the gap is larger than the size of the smoke seal then it won't work.

Q. What I'm going to play now is the sequence where we'll see, particularly on camera 12, the panel above the front door failing.

(The video was played to the Court)

A. So the view of camera 12 is quite obscured now. What

you can see is condensation of water and soot particulates and some tarry deposits that have occurred as a result of burning going on within the suspended ceiling. So we know that there is certainly a lot of smoke in the suspended ceiling for that to have occurred, but you can see through that that glowing is becoming apparent on the panel that's across the suspended ceiling from this camera, and that's visual confirmation that it's burning through and introducing flame directly into the suspended ceiling and whatever combustible contents would have been in there.

Q. We see it's glowing more brightly now.

A. Yes, that will continue to develop.

Q. Then, finally in the video, I'm going to move us on to about 54 minutes in, to the moment when the front door collapses.

(The video was played to the Court)

A. So with the continual heating of the rear of the front door as a result of the fire within the lobby area, that fire has continued to develop around the edges of the front door. It's actually also causing some damage to the suspended ceiling panels. By this stage, the panel above the front door is well and truly burnt away, but what we'll come to see as the flaming continues is that there's -- effectively what's happened is there's enough

damage around the frame and the interface between the frame and the door leaf that the hinges are no longer able to support the door, and you'll see the door collapse into the corridor. (Pause) It's worth noting, as you're viewing all of this, that in reality you would have had the wind conditions on the day of the incident which are effectively providing pressure, forcing the fire and whatever's going on from the flat, flat 79, into the corridor, and at this stage there would also have been potentially involvement of bedroom 2 and whatever combustible contents were within the bathroom of flat 79 contributing to the overall severity of heat and flaming that was being forced into the corridor. (Pause)

Q. We just saw the door collapse.

A. Yes, we've just seen the door collapse into the corridor. With the frame, worth noting.

Q. In camera 1, in the background, further from the camera, you can see the collapsing door of the flat, the front door; is that right?

A. Yes, that's right, and you can see that it's burning. Fire doors provide a level of fire resistance which is crucial, and we'll come onto the particular performance of these fire doors some time later, I believe, but it's worth noting that fire doors are not designed to be

non-combustible. They will burn. They are a fuel source in their own right. So their intention is to provide a barrier for fire spread from one side of the door to the other side of the door, not necessarily to prevent fire involving the surface of the door.

Q. And then camera 1, closer to the camera, is that the escape door we're looking at?

A. Yes, that's the escape door. Again, the escape door has performed somewhat better than the front door here, but we can see that flame has established itself around the edges of the escape door, and in particular we can see quite a bit of flaming around the interface between the top of the door and the frame and the boxing in, so you -- where you can see that flaming, you have the -- all the timber of the stairs which is alight and introducing heat and flaming onto that area, and the severity of conditions that are associated with that.

Q. I don't think it's necessary to play it, but the timeline shows that that escape door collapsed after 70 minutes.

A. Yes, that's correct.

Q. Madam, would that be a convenient moment to break?

THE CORONER: All right, thank you very much. Members of the jury, we'll have a break now, so could you be back for 2.10, please? Mr Crowder, again, please no talking

to anyone in the break, and could you be back for 2.10. Thank you.

(In the absence of the Jury)

THE CORONER: Can I just ask those at the back for an indication. Can you hear Mr Crowder better now, or is it still a problem?

A. Better.

THE CORONER: Better, but it could be better again?

A. Yes.

THE CORONER: We'll see what we can do, thank you.

(1.08 pm)

(The short adjournment)

(2.09 pm)

THE CORONER: Yes.

MR MAXWELL-SCOTT: Madam, before the jury come in, we've been having some discussions about the time estimate for Mr Crowder. It seems to be the case that there's no prospect of him concluding all of his evidence today, nor is he timetabled to do so. I think that I will finish before 3.45, but I'm asked to say that the consensus us amongst the advocates is that whenever I finish my questions would be a suitable moment to stop for the day.

THE CORONER: All right. Well that sounds sensible, unless it's too early, but -- okay, we'll work on that. Then

Mr Crowder to return ...?

MR MAXWELL-SCOTT: Tomorrow.

THE CORONER: Tomorrow, okay. And you're okay for that, are you, Mr Crowder?

A. Yes.

THE CORONER: Thank you very much. Thank you. I think we've tried to make some improvements to the amplification. Is that actually sounding better at the back? Some nods. Good. Well, if it's still a problem, please make sure we know. Anything else to raise? All right. Can we have the jury back in, please.

(In the presence of the Jury)

THE CORONER: Yes, thank you very much, members of the jury. We'll continue with Mr Crowder's evidence. Thank you.

MR MAXWELL-SCOTT: Good afternoon, Mr Crowder. We finished just before the break by getting to the end of the clips from the video footage that I wanted to look at with you. One result of that was that we jumped slightly ahead in the chronology from the reconstruction timeline. If we could turn that up at tab 23 in the jury bundle, please.

If we recap by reminding ourselves that we're looking here at time from ignition in the reconstruction of events in flat 79, and that we are working from, on the basis of your expert evidence, an approximate time

of 1625 hours on 3 July as the equivalent time for ignition.

A. Yes, that's correct.

Q. We looked at the video footage up until five and a half minutes from ignition. We saw that first bedroom window failed just before that. We note that the third and final bedroom window failed after nine minutes and 18 seconds. We didn't see that, but it's in the timeline. We then looked at the internal staircase becoming alight, 20 minutes or so after ignition, and where we come to now in the sequence, which we haven't looked at yet because there were no visual observations, is the time when the front door of flat 79 was first exposed to flames.

In order to look at that, we're going to look at figures 70 and 71. This is the first time we've looked at one of these graphs. Can you briefly explain the format of what we're looking at, because we're going to be looking at several of these.

A. Yeah. So the formatting of the graphs -- what you have along the X axis, along the bottom of the graph, is time from ignition, and then up the left-hand side, on the Y axis, is temperatures that are measured, and on this particular graph we have six sets of data that are plotted. These six signs correspond to six

thermocouples that were on the thermocouple column situated at TC tree D, which is in the lobby, the side of the lobby that was nearest to the stairs and the door to bedroom one.

Q. So we're thinking here, am I right, about the single column positioned in the lobby inside the front door of flat 79?

A. Yes.

Q. But having on it six thermocouples measuring temperature at different heights?

A. Yes, that's correct.

Q. If we look at the box to the right of the page, we see 0 meters, 0.5 meters, 1 meter and so on. Is that the height of the thermocouples above ground level?

A. Yes, that's correct.

Q. This shows the sequence from ignition for 100 minutes, so for the entire duration of the test; is that right?

A. Yes, that's correct.

Q. And if I go over the page to figure 69, does this focus on a particular section of that timeframe from 20 minutes to 35 minutes after ignition?

A. Yes. The X axis has been expressed to look at that particular time interval that's of interest.

Q. What do these two figures tell us about when the front door of the flat was first exposed to flames?

A. They tell us that the -- sorry, if we can go back to the previous figure. What you have is temperatures gradually increasing from the point of ignition. Now, just in case it isn't obvious, the temperatures that are furthest from the ground, so the higher temperatures, will increase more quickly than those that are low down because we have that hot smoke layer at the top of the room. It's worth noting that the line at 2.5 meters, that thermocouple, is actually against the concrete of the ceiling of the room, so there's a bit of a lag there. But what they show is the temperatures increasing to around 350/300 degrees, which is the lowest possible temperature where you can have sustained flaming.

Beyond that point, at around 20 minutes, shortly after the staircase is alight, then you have this dramatic increase in temperatures up to around 700 to 900 degrees Celsius. This indicates that we've gone from an early phase where conditions were hot but actually there wasn't flaming -- and that's confirmed by the video recording at the time -- to a scenario where the staircase is alight and there is actually direct flame infringement on the front door.

Q. So we've seen already from our timeline the internal staircase alight after around 20 minutes.

I deliberately left blank the box for the time when the front door of the flat is exposed to flames in this document because there isn't a visual observation. So what should we be thinking about putting in that box on the basis of that information?

A. We would be thinking -- sorry, we would be thinking about the time of around 23 to 25 minutes.

Q. If it were 25 minutes, that would equate to approximately 1650 hours in the afternoon?

A. Yes, that's correct.

Q. I'll come back later to ask you about the effect that this would have had on the 11th floor corridor and flat 81.

A. Okay.

Q. If we move on then to the next box that we don't have filled in. That relates to the time when the boxing in in flat 79 failed, and if we look here at figures 82 and 83. It's the same sort of chart, showing time from ignition, again here for the duration of the test, 100 minutes, and then also measures of temperature.

Over the page at figure 83 -- this is again 100 minutes -- this is thermocouple tree F. The previous page shows stair/box detail above door E. What do these two figures tell us about the failure of the boxing in?

A. Okay. In figure 82, you can see from the descriptions -- which I've tried to make as clear as possible but probably need some explaining. They had thermocouples situated throughout the various layers of the boxing detail, so one thermocouple actually on the lower surface of the staircase and then various thermocouples through the layers of those boards that were built up against the underside of the staircase, until we get to thermocouples actually within the suspended ceiling just on the outer surface of that detail.

What's apparent from this data is that you get gradually increasing temperatures which are not actually too dissimilar to the temperatures we saw in the previous figure, where sort of the ambient temperatures within the lobby were going up to around 300 degrees. These ones are a bit lower, but then at around 23 minutes there's a sudden jump in temperatures, which is, in my opinion, associated with the staircase becoming alight and actually the area -- that burning of the staircase spreading to involve the area where the boxing in detail was actually fixed onto the staircase, and what it shows is that the temperatures have been able to rise throughout that detail almost instantaneously. There's no delay in terms of the

various layers of that boxing in detail. You would normally expect that maybe the inner surface would become hot as it becomes exposed to the fire and there's a gradual process of the fire working its way through those layers, as you would in any fire-resistant construction, but in this case the temperatures have shot up to in excess of 800 degrees as soon as that's occurred on the staircase side.

That's reinforced on the next figure, which was 83. What you can see here -- the key line that you should take note of is that at 2.5 metres, which is the purple line, you don't see a dramatic rise here but what you do see is that actually the temperatures against the underside of the concrete on the suspended ceiling are able to start rising they early on. What that's indicating is that really the boxing in isn't providing any significant barrier to the passage of hot gasses and flame from the flat side into the suspended ceiling side. The remaining temperatures, particularly those that are below the level of the ceiling, remain very low until much later on, when we start getting burning in the corridor, around the edges of the doors and so on.

Q. Let's pause there and let me see if I have this right. Two things. I'm going to ask you whether they can be worked out from the information we're looking at.

Firstly, can one work out that the boxing in has failed after about 25/26 minutes from ignition?

A. Yes.

Q. And secondly, what does this information tell us about how long the boxing in succeeded in withstanding fire after it was first exposed to it?

A. It was a matter of, I think, between two and three minutes, if memory serves. It's in my report if you want me to check, but I think it was around two to three minutes.

Q. The boxing in was exposed to fire after about 23 minutes or so from ignition, and within a further two to three minutes, the boxing in failed?

A. Yes.

Q. That also would have been, on the basis of the evidence you've given earlier, at around 1650 hours on 3 July?

A. Yes, that's correct.

Q. We'll come back to the effect that that would have had on the 11th floor corridor and flat 81.

A. Okay.

Q. Then, having, as it were, filled in now those blank boxes on the timeline from fire reconstruction, I'll just recap with you the events after that. The panel above the front door failed after approximately 38 minutes from ignition, which, on the evidence you've

given earlier, would equate to just after 5 pm on 3 July.

A. Yes. That's when we have visual confirmation, although the temperatures were rising on that panel prior to that.

Q. Let's have a look at that, then, I think on figure 77. I think you want to look here at figures 77, 78 and 84. That's 77, this is figure 78, and this is figure 84. Does that assist you to help us with whether this information from the thermocouples is suggesting a time slightly earlier than the visual observation of 38 minutes after ignition?

A. Yes. What this shows -- if we go to figure 77 first. So in this figure we can actually see the -- so prior to 20 minutes and the staircase becoming alight, there's a dotted red line and a white line that show the highest temperatures in that region. Those are the temperatures to which the flat side of the panel is being exposed, and the reason they're so high is because the panel is the highest point on the door and doorframe assembly.

At around 25 minutes, we actually see the temperature of the panel start to increase dramatically, which is suggestive of the corridor side of that panel becoming involved in fire. The slight -- what we did in our interpretation was look at the time -- the initial

time during which the panel started to be involved in fire, or started to be exposed to elevated temperatures on the flat side, from around five minutes in, and that gave us a roughly 20-minute delay from the point that the panel was exposed to fire temperatures in our reconstruction to when burning appeared on the corridor side.

In carrying out our interpretation, we accompanied this data with what we knew from evidence of the actual incident and what we had from statement evidence and so on, and we came to the view that actually our reconstruction in this particular scenario might have presented slightly more elevated temperatures for the panel at that early stage than was during the incident, and that's as a result of the wind providing potentially some clearing effect of the smoke in the area at that time. So we shifted the predicted failure time back to -- I'll have to refer to my timeline, but it was something around -- I think it was around 5 pm during the incident. So we have a failure time of probably around 30 minutes, rather than 38 minutes. In fact, 35 minutes.

Q. Again, we'll come shortly to what effect that would have had on the 11th floor corridor and flat 81.

Then, just finishing off with the timeline, as we've

seen, the front door collapsed 54 minutes after ignition, which would equate, on the evidence you've given this court, to approximately 17.19 that afternoon.

A. Yes, that's correct.

Q. We'll come in a moment to the effect that would have had on the 11th floor corridor and flat 81.

Just finishing with the reconstruction, which, as we've heard from you, was focussed on replicating events in flat 79, once it was over, were there any particular differences that you observed between the reconstruction and what you believed to have happened in the real fire?

A. Yes, there were, and we took account of those in the report. So again, we weren't able to replicate the wind conditions that were on the day and that had an impact on the way that we were able to interpret the way that the fire developed into the corridor, which we'll come onto later.

The absence of bedroom 2 and the bathroom meant that we weren't able to look at the effect that the ignition of these areas of fuel might have had on the fire development into the corridor once that had occurred, although I can say that we would anticipate that ignition of bedroom 2 and the bathroom would have occurred some time after the ignition of the lobby, that being the route from which the fire could have spread

into those areas.

The window facade sets we didn't show. The upper floor window facade sets survived the duration of the fire, although they did suffer quite a lot of scorching and blistering during the course of the reconstructed fire. It's my opinion that that occurred because the reconstruction fire was somewhat less severe than the fire that occurred on the day, and that, again, is due to the combination of us not having had bedroom 2 and the bathroom and also the wind from the fire sort of driving the burning and pushing the flames up against the facade of the building, which it wasn't able to do during our reconstruction.

Other than that, the -- sorry ... oh, the burning behaviour of the suspended ceiling. What we had anticipated when we designed the reconstruction -- what I had anticipated -- was that once the fire burnt through the door and the panel and the boxing in and it involved the suspended ceiling, that that would actually start to burn quite quickly. At the time of carrying out the reconstruction, we weren't aware that the suspended ceiling had been upgraded during the 1980s after its initial installation to these Panoflam panels. Those suspended ceiling panels actually stood up very well to the reconstruction fire, although again, during

the reconstruction fire we didn't have the wind forcing the fire into the corridor and the effect that that would have had. What we concluded from that was that actually it was the contents of the suspended ceiling and the timber framework.

Now, we had included the timber framework but not the other contents such as the cabling, the insulation to other pipes and so on, and we concluded that they would have had a significant impact on the way that that fire did actually develop during the incident, but we weren't able to assess that in detail during the course of the reconstruction.

Q. Thank you.

A. The only final thing, if I may, which isn't a difference per se, but we -- I mentioned before the break that we -- one of the reasons for carrying out the reconstruction on flat 79 in particular was that there was a suspicion that maybe the fuel loading in flat 79 meant that the fire in flat 79 was particularly severe and that was why we had fire spread into the corridor and so on from there.

Q. Do you want to explain what you mean by fuel loading?

A. There was a lot of combustible material in flat 79. There were -- although we didn't go through them in detail, there were quite a few trestle tables in

addition to a regular table. There was at least one sofa, possibly two. There were boxes containing equipment for making wigs and so on, which I believe was the occupation of one of the occupants of the flat, in addition to a barber's chair, several sewing machines and -- the room was generally very heavily laden with fuel.

However, what we found during the course of the reconstruction was that actually the fire development became limited by the ventilation. Even though you had an open facade at the front of the room, that provided a certain amount of limitation on the degree to which the fire could develop, the speed at which it could grow and the temperatures that were achieved, and we came to the conclusion that actually the fire in flat 79, just as with the fire in flat 65, was very similar to what British standards refer to as a medium fire, which is a fire that's typical of a block of flats such as Lakanal, and therefore we came to the conclusion that the fire in flat 79 was not a particularly severe or onerous fire for the fire precautions within the building to deal with.

Q. Thank you. Your reports run in total to many hundreds of pages. Much of that, I think it's right to say, is taken up with computer modelling?

A. Yes.
Q. All I would ask you to say for today's purposes, is it right that the computer modelling produced results that were consistent with views that you'd already formed based on other evidence available to you?
A. Yes, so the -- well, the computer modelling at the time -- and this, again, is very early during the investigation -- it provided us with directions, as it were. It gave us markers of where to look next and it gave us a mechanism for which to check the data for the reconstruction against the timeline, and certainly at this stage it provides confirmation. We don't -- I don't need to rely on it in its own right to present to you the way in which the course of events occurred.
Q. Thank you. I'm now going to move on to a new topic, which is following the story forwards. We've focussed on flat 79 and now I want to ask you firstly about how fire spread out of flat 79 -- that's going to be the next topic -- and then secondly about how fire and smoke came to enter flat 81.

So firstly, dealing with fire spreading out of flat 79. We've looked at the timeline. Is it right that the first method by which fire got out of flat 79 in a position to do damage elsewhere in the building was when the boxing in failed?

A. Yes, that's correct.
Q. You told us that that would probably have been around 1650 hours?
A. Yes.
Q. If I show you some photographs. I'm firstly showing to show you photograph DSC0130. This, as I understand it, was taken on the 11th floor corridor, so one sees fire damage but we see boxing in that has survived; is that right?
A. Yes, that's correct.
Q. If I ask you then to look at DSC0133. This is also on the 11th floor corridor, and are we here seeing the absence of boxing in where one would expect to find it, in other words boxing in that has failed?
A. Yes, and we can see that the stair structure itself has burnt through.
Q. Just to reinforce the point, I'll show you DSC0134. Is that the same point?
A. That's the same point.
Q. Boxing in has completely failed?
A. Yes.
Q. And the stairs above as well?
A. Yes.
Q. Then DSC0135, a slightly closer up. You can see the underside of the stairs. We can see that there is no

boxing in where one would expect to see it and that the stairs that would have been behind the boxing in have also burnt away; is that right?

A. Yes, that's right.

Q. We've covered the fact that fire first got out of flat 79 through this failure of boxing in. What did it do after that?

A. Initially, once the fire had broken through the boxing in, it spread into the space above the suspended ceiling, involving the combustible contents of that space and being driven by the wind acting on the front face of flat 79, the facade, pushing heat and flames from the fire in flat 79 into that space and igniting those materials.

Q. Just pausing there, if we turn in the jury bundle to tab 13 and to photograph 80. What we see here is what the suspended ceiling looks like when it's cut away, so we can see the cavity and the services above it. Is that right?

A. Yes, that's right.

Q. So does it follow from what you've been saying that the first thing that happened after the fire broke through the boxing in under the internal stairs in flat 79 is that it got into this cavity that we can see here because the suspended ceiling is removed for this photo?

A. Yes, that's correct.
Q. Looking at this photograph, what can you tell us about whether or not the suspended ceiling is divided or undivided?
A. The -- the suspended ceiling is undivided, and in fact, although it's not visible in this particular photograph, the suspended ceiling -- or the space above the suspended ceiling -- was continuous throughout the length of the building. It actually also passed over the top of the lift lobby, so the -- not all of the lift lobby, but the part that was in line with the main corridor also had a suspended ceiling, and that space in both the north and south corridors above the suspended ceiling was continuous over the lift lobby as well.
Q. What do you mean by "undivided", just so we're clear on this?
A. I mean that the space above the suspended ceiling did not have any barriers to fire or smoke spread along its length.
Q. In your expert opinion, is that significant to the way in which fire and smoke spread?
A. Yes. Normally -- well, as with the fire spread from one floor to another, we would expect that fire would, if left unchecked, eventually spread to involve the entirety of a suspended ceiling void like this.

However, the presence of barriers to fire spread and smoke spread would have slowed this process down, and that would have -- in the normal run of things, that would keep a fire contained until it can be dealt with by some means, whether by firefighting or some other activity.

Q. Then if you turn back to photograph 17, that shows a corridor at the time with the suspended ceiling in place. Would there have been a time during the Lakanal House fire when that corridor would not have had fire in it but there would have been a fire spreading through the cavity above that suspended ceiling?

A. Yes. So at the time after the boxing in and also after the panel above the front door had failed but prior to either of the doors themselves having failed -- I mean, there may have been a certain amount of burning around the leaf of the door, as we saw during the reconstruction, but it's entirely possible there would have been a time where, aside from this sort of minor burning that we saw, there would have been or could have been a significant fire developing within that concealed space, and that would not have been seen by anyone that was in the corridor.

Q. You mentioned something earlier about the performance of the panels of the suspended ceiling. What happened to

them in the fire in your view?

A. In my view, the panels above the ceiling did burn. In the reconstruction, the panels that were nearest the doors, both the escape door and the front entrance door -- or the front door to the flat, they both burned but they didn't burn in the absence of an imposed heat source. So as soon as the fire died away that was actually attacking these panels, the panels wouldn't continue to burn in their own right. So it's my opinion that what occurred during the fire was that these panels may have burnt equally under an imposed fire load but wouldn't have burnt particularly quickly, and as a result they would have started to fall pretty much in their entirety, although they may have broken into large pieces, as a result of the burning through of the timber structure. So the timber structure that was supporting these panels would have burnt away certainly more quickly than the panels themselves would have done, and it would have been effectively a structural failure of that supporting structure, which would have led to the panels coming down into the corridor, and I think there are some -- well, I have seen photos and was personally present in the building walking over the large amount of debris that was in the floor of the corridor which had come down from the suspended ceiling.

Q. Do I understand the panels would have fallen down in stages then, rather than all at once?
A. Oh yes, they wouldn't have fallen down all at once. It would have been as the fire progressed and the amount of structural timber was burnt away. That would have happened gradually and that would have advanced along the suspended ceiling void as a gradual process and those panels would have come down in an equally gradual process, starting around or closest to flat 79 and moving away from it in a gradual process.
Q. We saw from the timeline that the front door collapsed around 54 minutes after ignition, which, on the basis of your earlier evidence, would equate to around 1719 hours in the afternoon. Are you able to assist us at all with what might have been happening at that time with the suspended ceiling, and in particular whether any of its panels would have fallen down, or some of them, or all of them?
A. It would be difficult to say with any certainty. It's entirely possible that some of the panels closest to the doors would have started to come down at that stage, but I wouldn't expect that any great proportion of the suspended ceiling throughout the corridor would have come down at that stage.
Q. What would the effect have been of the collapse of the

front door of flat 79?

A. That would have led to a very sudden introduction of extremely hot gasses, certainly from flat 79, potentially with a corresponding flame front extending from flat 79 into the corridor, involving whatever combustible surfaces were present to become involved.

Q. If we have a look at figure 138. Firstly, is it right that this is part of a computer model?

A. Yes.

Q. Is it intended to model the temperature of hot gasses flowing out of flat 79 into the 11th floor core door?

A. Yes. I don't know how clear it is, but what you have there is an arrangement of arrows which -- the size of the arrow -- well, the direction of the arrow indicates the direction of flow, the size of the arrow indicates the magnitude of flow -- so the larger the arrow, the faster the flow -- and the colour of the arrow indicates the temperature of the gasses in question. We have temperatures ranging from, in the dark blue, ambient temperatures, 20 degrees, up to the bright red, just over 1,000 degrees.

Q. What is your opinion on the severity of the fire on the 11th floor corridor after the collapse of the front door to flat 79?

A. Simply put, it was a very -- extremely severe fire.

That was evidenced not only by the computer modelling but by the condition of the doors that we saw along the length of the 11th floor corridor after the incident. Normally what you would expect to see in such a situation where a corridor may or may not have become involved in fire, or even a room that's been involved in fire -- you would expect to see that the upper portion of the door is the most damaged, because it's in that hot smoke layer that I mentioned earlier, and as you come down the height of the door the damage gradually decreases, because you have relatively fresh air at low level, and again, that temperature gradient that goes up to high level.

What we actually saw on the doors in the 11th floor corridor was consistent deep charring throughout the height of the doors, which indicated that you had these extremely hot fire gasses, probably flames, and associated severity of conditions throughout the height of the corridor, and in my opinion that would have been as a result of the heat of the fire from flat 79, potentially any additional heat coming from the corridor, but then that all being mixed up by the wind that was impacting on the western face of the building, mixing up these fire glasses and driving them down the length of the corridor.

Q. I'll show you in a few moments a photograph of one of those doors. What I'm going to turn to next is a topic of particular importance, which is how fire and smoke entered flat 81 and in particular the bathroom of flat 81. If I could ask for the final two documents for the jury bundle today to be handed out to the members of the jury. They are firstly a diagram, "Routes of smoke ingress to bathroom of flat 81", and then secondly supporting photographs. If they could be added to tab 26 of the jury bundle. I've put the first page of it up on the screen as well.

Mr Crowder, is this something that you have prepared for the purpose of the inquest?

A. Yes, it is.

Q. Can you explain, firstly by reference to the first page, what the three different routes were by which smoke entered the bathroom of flat 81?

A. Okay. I'll start with the route that involved burning from the corridor. So along the bottom of the diagram, you can see where there was severe burning within the corridor, and there are actually two points where burning of material actually passed across the boundary between the flat and the corridor. That was through the boxing in beneath the stairs of flat 81, through the stairs themselves. That started producing smoke, which

then filled the flat and entered the bathroom. There was some burning through the panel above the front door to flat 81, which again allowed smoke to enter the flat, and that passed through around the door of the bathroom into the bathroom itself. There was smoke spread not associated with burning which actually passed through some fire-stopping -- there were points where pipes had been passed through from the corridor into the flat. Varying degrees of fire stopping around these, but ultimately they were leaky enough to allow significant quantities of smoke to enter into an enclosure that housed a water tank in the flat and then from that closure, once it became smoke-filled, the smoke was able to pass round the panels that were around this closure and enter the bathroom via that route. Do you want me to mention the bathroom duct?

Q. Yes, and then we'll go back over some of this.

A. Okay. Then in the bottom right-hand corner of the bathroom, you can just see there's the duct, which is the vertical duct connected to all the bathrooms which I described earlier. That also provided a route by which smoke could enter the flat, and in this instance it was smoke, in my opinion, predominantly coming from flat 53, which was burning at -- well, at one time during the overall amount of time during which there

were people in the bathroom of flat 81.

Q. Okay, so before moving on, if we summarise there the three routes. One is through the ventilation grill into the bathroom caused by smoke coming from the fire in flat 53?

A. Yes.

Q. A second route is under the bathroom door?

A. Yes.

Q. And a third route is through gaps, for want of a better word, in the walls allowing smoke to spread from the corridor into the bathroom; is that right?

A. Yes, that's correct.

Q. Then if we turn over the page, we have a plan of the 11th floor corridor and the ground floor of flat 81, and a number of photographs, and red lines indicating where those photographs were taken; is that right?

A. Yes, that's correct.

Q. Just before moving on, we see on the left-hand side of the page in the middle a completely blackened door. Is that something that you were describing earlier when you said it was unusual to see a door that was equally blackened at the bottom as at the top?

A. Yes, that is a very good example of the depth of charring that occurred throughout the height of the doors. So you can see that it's charred the timber

that's around the outside of the door but also charred to quite a depth the chipboard, which was the main body of the door.

Q. What I would encourage us to do is to leave this page open. I am now, with your assistance, Mr Crowder, going to look at a panoramic set of photographs taken of the bathroom in flat 81. Are we here going to see a series of photographs in flat 81 stitched together to give a panoramic view?

A. Yes, and then within that there are also detailed photographs of relevant features, some of which are reproduced on the page.

Q. So here we're looking through the door into the bathroom of flat 81, and if I click on the "P", what do we see?

A. We see the ventilation grill into the bathroom, which actually corresponds with, on the printed page on the right-hand side, the second photo down. I don't know whether it's already been mentioned that attempts were made by the people in the bathroom of flat 81 to cover that grill, but there was a sheet of paper fixed over that for that purpose, and we can see the outside of the grill, and then on the screen in the panorama we can see, when that grill is moved to one side, the duct that is behind it, and actually the structure that you can see within that is the damper that's used for balancing

the amount of extraction that goes to each flat from the motors on the roof.

Q. We're now rotated through 180 degrees. Can you see the staircase?

A. Yes. It's not too clear on the panorama, although it's not desperately clear on the printed page either, but where the stairs turn through 90 degrees to go to the upper floor of flat 81, you can see that they've burnt through. Well, it's not too clear that they've burned through, but you can certainly see the staining on the wall and the charring and shooting that resulted from that staircase burning through.

Q. Is it right that up until the point where it turns through 90 degrees, the staircase is intact?

A. Yes, that's correct.

Q. What are we looking at here?

A. So here we're looking at the water tank that sits inside this box that was associated with the bathroom. The panel on the front of the box has actually been removed for the purpose of this panorama, but originally there would have been a panel there concealing the contents. We can see copper pipes associated with the central heating system and we can also see soot staining where smoke has passed through the wall separating the flat from the corridor, and smoke has entered that space, and

if you continue panning upwards a little bit further, please.

Then, at the top, where the batten is on the ceiling, we can see smoke staining where smoke -- once it had filled that particular space, smoke was then passing through the gap at the top of that partition and entering the bathroom itself.

Q. By reference to the second page of the A3 diagram, are we looking here at the small box area, boxed off by grey lines, to the right of the bathroom door, which has two blue arrows in it?

A. Yes, that's correct. What we see here is the pipes, or one of two pipes which, in my opinion, is likely to be the old heating system pipes which have been capped off due to the system no longer being used, but we can see that they pass through the wall and actually provide a route for smoke spread.

These are the newer central heating pipes. Smoke staining wasn't too significant here. We can see that some attempts have been made to fill the gaps between the pipes and the wall with material to minimise -- or prevent, hopefully -- that smoke spread from occurring.

Further down behind the pipes, there actually was originally a transfer grill within the walls between the corridor and the bathroom. These appear to have all

been blocked up at some point during the life of the building. These didn't provide a ready route for fire spread, so the sealing up that was done appears to have been effective.

That's just a close-up of the smoke staining arising from the smoke once it had filled that box, passing out into the bathroom itself.

Q. The smoke staining that we've looked at there in that small area with the tank in it, would that all have been caused by smoke entering from the corridor or would some of it have been caused also by smoke coming under the bathroom door, or smoke coming through the ventilation grill?

A. No, the smoke staining in that area would not have resulted from either smoke coming under the bathroom door or from the duct.

Q. So all from the corridor?

A. Yes.

Q. Unless there's anything I've missed on that, I'll close that down.

A. No, happy with that.

Q. So having looked at the images relevant to those three different routes of smoke spread into the bathroom of flat 81, I'm going to ask you about each of them in turn. Firstly, if I ask you about the smoke that came

through the ventilation grill. That came from the fire in flat 53; is that right?

A. Yes, that's correct.

Q. We've seen photographs that suggest that that fire started around 1648 hours.

A. Yes, that's correct.

Q. Are you able to assist with how long after that it would have taken for smoke to overwhelm the ventilation system and begin to enter flat 81?

A. Yes. Our assessment of that was based on a combination of witness evidence and some of the phone calls that were made from the bathroom of flat 81, but also from our interpretation of the rate at which the fire would have grown. Now, having found that the fire growth rate in both flat 65 and flat 79 was in fact a medium growth rate, then -- or very close to a medium growth rate -- then we thought it highly likely -- and I think it highly likely -- that the fire growth rate in flat 53 would also have followed this medium growth rate, which gives us a time at which the fire intensity would have reached its peak in flat 53 of around 1659, and we understand from the other evidence we have that smoke was starting to enter flat 81 at around 16.57, a couple of minutes before our prediction of when the fire in flat 53 would have reached its peak.

Q. So we're clear on this, this source of fire is unconnected to the fire inside flat 79; is that right? The source of smoke?
A. Yes, the source of smoke is independent from the smoke coming from flat 79.
Q. We've seen a photograph showing the fact that newspaper was used to block up the ventilation grill and we've heard some evidence about that. Can you assist us with how effective that would have been to prevent smoke from entering the bathroom?
A. It's somewhat difficult to say. My expectation, in the absence of any of this evidence, would have been for it not to have been a particularly effective method of preventing smoke from entering the bathroom, particularly given that there were signs of scorching as well as sooting on the inside of that paper, and I would have expected that a few more degrees and that paper would well have been capable of igniting, burning through and no longer being of any help.
Q. Does it follow from what you've said that it didn't ignite?
A. That's correct, and it's my opinion that actually that newspaper and tape performed very well in the task that it had of trying to prevent smoke from entering the bathroom of flat 81.

Q. So you wouldn't have expected it to, but in fact, looking at the evidence objectively, you think it was effective at blocking smoke?
A. Yes. Certainly more so than I would have expected.
Q. Thank you. Then if we look at the other two routes, from the corridor and under the bathroom door, firstly, is it right that if you look at those two routes and trace them back to their origins, both of the routes have as their origin the failure of the boxing in of flat 79?
A. Yes.
Q. Because it's that that allows the fire to spread, on the one hand, into the suspended ceiling and the boxing in to flat 81, and from there to send smoke under the bathroom door, and on the other hand allows fire into the corridor and the suspended ceiling, which in turn allows smoke to enter from the corridor into the bathroom; is that right?
A. Yes, that's right.
Q. So it's the failure of the boxing in in flat 79 which is the earlier cause of both of these routes?
A. Yes, that's correct.
Q. What I'd like to ask you now is about the sequence in which those two routes would have become significant -- in other words, whether one would have been earlier in

time than the other -- and then secondly about whether one would have been, at any time, the primary source of smoke entering flat 81, and the bathroom of flat 81 specifically.

A. Okay.

Q. If I ask you in this way: we have, from your reconstruction, a particular peg in time to rely on, which is the collapse of the front door in flat 79, which, on your earlier evidence, would have been at around 1719 hours. So perhaps if we look at this both before and after that.

A. Okay.

Q. Firstly, before the front door of flat 79 failed, what can you tell us about these two routes for smoke to enter the bathroom of flat 81?

A. Before that time of 1719, there would have been a certain amount of smoke entering flat 81 via the suspended ceiling.

Q. And therefore you mean by the corridor?

A. Yes, by the corridor.

Q. What about under the bathroom door?

A. There would have been a certain amount but it may not have been particularly obvious at that stage. I think the failure of the boxing in in flat 79, coinciding with -- or very shortly after with the stairs igniting,

I have at 16.48 or thereabouts. So from that time until 17.19, I think, there is a mechanism by which smoke is entering, in reasonable quantities, the space above the suspended ceiling in that corridor and is then reentering flat 81 wherein it can follow either of those two routes, so passing through the boxing in -- and I think we've already established that that boxing in, even before it became exposed to fire and might have failed completely, would have been a leaky route by way smoke could have entered flat 81 and from that gone into the bathroom -- but then also via these pipes that were passing through the wall above the suspended ceiling between the corridor and into the space in flat 81.

Q. Then when the front door of flat 79 collapsed, to what extent did that change things?

A. It made conditions worse. To -- the extent to which you could pinpoint how much greater, how many times more smoke would have been produced, it's very difficult do put an exact figure on, but it would have led to a significant worsening of conditions within the corridor. Potentially it would have increased the pressure in the corridor. So you have the wind pushing against the open facade of flat 79 and everything being forced into that corridor. What you had -- and this is after smoke has stopped coming in from flat 53 and the

duct connecting -- what you had, in effect, was a network by which there was extraction from the bathroom of flat 81, so you could -- well, you would say that the pressure in flat 81 is effectively being reduced by that gas constantly being drawn off of it or the atmosphere being drawn off of it. You have a high pressure area where the fire is in flat 79, with the wind being driven onto flat 79 and the increase in pressure in that zone, and you have a route that connects the two from the high pressure zone where the smoke is through to the low pressure zone where the extract is, and unfortunately the poor victims that were in flat 81 were caught in between. They were in a route for smoke spread that was being forced by this pressure difference between the high pressure zone of flat 79 and the low pressure zone of the extract of flat 81.

Just going back a bit, 17.06, I think I mentioned, was the time when smoke would have been entering the bathroom of flat 81 via the duct. At that time, that was the primary route by which smoke was entering the bathroom of flat 81, in effect, whereas in the later stages that extract was drawing air and smoke and gasses out of the bathroom and making its pressure lower. At the earlier stage of 17.06, where the extract system had been overwhelmed, it was actually introducing smoke. So

the bathroom of flat 81, the pressure would effectively have been increased. Only slightly, I mean, not to any appreciable extent, but enough that the flows of smoke in and out of that environment would be dominated by that particular route.

Q. What I want to ask you to help us with now, as best you can, is about the period of time when the potential escape route from the bathroom of flat 81 to the east balcony on the 12th floor would have been viable. If I just put up some images to introduce this topic.

This image illustrates the different escape routes in theory available from a west-facing flat, so in other words a flat like flat 81. We can see on the ground floor of it the bathroom is marked. So what I'm going to be asking you about is the time period in which, in your expert opinion, it would have been possible for persons in the bathroom of flat 81 to have come out of the bathroom into the small hall or lobby and then up the internal stairs marked in blue to the top, into the lounge, and then out of the lounge door on the east side of the 12th floor onto the balcony there, or alternatively, to put it another way, the timeframe in which it would have been possible for firefighters attempting to rescue persons to make their way from that east balcony into the lounge, down the internal stairs

into the bathroom of flat 81 and then back up again, okay?

A. Okay.

Q. We of course have to bear in mind the two factors that would have, at some point in time, made this impossible, potentially: one, the fire, and two, the extent of smoke-logging.

A. Yes.

Q. By way of introduction, we know from evidence that we've heard that the Nuhu family used this very route from the bathroom to the east balcony shortly before 1709 hours.

A. Yes.

Q. Because we've heard the evidence and there are photographs of Mr and Mrs Nuhu on the balcony at 17.09.

A. Yes.

Q. So firstly dealing with the effects of fire. We saw in the panorama the lower section of the staircase in flat 81, and we could see that the lower section remained intact. It was when one got to the top of the stairs, where it turns through 90 degrees, that it appeared to have been burnt away.

It's probably useful at this point, whilst keeping this image on the screen, to look in the jury bundle, tab 13, photographs 25 and 26. What we see at photographs 25 and 26 is intact staircases.

A. Yes.
Q. So if we compare that with what we saw in the panorama in flat 81, we're imagining that the longer section of the staircase remained intact but that the five or six steps at the very top would at some point have burnt away.
A. Yes, that's right.
Q. So assisting us as best you can, what can you tell us about the point when fire itself would have meant that this route we are discussing would have ceased to be possible, and perhaps reference it by talking about events before or after the front door of flat 79 collapsed, if that assists.
A. Okay. So the timeline that we developed as a result of the reconstruction and the computer modelling data indicated that the front door collapsed into the corridor some time after 1900 hours. I forget what the -- you gave me an exact time?
Q. 17.19.
A. 17.19. That would have led to significant worsening of conditions in the 11th floor corridor, which immediately makes that particular route, the corridor itself, an impassable route, certainly from the point of view of someone who is not wearing firefighting gear, and potentially also from the point of view of a firefighter

in firefighting gear. I'm talking about the corridor itself.

Q. Exactly. So there will come a point when, on the image of this screen, the corridor labelled "central corridor" would have been impassable through fire?

A. Yes.

Q. Then turning specifically to the possibility of using the route on the 12th floor through the lounge?

A. So our assessment of the performance of the boxing in and the rate at which the fire would have developed within the 11th floor corridor led us to conclude that at around 17.30/17.35 -- and a five-minute window was the best estimate that could be put on this, but around that time, it is my opinion that the boxing in beneath the stairs would have been reaching its limits of fire resistance. It would therefore from that time no longer have been providing protection to the stairs. The stairs would have -- the underside of the stairs would have become exposed to those extremely severe conditions in the 11th floor corridor.

From that point, there would have been an extremely -- what's the word -- you would not have wanted to have walked on those stairs at that point even before they had burned through, but that would have been followed a few short minutes later by them actually

burning through, and then that route would have been entirely impassable as a result of the fire burning through the stairs.

Q. So your estimate was that at around 17.30 to 17.35 the boxing in would have failed under the stairs in flat 81, making the stairs impassable; is that right?

A. Yes, that's correct.

Q. You said that there would have been a time before that when the fire, perhaps the heat, would have been such that it would have been a very unattractive route?

A. Yes.

Q. Are you able to be any more precise in terms of time periods when that route would have been realistically not possible to use because of fire and heat?

A. I would say it would have been an unattractive route, certainly from 17.30. I don't think I can realistically move that estimate much further forward, given that the collapse of the front door occurred at 19 minutes past. It would have taken some minutes for the fire to develop significantly within the 11th floor corridor. So there may well have been an increase in the smoke that was starting to permeate through the structure of the staircase, and that would obviously have had an impact on whether or not somebody would be prepared to use it as a route to get from the lower floor of flat 81 to the

upper floor and out onto the east balcony, but in terms of the actual burning, the fire involving that staircase and making it unattractive as a result of it being hot and unpleasant and then actually burning through, I think 17.30's probably the best estimate that I can put on that.

Q. What about the effects of smoke and smoke-logging, separately from fire and heat? Would they have, in your opinion, made the route impossible to use even before the heat became too great to use it, or not?

A. Probably. It's not something -- again, it's not something I could say with absolute certainty, but given what was observed from outside of the building in terms of the amount of flame and smoke that was emitted from the end of the 11th floor corridor, out of the ventilation grill at the end of that corridor -- that occurred very shortly after the front door to flat 79 collapsed into that corridor, and therefore I would think that around that time, that would be when, even prior to fire getting through, smoke permeating into that flat would have suddenly become significantly worse, and that could have been to the point where it would have discouraged anyone from using that as an escape route.

Q. You're describing events after the collapse of the front

door of flat 79, which you're putting at approximately 1719 hours.

A. Yes.

Q. Madam, if we were going to take a five minute break, that would be a convenient moment, because we've coming to the end of that topic.

THE CORONER: Thank you.

A five minute break, members of the jury. Do leave your papers behind if that helps.

Mr Crowder, a five minute break.

(3.24 pm)

(A short break)

(3.32 pm)

(In the presence of the Jury)

THE CORONER: Thank you.

MR MAXWELL-SCOTT: Mr Crowder, I have six topics to finish my questioning of you, each of which I expect to be relatively short. If we take them in turn. The first is about smoke spread and smoke-logging within the building as a whole. The jury have heard evidence and heard statements read from a number of witnesses. Sometimes witnesses describe quite severe smoke-logging on a floor and at other times they describe either no smoke or light, wispy smoke. Sometimes with firefighters we've heard the same witness describing the

conditions coming and going, not just becoming gradually thicker smoke as they go up the stairs, for example, but experiencing changes in smoke intensity in the stairs as a general principle.

What I wanted to ask you was about the mechanism by which smoke spread within the building, and whether there might be any explanation that would explain why some times the smoke within the same part of the building appeared to be severe and then to lessen in intensity and to gain in intensity again.

A. Okay. It would be useful to have a diagram to refer to, if that's possible. Maybe just the 3D model of the building.

Q. While I look for one, I'll put up this image of the smoke staining to the ventilation grills in the central staircase area. If you want to say anything about that, I'll have a look for a diagram that's going to assist you.

A. So I've already mentioned that on the day of the fire, the prevailing wind was westerly, so there was wind that was hitting the west face of the building, and we know that the building was designed with a cross-ventilation scheme. There were vents that were open on the west face of the building into the lift lobbies. There were also vents that were open at the ends of both the north

and the south end of the corridors, and we know that there were no smoke seals around the doors, and of particular relevance to what I'm about to explain is that there were no smoke seals around the doors that led from the lift lobbies into the staircase.

That all being the case, there was a net flow throughout the building at any one time that was governed by, effectively, high pressure in the lift lobbies, firstly allowing air to move north through the north corridor and out of the north end, south through the south corridor and out of the south end, but then also, even with all the doors closed onto the staircase itself, air would pass through the gaps around these doors and into the staircase itself. The staircase was closed at its top -- the only significant opening in the staircase was at the base -- and what happened as a result there was -- actually, it might be worth referring to one of the early figures in my report. Sorry, bear with me one moment.

Q. Is that figure 10, showing air flow?

A. It could well be, yes. Yes, figure 10. So what we can see in this figure, this was the modelling that was carried out using the data that was very similar to the data from the Met Office, and you can see the wind hitting the west side of the building. So west is left

on this diagram, it's facing north, and what you might be able to glean from this is we actually have a relatively low pressure zone on the right-hand side of the building, into which the exit from the stairways was actually connected. So what you had was all of the air in the building passing in through the west-hand side into the staircase, moving down the staircase and out at the base at the building and actually carrying on eastwards in the direction of the prevailing wind. What would happen when a door was opened onto the staircase was you would suddenly get that flow dominated by the position of that opened door, and whatever was in the lift lobby would transfer through the door into the stairwell and start travelling down the stairwell.

Now, if, for whatever reason -- well, let's take it as an example, the door on the 13th floor between the stairwell and the lobby is opened, and as a result of the wind direction, the smoke that's being emitted by flats on fire is actually passing across the ventilation grills so that smoke is entering those lobbies. If you then open the door into the stairwell, then you'll get a volume -- not a fixed closed space, but a cloud, effectively, of smoke that will enter that stairwell. If that's as a result of someone evacuating, the door will subsequently be closed once they've -- you know,

they open the door, they pass through, they close the door on the other side, and what will that happen then is you'll have that cloud of smoke and you'll still get a certain amount of smoke permeating through the door, but what you're effectively left with is a plug of smoke that starts moving gradually down the height of the stairwell. And that's what was encountered by firefighters and some people evacuating, in that they would be making their way up or down the stairs and suddenly encounter an area of thick smoke. They'd go in one side and then come out of the other, very similar to -- say, if you're driving in heavy fog, you might suddenly find yourself driving along a clear road and then suddenly you encounter a cloud of fog, you pass in it and out the other side. The same was true in this case with the stairwell in Lakanal.

Q. So to summarise that, are you saying that because of these changes in air pressure and people opening and shutting doors, you would get these clouds or plugs of smoke being sucked into the stairwell from time to time?

A. That's correct, yes.

Q. Thank you. The second topic, but a related one, is about the introduction in the 1980s of the doors from the lobby to the corridors, which we see, for example, in tab 13, photograph 11 of the jury bundle. You told

us earlier that these were not part of the original construction, but you thought were added probably in the 1980.

Just to introduce this topic -- there'll be later evidence on it, but is right that there were some conditions attached to an approval document in 1984 relating to the dimensions of the part of this door which allowed air flow?

A. Yes, that's correct.

Q. Is it your understanding that the door as we see it in that photograph didn't comply with those approval conditions?

A. Yes, that's correct. The opening in this door was smaller than that which was specified in the conditions attached to the approval.

Q. If the approval condition had been complied with, can you assist us with whether, firstly, there would have been less smoke-logging on the day of the Lakanal House fire?

A. Yes, this comes back to the evidence I gave earlier regarding the purpose of cross-ventilation in buildings, the overriding principle being that by ensuring that there is enough ventilation into these common spaces that any smoke that is introduced into these common spaces by fires will be effectively cleared by the fresh

air that can pass through the space. The fact that a condition was attached to the approval for these doors indicates to me that some assessment had been made of what sort of free area should be available in the door to ensure that that cross-ventilation scheme could continue to work.

Now, by the time the approval was issued, cross-ventilation had already started to be phased out but building regulations allow for the maintenance of existing measures in buildings, and --

Q. Coming back to the focus of the question, if the approval conditions had been complied with, do you think there would have been less smoke-logging in Lakanal House on the day of the fire?

A. There should have been, yes. So the restriction of the free ventilation area, in my opinion, what occurred was that you had a throttling down of that cross-ventilation effect so that the effect of fresh air in clearing away smoke was reduced. Smoke could still be introduced into the space by fire and because it wasn't subdivided and compartmented, there was no restriction on the ability of smoke to enter these areas, and a relatively small quantity of smoke can have a significant impact on conditions. Therefore, you were left with a situation where there wasn't compartmentation separating these

areas but there was not enough free ventilation to allow the cross-ventilation scheme to work as well as it could have done.

Q. Then my third short topic is about the mechanism by which the fires started in flats 37 and 53. On this point, can I ask you to have a look at photograph DSC6960. Can you tell us what this shows?

A. This is a picture taken in flat 81 -- sorry, not flat 81. Flat 37, from memory. It's taken in bedroom 1. So bedroom 2 was involved in fire; bedroom 1 was not. However, the windows to bedroom 1 were open, and what you see here is a photograph looking at a plastic strip that is at the base of the window facade set in bedroom 1 of flat 37. There's various pieces of debris that have fallen in through the window and landed on this strip, and what you can just about make out around some of these pieces of debris is that there is discolouration of the plastic, which indicates that the debris was hot. It may well even have been flaming when it came in through the window and landed here. It wasn't sufficient to ignite any fire within bedroom 1, but it is my opinion, also in conjunction with photographs which show smoke starting to appear in these flats whilst the panels were still in situ, that actually the fires in flats 37 and 53 were started by

hot and/or burning debris falling in through windows and igniting combustible items within those flats.

Q. So to summarise, this shows evidence that debris has blown through the open window and landed on the floor of this flat and caused the signs that one sees in the photograph; is that right?

A. Yes.

Q. Then my fourth topic is about the fire in flat 81 in 1997. I'm going to show you some photographs from that fire. I'm going to page 1084 in the advocates' bundle. I think the one you want is 1089, but stop me before we get there if you want to.

THE CORONER: Do you want to look at the photograph itself, or do you have it there? Or do you want to look at it on the screen?

A. I can see it on the screen, thank you.

MR MAXWELL-SCOTT: This is 1089. I'll show you the bottom photograph. What does this photograph, on the bottom of page 1089, tell us about what was in place in 1997 and therefore before the 2006/2007 refurbishment?

A. Okay.

Q. And what happened to it in this fire?

A. Yeah. Okay, what we can see in this photograph is the kitchen in flat 81. On the right-hand side, there is the half wall, the block-work wall that is still in situ

and has survived the fire. An appliance which looks like a fridge or freezer or fridge freezer appears to have been pulled forward in front of the door, but we can see that behind it that the fire door between the kitchen and the balcony is still in place. That's the brown rectangular item with the horizontal lines running across it.

THE CORONER: Can you just highlight that with the cursor.

MR MAXWELL-SCOTT: It's not showing an arrow but there's a -- is it immediately below that arrow that we're looking?

A. Yes, that's correct.

THE CORONER: Thank you.

A. It might be helpful to zoom in a bit further. And again. So what we can see is the -- so the door is still in place, and actually around the door we can see the charring that's occurred to the wooden frame that's around the door, and that charring actually continues around the window -- the top of the window to the right of the door.

To the left of the door, the frame actually continues to -- so there's a pipe that runs diagonally up the picture. Where that meets the top of the picture, directly down from that we can see there's a wooden frame that's heavily charred. Between that

left-hand vertical wooden frame and the left-hand edge of the door, there is a panel which is there. The panel has been affected by the heat. It certainly appears to be heavily soot-stained and it may be charred to a certain extent. I'm not aware of what the actual composition of that panel was, but whatever it was, it was able to survive quite a severe fire within this kitchen and is therefore indicative of the kind of performance of the elements of construction that were there at the time of the 1997 incident.

Q. You mentioned that the block-work wall underneath the window survived?

A. Yes.

Q. Just on a point of detail, did the block-work walls in the fire on 3 July 2009 in flats 79 and 65 survive?

A. Yes, they did.

Q. If I take you back to 1085, where you can see some smoke coming out of the north vent on the 11th floor corridor, and also 1084 at the bottom, does that enable you to make any comment on the smoke-logging within the building on that occasion?

A. Yes. The photos indicate to me that there was quite a significant amount of smoke within the common areas of the building. It does not appear as though fire has spread into those common areas.

Having said that, the smoke itself appears to be quite pale, quite light. It's not -- I don't think it's smoke of the sort that you would want be walking through it during the course of this fire, but the conditions are not as bad as they were during the incident in 2009.

Q. Then the fifth topic is about some tests that were done after the Lakanal House fire on some of the materials that were added to the building in 2006/2007. I'm going to take you to your report number 259449 and to page 238 firstly. Is this a separate test result on a specific material carried out by a different part of BRE Global?

A. Yes. The test has been carried out by the part of the company that is concerned with carrying out UKAS-accredited testing, hence the logo that you see at the bottom right corner. As a result of that, myself and my colleagues in fire investigation cannot get directly involved in this kind of work. We commission testing from our colleagues that do carry out this testing in accordance with UKAS requirements, and that then regularly becomes input data that we might use for our analysis, interpretation, reconstructions and modelling, but the report must be included in its entirety in order to comply with the requirements of UKAS.

Q. What was tested in the test that we see the front cover

of, the report here?

A. This report is concerned with tests that were carried out on window panels from one of the flats of Lakanal.

Q. Like the sample that we saw in court earlier?

A. Yes. In fact, it's the same panel that was tested to the sample which was in court earlier.

Q. If we go into the report, firstly to page 242, can you draw to our attention what we need to look at in the observations section.

A. Yes. So amongst all of the specimens that were tested, the very top one in that table states that incandescent spalling was visible throughout all test runs. What that means is that there were pieces of material that were falling away from the test specimen as it was being tested and that these materials were certainly glowing and that -- therefore at the very least very hot.

In test 1, flaming debris was observed with flaming occurring for a maximum of five seconds, and in test 2, flaming continued for 20 seconds after a piece had fallen off the sample onto the laboratory floor.

Q. Then if we go to page 243, over the page. Some of this terminology is in the glossary added to the jury bundle this morning at tab 22, which contains references to class 0 and also class 1. There will be more evidence about this in due course, but for the purposes of today,

is it right that the performance of materials when exposed to fire can be categorised by reference to class 0, class 1, class 2, class 3 and class 4?

A. Yes. In the case of this particular test, classes 1, 2, 3 or 4 can be achieved by a sample. Class 0 is only applicable where a sample achieves class 1 in this test and then is also tested to another standard and achieves a relevant level of performance for that standard, at which point class 0 can be assigned, but for the purposes of this test, classes 1 through 4 are applicable.

Q. What class was the most accurate one for categorising the composite panel?

A. The composite panel achieved a class 3 classification.

Q. Thank you. Then if we look on in the report to page 247. This is the second and final test we're going to look at. The test report is in a similar format to the one we've seen. What did this test?

A. This was the same test method as in the previous report, but this was carried out on a sample of balcony panel from Lakanal.

Q. If we turn to page 251 and the observations.

A. So the main observation of note is that there was not any flaming spalling. There was non-flaming spalling that occurred throughout the tests, ie lumps of material

were falling away from the test sample and landing on the laboratory floor but in this set of tests, none of those pieces of spalling were flaming when that occurred.

Q. Then the result at page 252, was this also categorised as class 3?

A. No, this panel achieved class 2.

Q. It's in the conclusion, yes, I see.

A. Yes.

Q. Thank you. Then the final topic that I have for you is to see if you can assist the jury with some of the questions that they asked during their site visit to Lakanal House. You've seen a copy of the current document of questions and answers and unanswered questions. It's at tab 16 of the jury bundle. If I could look at some but not all of those questions with you.

Firstly, question 3, in relation to the ventilation grills by the lobby. Is there a mesh over the grill?

A. Yes, there is.

Q. And have any tests been done to establish what it is or whether it's flame retardant?

A. No.

Q. Then question 4, the panel above the front door -- I think you told us already today that was timber?

A. Yes, that's correct.
Q. Question 6 was about the dwarf doors between the two bedrooms. Could it be used for access? Can you open it only from one direction or, as far as you're aware, from both directions?
A. As far as I'm aware, from both directions.
Q. Question 8 related to the area under the stairs. You'll recall that as you look through from the bedroom towards the corridor, there's the underside of the stairs on the left, and there's a panel on the right?
A. Yes.
Q. Is that panel something that we should regard as a potentially relevant feature of the building?
A. No, it did not have any bearing on the development of the fire or the spread of the fire.
Q. Thank you. Question 9 was obviously talking about a different flat, because the jury were on the 3rd floor of the building and they asked about the area on the right-hand side of the door to the bathroom. In terms of flat 81, where we're focussing, have we now seen the equivalent area in the panorama?
A. Yes, we have.
Q. Could I ask you then to turn to question 14. There's a question there about the extractor fans in the kitchen. Is that a potentially relevant feature of the

building for the purposes of fire development and spread?

A. Not for the purpose of fire development and spread, no.

Q. Question 15 was about electrics. Was that a potentially relevant feature of the building for the purpose of fire development or spread?

A. Not for the purpose of fire development or spread.

Q. Can I ask you then about question 17, which is about ventilation grills at the ends of corridors. As far as you are aware, were they original features of the 1950s construction?

A. As far as I'm aware, yes.

Q. You wouldn't know one way or the other whether or not they'd been replaced over time?

A. Not to my knowledge. I mean, it's entirely possible that they could have been, but I've no reason to think that -- had they been replaced, that there was any significant change in their performance, particularly in relation to fire development or spread.

Q. I think it follows from what you said earlier that they haven't been tested for fire resistance but what would be the implications of the fact that they are ventilation grills to the spread of fire through them?

A. They wouldn't provide any barrier to fire spread. The material that they're made of might be a material that's

capable of presenting some level of fire assistance, but given that it's an open vent, the product as a whole would not provide any fire assistance.

Q. Then question 18 was about the panel to the right of the door entry panel. I've put up on the screen photograph 13 from tab 13 of the jury bundle. I think we're talking about a panel just to the right of where that corridor door is. Is that a potentially relevant feature of the building for the purposes of fire development or fire spread?

A. Not for the purposes of fire development or spread.

Q. If I ask you then about question 21, which relates to the suspended ceiling. You told us earlier that the suspended ceiling went through the whole of the communal corridor and stretched through the lobby into the corridor on the other side.

A. Yes.

Q. Did the flats themselves have suspended ceilings in them?

A. No. Not that I'm aware, no.

Q. Then a bit further down that question, there was a question asked about whether there was access to the cavity above the suspended ceiling.

A. There were panels in the suspended ceiling that could be taken down. I don't think they were designed for easy

access because they were fixed using screws. They didn't have an easy access handle that you might use to gain easy access but they did appear to be intended specifically for access into the suspended ceiling, and there were seals fixed around the timber supporting structure, indicating that those panels were designed to be removed on a reasonably regular basis, or at least more regularly than the remainder of the suspended ceiling.

Q. Then if I ask you about question 23. These are about the collection of windows and frames in the bedrooms. Were they one piece, or were they a series of pieces that were put together on site?

A. They were a series of pieces that had to be put together. So they broke down into individual sections of aluminium with its coating, the individual panels and the individual sets of glazing, and then screws and fixings for putting all of that together.

Q. Then I'm going to ask you about question 27, when I've found a suitable photograph to accompany it. Photograph 25 is taken at the top of the stairs of one of the flats, and I believe that this question is essentially about the panel that's behind where the photographer is there --

A. Yes.

Q. -- at the top of the stairs. Is that a potentially relevant feature for the purposes of fire development and fire spread?
A. Not for the purposes of fire development or fire spread.
Q. Then question 29, what's the visual difference between a front door and an escape door? Firstly if I ask you in this way: were the escape doors the same height on the corridor side as the front doors?
A. Yes, they were.
Q. Then the question went on to say:

"Is there always a flat number on the front door?"

I suspect the question may be getting at the ability to recognise what's a front door and what isn't if one is in a smoke-filled corridor. What, as far as you understood the situation to be, was the position in relation to flat numbers on front doors?
A. Originally, all of the front doors were fitted with letterboxes, and on the right-hand side, I believe, of each letterbox, there was a slight extension to the structure of the letterbox where the flat number was displayed. Some tenants had decided to add their own number at eye level on the front door. Some had also changed the letterbox, but in general terms, the majority of doors in Lakanal displayed the flat number on the letterbox.

Q. Then finally question 30. I'm going to put up photograph 17. That shows a corridor with the suspended ceiling in place, and one sees the lighting in it. Firstly, was that how the corridors were lit as at the time of the Lakanal House fire?

A. Yes.

Q. And as far as you're aware, was that lighting original or had it been added since the construction in the late 1950s?

A. As far as I was aware, those particular lights were installed after the suspended ceiling was added. Originally, they were higher up the wall, in the area that's now covered by the suspended ceiling.

Q. Mr Crowder, thank you very much. I'm aware it's been a long day but that concludes my questions.

A. Thank you.

THE CORONER: Thank you very much. Let's break now until tomorrow.

Members of the jury, back for a 10 o'clock start tomorrow, thank you very much.

Mr Crowder, can you be back here for a 10 o'clock start tomorrow? Thank you very much. Please remember overnight not to talk to anyone about your evidence or the case. You're free to go now.

A. Thank you very much.

(The witness withdrew)

(In the absence of the Jury)

THE CORONER: Yes, just before we finish, the jurors handed in a question, and I would suggest that the best way of dealing with this is to ask Mr Maxwell-Scott and Mr Atkins to photocopy it and distribute it, and then we can discuss maybe first thing tomorrow morning how we deal with that. All right? Thank you.

(4.10 pm)

(The Court adjourned until 10 o'clock the following day)