Thursday, 22 November 2018
(10.00 am)
SIR MARTIN MOORE-BICK: Good morning, everyone. Welcome to today's hearing.
We are going to continue with the inquiry's experts. I think we are going to hear from Dr Lane.
Yes, Ms Grange.
MS GRANGE: Yes. Good morning, Mr Chairman, thank you.
Yes, today and continuing into Monday we are going to be hearing from Dr Lane, then later next week we'll be hearing from the other inquiry experts at Phase 1, including Dr Duncan Glover, Professor Niamh Nic Daeid and Professor Purser.
So can I now call Dr Lane.
DR BARBARA LANE (sworn)
Questions by MS GRANGE
SIR MARTIN MOORE-BICK: Thank you very much, Dr Lane. Sit down and make yourself comfortable.
(Pause)
All right?
THE WITNESS: Yes, thank you.
SIR MARTIN MOORE-BICK: Yes, Ms Grange.
MS GRANGE: Please can you give the inquiry your full name.
A. Dr Barbara Anne Lane.
Q. This is the continuation of your formal evidence in

Phase 1 of the inquiry following your presentation previously on 18 June this year.
At Phase 1, you were asked to identify the active and passive fire protection measures within the tower, and report on the extent to which they failed to control the spread of fire and smoke and contributed to the speed at which the fire spread; is that correct?
A. That's correct.
Q. You produced an initial Phase 1 report on 12 April this year, which consisted of 21 chapters and 11 appendices, A to K.
Since that time, you have revised and updated that report, including in the light of some of the factual evidence that the inquiry has been hearing at Phase 1.
Your revised report is dated 24 October 2018, and the conclusions in section 2 are dated 5 November 2018; is that correct?
A. That's correct.
Q. It consists of 21 chapters and 15 appendices, A to O, and the references for that are BLAS0000001 through to BLAS0000036 inclusive; is that correct?
A. That's correct.
Q. You've also recently produced a short corrections and addendum document dated 19 November 2018. That's BLAS0000037; is that correct?

A. That's correct.
Q. Thank you.
As you indicate in the declaration in section 21 of your report, you have provided it in the same way as you would've provided a report to a court; is that right?
A. Yes, I have.
Q. In section 1.1 and appendix A to your report, you've outlined your background and expertise relevant to matters in this inquiry.
In terms of some of the key points from that, you are a director of Arup, which is an independent company of designers, planners, engineers, consultants and technical specialists addressing professional services in the built environment; is that correct?
A. That's correct.
Q. You specialise ins fire safety engineering in the built environment, and you have 20 years' experience in the construction industry in England and internationally.
A. Yes, I have.
Q. You are a chartered fire safety engineer, having graduated from Trinity College Dublin.
A. Yes, I did, and I am.
Q. You are a fellow of Arup, which is an honorary title awarded to exceptional individuals within the firm.
A. Correct.

Q. You're also a fellow of the Royal Academy of Engineering and the Royal Society of Edinburgh.
A. I am.
Q. You have been involved in a number of landmark high-rise buildings, including the following: as project director for The Shard, responsible for on-site compliance works regarding at the approved fire strategy; is that correct?
A. That's correct.
Q. Project director responsible for developing fire strategies in relation to a number of the Canary Wharf high-rise buildings.
A. That's correct.
Q. You were also the fire project director for Elizabeth House, a mixed-use high-rise development in London, including commercial, residential and retail accommodation.
A. Yes, that was a planning project, yes.
Q. You were also an expert appointed to investigate the collapse of the World Trade Center 7; is that correct?
A. That's correct.
Q. Thank you.
Are the factual matters set out in your updated report true to the best of your knowledge and belief?
A. Yes, they are.

Q. Does this updated report accurately set out your opinions on matters relevant to this inquiry?
A. Yes, it does.
Q. Thank you.
In terms of the structure of my questioning, I'm going to ask you about some of the key conclusions in your Phase 1 report.
In the course of that, I'm going to ask you to explain some of the aspects in which you've updated your main report in your revised Phase 1 report.
A. Okay.
Q. I'm also going to seek to identify with you the extent to which your investigations are ongoing, and some of the particular areas that you wish to investigate further at Phase 2 of the inquiry's work.
A. Okay.
Q. In general, I'm going to try and follow the structure of your report as you have set it out and broadly in the order in which it appears.
A. Okay.
Q. That will mean that today we're going to focus predominantly on the external facade of the tower --
A. Okay.
Q. -- including the windows, and also looking at key timing events in the progression of the fire externally.

It's likely that day 2 of your evidence on Monday is going to focus in more detail on some of the active and passive fire safety systems inside the tower, including flat and stair doors, the fire main and active systems, including the lifts and smoke control system.
Does that make sense?
A. Yes.
Q. A lot of the material in chapters 3 and 4 of your report, in terms of the background to the tower and the background to the legislative regime, was covered in your presentation on 18 June, which forms part of your evidence today, and I'm not proposing to repeat all the of the detail of that today.
A. Yes.
Q. I want to start by looking at your overall approach to the active and passive fire safety systems, and I want to be clear at the outset how you have approached your assessment of those systems at Grenfell Tower in Phase 1 of your report.
A. Yes.
Q. Is it correct to say that throughout the vast majority of your report, you've assessed the active and passive fire safety systems against two key things.
First, the design guidance CP3 1971, which is the guidance that applied at the time of construction of

Grenfell Tower and which you have concluded was applied by the designers to demonstrate compliance with the London Building Act 1939.
A. Yes, that's correct, along with the other relevant regulations.
Q. Yes. I'm going to come to those in a moment?
A. Okay, yes.
Q. So the first thing is CP3 1971, we'll look at that in a moment.
The second is current statutory guidance made pursuant to the Building Regulations 2010 as contained in the prescriptive document, which is Approved Document B, Fire Safety Volume 2; is that correct?
A. That's correct.
Q. Let's go back to the 1970s and look at the regime which applied when Grenfell Tower was first designed and built in the early 1970s.
A. Yes.
Q. We believe that Grenfell Tower was designed, as far as we know, between around 1967 and 1972.
A. Yes.
Q. Is that right?
A. That's as I understand it, yes.
Q. We take that from a RBKC chronology which has been

provided to the inquiry.
A. Yes.
Q. Can you confirm that London was not subject to national building regulations at that time?
A. That's correct.
Q. It was the London Building Act 1939 and relevant bylaws, including the London Building (Constructional) Amending By-laws (no.1) 1964 that applied; is that correct?
A. That's correct.
Q. In assessing the original design of Grenfell Tower, is it right that you've considered both relevant London guidance and also relevant national guidance which may have been applicable at the time?
A. Yes. So in my assessment of Grenfell Tower, a building in that part of London and at that height is controlled by three sections in the London Building Act: number 20, number 34 and 98. In looking at those three, I then ended up having to look at the 1971 CP3 because of how I found Grenfell Tower to be constructed in its physical condition, yes.
Q. We're just coming to that.
In terms of London guidance at that time, you've explained in your report that this principally consisted of some London County Council guidance, Means of Escape in case of Fire 1954, amended in 1967.

A. Yes, correct.
Q. You refer to that in your report as the LCC 1967; is that correct?
A. Yes.
Q. Is it right that in 1967, when this was amended, it was actually the Greater London Council that amended it because the LCC didn't exist anymore?
A. Well, it's a very small point, but the GLC published that revision, but the original note that they republished had LCC on the top. So it's a very minor point, yes.
Q. That London guidance at the time also consisted of the GLC, the Greater London Council, section 20 code of practice.
A. That's correct.
Q. You just talked about section 20 of the 1939 Act, 1970, and that gave guidance relevant to section 20 of the 1939 Act and was a code of practice for buildings of excess height or additional cubical extent; is that correct?
A. Correct.
Q. That's the relevant London guidance.
At the same time, you've explained that there was relevant national guidance; is that correct?
A. That's correct.

Q. At the time, the Public Health Act 1961 and relevant Building Regulations in 1965 applied nationally; is that correct?
A. Yes, that's correct.
Q. That national guidance on fire precautions was produced in 1962 in the form of the British Standards Institution, BSI, code of practice CP3 1962; is that correct?
A. Yes, that's correct.
Q. Its long title is, "Chapter IV Precautions against Fire. Part 1 Fire Precautions in flats and maisonettes over 80ft in height". So that's CP3 1962.
But then that national guidance was revised in 1971 and was CP3 1971; is that's correct?
A. That's correct.
Q. And that was called, "Chapter IV-1 Code of basic data for the design of buildings. Precautions against fire. Flats and maisonettes (in blocks over two storeys)"; is that correct?
A. That's correct.
Q. You've explained in your report that this meant at the time there was an overlap in relevant guidance for firefighting provisions in a single-staircase high-rise building at that time; is that correct?
A. That's correct.

Q. You note that when the LCC guide was amended in 1967, the GLC actually issued a statement saying that the guidance was under revision and, pending its revision, applicants should discuss proposed schemes with the GLC. Is that right?
A. That's correct, from a means of escape perspective, yes.
Q. So in your opinion, during this period of transition, is it possible that designers could use either the London guidance, principally the LCC guide, or the national guidance, CP3 1962 or 1971?
A. Yes, I consider that to be the case.
Q. You've assessed the design of Grenfell Tower against these three guidance documents, and you've concluded that whilst all three guides permitted a residential building to be constructed with a single stair for means of escape, both the LCC 1967 and CP3 1962 each required specific conditions to be met with other single stair and these were not provided at Grenfell Tower; is that correct.
I'm going to take you through this in detail, if that helps, in a moment.
A. Okay. They didn't all allow a single stair, but anyway, if we're going to -- probably being a bit pedantic, but yes, the question is understood yes.
Q. Let's take CP3 1962. You've explained that three

conditions were necessary to be satisfied --
A. Yes.
Q. -- and that none of these were present at Grenfell Tower.
A. That's correct.
Q. Is it right that this is essentially because the staircase at Grenfell Tower is accessed by a central ventilated lobby, ie a single-lobby arrangement, that you say you don't think could have complied with CP3 1962?
A. Yes, that's correct. It required the stair at an external surface for external ventilation.
Q. Can we just look at your summary of the reasons you give for that in your report. Let's go to your report. That's BLAS0000004, at page 20.
If we can zoom in on paragraph 4.2.18, at the top.
So these are the ways that you're explaining that Grenfell Tower can't comply with the guidance in CP3 1962; is that correct?
A. Yes, that's correct. Yes.
Q. So if we just take each, what you're saying is section 208 part (c)(i), the ventilated lobby is not a balcony.
A. Yes, because the concept was even if you had a single central stair, you had to still have an alternative

access point to that stair by means of a balcony, and that is not at Grenfell Tower.

Q. The second point is that in Grenfell Tower, the ventilated lobby doesn't adjoin an external wall in which there's a permanent opening of not less than 15 square feet.

A. That's correct.

Q. The third point is that the ventilated lobby does not communicate with the staircase through a smoke-stop door off a balcony or ventilated lobby adjoining an external wall in which there's a permanent opening of not less than 15 square feet.

A. That's correct.

Q. So those three things are telling you that you don't think it's CP3 1962?

A. Those three things tell me absolutely that the 1962 version was not used.

Q. Whereas you say that CP3 1971, the later, revised guidance, permitted a single stairway and with a cross-ventilated single lobby; is that correct?

A. That's correct.

Q. If we stick with this page, just further down on 4.2.21, there you say:

"4.2.21. CP3 1971 ... permitted blocks of flats and maisonettes to:

"a) be provided with a single stairway for means of escape through a Stage II escape route (corridor or lobby) where that escape route was provided with cross ventilation and there are no fire risks in the corridor ..."

Is that correct?

A. That's correct. So a single internal staircase with an internal lobby. So nothing is connected to an outer wall.

Q. Yes, which is what we see in this core at Grenfell Tower.

A. Exactly. So it's all internal. That's the really important point: it's all inside the tower. And then there's also the limit on how far you can walk to reach that internal exit.

Q. Yes. That's the second point:

"b) for such stage II escape routes travel distances of up to 15m are permitted between the flat entrance door and the stair entrance door."

Is that correct?

A. That's correct.

It's probably worth pointing out that that distance is also unique to CP3 1971, so it's another indicator, if you will.

Q. Yes.

It's on that basis -- because we don't know for sure, do we, but you've deduced, looking at this -- because we haven't seen a definitive document that says it was designed to CP3 1971, but you've looked at the design and you think that that's the key indicator that suggests that it was CP3 1971.

A. Yes, that's correct. I have no paperwork where anything is said either way, so by a process of elimination, and looking at the building as it exists, that's how I've derived CP3 1971 for means of escape.

Q. Do you think it might have been likely that CP3 1971 would've been available to designers prior to it being first published in 1971? Do you think it's possible the design guidance may have been circulating and therefore able to be used in the design of Grenfell Tower earlier?

A. Yes. Obviously I wasn't around, but I think actually if you look at the 1962 guide, it actually lists out all the people on the committee, and you'll see that some very senior people from the statutory bodies in London sat on that committee. I can only imagine, therefore, that in London at that time, it was clear there was work being done to the 1962 version, and there was a lot of work going on to bring this kind of state-of-the-art guidance into the public domain.

So I have to assume it was understood, known about

and discussed at the time, but I don't have any paperwork that tells me either way.

Q. Yes.

A. But based on my own professional experience, now and over the last 20 years, those British Standards, those codes of practice, tend to be in circulation for some time before the formal publication date.

Q. That's helpful.

You've also made clear that the section 20 GLC code of practice would've also applied, specifically in terms of firefighting provision in the stairs; is that correct?

A. That's correct.

Q. You've identified three key differences between the CP3 1971 guidance and the GLC section 20 code guidance in your report.

A. Yes.

Q. You've carried out that comparison exercise in appendix 8. I just want to summarise what those key three differences are.

A. Okay, yes.

Q. The first is ventilation of the stair lobbies. The GLC section 20 code required a permanent vent at the head of the stairs of a greater square meterage than CP3 1971; is that correct?

A. Yes.
Q. The second key difference is about fire resistance of the staircase. You say that the GLC section 20 code required the staircase lobby and lifts to have a standard of fire resistance twice that of the constructional bylaws which CP3 1971 adopted.
A. Yes. So that's correct, because for a tall building, section 20 placed additional fire safety protection. It wasn't meant to replace or interfere, it was additional. So it made clear where it was additional to the bylaws and so to the means of escape guidance too.
Q. And you think that, in fact, the stairs were designed to achieve that higher section 20 standard, that higher standard of fire resistance; is that correct?
A. Yes, based on the concrete depth as I've observed on the plans, yes.
Q. So you think that's in all probability what the designers must have agreed with the relevant building control authority at the time?
A. Yes, I do. I think they would've been required to do that, yes, because it's a section 20 building.
Q. You've also concluded that the section 20 code permits something called a class A for entrance and stair doors, which can achieve a lower fire integrity than the 30 minutes for type 2 doors required by CP3 1971; is

that correct?
A. Yes.
Q. We're going to come in detail to that on the second day of your evidence. I'll take you back to it.
A. Okay.
Q. But -- sorry.
A. It's correct that section 20 refers to the bylaws on the matter of doors, yes. So there's no conflict between the bylaws and section 20. They're both clear --
Q. But there is potentially between CP3 1971 --
A. Exactly.
Q. -- and the section 20 code and the bylaws?
A. Exactly. So if you adopt CP3 1971 for your means of escape design, now you have to think about the intersection with the bylaws/section 20, yes.
Q. Yes, thank you.
A. Okay?
Q. So I think what you're saying is we could've had a situation where different codes applied to different bits of the building. I mean, predominantly you think it's CP3 1971, but there's a section 20 element as well.
A. Yes. I think section 20 and the bylaws are very complimentary, but the means of escape which was dealt with by the CP3 guidance, that's where -- I'll just say intersection is for now. So when we talk about doors

later, I can explain that better.
Q. Yes.
So that's 1970, when Grenfell Tower was built.
A. Yes.
Q. That's why you predominantly looked at CP3 1971.
A. That's correct.
Q. You've then looked, as well as looking at that, at current statutory guidance made pursuant to the Building Regulations 2010, those regulations having been made under the Building Act 1974, as contained in the prescriptive document, which is Approved Document B, Fire Safety Volume 2?
A. In the statutory guidance document, Approved Document B.
Q. Yes.
A. I don't agree with the word "prescriptive". I don't know if I'm meant to correct --
SIR MARTIN MOORE-BICK: We want your views, whatever they are.
A. Okay. Sorry, I'm not being rude. It's the statutory guidance document, Approved Document B.
Q. For shorthand, you often refer to that as ADB in your report. So when we have ADB, it's Approved Document B we're talking about?
A. That's correct.
Q. At the time of the original application for this

refurbishment, when it was made and resubmitted in August and October 2012, the Building Regulations 2010 were in force; that's correct, isn't it?
A. That's correct.
Q. Do you agree that the Building Regulations 2010 only apply to certain defined building work, including where there is a material alteration which has a very specific definition within the Building Regulations?
A. Yes, I do, with some qualifications that I'll get on to in my own work. But yes, I do, yes.
Q. In particular, there's a non-worsening principle, which means that the work should be no more unsatisfactory in relation to certain requirements in schedule 1 to the Building Regulations than before the work was carried out; is that right?
A. Yes, that's correct. If you do work on an existing building, you have a duty to understand if the existing building is compliant or not, and then your new works retains its status. So if it is compliant when you start, your works should make that no worse. If it's not compliant when you start, your works cannot make it any more unsatisfactory, is the word.
Q. That's a point that you have expressly referred to in a number of places in your report --
A. Yes, I have.

Q. -- in the early stages.
In section 3, you've expressly stated that you will investigate if the non-compliances which you've currently identified resulted in the building being less satisfactory than it was before the work was carried out at Phase 2 of your work; is that right?
A. That's correct.
Q. Is it right that at this stage, what you've done is look at each separate aspect of Grenfell Tower in terms of the active and passive fire safety systems --
A. Yes.
Q. -- and you've analysed compliance, looking at each in isolation?
A. Exactly. I've looked at each active and passive measure on its own as a separate entity, and I've not carried out any overall assessment of the intrinsic risk that may or may not have remained in the building when those works were completed.
Q. Yes, that's clear, thank you.
You've also recognised in your report -- this is expressly there -- that there may be alternative routes to compliance with the Building Regulations, as are permitted under, for example, paragraph 0.21 of ADB.
A. That's correct. The statutory guidance document makes clear that alternative routes to compliance are also

satisfactory.
Q. Is it your intention to investigate what, if any, alternative compliance approaches were in fact adopted at Phase 2?
A. Yes. I've been aware of that concept throughout my work for Phase 1, and in Phase 2 I will be very explicit -- you know, there's a lot more work to be done -- about where I think something was either deliberately or I'll say accidentally put forward as an alternative compliance route.
Q. You've also not considered industry practice at this stage, at Phase 1; is that correct?
A. Yes, that's correct. When I wrote that, I was thinking mostly about the cladding because of various publications that occurred in the years before and during the primary refurbishment, and I will deal with that as part of the culture of compliance work I intend to do in phase 2.
Q. Is it right that you will be giving a final view on compliance of the building works carried out over time at Grenfell Tower with the applicable regime in your Phase 2 report?
A. That's correct.
Q. Just pausing there, overall, can you explain why, at this first stage of your work, you've looked at,

effectively, the design guidance at the time of construction, CP3 1971, and the correct design guidance in ADB, the statutory design guidance in that document?
A. Yes. I was trying to be very transparent, so not trying to impose, say, standards now on something that may or may not have been worked on during, say, particularly the primary refurbishment. So I wanted to be very clear about then and now, as clear as possible. I thought it was fairer, and that's why I took that approach for now.
Once I enter into the domain of comparing compliance and non-compliance and contemplating material alteration or not, it becomes complex and a judgement will also be required.
So, for now, I wanted to keep it factual and separate and keep that until we get into other matters.
Q. Thank you.
I want to move on now and I want to start substantively, really, by looking at the composition of the external envelope at Grenfell Tower.
Both you and Professor Bisby spent a considerable amount of time in your oral presentations back in June explaining how the exterior of Grenfell Tower was configured, both before and after the major refurbishment works.
A. Yes.

MS GRANGE: We're not going to repeat all of the detail of that here.
In addressing the external envelope today, I want to concentrate on the extent to which the exterior of the building was able to resist the spread of fire, and what features of that exterior envelope you think were the most significant in terms of the events of 14 June.
Mr Chairman, I'm going to give a trigger warning now, because later in this section we are going to be looking at some photographs of the burnt-out tower, including some photographs of windows before and after the fire which some may find distressing.
Much later this morning -- it will be after the break, and it may even be this afternoon -- at one of the flame spread videos.
I give that warning now in case anyone wishes to take any action.
SIR MARTIN MOORE-BICK: Are we going to get to those soon?
MS GRANGE: We are going to get to some pictures of windows fairly quickly. The video comes later and I'll warn again.
SIR MARTIN MOORE-BICK: Thank you.
MS GRANGE: So I want to start by picking matters up at chapters 8 to 10 of your report, and considering your evidence about the construction of the external

envelope, including the window openings, and then the routes for fire spread both out through the window openings and then virtually and horizontally through the building envelope.

Before we get into the detail, does your conclusion remain that, as you've set out at paragraph 2.9.9 of your report, there were multiple catastrophic fire routes created by the construction form and construction detailing that was used? Is that still your overall conclusion?

A. That is my overall conclusion.

Q. Taking the window openings first, I just want to work through some of the key points that you make so you can explain them.

As you explain in chapter 8 of your report, the design of the windows was pushed outwards during the refurbishment; that's correct isn't it?

A. That's correct.

Q. One of the consequences of that is it brought into the external wall construction a horizontal void which had previously been on the exterior in the form of a sloping lip beneath the window. I want to take you to a figure to have a look at that.

A. Good.

Q. If we go to figure 8.6, BLAS[0000008, page 9] --

A. Yes.

Q. That's it.

A. Is it possible for the screen to come nearer? I seem to have developed eyesight problems overnight. Will I break something if I move it?

SIR MARTIN MOORE-BICK: We certainly can move it closer. I think what you may find is we can blow it up on the screens.

A. Oh, yes. Just for drawings, it's very hard for me to see. But I can look at my own one. Actually, I'll just look at my own one.

SIR MARTIN MOORE-BICK: Is that better?

MS GRANGE: Mr Trial Director, if we can -- yes, let's blow it up like that to start with.

SIR MARTIN MOORE-BICK: Just so that we know, is that a comfortable size for you? If not, we can move the screen.

A. I wouldn't mind it a bit nearer. Just for drawings, it's quite difficult to see the detail.

SIR MARTIN MOORE-BICK: I'm sure we can move it.

A. Yes, thank you very much.

SIR MARTIN MOORE-BICK: Is that better?

A. Yes, thank you.

MS GRANGE: Okay.

So here what we have is the original conditions on

the left --

A. Yes.

Q. -- and then the refurbished conditions on the right; is that correct?

A. That's correct.

Q. You've shown very clearly the way the window is being pushed out --

A. Yes.

Q. -- and moving out. I just want to focus -- we'll take this each in stages -- at the moment on -- can we zoom in on the right-hand image.

I'm looking at the bottom of the window, the little lip, and you've highlighted in yellow and hatched black a little space there.

A. That's correct.

Q. That's a horizontal void, and that's because of the original cut-away of the concrete --

A. Exactly.

Q. -- in the original design of Grenfell Tower. So when the windows go out, that suddenly becomes a horizontal void.

A. Yes.

Q. Is that correct?

A. That's correct.

Q. On the sides of the windows, abutting the columns, the

pushing out of the windows also resulted in a vertical gap down the side of the windows, which was formed by a groove in the original concrete exterior of the columns.

Again, we'll look at figures to support all of these points, and we looked at this with Professor Bisby yesterday.

Can we look at that gap. Let's start with figure 9.8, BLAS0000009, at page 12. If we can blow up figure 9.8.

Is it right that what we see there -- so the original concrete columns have these little cut-aways to them?

A. Yes.

Q. In these kind of -- I think you called them biscuits to start with.

A. Yes. So there's little grooves there, and then there's a larger groove between the existing spandrel and the column here marked in red (Indicates). So there's two types of groove through the existing construction.

Q. So by pushing out the window, it then incorporated that gap into the side of your window where it abuts the column.

A. Exactly. That all becomes part of the internal side of the new external wall.

Q. Yes.
A. Yes.
Q. There's a good photo of that in terms of the as-built construction. If we can go to figures 9.9 and 9.10, BLAS0000009 on page 13.
A. Yes.
Q. Perhaps if we can focus to start with on figure -- can you see it clearly enough from that?
A. Yes, that's fine.
Q. So the top photo --
A. Yes.
Q. -- we can see that gap very clearly down the side of the window; is that correct?
A. Yes. So you're looking downwards, and --
Q. Which is the inside and which is the outside?
A. Oh, sorry. So there is the window, there is the membrane and this is the inside here (Indicates).
Q. Yes.
A. Just everything has been stripped away in this particular photo.
Q. Yes.
A. You can see the groove going down between the two pieces of concrete there.
Q. If we can look at the bottom figure, figure 9.10 --
A. Yes.

Q. -- we can see there that someone's made an attempt to fill that with expanding foam.
A. That's correct.
Q. Is that correct?
A. Yes.
Q. I think Professor Bisby said yesterday some areas seem to have foam in it and some do not. Is that consistent with your site inspections?
A. Yes, it is.
Q. So there's a variation about whether that has any kind of foam in it.
A. Yes, if it's been done or not, yes, that's correct.
Q. You also note that the windows themselves were reduced in size, leaving a gap of between 30 and 120 millimetres between the sides of the windows and the adjacent columns; is that correct?
A. Yes --
Q. Again, let's look at a figure on that. So let's go to figure 8.15, BLAS0000008, page 17.
A. Yes.
Q. If we can go to the top left photograph and zoom in on that photograph.
A. Yes. Okay, so I think this is quite an important point. So the drawings, the Harley drawing -- and we can maybe show that later -- had a little note on it saying that

those works, the window works, needed to take into account that because the columns weren't perfectly plum, there was, you know, a variation, you call it. So anything between 30 -- I can't remember the exact numbers on the drawings -- I'm sorry, I'm a bit nervous -- it was 30 to I think it was 120 on the drawing. I would just need to look at it.
So it meant that there isn't a fixed width that's been designed. It changes as a function of the conditions one would find in that flat.
On site, I measured that in different places as either 20 or anything up to 130 millimetres, and that's very important to understand about that column condition, that depending on where you are in the building, the window either had to be close or had to be up to 130 millimetres away from that column.
SIR MARTIN MOORE-BICK: As you understand it, it was an inevitable part of the design, was it, that there should be a gap because the windows were narrower than the space available to put them in?
A. So the windows being narrower is one point. But this is to do with what's called construction tolerances. So if something isn't absolutely perfect on site, you know, you have to move things -- it's meant to be a very slight movement. But I think that drawing is very

important because it shows that that was the scale of tolerance they were dealing with.
So it's two points: the window size and then the plumness of the columns, and so dealing with that during construction.
SIR MARTIN MOORE-BICK: Yes, thank you.
MS GRANGE: We think it might be figure 8.13. That's BLAS0000008, at page 15.
A. Oh, yes, yes.
Q. Is that the right one?
A. Yes, hopefully you can see the note.
Q. If we can blow up -- I think it's the right-hand figure. Thank you.
A. Yes, it's slightly cut off here, but if you look at 35, the number 35 here, there's a little arrow over to a note. It's hidden here. In my report, there's a proper reference and someone can check for themselves.
So you can see that variation. You see the two red lines? So that was a designed-for variation. But what it means in terms of my interest in it is to do with fire and its interaction with that gap.
MS GRANGE: Thank you.
That gap was filled with a number of materials --
A. Yes.
Q. -- is that correct?

A. That's correct.
Q. It's filled with an EDPM rubber membrane, and is it right that that was bonded to the window frame and to the face of the concrete column on site?
A. Yes. I don't know how it was bonded, but it should be bonded and it forms a membrane and fills the gap, yes.
Q. In your view, is that material particularly prone to promoting flame spread?
A. Particularly prone -- I would just say it's combustible, if that's okay.
Q. Yes.
A. It's made of rubber.
Q. Yes.
A. I don't know what you mean by "particularly prone" in the context -- sorry, I'm probably getting really pedantic now -- in the context of what? So it's combustible.
SIR MARTIN MOORE-BICK: Since we're being pedantic, when you're asked to agree that the film fills the gap, would it be more accurate to say it covers the gap?
A. Yes, exactly. So to me, it covers over -- it's like putting a piece of paper over something. You just cover it over like wallpaper and they must have bonded it somehow.
MS GRANGE: And it's a damp-proof membrane, isn't it, it's

supposed to stop damp getting into the windows?
A. Yes, exactly, it's meant to stop that kind of ingress, yes.
Q. You've said in section 10.3.11 of your report that it's a combustible synthetic rubber material that ignites between 180 degrees C and 378 degrees C.
A. Yes.
Q. Can we just have a look at that.
A. Yes.
Q. That's BLAS0000010 at page 11. I think it actually goes onto the next page.
"... combustible synthetic rubber material that ignites ..."
Can we go over to the next page? Sorry, that's my --
A. And like all materials, it's changing state before ignition. It isn't in a cold state and then it ignites; it's changing states. Okay?
Q. Yes. And you've got that temperature range, 180 to 378, from this Ignition Handbook.
A. Yes.
Q. That's quite a big range. Do we know any more about that material at this stage?
A. That's not something I have gone into detail on for my own work. I'm just interested in if something is

combustible or not.
Q. Yes.
A. Other experts are getting into the absolute fine detail, millimetre by millimetre, degree by degree, on what those materials do.
Q. Thank you.
Is it right, therefore, that the EDPM membrane led directly into the column cladding cavity and onto the insulation that was behind the rainscreen panels on the column? Again, we're going to look at some figures on that.
A. Yes, exactly. So in behind the uPVC reveal, so the covering, you have the old window reveal covering, you have some additional insulation that's marked on the drawing as being required, and then you also have the EPDM.
I wonder if we could even go back to, say, figure 9.9 or just look at the side of the window, or even figure 8.13, where all the materials are marked up. Maybe figure 8.13 would be the best.
Q. Let's go to 8.13 then. BLAS0000008 at page 15.
A. Yes. I think that's the clearest way of trying to show it.
Q. Do you want to draw attention to --
A. Yes, so it's marked -- you've your uPVC, and

Professor Torero was very eloquent about how that loses its mechanical stiffness at quite a relatively low temperature. Then in behind here is what is very important. It says, for example, "Insulation by others". It says to retain -- up at the green up on the top there -- the original --
Q. "Existing frame remains in most cases. Remove by others where necessary."
A. Exactly. And I think, actually, this is a very important drawing. So you've got that information, and then you've got the little note telling you that it's anything from 35 up to 90 millimetres.
So when you think then about the location of the uPVC, because that has to line up with the window frame, there is either a small or actually quite a large gap, when you think about it, behind it. So that means then the length of the EPDM is a feature of this gap it's trying to fill. Okay?
SIR MARTIN MOORE-BICK: Yes.
MS GRANGE: Yes.
A. Once the uPVC is gone, and from what I know the insulation layer was glued onto the back of the uPVC --
Q. We're coming to that.
A. Oh, sorry.
Q. That's okay.

SIR MARTIN MOORE-BICK: We can see where you are going.
MS GRANGE: No, no, it's good.
Just with the EPDM membrane, can we look at a couple of pictures of that in its on-site configuration.
Let's go to figure 8.22, BLAS0000008 at page 22. If we can just zoom in on that figure.
A. Yes.
Q. So there I think what we're seeing is the rainscreen has been removed both on the spandrels below the window --
A. Yes.
Q. -- and on the column, and what we're seeing there right down the middle is the column insulation; is that correct?
A. That's correct.
Q. To the left of that -- again, we'll come back to the exposed faces of the insulation, let's not worry about those for the moment -- we see that black EPDM weatherproof membrane; is that correct?
A. That's correct.
Q. There we can see it going into the column, effectively.
A. Yes, that's correct.
Q. Covering up that column.
A. Yes.
Q. Can we also look at another figure on that, figure 8.23, on the next page, page 23.

A. Yes.
Q. There what you've shown in blue is what it would look like from the inside of the flat.
A. Yes.
Q. Where we have the column -- I think this is flat 13, which is on level 4. It's the kind of exemplar flat across the hallway from flat 16. So this is what the flat 16 window would've looked like; is that correct?
A. Exactly, and it's quite striking on site because you realise you could literally cut a hole in the EPDM and put your hand into the column cavity. Yes.
Q. You touched on it a moment ago, that gap on both sides of the window, behind the uPVC -- and this is both at the head and base of the window and down the sides -- was insulated.
A. Yes.
Q. We found two products on site; is that right?
A. Yes.
Q. It's either Celotex TB4000 or Kingspan Thermapitch TP10; is that correct?
A. Yes, that's correct.
Q. Again, can we see a picture of that. It's BLAS0000008 at page 19, figure 8.18, if we can zoom in on that.
So, again, here, is it right we can see the uPVC has deformed and melted and flopped over?

A. Yes.
Q. Then above that, you're drawing attention in the orange bubble to the combustible insulation; is that correct?
A. Yes, I'm drawing attention to the red logo.
Q. That's Celotex --
A. It appears to be.
Q. -- TB4000; is that correct?
A. Yes.
Just to be absolutely precise, it's a red logo, and at that thickness seems to be the TB4000.
Q. It's 25 millimetres; is that correct?
A. Yes.
Q. So that's a different insulation product to the product that we see when we get to the spandrel insulation in the column insulation on the outside; is that correct?
A. Exactly. There's small pieces of insulation around each side of the window, trying to fill up the gaps that were formed between the old and the new windows.
Q. Just to be absolutely clear, they're at the top and the bottom and at the sides; that's correct, isn't it?
A. So they are marked on the drawings as being required on the top, on the bottom and the two sides, and I have personally seen them on the top, on the bottom and on the Aluglaze side.
Q. As well as on the column side is what you're saying?

A. I didn't see the insulation myself on the column side, I have to rely on the drawing there.
Q. Yes.
A. Yes.
Q. Let's have another look at another drawing, BLAS0000009 at page 20. That's figure 9.13.
That's, again, another picture where we can see it --
A. Yes.
Q. -- on the left, the insulation that you're talking about behind the uPVC.
A. Yes, yes.
Q. You've asked for test data for the Celotex TB4000, but that's not been provided to date; is that correct?
A. Not yet, no.
Q. You say that the publicly available BBA -- that's the British Board of Agrément -- certificate says that has no determined performance or is European class F; is that correct?
A. That's correct.
Q. Whereas that should've been of limited combustibility; is that correct?
A. That's a complex question, because it's window insulation. So, yes, I think as a minimum it should have been limited combustibility.

It's probably worth stating that I couldn't today look up something in Approved Document B to see if window insulation and wall insulation are meant to be different.

Q. I think this is a good point just to clarify about the European classification system, because I'm going to come in some of my later questioning to ask you more questions about is this class E or class D, et cetera.

A. Yes.

Q. So I think it's worth, just in general terms -- I know this is a very complex topic that you've dealt with in appendix F, and we'll have to get into more detail on this at Phase 2 -- is it right that the European classification has a sliding scale of classifications, with seven different classes of reaction to fire.

A. That's correct.

Q. We have A1, A2 and then B through to F; is that correct?

A. That's correct.

Q. Is it right that when you get down to E and F, we're talking really burny; is that --

A. I couldn't use the phrase "really burny", I'm very sorry! It's dreadful! I would get sacked as an expert if I start saying "really burny"!

Q. I'm going to drop him in it! That's an explanation --

A. Sorry, anyway.

So on a more serious note, A1 is meant to be non-combustible, A2 is limited combustibility and then from B down there's greater degrees of flame and heat observed or allowed in the tests.

Q. Yes. I'm going to drop Professor Bisby in it, because that's how he first explained to me.

A. I can't accept that!

Q. Is it right that when these European standards were adopted -- you just explained it, but let's be clear -- where the national guidance specified non-combustible materials, the use of A1 materials was considered acceptable, and where the national guidance specified limited combustibility, the use of A2 was considered acceptable; is that correct?

A. Yes, it is. I know what you mean. Yes, it is, yes. But they're two different things, national and European.

Q. They are. There had to be some kind of harmonisation, even though they're not testing the same thing; is that correct?

A. Again, I couldn't say that there was harmonisation. So in Approved Document B, at the back, and table A6 and table A7, it lists out A1 or A2 as is appropriate.

Q. Yes. Thank you.

Do you want to go to the table that we see in BS EN 13501 that lists out the European classifications?

Do you think that would be helpful?

A. I think that would be helpful, because it's the clearest table then about all the different tests you need to do to get that letter -- I won't be able to keep repeating them endlessly, it's very hard to remember them, actually, there's no many -- so it would be good to see that table, please.

Q. Appendix F, figure F4.

A. Yes.

Q. That's it. If we zoom in on that figure.

A. Yes.

Q. So you've taken this table from BS EN 13501-1, table 1; is that correct?

A. That's correct.

Q. This gives us the classifications A1 down to F; is that correct?

A. Yes, that's correct. It sets out very clearly the activity required and so the relevant test, the evidence required, for each classification, and that's what I've looked for when a party has submitted test evidence to the inquiry.

Q. In a later section of my questioning, we're going to look at each product and I'm going to ask you what the classification is. I want to stick at the moment with windows.

A. Yes.

Q. So we have looked at the Celotex TB4000 which you say has class F.

A. Yes. And a material of limited combustibility is A2 or higher.

Q. Or better, exactly.

A. Yes.

Q. Kingspan Thermapitch TP10 is class E; is that correct?

A. That's correct.

Q. You actually believe that that Kingspan Thermapitch TP10 was originally specified to be used as the insert around the extractor fan in the windows; is that correct? You say that in your report.

A. Oh, yes, that was -- yes. So probably it's worth saying that the window insulation isn't specified, the products or -- it's not written down in the papers that I have at this stage.

Q. So in the design drawings you've seen thus far, you can't see any specification for what that window insulation was supposed to be?

A. Exactly.

Q. The uPVC window surrounds.

A. Yes.

Q. We've discussed those a lot this week, but can we just look at a picture. Go to BLAS0000008 at page 16,

figure 8.14.
A. Yes. Oh, yes.
Q. This is just to orientate ourselves back on the uPVC window surrounds.
A. Yes.
Q. Again, we've had a lot of evidence that these windows effectively become liquid between 75 and 100 degrees C, and you also make the point they release toxic hydrogen chloride gas.
SIR MARTIN MOORE-BICK: They deform, I think.
A. Yes, it isn't a liquid.
MS GRANGE: Yes, sorry --
A. But understood, they change state.
Q. They can change state, exactly.
A. Yes.
Q. In, for example, Professor Bisby's presentation earlier on in June, he said the typical day-to-day upper surface temperature limit is in the range of about 50 degrees Celsius and its melting temperature is between 75 and 105 degrees Celsius; that's correct? That's consistent with, I think, the figures in your report.
A. Yes, exactly.
Q. From a fire engineering perspective, given their low melting temperatures, do you have a view about the choice to use uPVC around the window surround? Is that

something you feel you can express an opinion on at this stage?
A. From a fire engineering perspective?
Q. Yes.
A. Oh ...
Q. Is there anything in particular you want to draw attention to in terms of the use of uPVC in the window surrounds?
A. Okay. Well, I suppose for me, I wouldn't be -- if I was asked to look at a drawing say, on another building -- particularly cognisant about the uPVC, it would be more about what's going on behind it.
Q. Which we're coming to.
A. Yes.
Q. Just to be clear, in the event, the uPVC was glued to the insulation behind; that's correct, isn't it?
A. Yes, it appears to be the case. I have some photos in my report showing the glue line.
Q. There's a good one in Professor Torero's report. Perhaps we can go to that, figure 55, JTOS0000001, page 42, and he drew attention to the squiggle of glue along the side; is that correct?
A. Yes, it appears to be.
Q. Did you see in any of your investigations any mechanical fixings ever?

A. No, I didn't see any mechanical fixings.
Q. Do you think that the presence of mechanical fixings could have potentially had an impact on the propensity of that uPVC to come away, fall away, deform, would mechanical fixings have potentially made a difference?
A. Yes, I think for any of those materials, uPVC or, say, composite panels too, when they're free, you know, free to move or just fixed very lightly, when they're losing their structural stiffness and they're changing state, I think that they can fall away or, you know, move more when they're not mechanically fixed.
I think appendix F and Approved Document B provide some very interesting information about the impact of mechanically fixing. It's in the context of a panel, but I think it's relevant to uPVC because it changes state like that as well.
Q. You've also identified the fact -- again, you touched on this earlier -- that the original window surrounds which were not removed contained other combustible materials.
A. Yes.
Q. Let's just list those. So we had the original wooden sills and the internal wood lining. They remained in place; is that correct?
A. They seem to have been left there, yes, yes.
Q. Can we have a quick look at that. That's BLAS0000008,

page 24, figure 8.25.
So in the bottom figure we can see a good illustration of that.
Is that what we see, the wooden frames?
A. So that's the supporting frame, so here and here (Indicates). They're the supporting frame. In other places, the actual timbers for the sill and the reveals are also present. So just in this particular photo, it's just the supports for the sill and the supports for the reveal, the old wooden lining. I have photos in appendix C where you can see both.
Q. Yes.
A. It's good to always refer back to this drawing in my report, figure 8.11, where it's drawn on that the sills, the reveals and the supporting frame were to be left.
Q. Yes. Do you want to bring that up?
A. No, it's okay, just to make that point.
Q. We also had something you identified as purlboard --
A. Yes.
Q. -- above and below the windows; is that correct?
A. Yes.
Q. Is it right that that's a layer of plasterboard with a combustible backing?
A. That's correct.
Q. So it's a kind of double-layer product; yes?

A. That's correct.
Q. Let's have a look at that. If we look at BLAS0000008 at page 16, figure 8.14.
You have marked that "Original Purlboard ceiling filler strip" above the window; is that correct?
A. Oh, yes, that's correct.
Q. You say in your report that this is a combustible material with an ignition temperature of 271 degrees; is that correct?
A. Yes, in pure form.
Q. Just to clarify, you also say there's purlboard underneath the window here; is that correct?
A. Yes.
Q. Is that in a kind of larger quantity there under the window?
A. It's like a lining underneath the window, yes, all the way along. Yes. So it's much larger underneath. It's a traditional form of insulating a room.
Q. You've identified a number of pathways between the outside and the inside in section 9.3 of your report, pathways for potential spread of fire.
I'm not going to go to every single one of those because a number of those are kind of theoretical pathways, but your conclusions are at paragraph 9.7. I just want to ask you about those.

Does it remain your position that once there was a localised fire near the window, the majority of the materials around the window had no potential fire-resisting performance?
A. That's correct.
Q. Therefore, no part of the construction had the ability to prevent fire spread from inside the building to the external wall cavity; is that correct?
A. That's correct.
Q. Once there was a fire in a flat anywhere near a window, there was a very high likelihood that it would break out of the flat and into the cladding?
A. That's correct.
MS GRANGE: That's your view.
Mr Chairman, I'm going to go to another topic now, which is about cavity barriers around the windows, and I want to spend a little bit of time on that.
I know people have been asking if we can have slightly more frequent breaks, and I think I have the time to accommodate that, so would now be an appropriate moment for a 10-minute break?
SIR MARTIN MOORE-BICK: I think it probably would.
You would probably welcome a break, wouldn't you?
THE WITNESS: I would love a little tiny break.
SIR MARTIN MOORE-BICK: We'll have a break now. I'm going

to say 11.15, which is slightly longer than 10 minutes, but it's easier to work to a figure on the clock.
I'm going to ask you not to talk to anyone about your evidence while you're out of the room, and if you go with the usher, we'll be back at 11.15. All right?
THE WITNESS: Okay.
SIR MARTIN MOORE-BICK: Thank you so much.
Right, 11.15, please.
(11.05 am)
(A short break)
(11.15 am)
SIR MARTIN MOORE-BICK: All right, Dr Lane?
THE WITNESS: Yes, thank you.
SIR MARTIN MOORE-BICK: Ready to carry on?
THE WITNESS: Yes, I am.
SIR MARTIN MOORE-BICK: Yes, Ms Grange.
MS GRANGE: Sticking with the windows for a moment, and stepping back and considering that window arrangement as a whole, and just leaving aside the combustibility of the materials for the moment, would you have expected to see some form of fire-resisting cavity barriers around the windows?
A. Yes, I would.
Q. I would quite like you to explain to us what the regulatory requirement was in relation to cavity

barriers. What I'd quite like to do is take you to a couple of sections of Approved Document B, if that is okay, and the diagrams --
A. Okay.
Q. -- just for you to explain to us what the requirement was.
A. Yes.
Q. So can we go to CLG00000224, page 82 to start with.
This is diagram 33. That's the correct diagram to start with, yes?
A. Yes, please, yes.
Q. So if you can blow that up -- that's great.
So by reference to this diagram, can you just explain to us what the requirement is for cavity barriers in relation to the windows. We'll come back to this diagram later when we look at cavity barriers in the external wall proper.
A. So in this diagram it shows that where the openings are made for a window, that opening must be sealed on all sides to seal up the cavity made by the construction of the wall. So you'll see you've got the external face and internal face of the wall, and fire-resisting construction is placed at the top and bottom of the wall, and also you seal the sides as needed.
Q. Yes. I think we're about to blow that section up.

I think that's a good idea. So in grey -- it's quite hard to see, but --
A. So those little grey squares indicate a cavity barrier is required to seal the cavity formed from the two parts of the wall. Outside and inside of the wall, a cavity is formed, and you seal the top where you've cut an opening in the wall for the window.
SIR MARTIN MOORE-BICK: Yes.
A. And so -- yes, then -- okay, just the windows.
MS GRANGE: Do you want to look at 9.3 as well of ADB about junctions and cavity closures, would that be helpful? That's on the next page, page 81.
A. I can do that from here.
Q. Okay, fine.
A. So where a compartment floor meets the external wall, within the cavity there -- so here is the compartment floor, and where it meets the external wall, within that cavity, a cavity barrier is required.
There is an additional item where the internal face of the wall meets the floor. They're called fire stops, they have a different performance.
The significance of having the cavity barrier at the floor and at the window opening is from this compartment to the next compartment, you have two cavity barriers sealing that cavity between those two compartment

floors. So one at the window, one at the floor, another at the window and you're into the next apartment.
SIR MARTIN MOORE-BICK: Thank you very much.
MS GRANGE: Yes.
In terms of cavity barriers for windows --
A. Yes.
Q. -- are they a kind of different type to the cavity barriers that we've seen on the external wall? We'll look at those later. Are there special cavity barriers for window openings?
A. So you can buy all different types of cavity barrier, and I don't know a whole range of products as such, but Approved Document B also allows you to use some classic construction materials as a cavity barrier, and it gives specific rules about the thickness of those materials if you want to rely on them as a cavity barrier.
So in terms of the cavity barriers that were installed in Grenfell Tower, they are made from a kind of mineral wool substance. So you could use that substance at a thickness to give you the performance, and the performance at a window is 30 minutes' fire resistance integrity and 15 minutes' insulation.
So it's about the material type and its thickness, and how you install it. Depending on the product supplier, they will have specific detailing

requirements.
Q. You just referred then to 30 minutes' fire resistance integrity --
A. Yes.
Q. -- and 15 minutes' insulation?
A. Yes.
Q. Can you just in very simple terms explain for us what the difference is.
A. Okay, so integrity is to try and stop fire and smoke kind of blocking it, so blocking the products, and insulation is about trying to stop the heat on the other side of a substance.
So you're blocking smoke and flame, and you're trying to insulate it so if there was something above, it's not getting too hot also. Because obviously even if the products get blocked, you still have heat transfer all the time upwards.
Q. So it sounds from your evidence that there might have been a number of different options that could've been available to provide for those cavity barriers around the window openings?
A. In a window opening.
Q. In any window opening.
A. In any window opening, there is.
Q. Just to be clear, you found no cavity barriers at the

windows when you did your site inspection; is that correct?
A. That's correct.
Q. In this location, as shown on the statutory guidance document, could they have inhibited the spread to the exterior by providing a barrier between the uPVC windows and the combustible components of the cladding system?
A. I think ... I can't answer that question directly because we have to remember the old window and the new window has moved and then the relative location of the cladding. I don't know if you want me to try and get into that. But, remember, the voids around the window and then the voids into the main cladding are very complex and interconnected. Okay?
So in a classic window, yes, you could seal off that cavity. At Grenfell Tower, it's much more complex than that because of the interconnection of all the cavities and the location of the ACP and the relative location of the two windows.
Q. Is what you're saying that it's not obvious how you could've provided cavity barriers with that kind of arrangement?
A. Exactly. In fact, I have spent a lot of time trying to work out how one could.
SIR MARTIN MOORE-BICK: I would like to pursue this a little

bit further, if I may.
You've examined some of the drawings for this work.
A. Yes.
SIR MARTIN MOORE-BICK: Did the drawings show the presence of cavity barriers?
A. No, they did not.
SIR MARTIN MOORE-BICK: So they were never provided for?
A. They don't appear to have been considered, no.
SIR MARTIN MOORE-BICK: No, all right. Well, then, the next question doesn't arise.
A. Okay.
SIR MARTIN MOORE-BICK: Thank you.
MS GRANGE: Just moving on a little, a point made in Professor Torero's report is that windows can't be designed to withstand the heat of an external fire when you have a big external fire going on, and he refers to the potential for an external fire to generate heat fluxes of up to 120 kilowatts per metre square.
In the light of that, do you still think the weaknesses in the window arrangement which you've identified potentially played a role at Grenfell Tower?
A. I do think the windows played a role. I don't quite understand the full extent of what Professor Torero means. Is that the glass or the frame or both?
Q. I think it's the glass predominantly.

A. Oh, the glass. Well, I agree with that, yes.
Q. Could it have played a role in terms of, first of all, facilitating the initial escape of the fire out of the compartment of origin?
A. The construction materials around the window?
Q. Yes.
A. Yes, it did. Yes.
Q. Again, we're going to come back to escape route later.
A. Yes, okay.
Q. Do you think that the weaknesses in the window arrangement that you've identified could've also accelerated the rate at which the fire could break back in once it's spread up the exterior?
A. Yes, I do.
Q. Is that whether or not you're looking at vertical fire spread or you're looking at kind of downwards fire spread, melting and dripping of materials setting fire to subsequent fires?
A. Yes.
Q. Do you think those weaknesses would've played a role in both scenarios?
A. Yes. So because of the voids around the window and how those voids then connected in to the larger cavities, and all the materials in those two parts -- the small cavities and the much larger, main cavities -- yes,

there is an easy route either above, on the spandrels above the window, on the columns beside the window, and also on the insulation core panel side of the windows also, where the Aluglaze panels were installed.
So it's about materials and just that interconnectedness of all the cavities.
Q. Do you think these weaknesses might be even more important when you're looking at maybe fires on ledges that have broken back down, and then smaller fires are generated from, say, melting and dripping products above, and then it hits on the window ledge, as we saw in Professor Bisby's evidence? Do you think potentially then the weaknesses in the window arrangement are relevant?
A. Yes. So there it's a heat transfer route, isn't it? It's a route for -- if there's a little fire pooling on -- do you mean on an ACP panel outside the window?
Q. Yes.
A. So if you have some kind of localised condition on the panel there, remember, as I've said, the cavity behind there is connected in to the cavity in the window, and you've got combustible materials around the window.
Q. I just want to ask you a few questions about spray foam.
Professor Bisby has identified the use of spray foam to seal gaps around the windows to provide a final

airtight seal.
A. Yes.
Q. He thinks that that might be potentially significant regarding the ingress of fire and smoke around the windows.
Your photos -- we can look at them -- demonstrate fire entry at windows. Do you have any views about the extent to which that process would've been exacerbated by spray foam around the windows?
A. I assume he considers the spray foam used to be one of the many combustible spray foams.
I don't think it exacerbated the situation in the sense I think there were plenty of other combustible materials there and that's just one more. I mean, if you wanted me to give a view, I'd kind of want to quantify all the relative quantities -- I can do that for next week -- but I wouldn't call it a dominant parameter in the context of heat transfer or flame progression through the construction around the window.
Q. Thank you.
I now want to turn to look at the pathways for smoke and fire in the external cladding arrangement.
A. Okay.
Q. This is addressed in detail in section 10 of your report. I'd like to just pull up BLAS0000010, at

page 5, which is your diagram of six pathways, figures 10.2 and 10.3.

So we're going to keep coming back to this, just to kind of keep orientating ourselves on this.

So here you have five different pathways, and then in 10.3 we'll see pathway F, which we'll come to last, around the crown.

A. Yes.

Q. So let's start with pathway A, which you have as vertical spread both up and down the height of the columns.

A. Yes.

Q. You say in sections 10.3.1 to 10.3.24 of your report, that the columns contained a number of combustible materials, including PIR insulation, there was the core of the aluminium composite panel, and then obviously we have the EDPM rubber proof membrane down the sides.

A. Yes.

Q. You've drawn attention to the fact that they were ventilated because of gaps between the cladding panels designed to permit ventilation of the cavity; is that correct?

A. That's correct.

Q. That's in the column, yes?

A. What's in the --

A. Yes.

Q. Do you agree with Professor Bisby that flames elongate up to five to ten times their expected length in a concealed space? Is that kind of recognised?

A. I agree that they elongate in a concealed space, yes.

Q. You've indicated that there were gaps of around 139 millimetres in depth between the face of the Reynobond panels and the outer face of the insulation over the columns.

A. Yes.

Q. Is that based on your site observations and measurements?

A. Yes, so I did some measurements, yes. But I've been thinking about this again because of this little detail on the drawing where there's that movement all the time. So there must have been other locations, if you think about geometry, when it was bigger or smaller.

Q. Yes. So the cavity --

A. Physically in the building when it was completed, when the works were complete.

Q. Are you saying that the cavity may have varied up the columns?

A. It should have if you think about this variation that was needed beside the window all the time.

Q. Yes.

Q. You're talking about the gap in the column.

A. Oh, the gaps in the panels attached to the column.

Q. Yes.

A. Yes.

Q. You say that, once ignited, the natural flow of air into the cavity, driven by the rising hot air, would provide a continuous source of oxygen, fuelling the fire; is that correct?

A. Yes.

Q. You're saying the fact they are ventilated columns is important; is that right?

A. Yes, exactly. I mean, there's been an awful lot of discussion in the last few days about the combustion process. So you need the right quantity of fuel, air and heat to have a good combustion process that also supports flaming. So clearly the gaps in the panels and the other means for air to enter that environment provided an adequate air supply, because we observed perfectly effective combustion and flaming combustion.

Q. Is it right that, in your assessment, these columns were the principal route for vertical flame spread? Is that your assessment?

A. The principal route, yes, in the beginning. Yes, correct.

Q. You say that at paragraph 5.5.2.

A. So then the column panels had to connect in to the spandrels, so there must be some change occasionally.

Q. We also have vertical cladding rails the full height of the building; is that correct?

A. That's correct.

Q. We have these cladding rails at the tips and also at the edges of the columns, these unbroken pathways.

A. That's correct.

Q. Again, do you think those are significant?

A. Do I think they're significant?

Q. In terms of vertical flame spread, or the potential for vertical flame spread.

A. For me, the material in the panel is the significant feature. The channels form a void -- you know, it's like one big, long void -- and they broke the cavity barriers too, but the cavity barriers were impacted by the material in the panel as well.

So I couldn't say that I thought the channels were very significant or, again, a governing parameter in terms of the vertical spread of flame.

I'll say it's one more thing, rather than the most dominant thing, if that's okay.

Q. Just to be clear, in terms of the vertical channels that were there, you have one at the column tip; is that correct?

A. Yes.
Q. We saw that yesterday in Professor Bisby's drawings.
A. Yes.
Q. But then also down the side, where you've got the line D, is it right that there's potentially a cladding rail with a panel coming into it on either side, and you sometimes have rails up the sides of those columns that could've also provided a vertical route?
A. Well, so on the corner columns, the condition is different.
Q. Yes.
A. So on these columns here (Indicates), you'll see two panels come together in a point. But at the corners, they look almost like a rectangle, and so you have two channels there.
Q. You've actually identified -- we're going to come back to this -- that there might have been a route of flame spread behind those columns; is that correct?
A. Yes. But where the column panels meet the building, yes, they interface, remember, with the laterals and there is a connection there.
Q. Yes.
A. There is a cladding rail there, a small one.
Q. Yes.
A. Yes.

Q. You've noted in your report that the top of column B5 on the east face was on fire within approximately 12 minutes of emerging from flat 16; is that correct?
A. Yes.
Q. You've also noted the ability of fire to spread both up and down the columns.
A. Yes.
Q. Let's look at figure 10.9 of your report.
A. Yes.
Q. BLAS0000010 at page 11.
A. Yes.
Q. We can zoom in on that figure.
A. Yes.
Q. So I believe this is column B1, which is on the west face; is that correct?
A. Yes.
Q. It's pretty obvious what you're drawing attention to here, but this seems to show an illustration of what you're referring to here, this mechanism of downward fire spread?
A. Yes.
Q. Can you just explain the processes you think might be going on there that we're seeing in that image?
A. Okay. So at this stage, when the flame front's down here, what I can see is the material, the core of the

ACP -- you have to observe it from the top, and there's all sort of video footage and the helicopter footage that shows it much better than this photo, but you see initially liquid burning polyethylene igniting the ACP panel, and then some kind of combustion process commences, an effective combustion process, and enough gases, enough products of combustion are produced to allow flaming combustion, and you can see it progressing down through typically the ACP panel on the column.
But at times also, when you're looking at the moving footage, it heats up laterals as it leaves them in its wake, as such, and then those laterals have received enough heat that fires start on either side of the column also and the flame front progresses downwards, fuelled by the combustible materials present there.
Q. We can see kind of on the right, there's a line on the right of that flame at the top where the window is. Is that where you can start to see the going --
A. Do you mean here and here (Indicates)?
Q. On the right, yes.
A. Yes.
Q. You give the mechanisms for downward fire spread at 10.3.23 of your report. That's BLAS0000010 at page 14.
You highlight two key things here.
A. Yes.

Q. The polyethylene from the Reynobond panels melting and running down the building and down the columns.
A. Yes.
Q. This is pathway A.
A. Yes.
Q. You also talk about radiation from the fire within the cavity heating materials below, within the fire, within the cavity.
Can you just talk about that latter part as well?
A. Yes, so I think before you see a flame, there are all sorts of things happening to materials when they're being heated. So as the flame front is progressing, it's kind of like -- you can't see it, but the materials in front, they're being heated, it's heating the materials as it goes, there's all sorts of heat transfer effects going on in the materials around it. When that preheating, if you will, is occurring, there's gases being produced and, at some point, they form a system that can support flaming.
So I think when there's a fire on a panel, it is heating the materials in the cavity behind it.
Q. You're talking here specifically about downwards as well, yes? Are you saying that the columns are effectively a kind of enclosed space that's going to get heated?

A. Yes, it's not cold. It's not, you know, freezing cold in front of the flame front, no matter the direction. It may be slightly different temperatures, but it's not freezing cold in front of the flame front and nothing's happening around it.
Q. Okay. Let's move, then, to pathway B that you've identified. You have this as horizontal spread across the Reynobond spandrel panels.
A. Yes.
Q. Can we just go back to your BLAS0000010 at page 5, and figure 10.2, and just look at that.
So here we have, in the darker blue, B, across those panels.
A. Yes.
Q. You say something very specific about this. You say that the panels contained a number of gaps. I think what you're drawing attention to is the gaps between the spandrel panels, those little black lines that we can see going --
A. Yes.
Q. -- with exposed PE cores.
A. Yes.
Q. And that those gaps permit air into the cavity and trap the flames and hot gases, which are then trapped by the return of the panel as it meets the concrete spandrel at

the windowsill; is that correct?
A. That's correct, yes.
Q. Let's just look at figure 10.26 so you can explain to us precisely what you're trying to illustrate here.
Is that the gap that you're referring to there above the window?
A. Yes. So there I'm showing you, you know, the two panels are not flush against each other. By design, you know, they need to have a ventilation gap between them.
Q. What you're saying is you think that that's a space that flame will be attracted to and go up?
A. Yes. So a flame can enter there and cause heating behind that panel when it's in position, yes.
Q. You're also drawing attention to the exposed polyethylene edges; is that correct?
A. Yes, I am.
Q. Again, I think Professor Bisby explained to us that around those corners, you have a number of exposed PE edges, as you can see in his --
A. Yes.
Q. That's his figure on the right there.
A. That's correct, yes.
Q. Which you think is significant.
A. Yes.
Q. Is it right, then, that once there's flames in these

channels, you think that that can then be a route to spread across the panels?
A. That's correct. So, again, you have, as you observed from the footage on the night, clearly a perfect flaming combustion process created, and that is how the flame was able to travel in both directions along the laterals. You have the fuel on the outside layer, the insulation layer, you've air, and so I'm just going to call it a perfect combustion process was clearly made.
Q. Can we just talk a bit about the bit immediately above the window where it goes back inside. Do we have an exposed PE edge around the back of those panels?
A. So you mean where it comes in towards the top of the aluminium window frame?
Q. Yes.
A. My understanding is it is exposed there, but now that you've asked me, I would want to look frantically at all my photos in appendix C to check.
Q. I think Professor Bisby thought there might be a small lip, a bit like we see on that picture.
A. It depends on how the flat panel was cut actually there.
Q. Yes.
A. So I would have to look at it.
Q. Okay.
A. I don't know which part of the flat panel was cut and

which part was folded in that exact location.
Q. You think those cut edges themselves would've promoted horizontal flame spread; is that correct?
A. Well, the cut edges expose fuel to the looming flame front. That's what I mean, yes.
Q. Do you agree that any horizontal or lateral flame spread here would be via effectively opposed-flow flame spread, so it's going to the side rather than up, and therefore it's likely to be slower --
A. Oh, yes.
Q. -- than vertical flame spread?
A. Yes, I do agree with that. And, again, there is very good visual evidence of that.
Q. Of it --
A. Of the difference in rate.
Q. Of it moving much more slowly?
A. Yes, of it moving slower.
Q. We explored that with Professor Torero.
A. Yes. I agree with that.
Q. To the extent that this is a mechanism, do you accept that this is going to be a much slower mechanism than what we would see, for example, with vertical flame spread up the column?
A. So much slower, you know -- in what context? I think that it moves slower than the flame front on the column,

but I think it's a perfectly effective flame front. Whether its speed is greater or less than the column is not significant to my mind.

Q. Let's look at pathway C. This is horizontally across the edges of the head and sill of the windows, and the edges, top and bottom, of the insulating window panels.

Let's just look at your marked-up figure 10.30 at BLAS0000010, page 30.

A. Yes.

Q. We can zoom in there.

A. Yes.

Q. Can you just point out where on this diagram you say we are seeing this horizontal -- let's focus on the head and sill of the windows for the moment.

A. I was trying to show, you know, particularly here (Indicates), that the construction products there are flaming also. I don't know if --

Q. Yes. So you're looking at these little lines of flame --

A. Yes, exactly.

Q. -- across the head and bottom of the window?

A. Yes, and if you pick one of the lines -- I can't do it there -- just up through that elevation, you tend to be able to find -- you know you can move your finger along, showing the flame, moving up horizontally or vertically,

just on the edges, not engulfing a whole panel. Yes.

Q. Just to be clear, it's difficult to tell from these pictures, but what do you think may be burning there along the head and sill of the windows?

A. Well, when I marked that up, I imagined that the construction materials there were burning.

Q. What materials are we talking about?

A. Oh, right, sorry, just around the window.

Q. Yes.

A. Yes.

Q. So you're talking about the insulation materials around the window?

A. Oh, yes. Exactly. So I've said that there was uPVC on the inside and then you had the timber, if you're at the sill, you have the timber sill, you've got the insulation --

Q. So all those components we were looking at earlier?

A. All those components, particularly when the ACP panel has gone, okay? That's what I meant.

Q. Yes. So you said this involved the combustible materials that make up the window surrounds, including the polymeric insulation which was used to fill the gaps we looked at earlier.

You've also referred here to the window infill panels.

A. Yes.

Q. We're going to look at these panels on a number of occasions.

Let's just be clear what the window infill panels are. Are they those white panels we see in the bottom-left?

A. Yes.

Q. There's still some remaining there.

A. Yes.

Q. The Aluglaze infill panels.

A. Mm.

Q. Is it right that those were extruded polystyrene, often referred to as XPS?

A. Yes, that's correct.

Q. Can we just be clear what these are. Is it right they are two layers of aluminium and a Styrofoam core, which is made up of this extruded polystyrene?

A. That's correct.

Q. You say in your report that we have 25 millimetres of the Styrofoam core and then 1.5-millimetre aluminium sheets on either side; is that correct?

A. Yes, that's correct.

Q. Professor Bisby has set out the properties of XPS in his report, paragraph 437 for the note. He says they have a melting temperature of 230 degrees C.

Is that your understanding?

A. Yes, it is, yes.

Q. You have them here as part of your pathway C, horizontally along the top and bottom of those window panels?

A. Mm.

Q. Can you just explain to us how you think they may have played a role in terms of horizontal flame spread?

A. In terms of horizontal flame spread?

Q. Yes, that's your pathway.

A. Yes. So the -- is there an image coming up?

Q. Shall we go back to that image? Can we go back to the image we had a moment ago. Yes, exactly.

If we look maybe at the top-right of that image, is that what you're trying to refer to?

A. So when I was referring to the pathways horizontally along the panels, again, I'm speaking about the materials surrounding those panels. I come on later to the panel itself.

So, again, the panels were inserted into an aluminium frame and, again, you had the voids underneath those, you had combustible materials on all sides of those panels too.

I wanted to draw attention just separately that again around not just the window openings, but around

those Aluglaze openings, if you will, there is a line separate to the panel that is formed with combustible materials.

Q. Yes.

A. The panel itself is a different pathway.

Q. I see. So you have combustible material down the sides --

A. Again, surrounding that.

Q. Yes. And along the top?

A. Along the top and bottom side and both lateral sides.

Q. Yes.

A. Okay?

And, yes, it's probably worth noting that there aren't any drawings that exist of the detailing there, so I have to rely on just what I saw on site and photos like this.

Q. Yes. Yes.

Professor Bisby was taken to this image and he says what he thinks you can see in some of those instances is actually pool fires burning at the bottom of those window infill panels?

A. Yes.

Q. Do you think that might be correct?

A. I think that some could be pool fires, and I think others could be the construction materials burning.

Q. Yes. Yes.

A. So I agree with his perspective. I don't think they're all pool fires and I don't think they're all the localised construction materials.

Q. If you have a pool fire there at the bottom of one of those window infill panels --

A. At the bottom of the Aluglaze?

Q. Yes, along the base of those panels, along the ledge, you have a pool fire there, what's your expectation in terms of the performance of that panel, given what we know about it?

A. So you mean if the pool fire has come from -- so it's liquid from somewhere else and it's managed to pool on the tilted panel under the window?

Q. Yes.

A. Oh. There would then be a localised heating condition of the next panel, so the Aluglaze panel.

Q. Yes.

A. They don't appear to have been mechanically fixed into the aluminium frame; they seem to just have been snapped in. Okay? So I would expect the aluminium on the outer face to heat up and relatively easily distort, and also it allows the conduction of heat through it into the Styrofoam, which degrades very nicely under heat.

Q. When you talk about distort, what you're talking about

is the distortion of the aluminium panels on either side of the Styrofoam; is that correct?

A. Well, actually, multi-directional. So it depends what temperature is where. So a relative distortion of the front and back face, but actually distortion along this plane also as a function of where the heat is at the front.

Q. Once they distort and there is a fire near them, what do you expect to happen?

A. I think that distortion -- so, first of all, there is the heat transfer into the core and, you know, aluminium can't stop that from happening, so it's heating anyway. Then any kind of distortion that allows, say, the edges of the Styrofoam to be exposed, or it might be the panel can actually snap out of the aluminium frame.

Q. Yes.

A. But the overriding condition is the Styrofoam being heated through the metal face.

It's probably worth saying that those panels, Aluglaze, we did some calcs, they make up about 16 or 17 per cent of the external wall, so they're a relatively low proportion.

Q. Can we have a look at figure 10.35 of your report. It's BLAS0000010, page 37.

If we zoom in on the figure at the top of that page.

So this is post-fire.

A. Yes.

Q. We can see some of the Aluglaze panels. Is the kind of distortion you were talking about evident on any of those photographs?

A. Yes. So I think I can see it -- if I just ... So here, potentially, and obviously here as well (Indicates).

Q. That one in the middle, the lower win in the middle, can we zoom in on that one, in the bottom. Do you think that's an example of the distortion?

A. Yes, because I think the core -- you know, I don't think it's a nice even -- the aluminium isn't over anything even anymore.

Q. Those panels were not backed themselves by any insulation. I know they had insulation down the sides and top, you just said, but they weren't backed by insulation; is that correct?

A. Those panels are insulation, that's their purpose, and that's what the Styrofoam is for.

Q. Let's just have a look at what those panels look like before they burn. Let's just go to figure 56 of Luke Bisby's report, LBYS0000001 at page 96.

If we zoom in on the top, this is a picture of one of those panels that was provided to Professor Bisby.

Is it right there we can see the 1.5-mill aluminium

sides and then the 25-mill Styrofoam core; is that correct?
A. Yes. Yes.
Q. I think Professor Torero said in his evidence that when this burns, there's a lot of air in it and it kind of burns to nothing, because I asked him if it could create a pool fire in itself.
Do you have a view on that?
A. I'm not aware that polystyrene burns to nothing, but I wouldn't take Professor Torero on about any scientific principles.
Q. When I asked him would it melt and potentially create its own pool fire, he said he didn't think it would because there's a lot of air in the product.
A. Okay, that's not my understanding. Not to do with Aluglaze specifically, but in general the reason why polystyrene sandwich panels are so negatively viewed in construction is the polystyrene forms a liquid and degrades the panels so quickly in a fire, and there's a lot of --
Q. Yes. I'm going to take you back to some of that, actually, because we're going to look at the properties of some of these specific materials in a moment.
SIR MARTIN MOORE-BICK: I seem to remember, Ms Grange, that he said it shrinks away from the flame. I think it was

polystyrene.
A. Very interesting.
MS GRANGE: We'll check the transcript.
SIR MARTIN MOORE-BICK: Does that sound right?
A. I thought polystyrene melted and formed a pool.
SIR MARTIN MOORE-BICK: It could do both, of course.
A. Yes.
MS GRANGE: Do you think these Aluglaze panels would've behaved differently to the ACM cladding panels? They both have an aluminium skin to them with a core. Is there any comparison as to how they behave in terms of warping, deforming, flaming?
A. Oh, I see -- no, I think the key characteristics of the core getting hot, the core being combustible, the panels, you know, the aluminium on both sides, may be under some -- all very complex, potentially, thermal gradients, are the same -- are similar, yes, characteristic of them.
Q. Just finally on this route C topic, you've also mentioned here -- I think you said it earlier -- the original timber window frames and reveals that were left in there.
A. Yes.
Q. You felt that that might have been important once a window is on fire in terms of horizontal spread across

the window; is that correct?
A. Yes, yes.
Q. Pathway D, if we go back to your figure 10.2, and we look at this.
So pathway D, you say, is vertically along the window edges and also along the edge of the Aluglaze insulating core panels. That's completing the picture --
A. Exactly. We've talked about it now, it's about the construction around the edges, not the panel itself, still.
Q. Yes. Professor Bisby drew attention yesterday to the fact that down the sides of the columns by the window, you've often got exposed PE along those edges.
A. Yes.
Q. Again, do you think that's potentially important in terms of vertical spread along those window edges?
A. The exposed PE on the horizontal face?
Q. I think he was talking about on the column cassette as it comes back and hits the window.
A. Do you mean on this edge facing the column or the top edge, sorry?
Q. No, if I can highlight it here. We're talking about on this edge down the side of the window (Indicates). That's where he was talking about it.

A. Oh, yes, that there's no aluminium foil there?
Q. We'll come back to that on the PIR.
A. Oh, right.
Q. I think he was talking about the ACM cassettes themselves.
A. Yes.
Q. As they come back and hit the window, you've got an exposed PE line down there.
A. Yes. So I think small details like that are important for a very short period of time at the start of a very small fire.
Q. Yes.
A. My own view is that when you have a very well established flame front, it's like overwhelming all these small details. So that's why -- yes.
Q. That's helpful.
A. Is that okay?
Q. You're drawing attention to all of these routes as potential routes that you've seen on Grenfell Tower, but the relative contribution of them is always important --
A. I'm just trying to show that at every turn, if you will, there's something there that can participate in a combustion process. So all the time, the flame front has something that will allow it to carry on. That's all that I'm trying to say.

Q. Can we look at, just on this pathway D, before we leave it, figure 10.34 of your report, BLAS000010 at page 35.
You've specifically labelled and drawn attention here to vertical fire spread between the insulating core panels. Can you see that line? If we zoom in on that line.
A. Yes. So we're back on the edge of the Aluglaze now, are we?
Q. Yes. So we were looking horizontally before, but you've highlighted vertically here, we can see a very clear line. Is that what you're drawing attention to?
A. Yes, I was trying to show that.
Q. Again, do you think that might be because of the insulation down the side there or the edge of the panel has caught and deformed? Can we tell?
A. I can't tell that from this photo, but there's a sizeable piece of insulation capping the Aluglaze there on the inside. Yes.
Q. Pathway E is vertically, by means of the Aluglaze panels, connecting with the spandrel panels.
A. Yes.
Q. Let's go back to BLAS0000010 at page 5 --
A. Yes.
Q. -- and look at the diagram of your six pathways.
A. Yes.

Q. So pathway E, here you're drawing attention to vertical flame spread as between these white panels; is that correct?
A. Yes, that's correct. So if you have, for example, flame -- and where that "E" actually is on the drawing, again, above that, there isn't glass -- okay? -- there is another combustible sandwich panel, and that can then also contribute in some way to fire spread in that localised area between one spandrel and the next.
Q. You've highlighted a particular photo here, 10.37. That's BLAS0000010 at page 39.
A. Yes.
Q. Can you just talk us through the bits that you were wanting to highlight on that picture?
A. Yes. So I just marked up, using the column locations the location of the Aluglaze -- you can see if you just follow the blue dotted line going from the top to the bottom of the picture, from the bottom up to the top, just trying to show that there does appear at times to be a localised vertical flaming effect.
The spandrels are very important in that, where the ACP is, but in those local areas there is also the other panel.
Q. Professor Torero thought that the total mass of energy might be relatively small that would be produced by

these panels when they burned, although he agreed that they would burn and potentially play a role. Would you agree with that?
A. Yes. I think, to me, it's like I said earlier, I think they make up about 15 per cent of the overall surface area. So they're present, but in the scale they're installed at Grenfell Tower, it's a 15 per cent based on surface. So, I mean, I'm not going to call that some, you know, very dominating feature. To me, it's one more material.
Q. Can we look at your final pathway, that's pathway F, around the crown of the building.
A. Yes.
Q. Again, can we just be clear what the crown is. We refer to it as "the crown". What is it?
If we have a look at BLAS0000010, page 69, figure 10.73.
A. What is it?
Q. Yes. What's its function on the building?
A. To me, I mean, it's an architectural feature.
Q. Yes.
A. But I don't know what they thought it was. It's just to make the top of the building look nice, I suppose.
Q. Just to be clear -- again, we looked at this in detail -- we have these C-shaped channels, I think what

you call "fins", which go vertically down, and then we have a particular detail at each of the column tops.
A. Yes.
Q. That's made up of just ACM panels; is that right?
A. It appears to be, yes.
Q. ACP panels.
A. Yes.
Q. Can we look at another figure of yours, figure 10.40, BLAS0000010 --
A. Oh, yes.
Q. -- at page 43.
Do you know how many of those fins were left after the fire?
A. Oh, no, I didn't count them.
Q. Yes.
A. Yes.
Q. From this photo, it doesn't look like many are left.
A. No. I mean, I can see bits of fin, but, I mean, I don't know if the polyethylene is there. I doubt it though. Yes.
Q. You say that there was no provision made to inhibit horizontal fire spread around the crown; is that right?
A. Yes. So the drawings don't show cavity barriers or any other material to prevent that.
Q. You also specifically note in this part of your report

that there were a large number of deaths on level 23, which is immediately below this crown.
A. Yes.
Q. What do you think -- just overall, before we look at it in more detail -- is the significance of this particular fire spread path?
A. Are you asking me that in the context of the deaths at level 23?
Q. No, I am asking you just in terms of as a fire spread route --
A. Oh, okay.
Q. -- how important do you think it was in the overall scheme of things?
A. In that context, once the flame got up to level 23 in the first place, above flat 16, it appears then to have been able to travel horizontally in both directions through the crown, and the helicopter footage and other moving images show the flame front progressing but, more importantly, causing extensive pools of burning polyethylene to flow down to the spandrels above those flats and, more significantly, down other columns. I don't know the order of them off by heart, sorry, but it causes burning of the laterals and the ignition of more and more columns as that flame front progresses.
So it's significant in the context of causing, in

the timing we saw at Grenfell, more columns being involved that way, and it is significant about what it did to the flats at level 23.
Q. Do you agree with Professor Bisby -- it sounds like you do -- that, therefore, lateral spread was most rapid at the crown, it was fastest at the crown?
A. Yes. I haven't done timing analysis, but, yes, it was a highly effective flame front along the crown, highly effective.
Q. Do you also agree it's most likely the primary route of horizontal flame spread around the building because of this falling, melting debris which then accumulates at lower levels and then sets fire to levels down the tower, which then travel upwards, creating this diagonal effect?
A. I think I do, yes. So did you say it's the most effective horizontal route --
Q. Yes.
A. -- overall in the whole building?
Q. That does seem to be Professors Bisby and Torero's evidence, that that's the primary route of horizontal flame spread around the building.
A. The primary -- okay, that's an interesting thing. To me, it was a rapid horizontal spread of flame that in that time caused other vertical and then horizontal.

Q. Yes.
A. Yes, I think I agree with them. I'm not entirely sure what the significance is. I think I agree. At that time, yes, it was the most important horizontal spread. But later on, the other lateral flame fronts became important then, didn't they, because the crown wasn't involved anymore?
Q. Yes.
A. Yes.
Q. So you're drawing attention, as I understand it, to the fact that although you accept that lower down the lateral flame spread might be slower, it still, you say, plays a role, particularly in the later stages of the fire?
A. Absolutely.
Q. Once it's gone round, and we've got all areas of the crown ignited, you've still then got lateral --
A. Yes. You still have other flame fronts lower down the tower. So it's a really important route at that time.
Later on, when you plot the flames coming down the columns and the flames moving away from each one of those columns, you're just getting more and more horizontal runs, yes.
Q. Can we just look at the characteristics of the architectural crown in terms of fire spread laterally.

If we can look at figure 34 of Professor Bisby's report, LBYS0000001, page 63.
Let's look at figure 34, first, at the top, where he's done a horizontal section through the crown.
A. Mm.
Q. So is it right that what we have are these C-shaped ACM channels which then slot into aluminium cladding rails behind them? Is that correct?
A. That's what that drawing shows.
Q. So there's no insulation in this part of the building; it's just ACM on these cladding rails.
A. Yes, apparently not. Yes, yes.
Q. Professor Bisby's view is that these provided a semi-continuous path for fire to spread around the crown; would you agree with that?
A. Yes, I would.
Q. He also has drawn attention to numerous exposed ACM edges in the way this was configured.
A. Yes.
Q. Again, would you agree that that is potentially significant?
A. Again, those small details are important at the very start of a small fire. When you have a very well developed flame front, no, I don't think the fact that the edge is exposed is a very big governing parameter.

But there are plenty of them there and each individual fin could create its own flame front, which could very easily ignite the next fin.
Q. He's also drawn attention to the fact that effectively these are C-shaped chimneys which might support flame extension. Again, would --
A. I don't think I need to give a view on that. Yes.
Q. He's also drawn attention to the fact that there were no cavity barriers anywhere in relation to this architectural detail; is that correct?
A. Yes. So my understanding from the drawings, which are very limited, is there are no cavity barriers marked there once you get above level 23.
SIR MARTIN MOORE-BICK: Just looking at that drawing, would it have been a practical possibility to insert some sort of material between each of the fins? Do you see what I --
A. No, no, I do know what -- I think if you're asking me could you have installed cavity barriers anywhere at the crown to stop the flame we observed, my view is no. The best way to stop --
SIR MARTIN MOORE-BICK: Because it was too well developed by that stage?
A. I don't know how you could -- the only way you could stop the crown from being a flame front on its own is to

not clad it in a combustible material. Trying to detail in little breaks or cavities, in my opinion, is not a practical mitigation measure. The best mitigation measure would be not to have that material there at all. But I think I'm probably straying beyond my Phase 1 duties.
SIR MARTIN MOORE-BICK: No, that's all right, I asked you to. Yes.
A. Yes.
MS GRANGE: Just to be clear, you don't think that, actually, the speed of the fire at that level can simply be explained by the fact that the fire plumes out and spreads out at the top as opposed to it being about the crown?
A. I'm sorry, I actually don't understand.
Q. As a flame rises up, it will naturally broaden as the flame goes up a face, it will naturally plume out towards the top.
A. Yes.
Q. You don't think what we can see at the top of the building is more about that effect than about the crown?
A. Oh, do you mean that when a flame front came up, say the first column, that we're not seeing the crown burning, we're seeing something burning from the column cladding?
Q. That's been suggested.

A. Oh. Oh, I wouldn't think that at all. Yes. It might be for the first few seconds, but then that just ignites the crown, doesn't it, and it progresses?
Q. Again, do you think the fact that -- so the edge of the roof was capped with an aluminium coping. We can look at this in a drawing.
If you go to figure 10.47, BLAS0000010 at page 48. This is one of your drawings --
A. Yes.
Q. -- which we've looked at earlier this week.
So what we see at the bottom of this is how the panels were configured at the very top of the building. We can see a spandrel panel and insulation behind it.
Sitting above that was an aluminium flashing or coping over the top of that.
A. Mm.
Q. And then the architectural fins on the top.
It's been suggested that some of that aluminium coping was very melted immediately above that insulation or below the fins but not on the edge, and that that might be significant. Do you have a view on that?
A. I don't have a view on that, no.
MS GRANGE: Mr Chairman, I'm about to move to another topic. I'm either happy to keep going or to have a 5-minute break. I'm entirely in your hands.

SIR MARTIN MOORE-BICK: I'll ask the witness.
Dr Lane, would you like a break at this point?
THE WITNESS: How much longer will we go if I don't have a break now?
SIR MARTIN MOORE-BICK: We would normally stop for lunch at 1 o'clock.
THE WITNESS: I think I would actually just prefer a very short break, if that's okay.
SIR MARTIN MOORE-BICK: I was going to suggest that. Shall we say 5 minutes?
THE WITNESS: Yes, please.
SIR MARTIN MOORE-BICK: We'll have a 5-minute break, then, please.
Same as before, don't talk to anyone about your evidence, if you wouldn't mind.
THE WITNESS: Yes.
SIR MARTIN MOORE-BICK: You go with the usher. Thank you very much.
12.20, then, please. Thank you.
(12.15 am)
(A short break)
(12.20 am)
SIR MARTIN MOORE-BICK: All right, Dr Lane, happy to carry on?
THE WITNESS: Yes, thank you.

MS GRANGE: So just to summarise overall, your evidence is that once the fire is in the cladding, it facilitated and promoted flame spread in six different ways; that's correct, isn't it?
A. That's correct.
Q. You've identified that the Reynobond 55 PE is responsible for the most rapid of the observed external flame spread.
A. That's correct.
Q. Does that remain your view?
A. It does remain my view.
Q. What's your view about the significance of the PIR insulation in terms of flame spread? You may have heard both Professor Torero and Professor Bisby on this topic.
A. Yes.
Q. What contribution do you think the PIR had to the speed and extent of the fire spread, if any?
A. Yes. So I would like to be able to refer to a drawing, please, in my report, figure 8.11.
Q. Yes. 8.11 is BLAS0000008, page 13. Figure 8.11 is the far right-hand drawing.
A. Yes.
Q. Do you want us to zoom in on that?
A. Yes, that would be great.
Yes, I use this drawing a lot when I'm thinking

about events at Grenfell Tower.
So in this drawing, you can see -- in the condition where there's just the small 35-millimetre gap, you can see the insulation relative to the ACP. When the gap is larger, it will look somewhat different.
My view is that having a -- you know, I've been talking about a combustion process and combustion in a system, and I think in a system with a combustible layer on the inside and a combustible layer on the outside, even before flaming combustion can happen, when you have a heat source, those materials are breaking down, they're producing gases, they're getting ready, if you will, to produce the perfect mix for flaming combustion. It's a huge expert area in its own right, combustion.
But from my perspective, the Celotex or any insulation in the cavity, in the system, contributes pyrolysis gases to the system, and the system needs that to create that perfect mix for flaming combustion.
I don't think I heard either Professor Torero or Professor Bisby say that didn't happen; I got the impression they said they couldn't quantify it or predict it, which I think it's a very different, very detailed view -- you know, in their minds, that's a very detailed: can you predict it exactly, second by second,

millimetre by millimetre?
But the concept of having pyrolysing material on the left, the insulation, and the ACP on the right, I think it's creating a highly effective system, and I understand the scientists will need to work out the numbers behind that.
Q. Yes.
A. I think, therefore, in that context, of how it performs when it's heated, the gases it produces in the pyrolysis process, is all part of that combustion system and the flaming combustion that we see. And for me, I think it's very important.
Q. Yes. That's very clear.
Do you draw any conclusions from the 8414 testing which was done after Grenfell, referred to by Professor Bisby, ie the DCLG tests, which sought to compare the PIR type of insulation we saw at Grenfell with, say, stone wool insulation, but using otherwise similar materials to Grenfell? Do you take anything from that at this stage?
A. I don't take anything from those tests because I don't consider them to be relevant, because they're so far away from the kind of construction detailing that people like me have to worry about in our profession. I would make no comparison of any material in that testing

regime, and I would prefer to keep all the other views I have to myself at this stage. I'm happy to write a very detailed chapter on the subject.
But I will absolutely not compare a mineral wool with the PIR material from that test programme, no.
Q. Okay. That's clear.
Have you heard or seen any other evidence in these proceedings which has caused you to change your view as to the primary responsibility of the Reynobond 55 PE for the rapid flame spread that we saw at Grenfell?
A. No, no, I haven't.
Q. Your view is that the cladding, as it was configured at Grenfell, rendered it unsuitable for a stay-put policy; is that correct?
A. Yes, it is.
Q. Before we leave flame spread, are there any other aspects of Professor Bisby or Professor Torero's flame spread analyses that have caused you to modify your views? Is there anything specific you want to pick up on?
A. I didn't listen to their evidence properly in the last few days, but I will and I'll let you know. But at this time, no.
Q. Do you think it would be helpful at all to do any kind of survey of the respective volumes of, for example, the

PIR insulation, the ACP, the Aluglaze, to survey the extent to which it was installed and then also to survey the post-fire condition? Do you think that can tell us anything about the respective contributions of these materials? Is that an exercise you think would be worthwhile doing?

A. Do you mean survey to quantify them?

Q. Survey the whole building to quantify, for example, what is left --

A. But there's nothing left in most places at all.

Q. If you could do a survey based on the records of the removal of what was left, do you think that would be a useful exercise?

A. I certainly don't need anything from a survey like that.

Q. One final specific question on this. At paragraph 8.2.8 of your report, BLAS0000008, page 4 -- can we just look at that.

A. Yes.

Q. You've set out a definition here of a combustible material.

A. Yes.

Q. You say it's a material that will ignite and burn when sufficient heat is applied and when an appropriate oxidiser is present.

You have that from Dehann 2007.

A. Yes.

Q. Do you agree this definition will result in mineral fibre and aluminium being classified as combustible?

A. Mineral what, sorry?

Q. Mineral fibre and aluminium being classified as combustible.

A. Do I have to answer that question? So mineral wool is non-combustible. The binders used to pack it together are combustible. Yes? But I find those arguments quite trite when one compares mineral wool with a polymeric foam of equal thickness. And the same goes for aluminium.

I understand that nearly everything in the world can burn, but in the context of construction, I like to keep things appropriate and relevant, and understand that a mineral wool is substantially less combustible, and in fact typically defined as non-combustible by test.

Q. Yes.

A. If that's -- yes.

Q. Do you agree that the regulatory definition of non-combustibility is based on the total calorific potential of a product?

A. I'd have to look up part 4, sorry. I'm happy to, if you want me to do it, I'll do it at lunch.

Q. But do agree in general terms that there is

a distinction between combustibility and flammability?

A. Combustibility and flammability ... I'd have to look up the definition of "flammability".

Q. Fine, okay.

Let's look at fire re-entry for a moment.

A. Yes.

Q. Is your position that the external fire then led to fire being able to re-enter on multiple floors?

A. Sorry, can you just repeat that again?

Q. It was a very simple question, the answer is probably obvious, but your position is that the external fire led to fire being able to re-enter at multiple floors at Grenfell Tower.

A. Oh, yes, that's correct.

Q. Do you agree that the physical evidence would suggest that the extractor fan and the small infill panel around the extractor fan was particularly vulnerable in that respect?

A. Yes, I do.

Q. In section 7.4 of his report, Professor Bisby has drawn attention, for example, to the large number of witnesses who comment specifically on early failure or ignition of those extract fan units and the supporting and surrounding XPS panels as a route for ingress.

A. Yes.

Q. Do you agree with that?

A. I do agree, and I observed that myself in the evidence.

Q. He also observes that many of these are on the flat 6s on the east face as highlighted in his analysis. Do you agree?

A. I do.

Q. Do you think this evidence is significant in terms of the route of fire spread back into apartments?

A. I think it is a route into an apartment and it is therefore significant.

Q. Yes.

A. But it's one of many rather than the only.

Q. So you would agree with Professor Torero; I think he said that there are a number of routes back in through the window, whether by the side, by a glazing failure --

A. Exactly.

Q. -- by the extractor fan going --

A. Exactly.

Q. -- by an open window?

A. Exactly.

Q. They're all routes back in?

A. They're all routes back in, yes. But I understand that there's a lot of resident evidence about particularly the extractor fan location.

Q. Yes.

A. Yes.
Q. Do you think there's any significance in terms of the timing when they're seeing that extractor fan unit go in terms of how quickly the window may be failing, based on your --
A. I'm not sure of the context of that, sorry. Do you mean --
Q. Well, as distinct, for example, from glazing failure, do you think that that weakness may have meant that the windows had a propensity to fail?
A. Oh, before the glass breaks?
Q. Quicker than the glass breaks.
A. Oh.
Q. Is that something you considered?
A. No, I wouldn't consider that, no.
Q. I think we mentioned this earlier, and I just want to take you to it. You've identified another potential means by which the windows could have facilitated fire re-entry and spread at the four corners, and I think you wanted to go to this.
This is figure 10.2.1, BLAS0000010, at page 21. Can we go to that figure.
A. Oh, yes.
Q. So I think you were mentioning this earlier and you have a concern -- is this right? -- about a potential flame

spread route at the column.
A. Yes. So --
Q. The corner column.
A. So, again, just to be clear, it's not like some particular concern, I'm just trying to find all the pathways. So in this condition here, this is the kind of rectangular cladding of one of the corner columns. I hope that's clear.
So it's a different detail. So you actually have two noses -- okay? -- as opposed to the one nose I think Professor Bisby was talking about later. You can think about the fire spreading through the cavity in that column, or, actually, just simply through one window to the next. I was just trying to show that it can go both ways, depending on the heating condition.
Q. Yes.
A. But it's not meant to be any very serious concern that I have relatively speaking.
Q. Okay. I'm now going to turn to some of the matters set out in section 11 of your report, where you've looked at the cladding against the B4 requirement in the Building Regulations.
Just to be clear on your position, your position on the cladding system is that you have in this Phase 1 report carried out an assessment of the compliance of

that system with the technical requirements of B4 of the Building Regulations 2010; is that correct?
A. That's correct.
Q. Let's just remind ourselves, B4 is the requirement that deals with the prevention of external fire spread. It's a functional requirement. It says this:
"B4. (1) The external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building."
Is that correct?
A. That's correct.
Q. Approved Document B itself envisages two means of compliance: either a large-scale test or what I've called the prescriptive route as between 12.6 and 12.9 of ADB.
A. Yes.
Q. Would you broadly agree with that?
A. I'm not going to use the word "prescriptive", okay?
Q. Okay.
A. So there's two routes set out in 12.5 using an 8414 test -- whether that's large-scale or not is another discussion.
Q. Okay.
A. So BS 8414 test, or there's statutory guidance given for

certain individual components in an external wall from 12.6 on.
Q. Just to be clear, have you seen any evidence that there was a BS 8414 test carried out in relation to the specific materials at Grenfell Tower, specifically for Grenfell Tower?
A. Oh, specifically for Grenfell?
Q. Yes.
A. I haven't been given any such evidence.
Q. Or any desktop study specifically for Grenfell Tower.
A. No, I haven't found any particular mention of the cladding.
Q. Can we be clear what a desktop study is? Is it basically an extrapolation of other tests that are then extrapolated through to a different set of materials and a different configuration and conclusions drawn as to performance on that basis? Is that a fair summary?
A. It depends who is doing the desktop assessment, and I really don't want to talk about that now. We'll get on to all of those issues in Phase 2. So there's rules about how they should be done, and then there's how they are done.
Q. But in general terms, would you agree with me, it's an extrapolation, it's an analysis, it's not another test?

A. Oh, no, no, no, it's a paper exercise rather than a fire lab exercise, yes.
Q. Is it your position that if you're using the route in Approved Document B, at 12.6 to 12.9, the construction used must be proven to comply by test evidence? That's your position, yes?
A. Oh, yes -- so that's not my position; it's the position of the statutory guidance document. It sets it out very clearly in appendix A for construction products, and I have relied on that position and I agree with it.
Q. Is it your general position -- again, we're going to come to each of the specific materials in a moment -- that such test evidence, so as to prove compliance with that route, was not available in terms of the materials which were selected?
A. That's correct.
Q. Is it correct that, having examined the available test evidence for each element, you find each to be non-compliant with the B4 requirement?
A. That's correct.
Q. Is another way of looking at it simply to examine the physical evidence of the fire spread and assess that against the functional requirement, as in what we saw in the videos and the footage?
A. Oh, I think that displays quite categorically that the

external wall did not adequately resist the spread of fire.
Q. That's my next question: is it your position that the entire building envelope system did not adequately resist the spread of fire over the walls, having regard to the height, use and position of the building and so was not compliant with B4?
A. That is my position, yes.
Q. Your conclusion, just for the note, is set out at 2.9.6, in your conclusions and 2.9.8. I don't think we actually need to go to that now.
I want to turn to look at each element of the cladding system.
The rainscreen cladding panels on the columns and the spandrels were Reynobond 55 PE silver metallic manufactured by Arconic; is that correct?
A. Yes.
Q. Your position is these should have been national class 0 throughout or European class B-s3, d2 or better; is that correct?
A. Yes, as set out in diagram 40.
Q. Yes, that's 12.6 of Approved Document B, diagram 40; is that correct?
A. Yes.
Q. Your evidence is that these Reynobond PE 55 cladding

panels did not have such certification certificates, either class 0 or class B or better; is that correct?
A. Yes, I haven't been provided with any relevant test evidence for Reynobond 55 PE that it has a performance of either class B or class 0.
Q. No riveted panels were used at Grenfell Tower, is that right, they were the cassette system?
A. That's correct.
Q. In a moment we're going to look at a couple of diagrams that help us about the difference between a riveted and a cassette system.
A. Yes.
Q. So we'll come back to that in a moment.
Is it right that the certificates that you have seen confirm that the Reynobond 55 PE cassette system is a European class E; is that correct?
A. That's correct.
Q. For the note, that's paragraph 11.6.10 of your report, page 19 of chapter 11.
A. Yes.
Q. Is it also relevant to note that this class E rating was dependent upon the panels being installed with a class A2 or better substrate; is that right?
A. Yes, that's correct, because of the test carried out at the CSTB, yes.

Q. Just to be clear, by that do you mean that the insulation it was tested with was class A2 or better?
A. I mean the substrate, so the material behind the Reynobond in that test had an A2 --
SIR MARTIN MOORE-BICK: "Behind" could have a variety of meanings; do you mean the material to which it's affixed?
A. Yes, well --
MS GRANGE: This is paragraph --
A. I would now take out the test report if I was in the office and show you some photos. So in the test in France, it is actually affixed onto what I think is a plasterboard. Okay?
SIR MARTIN MOORE-BICK: So we're not talking about another material some distance behind.
A. Exactly.
SIR MARTIN MOORE-BICK: We're talking about what it's fixed to?
A. Exactly. So in that test, don't imagine the panel, air, a big piece of insulation and a wall. That's not what that test does. It's a panel attached onto, in this particular case, one layer of a material to look at the panel on its own in a particular fire test.
MS GRANGE: That's helpful. We'll come to it in the next topic, but at Grenfell Tower, the insulation was

predominantly class D Celotex insulation; is that correct?
A. That's correct, yes.
Q. Is your view that, absent a valid applicable certificate, there's no proof that the product complied with the guidance in ADB; is that correct?
A. There's no proof -- it just doesn't comply because that evidence isn't available, yes.
Q. Just a point of detail -- and, again, we may need to get into this more at Phase 2 -- you found the silver metallic panels had both a black core and a translucent core on site; is that right?
A. Yes, that's correct. Both types appear to have been present at Grenfell Tower.
Q. You say that they achieve different test results to BS EN 13823?
A. Yes.
Q. You've said that they both achieved the same reaction to fire test rating -- sorry, different test results to that standard, but then they both achieved the same reaction to fire test rating; is that correct?
A. Can you just refer me to where you're --
Q. BLAS0000011, at pages 18 to 19, paragraphs 11.6.9 and 11.6.10.
Focusing on 11.6.9 at the bottom.

So you note --
A. Yes.
Q. -- they either have a black or a translucent core.
A. Yes.
Q. Then if we can go over the page, the two different core types achieved different test results, but you note that both core types are classified with one reaction to fire performance.
Can you just explain us to why you were interested in that?
A. I was just pointing out that, for a while, they seemed to pick the lower performance when they issue the classification report.
Q. Right. Okay.
A. Yes.
Q. In your original report of April 2018, you explained that you did not accept a 2008 British Board of Agrément, BBA, certificate as valid for the cassette system, although you did accept at that time it might be valid for the riveted system; is that correct?
A. No, it isn't, sorry, no.
Q. It's not now, but in your original report you said you certainly wouldn't accept it as valid for the cassette system, but you didn't give detailed reasons.
A. No, I didn't.

Q. Is it right that in your most recent report you've expanded on the reasons why you don't think that 2008 BBA certificate is valid for the cassette system?
A. Yes, that's correct.
Q. That very detailed analysis -- I'm not going to take you to all the detail, it's there at paragraph 11.8 of your report and in appendix O specifically; is that right? That's where we see the detailed analysis?
A. Yes.
Q. I do just want to look at the certificate and get you to highlight a few of the very key points.
A. Yes. Can I just say, we're in a very important and complex subject now and I'm getting really tired, so I think pretty soon I'd need a break, because I want to give the BBA cert good service, while you're rapidly asking me all these questions at the moment. Yes. Big questions coming very fast.
MS GRANGE: We could have an early lunch.
SIR MARTIN MOORE-BICK: We could have an early lunch.
THE WITNESS: I'm happy to answer that question, but they're very complex questions and I can't move as quickly as you are at the moment.
MS GRANGE: They will be quite simple questions.
SIR MARTIN MOORE-BICK: It's always easier to ask the questions than answer them.

THE WITNESS: Okay. So just ask me that question again, the BBA one.
MS GRANGE: No, I'm very happy --
SIR MARTIN MOORE-BICK: I think we'll come back to this.
THE WITNESS: Okay. It's a big subject.
MS GRANGE: I was going to go to the certificate and then we can take our time over it if we do it after lunch.
SIR MARTIN MOORE-BICK: 1.45?
MS GRANGE: Yes, that's fine.
SIR MARTIN MOORE-BICK: We'll have a break now.
THE WITNESS: Is that okay? This is a really important part.
SIR MARTIN MOORE-BICK: Of course it is, yes. We'll have a break now until 1.45.
THE WITNESS: Okay.
SIR MARTIN MOORE-BICK: Don't talk to anyone about your evidence, please, while you're out of the room, and then we'll resume after that. Okay?
THE WITNESS: Thank you.
SIR MARTIN MOORE-BICK: If you would like to go with the usher.
Right, we'll break, then, and resume at 1.45, please. Thank you.
(12.45 pm)
(The short adjournment)

(1.45 pm)
SIR MARTIN MOORE-BICK: All right, Dr Lane?
THE WITNESS: Yes.
SIR MARTIN MOORE-BICK: Feeling refreshed, I hope?
THE WITNESS: Yes, much better, thank you.
SIR MARTIN MOORE-BICK: Yes, Ms Grange.
MS GRANGE: Thank you.
We were on the subject of the BBA certificate and --
A. Where do you want me to turn to?
Q. Just to set the scene for a moment.
A. Yes.
Q. In your original report you looked briefly at this, and then in appendix O we now have a much more detailed explanation as to why you don't think that 2008 BBA certificate is valid for the cassette system.
What I want to do is pull up the certificate itself and just look at some key points, because it is very detailed what you've done in appendix O and I just want to get the headline points across.
A. Yes.
Q. So this is the BBA certificate from 2008 [ARC00000368].
A. Yes.
Q. If we look at the first page, you note the heading is "Reynobond architectural wall cladding panels"; is that correct?

A. Yes, it is.
Q. I want to look at page 3 of this certificate to start with.
A. Yes.
Q. It's figure 1, the diagram at the bottom.
A. Yes.
Q. So we touched on this earlier, and I think this is a helpful diagram, I hope, to try and explain the difference between a riveted system and a cassette system.
A. Oh, yes.
Q. Can you just help the chairman, just by reference to these two drawings, and explain what the difference is between the two?
A. Yes. So a riveted system and a cassette system are both made with a flat panel. The difference is to do with the end shape of the flat panel.
So for a riveted system, as you can see here on the left, the flat panel is left as is, as such. It's cut into pieces and it's riveted onto a support structure.
The cassette system has another piece of work done to the flat panel. It's shaped into -- it's like the cover of that box there (Indicates). It's shaped into a piece like that, and they can have all different depths, or depths of the box top.

On the Arconic website, it gives very detailed information on standard sizings for shaping the cassettes, and then the cassettes can be fixed in different ways to a building: they can be hung, they can be screwed, they can be riveted.
SIR MARTIN MOORE-BICK: It looks as though Arconic contemplate that, in either of the systems, there will be rails fitted to the facade of the building to carry the panels.
A. That's correct.
SIR MARTIN MOORE-BICK: You either rivet the panel to the flange of the rail or you hang the cassette into which -- or what the panels have been used to make, onto bolts themselves carried in those channels.
A. Exactly. So in the channel on the right you'll see there is another bracket with a bolt in it, and in this picture, the cassette system has a little -- the thing on the edge on the box top can slot in onto that bolt.
SIR MARTIN MOORE-BICK: Thank you that's very useful.
A. But a cassette is about its shape. So you're shaping the flat panel.
MS GRANGE: Just to be clear, and in very general terms, it's important, isn't it, to know the distinction between the riveted and the cassette in terms of their ability to resist the spread of fire --

A. Absolutely.
Q. -- their testing. Yes.
A. So what I've learnt because of looking at the test evidence provided in this inquiry is that when the flat panel is in a cassette shape and hung as a cassette is, it performs differently under fire compared to a flat panel which is riveted.
SIR MARTIN MOORE-BICK: What are the differences?
A. A much poorer performance in fire. Actually, it's probably worth me mentioning something. I did hear Professor Bisby yesterday refer to the French tests. We have very detailed test reports, reaction to fire test reports, and I thought it worth mentioning that the riveted system, as you know, has been classified in those tests done in France.
When they tested the cassette shape, they had to stop the test because such a high level of heating behind the cassette occurred in the test. When you put the two photos, the riveted system photo and the cassette system photo, side by side, they almost look identical, but one gets a classification and other cannot get a classification, the cassette, because it burnt so much in that test.
SIR MARTIN MOORE-BICK: All right, thank you.
MS GRANGE: Yes.

Just coming back to this certificate, and I just want to briefly establish the key reasons why you've rejected it as a valid test.

So one of the points you make is that the certificate is potentially misleading, in that it purports to relate to all Reynobond architectural wall cladding panels, of which you find that there are 14 types; is that right?

A. Yes. So I've used the words "factually incorrect" not "misleading" in my report, and it says on the front cover, "architectural wall cladding panels". But, for example, I haven't seen any cassette that has got the performance -- this Agrément certificate of fire, because the most important thing about the certificate is the performance it refers to, which is class 0.

Q. Yes.

A. Okay?

Q. So what you've found is that the certificate relates to three types of panels but, in fact, only one of those panels referred to in the certificate is class 0; is that correct?

A. That's correct.

Q. That is a Reynobond FR ACM metallic grey PVDF panel; is that correct?

A. There is relevant test evidence for that fire retardant

core panel.

Q. I was going to ask you what FR stands for.

A. Okay. Well, so I think it stands for "fire retardant" and it's referring to the core of the panel. But FR isn't something that's defined anywhere, as such. So I assume it means some fire retardants have been added to the core and so the product is being called or named a fire retardant product.

Q. Just to be absolutely clear, is that the same kind of panel that we have with the PE core at Grenfell Tower?

A. My understanding of the core at Grenfell is that it is PE -- they call it a standard core.

Q. So not the FR core?

A. It is not the FR core.

Q. The BBA have confirmed in response to questions from the inquiry that the certificate was based on four product test reports.

A. It would be useful if they could come up on the screen.

Q. I wasn't going to take you to all of those test reports.

A. Yes, that's fine.

Q. But the point I wanted to ask you was that the certificate itself doesn't actually identify the test reports which underpin it, does it? It doesn't actually identify on the face of the certificate what the test reports are, does it?

A. No, it does not.

Q. No, you've had to ask for those and we've had to get those separately.

A. Exactly.

Q. Do you think it should've identified those test reports?

A. As a designer myself, or someone who has to sign off on buildings myself, which I've done a lot in the past, I very much wish now it had, and I certainly think that such certificates should now come with the relevant test evidence, so one can establish for oneself if that certificate is applicable to the construction form you're taking responsibility for.

Q. So for those key reasons, but for also the detailed reasons you've set out in appendix O, you have rejected that test certificate as valid for Grenfell Tower?

A. Yes. So at Grenfell Tower specifically, we have a cassette system, and I have seen no test evidence where a cassette system performs to the requirements of Approved Document B; we have a standard core, and I have no test evidence to support a standard core panel with the performances set out in diagram 40 of Approved Document B.

Q. As we established earlier, just before the lunch break, the certificates you've seen suggest that the Reynobond PE 55 cassette system is European class E. That's what

you said before the break.

A. Yes. Yes, so the test reports I've read show me that.

Q. I want to move on from this now unless there's anything more you wanted to say about it specifically.

A. No, no.

Q. So as to the manner in which the Reynobond 55 PE was fixed and the exposed PE filler and core, can we look at BLAS0000008 at page 59, figure 8.65.

I wanted to turn this up because we looked at quite a lot of exposed edges yesterday with Professor Bisby, exposed edges in relation to the spandrels. But here we're looking at the column rainscreen panels; is that correct? That's what the diagram seems to suggest.

A. Yes.

Q. Is it right what you're drawing attention to here is a number of exposed PE core edges of those panels?

A. Yes.

Q. I think we discussed earlier, is your evidence that there are considerable risks posed by this particular exposed PE in the installation because the PE is exposed? It's just a simple point.

A. So PE poses a risk, whether it's exposed or not.

Q. Yes.

A. I feel like I'm saying the same thing over and over again.

Q. Sorry, if you are.
A. But these small details are important in the early stages of a fire when there's a small fire. When you're into a really large flame front, I cannot say that something like an exposed core is truly significant at that point relative to anything else. Okay?
But, yes, at Grenfell Tower there were very many exposed lines of polyethylene.
Q. Yes.
I want to turn to talk about mountings and fixings. Is it right that you also consider that the Reynobond 55 PE certificates for the cassette system which do exist wouldn't be valid anyway, because your view is that the test conditions should accurately replicate the end use condition?
A. Okay, so can we just break that down. Did you say the test certificates?
Q. I said the Reynobond 55 PE certificates for the cassette system would not be valid, because your view is that the test condition must accurately replicate the end use condition.
A. Yes, yes, that's correct, yes.
Q. So one of the things you've noted is that the panel shapes and the fixing method which was used at Grenfell varies from the standard Arconic details; is that

correct?
A. Okay. So a separate point -- okay? -- is that the cassette, the box top, if you will, at Grenfell Tower, is particularly deep, and at the moment I can only look at the Arconic website about this. It gives certain depths, and I have them -- it's in my report somewhere if we want to get into the detail -- and the depth of return at Grenfell Tower is much deeper than those.
Q. So they're not the standard -- is that about the fixing method? What I was specifically asking about was the fixing methods from the panels. You say it varies from the standard Arconic details.
A. No, so I think we're talking at cross-purposes here. So that's what I'm trying to be very clear about.
Q. Yes.
A. The depth of return is different.
Q. Yes.
A. The fixing difference is the cassette is hung at Grenfell Tower.
Q. Is that different from the standard Arconic details?
A. No, Arconic have a hung detail, but they do appear to have some kind of screw or rivet as well.
SIR MARTIN MOORE-BICK: Can I ask, is the depth of return in your view likely to be significant?
A. Well, yes, I think it is, actually, because I don't know

if you can remember earlier, when we were talking about the PIR, and this kind of containment function, so the cover of the box, if you will, is acting like a container, and if it's relatively deep, you're heating up a very nice space.
I think the CSTB test reports are very interesting to compare for that reason too, that when you have this shape, the test has to be stopped because the heating effects are so different, so early.
So it seems to be significant.
MS GRANGE: Yes.
SIR MARTIN MOORE-BICK: Thank you.
MS GRANGE: What I'm getting at is: can you just explain why what might appear to be insignificant differences in fact are potentially very important when it comes to fire safety, so that they might invalidate a certificate?
A. Okay.
Q. You highlight a number of parts of Approved Document B which stress that these differences are important when you're looking at test evidence; is that correct?
A. Okay, I understand what you mean now.
So I think in different parts of my report, so for doors, for the cladding, the importance is the word "relevant". What you have to provide is relevant test

evidence.
I think there are all sorts of places where it's explained that you can have a material with all different performance rankings -- okay? It can be the same material, but have a totally different reaction to fire classification as a function of what's behind it and how it's attached to the material behind it. So it's the system or the assembly that is really important.
So as a designer, I cannot choose a material and ignore the construction context that I'm going to place that material in. Okay? Because it changes its fire performance. Either better or worse; it works both ways.
Q. Can we look at one example of that. You stress that this is emphasised in a number of pieces of guidance. Let's look at Approved Document B itself.
A. Okay. If that could go up on the screen.
Q. Yes, of course. CLG00000224 at 119.
So the bit I want to take you to is, first of all, at the bottom of that first column, note 1. That very last bit of text under note 1 at the bottom. So there we see it says:
"Note 1: Different forms of construction can present different problems and opportunities for the provision

of structural fire protection."
That's one aspect you draw attention to; is that correct?
A. Yes, that's structural fire protection, yes.
Q. Note 2 is perhaps more relevant to what we were just discussing, the top of the next column. That states:
"Note 2: Any test evidence used to substantiate the fire resistance rating of a construction should be carefully checked to ensure that it demonstrates compliance that is adequate and applicable to the intended use."
Then it says this:
"Small differences in detail (such as fixing method, joints, dimensions and the introduction of insulation materials etc.) may significantly affect the rating."
Is that an example of where designers are being warned about what you were just discussing?
A. Yes, and that's in the context of fire resistance, so now we're talking doors, floors and walls. Okay?
Q. I see, yes.
A. But the same principle applies for reaction to fire if you go into part 10 of BS 476. Anyway ...
So everywhere it's clear that the context of the product you're selecting has to be understood, and that's why the test evidence has to be relevant.

Q. Yes.
A. And relevant means to how it's going to be installed in that building.
Q. Yes. I think for the note, you refer to BS 476, part 10 as well --
A. Yes.
Q. -- in paragraph F1.1.8 of your report.
A. Yes.
Q. We don't need to go to that.
A. Okay.
Q. You say that is making the point even more firmly about test evidence.
A. Yes, but that is specifically relating to reaction to fire, and reaction to fire is the performance relevant to the cladding at Grenfell Tower. So it's more relevant than this note here.
Q. Insulation. Can we move to the insulation, then.
Can we just orientate ourselves again and just work out what we're talking about. BLA00000495 is an image of the insulation being installed on spandrel panels.
A. Yes, so what figure is that in my report?
Q. I think it's a stand-alone photograph --
A. Yes.
Q. -- which particularly clearly you can see the guys actually installing the spandrel insulation; is that

correct?
A. They are actually taking it off.
Q. Oh, sorry.
A. Sorry to be annoying. They're actually taking it off, yes. But there are men there and they are touching the insulation, yes. Okay. I think maybe -- yes. Yes.
Q. And that's one of the spandrel panels.
A. Yes.
Q. And you had two of those; is that right?
A. Yes, that's correct.
Q. Behind the spandrels, 80 millimetres in thickness each; is that correct?
A. That's correct.
Q. The key point is that the insulation is required to be of limited combustibility under Approved Document B, so that's A2 or better.
A. That's correct.
Q. Is your conclusion that none of it was?
A. Correct.
Q. So let's just explore that a little bit.
The Celotex RS5000 insulation which was installed on the spandrel panels where we were just looking and the column panels --
A. Yes.
Q. -- the test reports that you've reviewed indicate that

that achieved European class D --
A. That's correct.
Q. -- is that correct?
A. Yes. And only those tests were done after the Grenfell fire.
Q. Yes. And you've considered all of that relevant test evidence in your appendix E.
A. Yes.
Q. So there was a BS 8414 test report carried out by the BRE in August 2014.
A. Yes.
Q. Which was subsequently withdrawn, we'll come to that in a moment. In any event, you say you would reject that because the configuration of that test had a rainscreen system with a Marley Eternit cementitious board -- is that right? -- used as the insulation?
A. That's correct.
Q. So you've rejected that.
You also rejected a desktop --
SIR MARTIN MOORE-BICK: Do you want to say something?
A. So the Eternit board is that external surface, instead of the panel. The insulation is separate.
Q. So it's not the same --
A. Absolutely not the same .
Q. -- as what we have at Grenfell Tower, so you can reject

that in any event.
A. Correct.
Q. You also say in appendix E that you rejected a desktop assessment produced by Exova Warringtonfire in May 2015 because none of the rainscreen cladding types were representative of the ACP panels at Grenfell.
A. That's correct, and Exova also warned the reader about choosing a material with aluminium in their report.
Q. Yes.
You also note that that BS 8414 test report by the BRE in August 2014 was subsequently withdrawn by Celotex.
A. That's correct.
Q. You've noted in your report discrepancies between what's reported to have been tested and what in fact was tested; is that correct?
A. Yes.
Q. Is that a topic you think should be investigated further in Phase 2?
A. Very much so.
Q. We touched on this earlier, you note in your report that the Celotex brochure requires the insulation boards to have a self-adhesive aluminium rainscreen foil tape over the joints of the insulation board.
A. Yes.

Q. Do you interpret that as meaning that all of the exposed edges of the insulation foam should have had that foil tape on them?
A. I wouldn't know how to interpret it, in the sense -- to me a face is different to a joint, and they mentioned joint. I think it would be useful if it said "and the facings or any exposed edges" if that's what they required the designer to contemplate.
Q. Yes.
A. But at that time it just said "joints".
Q. Can we just look --
SIR MARTIN MOORE-BICK: I'm sorry, can I just ask, is there any reason why one would wish to tape the joints but not tape the cut edge?
MS GRANGE: We're going to come to a photograph, actually, that shows this.
SIR MARTIN MOORE-BICK: All right, sorry, I'm getting ahead of us.
MS GRANGE: No, no, this photograph might help with that question.
A. Okay.
Q. If we go to figure 8.37, BLAS0000008 at page 35.
We're looking at the insulation on the columns on the right-hand side; yes?
A. Yes.

Q. Is it right that we can see that tape in between some of the --
A. Yes, we can.
Q. To answer the chairman's question, do you think there might be a reason why they've done that in those locations?
A. I have no idea why they say to just tape joints and not tape exposed edges. I don't even know if they want the joints taped for fire reasons or not. So that's a level of detailing I can't advise you on.
So what we need to know is why the tape is needed, if it's relevant to fire or not, when Celotex give that advice. So it would be best if they explain that, if that's okay.
Q. What we can see is that they did have some kind of foil tape on site.
A. Yes.
Q. But they seem to have been using it in that way, but not, as we can see, to seal the edge.
A. On the cut edges, exactly. So when you have two cut edges together and you form a joint, they seem to want to seal it, and if you have a plain cut edge not up against another piece of Celotex board, you don't put any tape there.
Q. It's also believed that Kingspan Kooltherm K15 was used

on the building.
A. Yes.
Q. Professor Bisby's estimated that that might account for less than 7 per cent of the total insulation used on the building.
A. Yes.
Q. Do you agree broadly?
A. Yes, it was a relatively small amount, yes.
Q. Is it right that that achieved national class 0, but that's not a method of determining limited combustibility?
A. Yes, so class 0 is to do with the surface, yes. It's not an insulation test.
Q. At paragraph 8.9.4 of your report, you've referred to the fact that in order to affix these insulation panels to the building, they used 180-millimetre stakes.
A. Yes.
Q. Do you know -- you may not, because I'm not sure it's something we focused on -- whether the type and length of fixing was used consistently?
A. Oh, I don't know that, sorry. Yes.
Q. Do we know the brand or --
A. No, no, I don't actually know anything about them. So, again, it would be a nice piece of information to be given.

Q. The Aluglaze window infill panels, we've already discussed these, they are XPS extruded polystyrene, and you say in your report that you think they made up about 13 per cent of the surface between levels 4 to 23 of Grenfell Tower; is that correct?
A. Yes.
Q. Can you clarify, I think you said it earlier, are these properly to be characterised as sandwich panels?
A. Yes, insulation core panels is the phrase used in Approved Document B.
Q. What is the purpose of those panels?
A. To insulate the building.
Q. Yes.
A. Insulate that part of the building, sorry. Yes.
Q. You say in your report that no formal test evidence for those panels has been disclosed to the inquiry; is that correct?
A. That's correct, yes.
Q. But you say from some publicly available datasheets, you think that might have been class E; is that right?
A. Well, the website where the product is is actually very clear, yes.
Q. You note that the manufacturers, Panel Systems Limited, state that they don't achieve a national class 0 on their website.

A. Yes.
Q. When we're thinking about these kind of panels, these sandwich panels, these XPS panels, is it relevant to consider what is said in appendix F of ADB about insulating core panels?
A. Yes, I think so. Yes. Because I think Approved Document B is explicit about that type of panel.
Q. Could we just look at that.
A. Yes.
Q. CLG00000224 at page 147. So I think what we get is paragraph 3.
In appendix F.
A. Yes.
Q. So it says this:
"3. When compared with other types of construction techniques, these panel systems therefore provide a unique combination of problems for firefighters, including:
"• hidden fire spread within the panels with thermoplastic cores;
"• production of large quantities of black toxic smoke; and.
[• loss of structural integrity of panel]
"• rapid fire spread leading to flashover."
A. Yes.

Q. Is that the warning that you were just referring to?
A. Yes, because some buildings are formed almost entirely out of these panels for other reasons to do with hygiene and other things, and there have been firefighter deaths and some other quite serious problems with them for I think it's nearly 20 years or so now. Yes.
Q. Thank you.
Cavity barriers.
A. Yes.
Q. I now want to come to cavity barriers. I think we'll cover this topic and then probably break, if you are comfortable with that.
A. Oh, yes. Yes, yes.
Q. We looked earlier at Approved Document B and where those are required if you are following that guidance.
A. Yes.
Q. Can we just look at that again.
In fact, it's in your report: BLAS0000011, page 69, figure 11.22, which is the relevant extract.
If we can zoom in on that diagram.
So just to remind ourselves, these cavity barriers are required to close around openings in the external wall at the junction of fire-resisting elements; is that correct?
A. Yes.

Q. So, again, they're quite hard to see, but could you point them out so we're absolutely clear.
A. So on this diagram, they're the little light grey things at the windows, at the floors.
Q. Yes.
A. Also where a compartment wall intersects with the external wall too. And at the top of the wall to close off the cavity up here.
Q. Yes, I wanted to emphasise that. Yes.
A. Yes.
Q. The cavity barriers that were installed on site were SIDERISE RH 25 open state cavity barriers; is that right?
A. That's correct.
Q. Can we just look at a picture of those. Can we go to BLAS0000008, page 42, at figure 8.46.
So perhaps starting with the bottom picture, this is a picture from the SIDERISE product literature.
Can you just explain to us, for those that aren't familiar with this, what an open state cavity barrier is?
A. Okay. Can we go back to the ADB picture? Is that okay?
Q. I'm sure we can.
A. Yes. So in this diagram, if you just look at one of the cavity barriers either at the floor line or at the

window, the concept is it fills the space formed between the internal and external wall construction, and it provides a fire-resisting barrier fully between those two pieces of material. Okay? So it's a full fill of the cavity in that location.

Q. That's what's meant by open state, is it?

A. No, so that's a cavity barrier.

So now when you go to an open state cavity barrier, the idea is that in a normal condition, it doesn't fill the cavity, it leaves a gap.

If we want to go to the SIDERISE picture now ...

It leaves a gap for day-to-day reasons, okay? And when heat approaches the cavity barrier, in behind that black layer is something called an intumescent, and an intumescent changes shape under heat and can move -- it, like, expounds and so fills the gap that's there day-to-day.

So an open state cavity barrier is one that, in a normal condition, allows an opening in the cavity, but once heat comes near the intumescent, it swells and fills that gap and so is meant to form that full seal I mentioned when we were looking at the Approved Document B picture.

Q. Can you just confirm, these cavity barriers here, they are made of mineral wool; is that right?

A. Yes, as I understand it.

Q. They'd be non-combustible; is that correct?

A. They're non-combustible?

Q. I think that's what you say at 8.9.33 of the report.

A. Yes, sorry. Okay, yes, they are.

Q. So they would be A1 if they're non-combustible?

A. They would be, yes.

Q. You go on in your report to note -- this is paragraphs 11.21.12 and 11.21.14 -- that the use of cavity barriers is potentially problematic with a rainscreen cladding system formed with an aluminium composite panel; that's correct, isn't it?

A. Yes, it's not potentially problematic, it is entirely problematic.

Q. Let's look at your figures. I want to take you through figures 10.17 to 10.19. Can we start with 10.17 --

A. Hold on, hold on, just slow down there, please. I just want to open up 10. So 10-point-what?

Q. 10.17. It's on page 19 of chapter 10.

A. Yes.

Q. This is the first of a sequence of figures that we have in your report.

A. Yes.

Q. Which is explaining, I think, the point you've just made about why they are problematic in a rainscreen system.

A. Yes, yes, so --

Q. Can you talk us through --

A. Again, it's about going back to that diagram in Approved Document B. The wall is meant to adequately resist the spread of fire, and the cavity barrier is sealing that gap in the wall. So the cavity barrier is there to -- when the flame goes into the cavity, it is stopping the flame from exiting one compartment to the next, if you will. Okay?

A cavity barrier cannot stop a flame in a cavity if the wall itself is burning. So the very founding principle is that the wall is not burning and the cavity barrier is stopping a flame in the cavity.

The cavity barrier cannot stop the whole wall from burning in that position.

Q. If we go to the next figure, 10.18, I think that's over the page.

Here I think the point you're trying to make is about you could have fire spread through the combustible panel itself; is that correct?

A. Yes.

Q. You are showing that with the red dotted line through the panel?

A. Yes. So here, the cavity barrier, it's beside an edge of a wall that itself can burn, so the flame front can

quite simply pass by it.

Q. Then figure 10.19, which is on the same page, just at the bottom.

A. Yes.

Q. There, I think the point you're making here is that potentially you get distortion of the panels; is that right? Do you want to talk us through --

A. Yes, because the panel is a lightweight structure. Rather than, say, a classic masonry wall, they can distort and produce a bigger gap, which the intumescent would then need to fill.

But I think that's a secondary issue compared to the primary issue of putting a cavity barrier in a rainscreen cladding system, which is quite simply the wall itself is burning and so the cavity barrier cannot seal the cavity, because in a way there is no cavity, because the wall is burning.

Q. This distortion, delamination, debonding that you're talking about, do you think that there would be any difference if the cavity barriers had been placed at the base of the spandrel panels as opposed to where they were, which is kind of partway up?

A. I think it makes no difference whatsoever where the cavity barriers at Grenfell Tower were because they were put in a rainscreen cladding system formed of

a polymeric core.
Q. Professor Bisby at paragraph 887 of his report says horizontal cavity barriers are considered important within rainscreen cladding systems, particularly when combustible cladding insulation products are used.
Would you agree with that statement?
A. When combustible insulation products are used?
Q. That's what's said.
A. I've no idea why he said that.
Q. Professor Torero drew a distinction between what's going on in the cavity and what's going on outside and said potentially they might slow the spread of smoke or fire. Again --
A. Oh, I don't know. How could they do that? If the cavity barrier is jammed into a combustible piece of insulation on the right-hand side, and a burning polymeric flame front on the left-hand side, I don't know what that cavity barrier can do in that context.
Cavity barriers are very effective in a wall that isn't burning on both sides.
Q. Would it have been possible to penetrate the rainscreen system with cavity barriers at levels? Have you ever seen that done before?
A. I haven't, but the principle of trying to have some kind of break in the panel I think is probably what they

mean.
I just -- I don't think that's ... that's not a mitigation measure that can mitigate the flame front that can be created from a polymeric rainscreen panel.
SIR MARTIN MOORE-BICK: I suppose that even if you could fit a barrier that ran from, in this case, the concrete outer surface of the building right through the rainscreen panel --
A. Yes.
SIR MARTIN MOORE-BICK: -- it wouldn't do much good if the panels below were heavily alight; it would simply bypass it, wouldn't it?
A. Yes. Then you're getting into problems of what is installed, if the panel falls away, if the panel's burning, and also remember --
SIR MARTIN MOORE-BICK: You get heat flux --
A. You still have flame, you're going to have heat, you know, you're going to reach the point where you need some kind of big kind of horizontal screen or something to try and stop the flame from getting from one floor to the next. So I think it's entirely impossible, actually, yes.
MS GRANGE: Just a few more questions on this.
What about downwards flame spread? Do you think cavity barriers have any role there or is ...

A. Do you mean trying to stop the flame front on the --
Q. Yes, or stop melting and dripping material. I mean, is that --
A. Oh. Well, if they were very well fitted and sealed, you might get a little pool of melted polyethylene on them, but -- you know, they're all what I call little details. The flame front is roaring past. That's what happened at Grenfell. Yes.
Q. What about using concrete upstands to butt the cavity barriers up against?
A. Where would the concrete upstand be?
Q. Yes, I mean, I think at intervals is what is being suggested.
A. To answer that question of -- I don't know who wants to know that. If there was a sketch, I'm happy to --
I don't know where the concrete upstand would be and where the cavity barrier would be fixed. But I'm happy to answer that with a sketch if someone gives me a sketch.
Q. In any event, putting aside those areas, you've explained in your report that you have some concerns about the way in which the SIDERISE cavity barriers were installed at Grenfell Tower; is that correct?
A. Yes. Again, I mean, my job is to point things out. So just to be absolutely clear, when I'm doing my own work,

we always categorise defects as major or minor, primary or secondary. So I think the installation quality of the SIDERISE cavity barriers is a defect, but I would classify that as a minor defect if it was another building.
Q. Actually, sorry, before we get to those defects, what I meant to say before we get to that is that you've noted that the horizontal cavity barrier product that was used at Grenfell Tower was only tested as fixed between concrete panels on either side.
A. Yes.
Q. Is that correct?
A. That's correct, yes.
Q. For the vertical product, it was only tested between a lightweight aerated concrete wall, not in a rainscreen cladding system.
A. Exactly. I haven't been given evidence of the SIDERISE cavity barriers with a standard polyethylene cored rainscreen, no.
Q. That's helpful.
I drew the distinction there between horizontal and vertical.
A. Yes.
Q. A vertical cavity barrier, is that normally with an intumescent or is that more of a block?

A. Well, at Grenfell Tower they were specified as being that full seal I mentioned earlier, so it should've been from the concrete flush tight up against the external surface.
Q. I know you've said it's a minor issue, but I just want to summarise the issues you've raised --
A. Absolutely fine.
Q. -- about the installation.
You've said they were in your view not fitted in accordance with the manufacturer's specification. I'll run through the key points.
You say they were rough cut with gaps between barriers in the external wall.
A. Yes.
Q. Not tightly abutted and with cladding rails cut through the barriers.
A. Yes.
Q. I think we've seen photographs of that, so I'm not going to take you to that again.
A. Yes, you have.
Q. You've noted the lack of any cavity barriers in the nose of the column, in the tip of the column --
A. Yes, yes.
Q. -- is that correct?
Can you give a view how common you think these

issues were across the cavity barriers, based on your inspections?
A. Yes, so it seemed to have been very consistent, I have to say. I did get the chance to go out onto the scaffolding and I observed the rainscreen panels being removed in several places.
So in general I saw that the cavity barriers in the columns were particularly ... uneven, and I was going to say kind of jimmied in, whereas the horizontal cavity barrier was better fitted.
Q. Because you've also found that horizontal cavity barriers had been used in the vertical position; is that correct?
A. Yes. So whoever installed the cavity barriers and the columns seemed to just take the product that was specified for the horizontal condition and just turn it around, cut it and shove it in behind the ACP.
Q. You also say that cavity barriers were absent at the head of the rainscreen cladding system at the top of the building.
A. Yes. They don't appear to have been specified on the drawings. I did not get to go up and look and, anyway, actually there's nothing to see there, yes.
Q. But I think you emphasised earlier that Approved Document B does suggest, if you are following that

guidance, that they should be there at the head.
A. Yes, you have to seal the wall on the final floor, yes. Sorry, the top of the final floor, excuse me, yes.
Q. Although the logical question follows: do you think that the presence of cavity barriers at the top of the building, before you get to the crown, could've made any meaningful difference in terms of fire spread at Grenfell Tower?
A. Not at Grenfell Tower, no.
Q. You've also noted in your latest report that at the time of construction of Grenfell Tower, the manufacturers' instructions for the type of cavity barrier that were used, ie SIDERISE RH 25 with the green strip at the top, didn't state that they should be installed with that green logo tape at the top; is that correct?
A. For the product with the smaller gap, 25, yes, that's correct. I had thought it was for any product, but then it was only for the open state cavity barriers that are tested for adequate performance with the larger 50-millimetre gap.
Q. Do you understand why one product should be installed in one orientation and not the other?
A. No, I don't, and not particularly since I've read all the SIDERISE fire test reports.
Q. What is it about those fire test reports?

A. Because in all the test report it says the intumescent is 75 millimetres deep. So I don't understand, when you have cavity barriers that are deeper than 75 millimetres, why it doesn't matter where the intumescent is.
Q. Is that something you want to explore in more detail at Phase 2?
A. I mean, yes, I will look into it. But, again, everything about this product are what I call minor defects in the context of Grenfell, because of the overall wall it was fitted into. In other buildings, with a masonry wall or whatever, those smaller details in the context of Grenfell are then very important. Okay?
Q. Yes. So it's important to note, I think, that whilst you said in your first report that the barriers were upside down and that was a non-compliance, you're not saying that's a non-compliance in your revised report.
A. I'm using more neutral language. I remain technically entirely unclear why it doesn't matter.
Q. Finally, as we discussed earlier, you found no cavity barriers around any of the windows.
A. No, I did not.
MS GRANGE: Mr Chairman, I think that's a good moment for a break because I'm moving to a different topic.

SIR MARTIN MOORE-BICK: Yes.
How are you getting on?
MS GRANGE: Yes, good.
SIR MARTIN MOORE-BICK: Shall we have 5 minutes or 10, is really what I'm asking you.
MS GRANGE: I think let's have 10.
THE WITNESS: Oh, that sounds great!
SIR MARTIN MOORE-BICK: Good. We'll have a 10-minute break then. Don't talk to anyone about your evidence and back at 2.45, then, please. Thank you very much.
2.45, then, please.
(2.35 pm)
(A short break)
(2.45 pm)
SIR MARTIN MOORE-BICK: All right, Dr Lane?
THE WITNESS: Yes.
SIR MARTIN MOORE-BICK: Good.
MS GRANGE: Thank you.
If I can just start by giving a trigger warning. In about 3 or 4 minutes we're going to come to look at the escape of the fire out of flat 16 and issues around that. I know Dr Lane is keen to be able to look at Professor Bisby's video.
SIR MARTIN MOORE-BICK: Yes.
MS GRANGE: So we're going to watch a portion of that again,

I'm afraid. I'll give the trigger warning again when we get to it.
SIR MARTIN MOORE-BICK: Thank you, yes.
MS GRANGE: But I'm warning people now that we're just a few minutes away from that if they wish to leave, and that that will involve scenes of the tower on fire which some may find distressing.
Before I come to that new topic, I just have two follow-up questions from the issues we were just discussing.
First of all, a number of residents in their evidence have referred to the fact that after the refurbishment, they felt that there were draughts around the windows that they could really feel.
Do you have any insight into what might have been the source of those draughts? Is that something you thought about?
A. So as a fire safety engineer, I don't think about draughts, but what I would say is I think it's really important to just remember that detailing under the uPVC. So my interest in it is what is under the uPVC, and I've told you several times today about those voids. So one can imagine -- you can translate from there, then, to sizeable voids and loose materials.
But it's better for an architect or appropriate

person to give a proper view.
Q. Just one point of detail and clarification about your diagram 10.18. This is on page 20 of chapter 10. That's BLAS0000010 --
A. Sorry, 10.18?
Q. Yes. It's figure 10.18 at the top of page 20.
A. Yes.
Q. We were looking at that earlier in the context of cavity barriers, and here you have this diagram of the fire spreading through the combustible polyethylene core of the rainscreen cladding panel.
I've been asked to get you to clarify, so far as you're aware, could the aluminium skin stay in place and the PE burn up the middle of the panel, or would the aluminium have to delaminate somewhat in order for that to happen?
A. To make the PE burn?
Q. Yes. I mean, can you literally get fire spread inside the panel with the two pieces of aluminium still in place?
A. Okay, so then that the cavity barrier could work perfectly well with the remaining aluminium?
Q. No, I don't think that is what is being suggested. I think it's just to clarify, when it's circumventing, can it circumvent the cavity barrier by literally going

right up the middle --
A. Oh, right.
Q. -- or would you always get or need to have for oxygen purposes some kind of delamination, debonding of the aluminium?
A. So I suppose it depends on what the flaming situation is at that location at that time, isn't it? So if it's at the start of something, it might just be the core, but when you have that very well established flame front on a column I think there is more than just the core changing going on, yes.
Q. I'm now going to turn to a different topic, which is to effectively go back to the sequence of events at Grenfell Tower and to summarise your evidence by reference to the sequence of events in the early stages.
I'm then going to want to explore with you on Monday, when your evidence continues, the active and passive fire safety systems inside the tower in more detail, and we'll start with doors on Monday.
A. Yes.
Q. So first I want to consider the route of fire spread out of flat 16.
A. Yes.
Q. You've heard both Professor Torero and Professor Bisby being questioned about this.

In your report, you address this at 10.3.7, where you say you think the most probable escape route was the higher portion of the kitchen flat window through the column-side jamb and head of the window; is that correct?
A. Yes, that's correct.
Q. Does that remain your position?
A. Yes, it does.
Q. At this point, is it appropriate to watch the video of Professor Bisby --
A. Yes.
Q. -- before we come on --
A. Do you want me to explain my conclusion on it?
Q. I think it's possible for us to -- we did it yesterday -- stop the video if you want to at particular parts, or we can just watch it all the way through.
A. Well, I think if we're talking about the fire coming out at the top and the side of the window, so anything, say, from about 01.06 onwards would be fine, just a few minutes, and then I can just maybe do some talking. Yes.
Q. That's fine. Can we do that?
Before we play this, I'm going to give the trigger warning one more time.
We are about to play the video of the fire spread

out of the kitchen window and up the east face, if anyone wants to stop watching or leave the room now.
(Video Played)
That's 01.08. Can we take it back to 01.06.
A. Yes, maybe 01.06. That's fine, yes.
(Video Played)
If we stop there.
It would be good to stop there. Is that okay?
SIR MARTIN MOORE-BICK: Yes, of course.
A. So, again, it's about going back to this drawing at 8.11. When you look at this image here, so you can see some flame, it's still internal, you can see glowing from inside the room, and we also know from the thermal imaging from London Fire Brigade the general area of the heat source. And all of that is going on near the uPVC on the side of the window, the uPVC at the top of the window, and this complex gap I've been referring to, which can be anything from 30 to 130 millimetres.
Q. Do you want to pull up that drawing -- I think we can split the screen. Can we do that with the video? I may be asking too much.
The drawing is at BLAS0000008, page 13. It's that right-hand drawing -- that's it, the far right drawing. If we zoom in on the far right-hand figure.
A. Yes, that's fine.

So you've heard an awful lot in the last few days about how uPVC behaves in relatively low temperatures, and I'm not talking about when it's ignited or anything like that, and we've had a discussion that it was glued on, you know, it wasn't mechanically fixed to the window area either.
So, you know, in my mind, it's a localised fire, but in that localised area, relatively speaking, it's a substantial fire near that corner of the window before it gets out.
But what we can't see is there is now heat transfer through that corner. Okay? Through this corner -- sorry, if I stand up here -- you have some kind of fire condition here, you have heat transfer, heat transfer in through this corner (Indicates), which may be 35, it may be three or four times larger than that.
By the time we see the flames on the exterior -- so out the glass, to put it bluntly -- we've had that localised heating condition going on in that corner for several minutes, and I think that it's more probable, therefore, that the heat transfer and the fire condition there has entered the column cavity within minutes of the first minute we see the flame on the outside.
Q. Yes.
A. Okay? I don't think it happens later. I think it's

been going on -- the conditions have been, if you will, the materials -- everything's been getting ready and, after a few minutes, the heat is transferring into that cavity all along.
Q. So just to be clear about the mechanism, the uPVC is potentially melted, deformed --
A. uPVC may have fallen away, might be distorting, okay?
Q. Then we have the insulation behind that.
A. Yes, we've a little piece of insulation glued onto the back of it, and then after that, then, it's fresh air and the membrane, into the cavity and the column.
Q. So the EDPM membrane, and then you're straight into the insulation?
A. You're straight into the cavity in the column, and heating any material in behind the panel there. So the panel itself and the insulation.
Q. Okay.
A. Okay?
Q. Do you want to carry on watching the video?
A. Well, I don't know what your next question is.
Q. In terms of --
A. Sorry. I don't need to know, I'm fine, for now. But if you are going to ask me something else -- yes.
Q. Is there anything else in that video sequence that you want to draw attention to?

A. Well, I think I was struck by some of the evidence about this issue of breaching of the compartment, but I don't know if I should talk about that now or not.
Q. Feel free. I'm trying to get you to explain why it is that you think that's the likely route out of flat 16. If you want to express a view on the other theory we were discussing, which is kind of through an open window, possibly through the extract panel window --
A. Oh, right, okay.
Q. Is that what you were just talking about?
A. So I can see that the flame reaches the glass and the extractor fan and then becomes an external flame. But I think in the time period it's taking for us to finally see that, this internal heating is going on in this complex corner that we have. Okay?
In terms of breaching the compartment, I thought it was, just having listened to everybody for the last few days --
Q. I'm coming to that in a moment.
A. So that's all. But in my mind, I think that the most probable first route is through the connection of the corner of the column.
Q. That's helpful.
I think one of the things you refer to in your report is the thermal imaging from within flat 16.

A. Yes.
Q. Is that right?
A. It shows the location of the heating.
Q. Shall we go to that?
A. Yes.
Q. That's figure 9.38, BLAS0000009 at page 45.
It's that thermal imaging -- well, actually, sorry, let's keep the page as it is, because I think --
A. Yes. So I just --
Q. You've drawn attention to this in your report.
A. Yes. I mean, I'm only interested in the thermal imaging for kind of a general location, but when you think about that overlaid on the construction, that's what interests me.
In this picture, the uPVC beside the column is removed, but you can see that the area, just that concentrated area from whatever's happening in the kitchen, is all over by that corner of the column with the window, and I'm clear in my own mind how easy it is for heat to transfer through that connection, through that detailing, into the cavity. That's the point I'm making there.
Q. I think as a fact you say that you think the fire was already in the cladding certainly by 01.08; is that correct?

A. Yes, I think so. I think by the time we see that external flame front. There has been a lot going on for the 10 -- even longer -- you know, in fire sense, 10 or so minutes and that type of heating with those materials in a localised sense is a substantial event. It's a localised event, yes.
Q. For that 01.08 time, I think you refer -- let's look at this photograph, which is a still. That's IWS00000051.
(Pause)
I think that's the photograph that you've referred to in your report.
A. Can you just tell me where you are?
Q. Sorry, I should've taken you to it in your report. That's at BLAS0000005, page 10.
A. Of what chapter?
Q. Sorry, chapter 5, page 10.
A. Yes. So figure 5.5?
Q. Yes, it's figure 5.5, I think that's the same as the photo we've just had. This is clearer, actually, because you've put the lines on it. So it's that photograph that you're now highlighting --
A. Yes.
Q. -- in terms of external flaming outside the window at 01.08; is that correct?
A. Yes.

Q. You say:
"This is the earliest evidence I have seen of external flaming based on the photographs and videos I have reviewed to date."
A. Yes.
Q. Does it remain your view that once the fire is near the window -- or, indeed, anywhere in the flat if allowed to develop and cause heating of the window components -- spread to the exterior is practically inevitable?
A. Yes, if the fire isn't interfered with, yes. Yes.
Q. Is it also your view that once the fire was within the cladding, there was nothing to impede the spread of fire and smoke around the building?
A. That's correct.
Q. You say this created the conditions for a catastrophic fire event to occur.
A. Yes, I did, yes.
Q. I now want to turn to the topic you were just touching on, which is about breach of compartmentation.
A. Oh, yes.
Q. I want to ask you when you think the breach of compartmentation occurs.
A. Yes.
Q. At what moment.
A. Yes.

Could I use that figure in Approved Document B, actually, please, where we've been looking at the cavity barriers all the time?
Q. Yes. So --
A. I just want to explain the kind of statutory perspective on a compartment breach. I just wanted to introduce that, having heard the other experts.
Q. Yes, we'll just find that. So it's BLAS0000011, page 69, which is figure 11.22 of your report, I think.
A. Yes, yes, okay. Just to use this again. Yes.
Okay, so it isn't assumed that the fire is kept within the compartment and once it passes, say, a millimetre line, the compartment is breached. So, first of all, to think about the cavity. So it is assumed fire can enter a cavity, but then that it's contained from spreading to a cavity in the next apartment.
If you look at this, in this condition here, if the fire is in this room, between this room at this level, and the room at the next level above, you have to break one and two cavity barriers before the flame is in the next compartment, and three cavity barriers, if you will, before you interfere with the next window.
So the fact that the flame is in the cavity in flat 16, is not a compartment breach at that time. It

becomes a compartment breach in the cavity only when it reaches the next flat, above or below.
It's the same with external flame projection. It is taken account for that flames may break a window and project, and that's exactly why the external surface is meant to adequately resist the spread of fire, because it's assumed that that will occur. It's just then it cannot cause a fire in the next apartment.
There are two very distinct things that are factored in. You can have the fire, it can break into the cavity, it can break out the window, but the principle is it then does not go on to burn the next compartment.
So the first sign of flame out the tower is not compartmentation breach, as I understand the statutory guidance.
Q. So it follows from that answer that you think that compartmentation is breached when we have fire up at the next level --
A. Exactly, once it goes above --
Q. -- impinging on the compartment above.
A. Exactly.
Q. You say in your report that internal compartmentation had started to fail by 01.13.
A. Yes.
Q. Would you put 01.13 at the point when --

A. Yes, so around 01.13, you can see the flames above the compartment floor line at level 5, and by the time it gets to 01.15 -- did I say 01.13 there, sorry?
Q. I think you said 01.13 --
A. I should've said 01.13. Within 120 seconds, you can actually see the flame flashing underneath the cladding, on the column at level 5.
So now that is compartmentation breach.
Q. So we have compartmentation breach at that point?
A. By then.
Q. Do you think that was visible, then, at Grenfell Tower --
A. To who?
Q. -- based on the evidence you've seen that there was compartmentation breach by 01.13/01.15?
A. Do you mean to firefighters?
Q. To people watching, yes. Do you think that was visible?
A. Well, you'll note that I haven't said the building failed at 01.13/01.15, because even when the flames start to impinge on level 5, in the moment it's still -- I kind of feel bad even saying this in the context of what actually happened -- a small fire in one small part of flat 16 and the flat above. So in that moment, there is no reason to think it's necessarily going to carry on in those moments, okay?

It's the same when it gets to 6 and 7, and I'm interested in all the other levels, because ideally, using a handheld hose up to about level 7, it's still a fire that can be mitigated potentially. Even when it gets up to level 11, it's still a localised fire. Yes, it's on multiple floors, but it's in a localised area of the building, and it's still within reach of maybe an aerial appliance.
The reason why I went on -- I thought about it for a very long time -- to pick the time of 01.26 for building failure, rather than 01.15, is because at that point, it's very clearly visible that the flame front is now what I would call unstoppable. Okay?
So in those first few storeys, it's still in a small part of those compartments and within reach. Okay?
SIR MARTIN MOORE-BICK: Can I just clarify --
A. That's just my opinion.
SIR MARTIN MOORE-BICK: I understand the proposition that the building did not actually fail in one sense until the fire had progressed from floor 4 up a number of floors.
A. Exactly.
SIR MARTIN MOORE-BICK: But I think I understood you to say that once the fire had got out of flat 4, into the cavity, there was nothing to stop it after that?

A. Yes, that's correct.
SIR MARTIN MOORE-BICK: So in one sense, the building had failed as soon as the fire got into the cavity, had it not?
A. So in hindsight, we know that.
SIR MARTIN MOORE-BICK: Yes.
A. Okay, don't we?
SIR MARTIN MOORE-BICK: It's a matter of perspective.
A. I keep using this "in the moment". So there is no reason in the moment to think that external flame projection, or even a fire in the cavity at level 4, can carry on, and that's why I used the word "catastrophic", okay?
SIR MARTIN MOORE-BICK: In a sense, I think -- I hope I'm right in understanding this -- it's a matter of perception or recognition. So once it had got into the cavity at floor 4 --
A. Yes.
SIR MARTIN MOORE-BICK: -- the ensuing series of events was bound to happen. But you wouldn't know that until it had developed quite a lot further; is that right?
A. Exactly. I suppose if I can say it this way: I think it's unreasonable to expect back then -- now is obviously very different, okay? -- but back then, I think it would be unreasonable for me to say

now: everyone should have known, the minute the flame was in the cavity at level 4, we all knew what was going to happen. I think that would be very unreasonable for me to say.
I still think just within a few storeys, it was an event that maybe could have been mitigated.
SIR MARTIN MOORE-BICK: If you had known the nature of the materials in the cladding, both the insulation and the rainscreen, would that affect your view of what you would've inferred from seeing the fire breaking out of floor 4?
A. Well, I'd go actually even further than that. I think that if those materials had been known -- okay? -- the building shouldn't have been occupied, because the Fire Brigade would have then also known what was facing them.
SIR MARTIN MOORE-BICK: Yes.
A. Okay? So now we're kind of mixing all the time hindsight and in the moment.
So as far as I'm concerned, in the beginning it was a localised fire. It breached the first compartment around 01.13/01.15. It was still a fire that could be mitigated. But above a certain level, it became a fire that could not be mitigated and was clearly not going to stop, because it couldn't stop, because of the construction materials that existed all around the

building.
SIR MARTIN MOORE-BICK: All right. That's very helpful.
A. That's my view.
SIR MARTIN MOORE-BICK: Thank you very much.
MS GRANGE: Just linking that to the stay-put policy.
A. Yes.
Q. You say in your report that the internal compartmentation and the principles of the stay put evacuation regime had started to fail by 01.13.
A. Yes.
Q. Then you say they'd substantially failed by 01.26.
A. Yes.
Q. Is that a distinction that you're still drawing?
A. Yes. It's basically a shorter way of saying what I've just explained there, okay?
Q. In your report you say by 01.21, eight flats had been impacted by the external flame front, and by 01.26 that had risen to 20 flats.
Let's just go to your figure 12.1 on page 8 of chapter 12, BLAS0000012.
A. I don't have that. Oh, yes, here I am. What figure?
Q. Sorry, it's 12.1 I think you're referring to here when you make the point about the flats that are impinged by external flame.
A. Yes.

Q. If we can look at the right-hand two columns here, you say in your report that by 01.21, eight flats had been impacted, and 01.26, 20 flats.
A. Exactly. So this is just a very simple diagram, and each flat is marked red, once the flame front reaches it in any way. It's just trying to show progression. Okay?
Q. Sorry, I should've given a trigger warning before going to that. I was actually wanting to go to the two diagrams below where you've actually tried to just map out the difference.
A. Yes, yes.
Q. Just to test your views on stay put for a moment, it's not your view that stay put was untenable the moment compartmentation was breached around 01.13?
A. Not in that moment, no.
Q. What about at the point at 01.14 when the LFB changed their tactics and they request a hydraulic platform? Do you think that's relevant to when stay put becomes untenable, that event?
A. I think that's a recognition that unplanned for external firefighting is becoming necessary. I think we'll probably be talking about this some more on Monday with the measures.
Just a reminder that a designer only puts into

a high-rise residential building equipment for internal firefighting.

Q. Do you think it was clear at that point that defend in place had failed? This is kind of the mirror image of stay put.

A. Defend in place firefighting is about fighting the fire internally using equipment the building provides for you as a firefighter, and it relies, as does stay put, that there is a flashover fire in one flat that may be impacting another floor above.

Q. What about the ferocity and speed of attack of the fire going up that face? Do you think, before 01.26, the speed and the ferocity perhaps should've indicated that stay put had failed?

A. So I struggle with this bit because I think it's really easy for me to say that now because I woke up the following morning as such, okay? But I think in those moments -- and that's why I want to keep emphasising why I picked 01.26 -- and the minutes that passed, I think up to about storey -- you know, I said between about storey 7 and storey 11, this was still a fire in a corner within reach of typical equipment. Okay?

After that, there was a need for that recognition to occur then. Yes.

Q. Just on the concept of stay put just generally and the

definition of stay put, you have said in your report that the concept of occupants in dwellings adjoining the dwelling on fire being safe if they remain where they are during a fire is the stay-put strategy, and that's how you define it in your report.

A. Yes, yes, that's correct.

Q. Do you agree that the stay-put strategy means you stay in one's flat until that flat becomes compromised by fire or smoke?

A. Yes, or you're free -- it's been written in guidance, certainly since 1971 -- I actually think it's 1962 -- unless you make the decision to leave anyway. So the idea is you may decide to escape anyway and it's safe to do so, or it's safe for you to stay in your flat until you're impacted by products or combustion or you're instructed to do so.

Q. I've been asked to put to you -- if we could just look at the LGA guide on purpose-built blocks of flat, that has a definition of stay put.

A. I'd need that up on the screen.

Q. I'm bringing it up. So it's at 19.1. That's CTAR00000033 at page 30.

So if we look at the bottom of that page, there's a definition here of stay put. So it says:

"19.1. A 'stay put' policy involves the following

approach.

"• When a fire occurs within a flat, the occupants alert others in the flat, make their way out of the building and summon the fire and rescue service.

"• If a fire starts in the common parts, anyone in these areas makes their way out of the building and summons the fire and rescue service.

"• All other residents not directly affected by the fire would be expected to 'stay put' and remain in their flat unless directed to leave by the fire and rescue service."

Do you think that definition in any way differs from the way you've used stay put in your report?

A. Yes. Well, there's a few things that strike me about this -- and I just need to say now, I haven't thought about this before you put it up on the screen.

So, I don't know, who are the people in the common parts and how are they going to know how to make their way out? Or is it that -- is it people in the flats around that common part? Because, remember, there's no detection, there's nothing to alert you even if there's a fire in the common parts in this country in a residential building.

So I see this text from the LGA guide -- I don't know who wrote it or why -- but it is slightly

different, I would suggest, to the statutory guidance document.

I'd need to understand the context of that question to give a proper answer.

Q. Yes.

A. Okay? But ... Yes.

Q. In terms of the last point, is there anything you want to say about that?:

"• All other residents not directly affected by the fire would be expected to 'stay put' and remain in their flat unless directed to leave by the fire and rescue service."

A. Yes, so I understand the sentence, but you know in my own report I've explained at length that, in terms of the building design condition, how the fire and rescue services are expected to do that -- there is no provision made for them.

Also, the statutory guidance is that one is always free to leave a building and one is not meant to rely at all on the fire and rescue services. That's the very kind of foundation. In B1, it makes that clear.

Q. Yes.

A. So I don't know who wants to know this, but if there's something I've missed there, they should maybe ask me another question.

Q. Yes.
Dr Lane, I have really one more key topic today and then, with the chairman's permission, I think what we might do is then break for the rest of today and begin again, because I don't want to start -- the next big topics are flat doors and stair doors, and I want to be able to deal with them in one go. I think that makes sense.
A. Yes.
Q. So I want to ask you a few questions about evacuation now.
You have said, based on a very detailed analysis that you've done of all the evidence available to you, including evidence of the conditions in the lobbies and stairs, that you think there was a window from between 00.58 and 01.40 when a total evacuation needed to occur; is that correct?
A. Okay, so just to explain what I mean by that.
So 00.58 to 01.40. So what I mean by that is -- I don't know if we can put up the clause from -- anyway, Approved Document B, it makes clear there's a fire in one flat, so the probability of fire and smoke spread is low, no reliance on external rescue, and so a total evacuation is highly unlikely to be necessary, I think it is.

So because a building with this form of external wall could never provide the high degree of compartmentation required to support stay put, from my perspective, at handover of that building, with the external wall in the condition it was, a stay-put evacuation strategy should not have formed the fire safety strategy basis of the building anymore, and the only evacuation strategy possible in that context was a total evacuation.
So I'm saying that from what I call a building design condition. So at handover, the high degree of compartmentation cannot be maintained, and so, as the statutory guidance document says, therefore a total evacuation is highly probable to be needed, highly likely to be needed. That's what I mean there.
Q. In terms of the significance of the time 01.40, you basically showed in your analysis that the evacuation substantially slowed at that point; is that correct?
A. Yes. So the thing I've just said there is to do with the building condition.
Now, starting to look at events as they unfolded, in the graphs -- I feel a bit uneasy not having the graph, but I'll crack on -- I have plotted the evacuation rates, and you can see some clear changes through that data, and I've made very clear that was not available

during the fire. That's something I can do in hindsight.
At 01.40, there is a considerable change, and I've explained in section 14 in my report, from all the different types of witness evidence we have, how the stair and the lobbies were changing from 00.58 all through the night, and we know from 01.40 conditions were starting to deteriorate.
Q. Yes.
You have said in your report that before the stay-put guidance began to change at 02.35, 177 occupants had already evacuated. That left 117 in the building at that point.
Thereafter, you said that after 02.35, a further 46 occupants evacuated, the last leaving at 08.07. That's a pattern you've drawn attention to; is that correct?
A. Yes.
Q. I just want to ask you some general questions. We can come back to this on Monday if we need to.
What do you think is potentially going on in terms of smoke ventilation/migration to enable those evacuations at the later stages? Do you have any views as to what might --
A. What's going on with the smoke?
Q. Well, to enable those people to get out of the building.

A. Enable? I don't think they were enabled at all. I think that the people evacuated in life-threatening conditions.
Q. Yes.
Do you think that simultaneous evacuation was fundamentally inconsistent with firefighting operations that were going on at the time in the building?
A. No, I do not.
Q. And --
A. But I just -- sorry, because things get taken out of context.
So I think that the stair capacity and the relatively low occupancy of a building using a single staircase, that is possible. But I just have to keep reminding everyone all the time: buildings designed this way have no means to raise an alarm to tell people to leave.
It just sounds very trite of me to simply say it wouldn't have impacted the firefighters.
There was room on the stairs for everyone. But that's only the start of the story in my opinion.
Q. That's the key thing I wanted to take you to, actually, is what you've done in your report, based on your perspective, is look at the width of the stair and the guidance that's given in Approved Document B; is that

correct?
A. Yes. So that's a very simple capacity check that designers use.
Q. Yes. What you've said is a stair of this width and height is deemed to provide an escape capacity for simultaneous evacuation of 1,030 people. That's what the guidance suggests.
A. Yes, in a very simple way, yes. So that's, you know, ignoring all the realities of an evacuation, yes.
Q. You've also said that even if we assume a 50 per cent capacity of the stair, that's going to be around 515 persons.
A. Yes.
Q. And you say that that is substantially higher than the peak number of firefighters and persons in the tower --
A. Yes.
Q. -- which is 321 persons, which I think is 294 residents and 27 firefighters --
A. Yes.
Q. -- is that correct?
Is it right that that is broadly consistent with Professor Purser's analysis. He, from a different perspective, has calculated that the maximum standing capacity in the staircase was 460 persons.
A. Yes.

Q. Then he gives his views about simultaneous evacuation.
A. So they're very simple capacity checks.
Q. Yes.
A. When you're doing what I call a detailed, proper evacuation analysis, there's all different timings that have to be factored in. How long it takes people to move. We have to remember, even though the statutory guidance makes no provision currently, all the people who find it very difficult or impossible to use the staircase.
So I think in Phase 2 there will be what I would call a very robust evacuation analysis done, and that will factor in all those realities. These are simple capacity checks to show the capacity of the staircase area.
So I don't think, based on the stair width, it was a primary problem. Okay? What was happening on the staircase in terms of smoke and heat and other things is the dominant parameter.
Q. Yes. That's helpful, yes.
So just finally to round up here, you conclude that the required single safety condition, stay put, was not provided for as was required as a result of the rainscreen system installed during the primary refurbishment; is that correct?

A. That's correct.
Q. You say that Grenfell Tower should never have been handed over with this rainscreen system in circumstances where a stay-put strategy was in place; is that correct?
A. That's correct.
Q. Does that opinion assume that all other active and passive measures in the tower were fully functional and in working order?
A. I don't think it's possible, with the external wall construction that there was, to mitigate the type of fire that those materials cause, and that's a whole combination of active and passive fire protection measures, and their condition. I don't think it's possible to mitigate that type of fire, which is why I said the building should not have been handed over in that condition.
MS GRANGE: Dr Lane, I think that is a good moment for me in my questions. If that's okay to finish early today.
SIR MARTIN MOORE-BICK: Yes.
MS GRANGE: Because I want to then go to some of the active and passive measures inside the building.
THE WITNESS: Is that okay?
SIR MARTIN MOORE-BICK: Dr Lane, I understand you've been good enough to say you'll come back on Monday?
THE WITNESS: Oh, yes, very happy to.

SIR MARTIN MOORE-BICK: I think it is going to be of help to everyone if we deal with the next topic in an unbroken way, so we will stop for now for today.
THE WITNESS: Okay, yes.
SIR MARTIN MOORE-BICK: Perhaps you'll be quite pleased anyway because it has been quite a long day for you, we know.
THE WITNESS: Yes.
SIR MARTIN MOORE-BICK: We'll resume at 10 o'clock on Monday with your evidence. I'm going to ask you not to talk about your evidence over the break, if that is all right.
THE WITNESS: That's fine, yes.
SIR MARTIN MOORE-BICK: And we'll look forward to seeing you on Monday morning.
THE WITNESS: Okay, thank you.
SIR MARTIN MOORE-BICK: 10 o'clock. Is that all right?
THE WITNESS: Thank you, yes.
(The witness withdrew)
SIR MARTIN MOORE-BICK: Well, that's all for today.
Just to remind you that we shall be sitting tomorrow to take some further evidence from firefighter witnesses, in particular control room officers. That will be at 10 o'clock tomorrow morning.
But for the time being, that's it, yes?

Thank you very much.
10 o'clock tomorrow. Thank you.
(3.35 pm)
(The hearing adjourned until Friday, 23 November 2018 at 10.00 am)

I N D E X