

| | |
|--|---|
| <p>1 Monday, 18 June 2018</p> <p>2 (10.00 am)</p> <p>3 SIR MARTIN MOORE-BICK: Well, good morning, everyone, and</p> <p>4 welcome to this week's hearings. We're going to begin</p> <p>5 the week by hearing some presentations from the various</p> <p>6 expert witnesses instructed by the inquiry.</p> <p>7 Yes, Ms Grange.</p> <p>8 MS GRANGE: Mr Chairman, thank you.</p> <p>9 This is the first of three days of expert</p> <p>10 presentations. These will be given by Dr Barbara Lane,</p> <p>11 Professor Niamh Nic Daeid and Professor Luke Bisby. As</p> <p>12 Mr Millett outlined in his opening submissions, the</p> <p>13 purpose of these expert presentations is to set in</p> <p>14 context the factual evidence which will shortly be</p> <p>15 called in Phase 1.</p> <p>16 Dr Lane will be introducing key aspects of the</p> <p>17 building and its history, and will identify the active</p> <p>18 and passive fire and safety measures which were present</p> <p>19 in the tower at the time of the fire.</p> <p>20 Professor Nic Daeid's presentation will address</p> <p>21 three principal topics: first, the basic science of</p> <p>22 fire; second, the element of fire investigation, and in</p> <p>23 particular what evidence such as fire markings can tell</p> <p>24 us about the origin of a fire; and, third, a summary of</p> <p>25 her preliminary analysis of the cause and origin of the</p> <p style="text-align: center;">Page 1</p> | <p>1 fire spread to and on the exterior of the tower and the</p> <p>2 fire and smoke spread within the tower.</p> <p>3 We will also hear from Professor Purser. He will be</p> <p>4 dealing with the issues relating to the production of</p> <p>5 toxic gases, including the toxicity performance of</p> <p>6 materials present in the tower on the night of the fire.</p> <p>7 Mr Chairman, the core participants were informed by</p> <p>8 letter last week that if they wish to suggest relevant</p> <p>9 questions for the inquiry experts when they provide</p> <p>10 their oral evidence, those should be submitted to the</p> <p>11 inquiry solicitor's mailbox by Monday, 3 September 2018.</p> <p>12 If there are any further questions which arise out of</p> <p>13 factual evidence heard after that time, then those will</p> <p>14 need to be provided no later than five clear working</p> <p>15 days before the relevant expert is due to give oral</p> <p>16 evidence.</p> <p>17 Prior to calling Dr Lane, who will give today's</p> <p>18 presentation, I need to give some trigger warnings about</p> <p>19 the content of the forthcoming expert material.</p> <p>20 The presentation of Dr Lane which will take place</p> <p>21 today will contain images of the tower before the fire,</p> <p>22 and also some detailed images of certain parts of the</p> <p>23 building after the fire, concentrating on the physical</p> <p>24 features of, for example, the cladding, the windows and</p> <p>25 fire doors. There will also be a simulation of a fire</p> <p style="text-align: center;">Page 3</p> |
| <p>1 initial fire within the kitchen of flat 16.</p> <p>2 Professor Bisby will be explaining certain key</p> <p>3 scientific concepts relevant to flammability and flame</p> <p>4 spread, and will describe the material properties of</p> <p>5 certain materials present in the facade and the windows</p> <p>6 in the tower. He will also set out the preliminary</p> <p>7 evidence which assists in understanding the pattern of</p> <p>8 flame spread out of flat 16 and over the exterior of the</p> <p>9 tower on the night of the fire.</p> <p>10 It is hoped that these expert presentations will</p> <p>11 assist in setting the framework and context to the</p> <p>12 factual evidence which will follow, including from</p> <p>13 firefighters, who will be called first, and from the</p> <p>14 bereaved and survivors of the fire who escaped from the</p> <p>15 tower and who will give evidence from September.</p> <p>16 In terms of the substantive conclusions of the</p> <p>17 experts in their Phase 1 reports, those will be tested</p> <p>18 when they come to give detailed evidence in October, and</p> <p>19 once they have heard and taken account of the factual</p> <p>20 Phase 1 evidence. It is at that time that the experts</p> <p>21 will be questioned on the key opinions they have</p> <p>22 expressed in their reports on Phase 1 issues.</p> <p>23 At that stage, we will also hear from other inquiry</p> <p>24 experts, and in particular Professor Jose Torero, who</p> <p>25 has considered the ignition of the facade materials, the</p> <p style="text-align: center;">Page 2</p> | <p>1 in a flat with reference to how stay put is intended to</p> <p>2 operate.</p> <p>3 I will be calling Dr Lane today.</p> <p>4 The presentation of Professor Nic Daeid, which will</p> <p>5 take place tomorrow, will contain detailed images of the</p> <p>6 flat of origin, flat 16, after the fire, the burnt-out</p> <p>7 compartment. It will also include videos showing the</p> <p>8 early development of the fire and thermal images of the</p> <p>9 firefighting in flat 16, together with the playing of</p> <p>10 the first 999 call by Mr Kebede.</p> <p>11 Mr Andrew Kinnier QC will call Professor Nic Daeid</p> <p>12 tomorrow.</p> <p>13 Finally, the presentation of Professor Bisby, which</p> <p>14 will take place this Wednesday, will include a large</p> <p>15 number of images and videos depicting the external flame</p> <p>16 spread on the night of the fire. This will include the</p> <p>17 playing of his composite flame spread video, which was</p> <p>18 played by Mr Millett in his opening, and detailed</p> <p>19 consideration of that and of other flame spread material</p> <p>20 which shows the tower burning and on fire.</p> <p>21 Some of the videos include the audio of persons</p> <p>22 witnessing the fire and their distress at the unfolding</p> <p>23 events. The presentation will also contain a number of</p> <p>24 images of the burnt-out tower after the fire and the</p> <p>25 playing of the first 999 call again.</p> <p style="text-align: center;">Page 4</p> |

| | |
|--|---|
| <p>1 Mr Millett will call Professor Bisby. 2 So I would now like to call Dr Lane. 3 SIR MARTIN MOORE-BICK: Yes, thank you. 4 DR BARBARA LANE (sworn) 5 SIR MARTIN MOORE-BICK: Thank you very much. Sit down if 6 you like. 7 MS GRANGE: Thank you, Dr Lane. 8 Can you give the inquiry your full name? 9 DR LANE: Dr Barbara Lane. 10 MS GRANGE: I'm going to put to you a number of propositions 11 which I hope will be uncontroversial. 12 You have provided to the inquiry a preliminary 13 Phase 1 report which is dated 12 April 2018 and which 14 consists of 21 chapters and 11 appendices, A to K. 15 DR LANE: Yes, I have. 16 MS GRANGE: That report addresses in particular the active 17 and passive fire protection measures within the tower 18 and the extent to which they failed to control the 19 spread of fire and smoke and contributed to the speed at 20 which the fire spread. 21 DR LANE: That's correct. 22 MS GRANGE: As you indicate in the declaration in section 21 23 of your report, you have provided it in the same way as 24 you would have provided a report to a court. 25 DR LANE: That's correct.</p> <p style="text-align: center;">Page 5</p> | <p>1 Edinburgh. 2 DR LANE: Yes, I am. 3 MS GRANGE: Thank you. 4 I outline that, Dr Lane, so that everyone will 5 appreciate the expertise that you are able to bring to 6 bear and your experience in dealing with the matters 7 this inquiry has asked you to consider. 8 Are the factual matters set out in your report true 9 to the best of your knowledge and belief? 10 DR LANE: Yes, they are. 11 MS GRANGE: Does your report accurately set out your 12 opinions on matters relevant to this inquiry? 13 DR LANE: Yes, it does. 14 MS GRANGE: Thank you, Dr Lane. 15 Now, in your own time, please, would you go ahead 16 and give your oral presentation. 17 DR LANE: Okay, thank you. 18 SIR MARTIN MOORE-BICK: If you would like to stand or sit, 19 you do whichever is most comfortable. 20 DR LANE: I'll move around a bit. 21 SIR MARTIN MOORE-BICK: Yes, do that too. 22 DR LANE: Good morning. 23 I've arranged my opening presentation into an 24 ordered series of subjects as follows. 25 First, this morning I will start by explaining the</p> <p style="text-align: center;">Page 7</p> |
| <p>1 MS GRANGE: In section 1.1 and appendix A to your report, 2 you have outlined your background and experience 3 relevant to the matters in this inquiry. 4 DR LANE: Yes, I have. 5 MS GRANGE: Now, we don't need to rehearse all of that in 6 detail today, but I want to pick out some key points. 7 You are a director of Arup, which is an independent 8 company of designers, planners, engineers, consultants 9 and technical specialists addressing professional 10 services in the built environment. 11 DR LANE: Yes, I am. 12 MS GRANGE: You specialise in fire safety engineering in the 13 built environment and you have 20 years' experience in 14 the construction industry in England and 15 internationally. 16 DR LANE: That's correct. 17 MS GRANGE: You are a chartered fire safety engineer, having 18 graduated from Trinity College Dublin. 19 DR LANE: Yes, that's correct. 20 MS GRANGE: You are a fellow of Arup, which is an honorary 21 title awarded to exceptional individuals within the 22 firm. 23 DR LANE: Yes, I am. 24 MS GRANGE: Finally, you are also a fellow of the Royal 25 Academy of Engineering and the Royal Society of</p> <p style="text-align: center;">Page 6</p> | <p>1 original construction materials and the original 2 building form and layout when Grenfell Tower was 3 designed and built between 1967 and 1974. I will 4 provide information on the external landscape around the 5 tower at that time also. 6 I will then provide a detailed presentation on the 7 fire safety requirements for high-rise residential 8 buildings in England. 9 In part 1, I will address the Building Regulations 10 and the requirement to provide a stay-put strategy, how 11 it is a design condition and why it is not a Fire 12 Brigade policy. I will address how this is the single 13 safety condition required to be provided. 14 In part 2, I will explain each of the required 15 active and passive fire protection measures that are 16 provided for the stay-put strategy. 17 I will then move specifically on to Grenfell Tower. 18 I will explain the summary time-line I have derived 19 regarding the recorded building works to the tower since 20 1974, before explaining, in chronological order, each 21 of: the replacement of the passenger lifts which took 22 place in 2005; the replacement of the majority of the 23 flat entrance fire doors in 2011; a description of the 24 gas supply refurbishment works which had commenced in 25 2016 and were still in progress the night of the fire.</p> <p style="text-align: center;">Page 8</p> |

| | |
|--|---|
| <p>1 I will then dedicate the rest of the afternoon 2 session to describing in detail the works that were 3 undertaken on the building as part of the primary 4 refurbishment carried out between 2012 and 2016. This 5 includes a description of the work done to the interior 6 of the building as well as the works done to the 7 exterior of the building.</p> <p>8 I will provide an overview and then explain in the 9 following order the external works to the immediate 10 surroundings of Grenfell Tower: the reconfiguration of 11 ground level to level 3; the reconfiguration of the 12 internal fire main; the refurbishment of the existing 13 smoke control system; the provision of a new heating 14 system and the new hot and cold water systems, before 15 ending with a detailed explanation of the materials 16 forming the rainscreen cladding works as I have found 17 them in my work for the inquiry.</p> <p>18 My colleagues working with me on my factual 19 investigations are Susan Deeny, Peter Woodburn, 20 Tom Parker, Alfie Chapman, Daniel Antonellis and 21 Graeme Flint.</p> <p>22 Dr Flint is in attendance to operate the series of 23 photos, illustrations and animations throughout the 24 presentation which we have provided in order to help 25 understand the technical issues I'm focusing on today.</p> <p style="text-align: center;">Page 9</p> | <p>1 that allowed access from each of the finger blocks over 2 to the tower. The finger blocks extend to the south 3 side of Grenfell Tower and enclose two large green 4 spaces. The area to the immediate east of 5 Grenfell Tower is Lancaster Green and there were 6 children's play areas to the immediate west. To the 7 north side lies Silchester Road.</p> <p>8 Grenfell Tower is owned by the local authority, 9 Kensington and Chelsea London Borough Council. 10 Grenfell Tower was part of their provision of social 11 housing in the borough. The management of social 12 housing in the borough was devolved in 1996 to the 13 Kensington and Chelsea Tenant Management Organisation.</p> <p>14 Originally, the main fire vehicle access designed 15 for was via Grenfell Road at the south end of the tower. 16 Based on the original design drawings, it also appears 17 that fire vehicles could also have accessed the building 18 via Silchester Road at the north end of the tower if 19 that was needed.</p> <p>20 As shown in this 3D model, fire vehicles approach 21 the building from Grenfell Road in the south, with 22 access to the southeast corner of the tower provided by 23 driving under the level 2 walkway.</p> <p>24 In this series of photographs, this southern 25 approach route is shown, which was the state before the</p> <p style="text-align: center;">Page 11</p> |
| <p>1 The original building construction and layout. 2 As I've explained in section 3 of my preliminary 3 Phase 1 report, Grenfell Tower is a 25-storey building 4 with a basement level and a ground to level 23 5 inclusive, plus a plant room located above level 23 at 6 roof level. It is a residential block built in the 7 early 1970s and is located in the Lancaster West Estate 8 in the North Kensington area of London.</p> <p>9 The Lancaster West Estate is located in the Royal 10 Borough of Kensington and Chelsea. The estate was 11 designed by Clifford Wearden & Associates in the late 12 1960s. Phase 1 was approved in 1970 and consisted of 13 the tower as well as three low-rise residential blocks 14 called finger blocks. These are Testerton Walk, 15 Hurstway Walk and Barandon Walk. They are three- and 16 four-storey buildings.</p> <p>17 Construction of Grenfell Tower by contractors 18 AE Symes of Leyton, London, commenced in 1972, with the 19 tower completed in 1974.</p> <p>20 To help explain the external spaces around the 21 outside of Grenfell Tower, I have drawn on some 22 additional information not currently in my report, using 23 online mapping services and commercially available 24 context models of the surrounding area.</p> <p>25 There was a walkway at level 2 of Grenfell Tower</p> <p style="text-align: center;">Page 10</p> | <p>1 last refurbishment works occurred. The height between 2 the road surface and the underside of the walkway 3 structure is approximately 4.8 metres.</p> <p>4 The presence of the walkway is important in 5 retrospect because it means that, whilst it was tall 6 enough to allow fire vehicles to access underneath the 7 walkway for the purposes of internal firefighting, such 8 a walkway provides an obstacle for unplanned external 9 firefighting, as became required during the fire.</p> <p>10 High-reach appliances would need to move out from 11 underneath the walkway to deploy their ladder or 12 platform and to deploy their stabilisation systems.</p> <p>13 The areas around the east, north and west side of 14 the building were quite open, with a mixture of grassy 15 areas and hard landscaping. It is useful to orientate 16 from the south side, where the three finger blocks are 17 located.</p> <p>18 Originally, outside and around the tower at ground 19 level were positioned a ballgame pitch, nursery play 20 areas and other amenity landscaping. From online 21 mapping services, it is apparent that the amenity 22 landscaping around the base of the tower was largely 23 retained until around 2012.</p> <p>24 In this image, all the areas around the building 25 that could support vehicle access are highlighted in</p> <p style="text-align: center;">Page 12</p> |

| | |
|--|---|
| <p>1 red. In its original form, therefore, fire vehicles 2 could have moved around the base of the tower as 3 follows: three-quarters of the south side; full access 4 to the east and north side; half of the west side. 5 Pedestrians and, therefore, firefighters could 6 additionally reach all parts of the outside of the 7 building originally at ground level as I have marked 8 here. 9 Originally, there were three main pedestrian entry 10 routes into Grenfell Tower. At ground level, 11 firefighters could access the lifts within the central 12 core there. Alternatively, they could climb one of the 13 three open stairs external to the tower up to the 14 walkway at level 2. At this level 2, access was also 15 possible into the central core, to the protected 16 internal stair and the original lifts. Therefore, 17 firefighters would've been able to access the inside of 18 the tower by the walkway. However, fire vehicle access 19 was only provided at ground level. 20 Grenfell Tower is 67.3 metres tall. Originally, it 21 contained 120 one- and two-bedroom flats. There were 22 six dwellings per floor on 20 of the 24 storeys, with 23 the other four storeys being used for non-residential 24 purposes. It was originally intended to house up to 600 25 people. Levels ground, 1 and 3 were more flexible open</p> <p style="text-align: center;">Page 13</p> | <p>1 the floor is provided by the concrete cross walls 2 between the flats. 3 To add further detail to the description I've 4 currently included in my report, the floor slabs were 5 20 centimetres thick. The walls enclosing the protected 6 lobbies, stairs and lift shafts on every level are 7 collectively referred to as the core walls. The 8 thickness of the core walls vary between 20 and 9 30 centimetres. 10 The perimeter beams are approximately 25 centimetres 11 thick. The perimeter columns are approximately 12 70 centimetres square. This does not include the 13 precast ridge facing that was used as sacrificial form 14 work. This ridged facing, as visible today on the 15 tower, was permanently connected to the columns through 16 the provision of metal wires embedded in the concrete. 17 The structural walls between flats were 20 centimetres 18 thick. 19 The original external wall of Grenfell Tower 20 consisted of exposed concrete surfaces and glazing. The 21 perimeter beams were solid concrete. The opening 22 between each perimeter beam was filled with a 23 combination of sliding windows held in aluminium frames 24 and non-structural, non-combustible infill panels. The 25 specific material of the infill panels is currently</p> <p style="text-align: center;">Page 15</p> |
| <p>1 spaces which were created for uses such as a nursery, 2 offices and a community health centre. Level 2 was left 3 entirely open as a continuation of the walkway 4 connecting to the adjacent blocks of the Lancaster West 5 Estate. 6 Each storey in Grenfell Tower is 2.6 metres high, 7 except for level 2, which is 4.3 metres high, and 8 level 3, which has a height of 3.9 metres. 9 Grenfell Tower has a plan floor area of 10 approximately 22 by 22 metres. It has a single central 11 reinforced concrete core, reinforced concrete floors and 12 with perimeter reinforced concrete columns. Reinforced 13 concrete cross walls were provided to separate each flat 14 at level 4 to level 23 inclusive. These walls did not 15 extend to the basement level, nor did these walls exist 16 at ground to level 3. 17 The structural stability mechanism for 18 Grenfell Tower is that of a conventional concrete 19 building, with a lateral stability core in the middle of 20 the building and concrete columns around the perimeter 21 supporting gravity loads. The floor is a flat 22 reinforced concrete slab transferring load directly to 23 the core. At the perimeter of the building, loads are 24 transferred into the columns directly by the floor and 25 via the precast perimeter beams. Additional support to</p> <p style="text-align: center;">Page 14</p> | <p>1 unknown, but I understand it to consist of 2 asbestos-bearing cementitious material. 3 As you can see in this photograph and highlighted by 4 the yellow dotted line, the windows fully filled the 5 space vertically between the top of one perimeter beam 6 and the underside of the next beam. 7 Horizontally, the metal window frames were fixed 8 directly to the concrete structure on three sides and to 9 the infill panel on the fourth side. The external wall 10 of the building was, therefore, entirely 11 non-combustible. 12 The external wall was a single system. This meant 13 there was no void or space concealed within that 14 external wall. 15 From here, I will refer to such spaces, concealed 16 spaces, as cavities. Cavities are spaces enclosed by 17 elements of a building or contained within an element of 18 the building. I will be presenting more information on 19 the issue of cavities and building construction later in 20 my presentation. 21 I now move inside the building to describe the 22 original construction of the window and the external 23 wall internally. 24 Here is a photograph of the inside of a two-bedroom 25 flat before the refurbishment works were undertaken.</p> <p style="text-align: center;">Page 16</p> |

| | |
|--|---|
| <p>1 This is taken from section 8.4 of my report. The 2 photograph shows the original form of the interior 3 window finishes and the windows themselves. The windows 4 were originally side sliding metal framed windows in 5 a wooden frame fixing system. As I have already noted, 6 these windows and the adjacent infill panels fully 7 filled the space between each perimeter beam from floor 8 to floor. 9 The window cills, the window jambs on both sides and 10 the head of the window appear to be lined in timber. 11 The original infill panel also appears to have been 12 faced with timber on the room side. 13 Below the windows, a plasterboard covered with 14 a polymeric insulation, a product called purlboard, was 15 applied directly to the concrete perimeter beams. This 16 layer of purlboard was also applied to the concrete 17 ceiling in a small area close to the external wall, but 18 ran along the full perimeter of every room in every flat 19 at ceiling level. 20 Therefore, in terms of combustible material, the 21 original design contained the internal timber surrounds 22 and timber lining of the infill panel, as well as the 23 purlboard above and below the window on the room side. 24 This combustible material did not extend to the outside 25 of the building.</p> <p style="text-align: center;">Page 17</p> | <p>1 The basement has been used since 1974 as a plant 2 space for the various electrical, gas, water and heating 3 systems in the building, with multiple services shafts 4 rising up from the basement through every storey in the 5 tower. 6 Level 24 is roof level. This level had a fully 7 enclosed plant space in the central portion of the 8 storey, with an open walkway around the perimeter of the 9 roof. A ladder was also provided to the roof of this 10 main plant enclosure. There, at the roof of the plant 11 enclosure, was located: the outlets from the flues from 12 the basement gas boilers; the outlets from the smoke 13 control system; the outlets from the lift motor room and 14 lift shaft ventilation systems; the permanently open 15 vent provided at the top of the stairs; the output vents 16 to the waste pipe stacks serving each of the flats on 17 each of the floors. 18 This ends my explanation of Grenfell Tower and its 19 surrounding area as it was designed and constructed 20 between 1967 and 1974. 21 I will now set out the fire safety requirements for 22 high-rise residential buildings in England and, in doing 23 so, address specifically the design requirement to 24 provide a stay-put strategy. I will explain how it is 25 designed and how it is intended to operate.</p> <p style="text-align: center;">Page 19</p> |
| <p>1 Levels ground, 1 and 3 contained a nursery at ground 2 floor, community use rooms at level 1 and a health 3 centre at level 3. 4 The layout of levels 4 to 23 were the same on every 5 storey. There were six flats on each of these storeys. 6 The flats in each corner were two-bedroom flats, and the 7 retaining two, one on each side of the core, were 8 one-bedroom flats. Reinforced concrete cross walls and 9 floors separated each flat on level 4 to level 23. 10 Therefore, each flat was enclosed in fire-resisting 11 construction. This is known as compartmentation and 12 I will further describe this concept later on. 13 Within the central core was a common lobby that 14 provided access to each of the flats. This lobby also 15 provided access to the residential lifts and the only 16 means of escape, the single escape stairs. This lobby 17 was a separate compartment to the flats and enclosed 18 within its own fire-resisting concrete walls. 19 The original smoke control system used automatic 20 vents on the north wall of the lobby to exhaust smoke 21 into smoke exhaust shafts on the north side, with fresh 22 air being supplied from fresh air shafts through 23 automatic vents on the south wall of the lobby. These 24 smoke and fresh air fans were provided for firefighters 25 to operate if required.</p> <p style="text-align: center;">Page 18</p> | <p>1 After a short break in the second part of this 2 presentation, I will then explain each of the active and 3 passive fire protection measures required to create the 4 safety condition, the stay-put strategy. 5 Building fire safety is dealt with through the 6 requirements of the Building Regulations. The Building 7 Regulations state that the requirements shall not 8 require anything to be done except for the purpose of 9 securing reasonable standards of health and safety for 10 persons in or about buildings and any others who may be 11 affected by buildings or matters connected with 12 buildings. 13 The Building Regulations contains a series of 14 requirements; they are all listed on this slide. 15 Fire safety requirements are dealt with in part B of 16 the Building Regulations: Part B -- fire safety. 17 The Building Regulations make clear that 18 Approved Document B, fire safety, is approved by the 19 Secretary of State for the purposes of the 2000 20 regulations. Approved Document B is therefore what 21 I refer to as the statutory guidance document in my 22 report and in this presentation. 23 Fire safety requirements are considered by means of 24 five specific requirements. I've reproduced each one on 25 each of the next five slides.</p> <p style="text-align: center;">Page 20</p> |

| | |
|--|--|
| <p>1 B1 deals with means of warning and escape. The 2 building shall be designed and constructed so that there 3 are appropriate provisions for the early warning of 4 fire, and appropriate means of escape in case of fire 5 from the building to a place of safety outside the 6 building capable of being safely and effectively used at 7 all material times. 8 Requirement B2 deals with the requirements to 9 inhibit internal fire spread as it relates to the 10 internal linings of a building. 11 Requirement B3 deals with further requirements for 12 internal fire spread as relates to the structural 13 stability of the building, subdividing a building with 14 fire-resisting construction and preventing the unseen 15 spread of fire and smoke within concealed spaces. 16 Requirement B4 makes requirements regarding external 17 fire spread and, specifically, that the external walls 18 of the building shall adequately resist the spread of 19 fire over the wall and from one building to another, 20 having regard to the height, use and position of the 21 building. It makes requirements for the fire 22 performance of the roof of the building. 23 Requirement B5, the fifth and last of these building 24 requirements, deals with the requirements for access and 25 facilities for the fire services. Specifically, it</p> <p style="text-align: center;">Page 21</p> | <p>1 to design and construction stages only. 2 There is a further requirement for any building to 3 which the Regulatory Reform (Fire Safety) Order will 4 apply once that building is occupied; that is 5 a requirement to make a full plan submission. This 6 means providing a description of the proposed building 7 work and any other plans necessary to show that the work 8 would comply with regulations. 9 The final requirement is the requirement of the 10 local authority to provide a completion certificate for 11 buildings to which the Regulatory Reform (Fire Safety) 12 Order will apply. 13 I note the requirement for a local authority to 14 ascertain, after taking all reasonable steps, that the 15 relevant requirements specified in the certificate have 16 been satisfied. The relevant requirements mean the 17 requirements of regulation 38 regarding the required 18 fire safety information being provided to the 19 responsible person and the five requirements of part B. 20 I note also that the Building Regulations currently 21 state that such a certificate is not conclusive evidence 22 that the requirements specified have been complied with. 23 These are the requirements under the Building 24 Regulations. 25 I would like now to draw your attention to</p> <p style="text-align: center;">Page 23</p> |
| <p>1 requires that the building shall be designed and 2 constructed so as to provide reasonable facilities to 3 assist firefighters in the protection of life. Further, 4 it requires that reasonable provision shall be made 5 within the site of the building to enable fire 6 appliances to gain access to the building. 7 There are three other general requirements, but 8 specifically relating to fire safety. 9 The first of these three is the requirement to 10 provide fire safety information, regulation 38. This 11 requires the person carrying out the building work to 12 give fire safety information to the responsible person 13 for that building no later than the date of completion 14 of the work and as reproduced on this slide. The 15 responsible person is the person who owns or controls 16 the building. 17 The required fire safety information to be provided 18 is defined in the Building Regulations as information 19 relating to the design and construction of the building 20 which will assist the responsible person operate and 21 maintain the building with reasonable safety. This is 22 for any building where the Regulatory Reform (Fire 23 Safety) Order applies. This is the legislation that 24 provides for fire safety duties when buildings are 25 completed and occupied. The Building Regulations relate</p> <p style="text-align: center;">Page 22</p> | <p>1 Approved Document B for fire safety, which is approved, 2 as I said, by the Secretary of State for the purposes of 3 what's called practical guidance with respect to the 4 requirements contained in the Building Regulations. 5 Therefore, Approved Document B communicates practical 6 guidance for the five fire safety requirements, B1 to B5 7 inclusive. 8 I note it acknowledges that there may well be 9 alternative ways of achieving compliance with the 10 requirements. I have no evidence that such 11 an alternative approach was considered in matters 12 relating to Grenfell Tower and will therefore not 13 mention the concept of an alternative approach again. 14 I will refer to this statutory guidance document, 15 Approved Document B. 16 Just as the Building Regulations directly connect 17 design and construction-related duties to the Regulatory 18 Reform (Fire Safety) Order, so too does the approved 19 document make that clear. 20 Approved Document B states, for blocks of flats, the 21 Regulatory Reform (Fire Safety) Order applies to the 22 common parts of blocks of flats only. It advises it 23 would be useful for designers to carry out a preliminary 24 fire risk assessment of the building as part of the 25 design process, and how this fire risk assessment can</p> <p style="text-align: center;">Page 24</p> |

6 (Pages 21 to 24)

| | |
|---|--|
| <p>1 then be used in the Building Regulations submission and 2 can be used to assist the fire safety enforcing 3 authority in providing advice on any additional 4 provisions that may be necessary in the occupied 5 building. 6 However, for high-rise residential buildings the 7 Housing Act 2005 also applies and exists in parallel 8 with the Regulatory Reform (Fire Safety) Order. 9 Section 3 of the Housing Act requires local housing 10 authorities to keep housing conditions in their area 11 under review and to investigate and take action against 12 hazards that may be present. Fire is explicitly 13 referenced as a relevant hazard in section 10 of the 14 Act. 15 Where fire hazards are identified in the common 16 parts of flats, the Act requires the local housing 17 authority to consult the local fire authority, where 18 possible, before taking action. 19 It is important to note that the Housing Act 2004 20 states the common parts of a building include the 21 structure and the exterior of the building. 22 Before I explain the stay-put strategy, it's 23 important to note that the term "stay put" is not used 24 anywhere in Approved Document B. It states: 25 "a. the fire is generally in a flat;</p> <p style="text-align: center;">Page 25</p> | <p>1 remains cited in the Building Regulations. It is now 2 superseded by British Standard 9991 called, "Fire safety 3 in the design, management and use of residential 4 buildings". 5 BS 9991 does refer to the stay-put strategy and in 6 four specific locations. 7 First, regarding escape, which is almost identical 8 to the text used in Approved Document B. It goes 9 further and refers to occasions where operational 10 conditions are such that the fire and rescue service 11 decide to evacuate the building. This is the only 12 reference in the standard and no specific provisions are 13 made in order to enable the communication of this change 14 or the management of this change with regard to the 15 provision of active and passive fire protection measures 16 within the building. 17 Secondly, BS 9991 refers to the need for additional 18 protection to the staircase by the provision of smoke 19 control because of the stay-put strategy. 20 Thirdly, regarding an increase in fire resistance 21 periods for structure for the occupants of other 22 dwellings remaining in place. 23 Finally, it specifically references the stay-put 24 strategy regarding the fire performance of the external 25 face of the building. It says flame spread over or</p> <p style="text-align: center;">Page 27</p> |
| <p>1 "b. there is no reliance on external rescue ... 2 "c. measures in section 8 ... provide a high degree 3 of compartmentation and therefore a low probability of 4 fire spread beyond the flat of origin, so that 5 simultaneous evacuation of the building is unlikely to 6 be necessary; and 7 "d. although fires may occur in the common parts of 8 the building, the materials and construction used there 9 should prevent the fabric from being involved beyond the 10 immediate vicinity ..." 11 It further states these provisions assume that, in 12 the design of the building, reliance should not be 13 placed on external rescue by the fire and rescue 14 service, nor should it be based on an assumption that 15 the fire and rescue service will attend an incident 16 within a given time. 17 This approved document has been prepared on the 18 basis that, in an emergency, the occupants of any part 19 of a building should be able to escape safely without 20 any external assistance. 21 Approved Document B refers for means of escape from 22 flats to a British Standard, British Standard 5588 23 part 1, which is called "Fire precautions in the design, 24 construction and use of buildings: code of practice for 25 residential buildings". This is no longer current but</p> <p style="text-align: center;">Page 26</p> | <p>1 within an external wall construction should be 2 controlled to avoid creating a route for rapid fire 3 spread by bypassing compartment floors or walls. This 4 is particularly important, it says, where a stay-put 5 strategy is in place. 6 I would like to conclude with a reminder from the 7 very first British Standard code of practice for flats, 8 referred to as CP3, where in 1962 it provided the first 9 explanation of the stay-put strategy, where occupants, 10 if they choose, remain safely on their own floor and 11 occupants on the floor on which the fire occurs, and in 12 some circumstances those floors in the immediate 13 vicinity of the fire, should be free to reach safety in 14 another part of the building via the staircase. Since 15 that time, a total building evacuation has not been 16 provided for when designing the active and passive fire 17 protection measures. 18 I have set out each of the statutory guidance 19 document, Approved Document B, and the British Standards 20 since 1962 because they all provide the same requirement 21 for active and passive fire protection measures in 22 high-rise residential buildings. 23 I note that whilst stay put is directly referenced 24 in the British Standards, no such mention of it nor what 25 it relies upon is provided in Approved Document B.</p> <p style="text-align: center;">Page 28</p> |

| | |
|--|---|
| <p>1 I will refer to those published guidance documents 2 at times throughout my presentation today. These 3 published guidance documents are all matters of Building 4 Regulations; they are not matters of Fire Brigade 5 policy. 6 The stay-put strategy. 7 During a single flat fire, the occupants of that 8 flat evacuate and all other occupants are safe if they 9 remain where they are. The concept of being safe to 10 remain where they are during a fire is the stay-put 11 strategy. 12 It is the single safety condition provided for 13 through the statutory guidance document, 14 Approved Document B, and all versions of the British 15 Standards for flats to date. 16 It is a single safety condition, but with multiple 17 layers of protection provided. These layers of 18 protection, or safety layers, are provided through the 19 required active and passive fire protection 20 measures: the building construction, including its 21 external walls, the internal compartmentation in the 22 building and the structural stability system of the 23 building, or the active fire protection measures, such 24 as smoke control to the staircase. One of the other 25 layers of safety is something I have chosen to refer to</p> <p style="text-align: center;">Page 29</p> | <p>1 This is in order to explain how the design of the active 2 and passive fire protection measures, which includes the 3 external wall fire response, provides the safety 4 condition required, which is for the building residents 5 and for the firefighters. The content of this section 6 of my presentation is drawn from section 3.2, 3.3, 3.4 7 and section 18 of my report. 8 In the event of a fire in a flat, a fire detection 9 and alarm system should be present in the flat and raise 10 the alarm for occupants in that flat only. No alarm 11 will sound anywhere else in the building. The Fire 12 Brigade will not be alerted automatically. 13 Once alerted to the fire, the occupants should leave 14 the flat with the door shut behind them. To support 15 this first stage of evacuation from the flat itself, 16 a protected entrance hall is required within the flat. 17 In a single stair building, the person from within 18 the flat on fire must first escape through the common 19 lobby over to the stair entrance. 20 A range of fire protection measures are provided to 21 protect the occupants when travelling through the 22 lobby: fire-resisting walls around the flat of fire 23 origin; fire-resisting walls around the protected lobby 24 and around the protected stairs; fire doors in the 25 relevant fire-resisting walls; a smoke control system</p> <p style="text-align: center;">Page 31</p> |
| <p>1 in my Phase 1 report as "defend in place" firefighting. 2 Since 1962, CP3 states the guiding principle in the 3 recommendations which follow is safety of life. In 4 securing this, means of escape, construction and 5 firefighting all play a part. 6 Section 701 goes on to state that in high blocks of 7 flats it is essential that provision should be made to 8 assist the fire service in applying water to a fire as 9 early as possible. The need to apply water early in 10 a fire and the need for the fire being extinguished 11 early are required of the Fire Brigade. This form of 12 firefighting is provided for by means of the active and 13 passive fire protection measures in the building too. 14 So the building construction, its active fire safety 15 systems and the firefighting in combination provide the 16 safety of life and are the foundation of the stay-put 17 strategy. 18 Defend in place firefighting also relies on the high 19 degree of compartmentation in a high-rise residential 20 building, because it is this compartmentation which 21 enables this single flat fire event upon which the 22 stay-put strategy relies. This compartmentation is the 23 very basis of design. 24 I will now narrate an explanation of how the 25 stay-put strategy is designed to function in a fire.</p> <p style="text-align: center;">Page 30</p> | <p>1 extracting heat and smoke from the protected lobby, 2 designed to prevent smoke from being able to penetrate 3 into the stairs, but providing some local protection in 4 the lobby too; controls on materials in the common lobby 5 to prevent rapid fire spread through this part of the 6 escape route in the event fire breaks out of the flat 7 compartment. 8 People in adjoining dwellings on the same floor do 9 not automatically evacuate. They have received no alarm 10 or signal to evacuate. The design is focused, 11 therefore, on containing a fire within the flat of fire 12 origin, creating a single flat fire event. This is 13 provided through the fire-resisting walls and floors in 14 that flat. 15 The final side of the fire-resisting box is the 16 external wall. In accordance with the Building 17 Regulations, the construction of the external walls are 18 required to adequately resist the spread of fire. 19 Therefore, the people in adjoining flats on the same 20 floor, who rely on the same horizontal escape route 21 through the lobby, are protected, because the design 22 intent is that the fire stays within this one 23 compartment or box around the flats. Everything is 24 invested in preventing the internal spread of fire. The 25 required external wall fire performance based on</p> <p style="text-align: center;">Page 32</p> |

| | |
|--|---|
| <p>1 adequately resisting the spread of fire is intended to 2 prevent an external fire scenario beyond the single flat 3 on fire. 4 Equally, people on the floors above the floor where 5 the flat fire has started are also to be protected from 6 the single flat fire below them, again, by the measures 7 provided to contain the fire in one flat; again, through 8 the compartmentation to the flats, lobby and stairs, 9 along with the lobby smoke control; and, again, the 10 external wall and the requirements for the construction 11 of that external wall should also provide protection to 12 the people in the flats above the flat on fire. 13 A person requiring assistance will also need to 14 escape from their flat to the lobby. Once they are out 15 in the lobby, they are now separated from the immediate 16 effects of the fire in the flat. However, protection 17 measures for the lobby are not intended to provide 18 indefinite protection and it may not be safe for 19 a person to remain within the lobby. 20 At this stage, the choices available to a person 21 requiring assistance to escape are: to escape using the 22 stairs if they are able; to use an evacuation lift with 23 assistance from building management if such assistance 24 is available; to use the firefighting lift with 25 assistance from the Fire Brigade; to be carried down the</p> <p style="text-align: center;">Page 33</p> | <p>1 The protection measures in the lobby and the stair, 2 however, are also provided to create a safe working 3 environment for the Fire Brigade. The Fire Brigade 4 require this safe working environment in order to be 5 able to access the building, travel up to the flat on 6 fire, and suppress the fire in that flat early. They 7 also rely on the safe working environment in the lobby 8 and the stairs to allow them time and a protected route 9 to travel to rescue any residents in what is expected to 10 be the immediate vicinity of the flat on fire. 11 Nothing more extensive than that is provided for 12 through the building design requirements for the 13 stay-put strategy. The requirements of the Building 14 Regulations to provide active and passive fire 15 protection measures are relied on by all building 16 occupants during a fire -- all residents and all 17 firefighters. 18 Since the first code of practice for fire safety in 19 flats was published, it states: 20 "Reliance on such appliances as manipulative types 21 of escape or mobile ladders is considered 22 unsatisfactory." 23 High-rise residential buildings must, therefore, be 24 designed on the basis that firefighting does not occur 25 from outside. This concept has been carried over into</p> <p style="text-align: center;">Page 35</p> |
| <p>1 stairs by firefighters, building management staff or 2 potentially their neighbours. 3 There is no provision required in the statutory 4 guidance for residential buildings, unlike other 5 building types, to provide equipment for those persons, 6 so there is no provision made for them to either contact 7 building management, should they even be present in 8 a building, nor to communicate directly with the fire 9 service present in the building. The person can only 10 make a personal 999 call. In other building types, 11 refuges with communication devices are required. 12 Once occupants of the flat on fire have made their 13 way through the lobby, the final part of their 14 evacuation is down the stairs. Once down the stairs, 15 they should now phone 999 and alert the Fire Brigade to 16 the fire. 17 The protection provided to stairs is intended to 18 physically prevent the penetration of smoke and fire 19 into the stair enclosure by provision of fire-resisting 20 construction, including the stair door; prevent smoke 21 from entering the stair by provision of fire-resisting 22 lobbies, including the flat entrance fire door and smoke 23 ventilation systems; and so also prevent the spread of 24 fire and smoke blocking use of the protected stair for 25 any residents above the fire floor.</p> <p style="text-align: center;">Page 34</p> | <p>1 all modern design codes, where the regulations require 2 provisions only for internal firefighting in high-rise 3 residential buildings. 4 Therefore, the Building Regulations require adequate 5 access to buildings for firefighters and their vehicles 6 only at the entry point to the building and nowhere else 7 around the building. 8 The provisions made for firefighting are also based 9 entirely on an internal fire occurring. By design, 10 these provisions are made on the assumption that 11 a single internal flat fire and contained within the 12 compartment will occur. 13 The construction of the external wall to this 14 compartment is to adequately resist the spread of fire, 15 such that mitigating a spreading external fire is not 16 incorporated into any of the other protection measures 17 in the building as provided for the firefighters. The 18 external fire scenario not happening is critical to 19 maintaining this box around each flat. The high degree 20 of compartmentation is also required for safe 21 firefighting in high-rise residential buildings. 22 Therefore, on the basis of internal firefighting 23 only, Approved Document B provides for suitable road 24 access and a parking space for a single fire vehicle 25 within 18 metres of the firefighter entrance and the</p> <p style="text-align: center;">Page 36</p> |

| | |
|--|--|
| <p>1 fire main inlets. It is from here the Fire Brigade will 2 prepare for internal firefighting operations. 3 Once inside the building, the following is provided 4 for firefighters: a firefighting stair; a firefighting 5 lift, which is a lift that can be operated under sole 6 Fire Brigade control and has safety features to permit 7 it to be used during a fire; a firefighting main, 8 a dedicated system for conveying firefighting water to 9 the upper floors of a building; a protected lobby on 10 every floor, including a smoke control system; 11 a protected space between the firefighting stairs and 12 all flats. 13 The design requirements provide for the following 14 firefighting process. On arrival, the Fire Brigade will 15 secure a water supply for firefighting from outside the 16 building by means of the required water hydrant in close 17 proximity to the building. The firefighting teams move 18 towards the building and enter. 19 The statutory guidance provides them with a 20 firefighting lift within a protected lobby. The 21 firefighters can approach the firefighting lift and take 22 it under their direct control. The lift is then used by 23 fire crews to carry their equipment, such as hoses, 24 tools and breathing apparatus, and, by design, is 25 assumed to go to the lobby two floors below the fire.</p> <p style="text-align: center;">Page 37</p> | <p>1 compartmentation is so important when firefighters split 2 the building into sectors. 3 Firefighters rely on the compartmentation and the 4 smoke control to the lobby to also set up any search 5 sectors needed above a fire sector. They rely on the 6 protected stairs and lobby to move safely to any of 7 these required search sectors. 8 They rely on the compartmentation and smoke control 9 within the building to set up what they call the lobby 10 sector, which is below the fire sector and used for 11 co-ordination of all their required logistics. Again, 12 they rely on the protected stairs and lobbies to move 13 safely up and down to the lobby sector. 14 Finally, the firefighting lifts are provided so that 15 they can be safely used during the fire to transport 16 firefighters and their equipment to a floor of their 17 choice. 18 Two final points. 19 The fire protection measures must be constructed and 20 then maintained to ensure they are fit for purpose in 21 the event of fire. The stay-put strategy is provided 22 through design construction and ongoing maintenance. 23 All building occupants, including the Fire Brigade, rely 24 on it in the event of a fire. It is the single safety 25 condition provided for in the design of high-rise</p> <p style="text-align: center;">Page 39</p> |
| <p>1 This lobby becomes the bridgehead, which is an area 2 used to muster firefighters and their equipment. This 3 lobby is designed to protect the firefighters from fire 4 and smoke on the fire floor above and maintain a safe 5 air environment there. That is air safe to breathe 6 without the protection of breathing apparatus. 7 Firefighters will be tasked with approaching the 8 flat containing the fire and extinguishing it. From 9 within the stair, they connect their fire hose and 10 branch into the building fire main. 11 Firefighters use the protected stair to walk up to 12 the fire floor with the charged hose. They are provided 13 with sufficient water by means of the building fire main 14 provisions, and this includes the provision to charge 15 a second hose as may be required to protect those 16 firefighters who are now in the flat on fire and 17 suppressing that fire there. 18 The firefighters are now operating within what they 19 term the fire sector. One example of this is a fire 20 sector which includes the fire floor, the floor above 21 and below. The active and passive fire protection 22 measures are required to prevent a fire from 23 significantly spreading beyond a single flat in the fire 24 sector. 25 I have found it useful to understand how</p> <p style="text-align: center;">Page 38</p> | <p>1 residential buildings in England. 2 The statutory guidance makes no provision within the 3 building for anything other than a stay-put strategy. 4 There is no means of warning nor a means to communicate 5 the need to increase the areas to be evacuated as is 6 currently regulated for other building uses. 7 As I explain in my report, I consider the building's 8 stay-put strategy to have failed at 1.26 am, and that 9 all events after that time occurred in the context of 10 the total loss of the only safety condition provided 11 for. 12 Thank you. 13 MS GRANGE: We were going to take a 15-minute break at this 14 point. 15 SIR MARTIN MOORE-BICK: Yes. That would be convenient, 16 would it, to have a break now? 17 DR LANE: Yes, please, thank you. 18 SIR MARTIN MOORE-BICK: Well, let's say resume at 11.15 19 sharp. All right? Thank you very much. 20 (11.00 am) 21 (A short break) 22 (11.15 am) 23 SIR MARTIN MOORE-BICK: Yes, Dr Lane, when you're ready. 24 DR LANE: Okay, thank you. 25 Okay, I'm just going to start the second part about</p> <p style="text-align: center;">Page 40</p> |

| | |
|--|--|
| <p>1 fire safety in a high-rise. 2 In table 3.1 of my Phase 1 report I have provided 3 a full list of the active and passive fire protection 4 measures required through the Building Regulations for 5 high-rise blocks of flats. 6 A passive fire protection system is one that is 7 an inherent part of the building construction and so 8 does not require any further power, action or 9 intervention to perform its intended purpose. 10 By contrast an active fire protection measure is one 11 that must undertake an action of some kind, either 12 automatically or manually, in order to perform its 13 intended purpose. Active protection measures typically 14 also require a power supply in order to perform their 15 function. 16 I will first describe the required passive fire 17 protection measures. 18 Buildings are required to be subdivided into 19 fire-resisting compartments to prevent the spread of 20 fire. These compartments are constructed from walls, 21 floors and fire doors, required to have fire resistance. 22 Approved Document B defines fire resistance as 23 follows: 24 "The ability of a component or construction of 25 a building to satisfy for a stated period of time, some</p> <p style="text-align: center;">Page 41</p> | <p>1 If a fire separating element is to be effective, 2 every joint or imperfection of fit or opening to allow 3 services to pass through the element should be 4 adequately protected by sealing or fire-stopping so that 5 the fire resistance of the element is not impaired. 6 Approved Document B defines a fire stop as: 7 "A seal provided to close an imperfection of fit or 8 design tolerance between element or components, to 9 restrict the passage of fire and smoke." 10 Fire doors are also a form of protection to 11 an opening in fire-resisting compartment enclosures. 12 A fire door is defined in British Standard 8412 as: 13 "A door which, together with its frame and hardware 14 as installed in a building, is intended (when closed) to 15 restrict the passage of fire and/or smoke, and is 16 capable of meeting specified performance criteria to 17 those ends." 18 As with the tested performance of compartment walls 19 and floors and fire-stopping, there are also required 20 methods for demonstrating the specific performance 21 criteria set for fire doors through fire testing. 22 Appendix I of my Phase 1 report identifies five 23 specific types of fire door that are critical to 24 maintaining the compartmentation required to support the 25 stay-put strategy, as well as support the defend in</p> <p style="text-align: center;">Page 43</p> |
| <p>1 or all of the appropriate criteria specified in the 2 relevant standard test." 3 These compartments, or fire-resisting boxes, are 4 required in multiple locations: the box enclosing each 5 flat; the box enclosing every lobby; the box enclosing 6 any vertical or horizontal shafts; the box enclosing the 7 escape stair. 8 These internal compartment walls and floors protect 9 the occupants of the building. This is achieved by 10 preventing the fire from spreading to adjacent flats or 11 to shared public spaces through the provision of 12 fire-resisting walls and floors and protecting any 13 openings in those walls and floors. 14 Compartment walls and floors are fire tested to 15 demonstrate their ability to prevent the passage of fire 16 and heat. 17 As well as the structure of the walls and floors, 18 buildings also need to contain a variety of different 19 services, such as cables, ducts and pipes. These 20 services need to be able to pass through the building in 21 order for the mechanical services to operate as 22 intended. Openings are therefore created to allow the 23 services to pass through. These openings need to be 24 sealed to prevent the spread of fire through any 25 required fire-resisting compartment enclosure.</p> <p style="text-align: center;">Page 42</p> | <p>1 place firefighting. These are: fire doors in 2 a protected stair enclosure; main flat entrance fire 3 doors; protected lift shaft fire doors; the doors within 4 the protected entrance hall in a flat; doors into any 5 fire protected service shafts. 6 Moving to the external wall component of the 7 enclosure to a flat. 8 This image shows the external wall forming one side 9 of the fire-resisting box enclosing a flat. 10 Regulation B4 requires the external walls are 11 constructed so that the risk of ignition from 12 an external source and the spread of fire over their 13 surfaces is restricted by making provision for them to 14 have a low rate of heat release. This is dealt with in 15 section 12.5 of Approved Document B which states: 16 "The external envelope of a building should not 17 provide a medium for fire spread if it is likely to be 18 a risk to health or safety. The use of combustible 19 materials in the cladding system and extensive cavities 20 may present such a risk in tall buildings. 21 "External walls should either meet the guidance 22 given in paragraphs 12.6 to 12.9 [of 23 Approved Document B] or meet the performance criteria 24 given in the [Building Research Establishment] report 25 'Fire performance of external thermal insulation for</p> <p style="text-align: center;">Page 44</p> |

| | |
|--|--|
| <p>1 walls of multi-storey buildings' ... for cladding 2 systems using full-scale data from [British Standard] 3 8414 ..." 4 That report is referred to as BR 135. 5 So taking each of paragraph 12.6 to 12.9 in turn 6 first. 7 Section 12.6 of Approved Document B states: 8 "The external surfaces of walls should meet the 9 provisions in diagram 40." 10 Section 12.7 states: 11 "In a building with a storey 18m or more above 12 ground level any insulation product, filler material 13 (not including gaskets, sealants and similar) etc used 14 in the external wall construction should be of limited 15 combustibility ..." 16 Finally, section 12.8 and 12.9 relate to cavity 17 barriers. The Approved Document B advises: 18 "9.2. ... The provisions necessary to restrict the 19 spread of smoke and flames through cavities are broadly 20 for the purpose of subdividing: 21 "a. cavities which could otherwise form a pathway 22 around a fire-separating element and closing the edges 23 of cavities; therefore reducing the potential for unseen 24 fire spread; and ... 25 "b. [subdividing] extensive cavities ...</p> <p style="text-align: center;">Page 45</p> | <p>1 I present here the structural form of Grenfell Tower 2 as an example. I described earlier this morning how the 3 floors, walls, beams and columns all contributed to the 4 designed fire stability system. 5 Approved Document B states that the load-bearing 6 elements of the structure of the building must be 7 capable of withstanding the effects of fire for an 8 appropriate period without loss of stability. 9 Approved Document B defines this as resistance to 10 collapse, the ability to maintain low-bearing capacity 11 during a fire. 12 For concrete buildings like Grenfell Tower, the 13 structural fire resistance of the structure is achieved 14 through the depth and thickness of the member, and 15 a specific depth of concrete insulating the embedded 16 steel reinforcing bars. This combination of concrete 17 and the reinforcing bars provide the stability system. 18 Structural fire resistance is a passive fire 19 protection measure because it requires no power to 20 activate and, once installed, remains an intrinsic part 21 of the building safety condition. 22 Approved Document B states: 23 "B2.i. The choice of materials for walls and 24 ceilings can significantly affect the spread of a fire 25 and its rate of growth, even though they are not likely</p> <p style="text-align: center;">Page 47</p> |
| <p>1 "Consideration should also be given to the 2 construction and fixing of cavity barriers provided for 3 these purposes and the extent to which openings in them 4 should be protected." 5 Section 12.5 of Approved Document B states that, as 6 an alternative to following that guidance in 12.6 to 7 12.9, as I have just set out, the fire performance of 8 the construction of external walls can be determined 9 instead by reference to BR 135. This describes a fire 10 test for external cladding systems so that they can be 11 installed as close to typical end-use conditions as 12 possible, and subject to a specific localised fire. 13 So either carrying out this test or complying with 14 the guidance set out in Approved Document B is intended 15 to provide the required performance to the external wall 16 of the flat. 17 That external wall should therefore be constructed 18 so that the risk of ignition from an external source and 19 the spread of fire over its surface is restricted by 20 making provision for the external wall materials to have 21 low rates of heat release. That is the provision made 22 for the external portion of the box around each flat. 23 Another passive fire protection measure is the 24 provision of an overall stability system for the 25 building during a fire.</p> <p style="text-align: center;">Page 46</p> | <p>1 to be the materials first ignited. 2 "It is particularly important in circulation spaces 3 where linings may offer the main means by which fire 4 spreads and where rapid spread is most likely to prevent 5 occupants from escaping." 6 Therefore, for a means of escape to comply with 7 regulation B1, capable of being safely and effectively 8 used at all material times, it is required that the 9 surfaces of walls and ceilings within protected lobbies 10 and stairs are materials that restrict fire spread. 11 Additionally, in accordance with clause 5.19, 12 firefighting stairs must be constructed of materials of 13 limited combustibility. 14 I have described the passive fire protection 15 measures. They are considered to be materials, products 16 and structures. Their required fire performance and how 17 to achieve that performance is then addressed in 18 appendix A of the Approved Document B. Appendix A 19 describes each of the different classes of performance 20 and each of the appropriate methods of test. 21 Appendix A states: 22 "In such cases the material, product or structure 23 should: 24 "a. be in accordance with the specification or 25 design which has been shown by tests to be capable of</p> <p style="text-align: center;">Page 48</p> |

| | |
|---|---|
| <p>1 meeting that performance; or. 2 "b. have been assessed from test evidence against 3 appropriate standards, or by using relevant design 4 guides, as meeting that performance; or ... 5 "c. where tables of notional performance are 6 included in this document, conform with an appropriate 7 specification given in these tables ..." 8 Therefore, the fire resistance of walls, floors and 9 doors are determined using a standard furnace. 10 I present in this image a furnace designed to undertake 11 standard fire-resisting resistance testing on floor 12 systems. This image shows a modern furnace test of 13 a door to determine its fire resistance. The gas 14 temperatures within the furnace must follow the 15 temperature with time profile shown here, reaching 16 1,000 degrees Celsius after approximately an hour and 17 a half. 18 There are a multitude of reaction to fire tests as 19 applied to the performance of the materials forming the 20 external wall which I have explained in substantial 21 detail in appendix F of my Phase 1 report. 22 Finally, I present three images replicated from the 23 BR 135 guide, which shows how it explains the concept of 24 fire spread through external wall cavities, and then two 25 photos from the fire test it represents: BS 8144. These</p> <p style="text-align: center;">Page 49</p> | <p>1 intention is that occupants of that flat should have 2 sufficient time to evacuate before the entrance hall 3 becomes impassable due to fire or smoke. 4 Under certain circumstances, a detection system may 5 need to be enhanced by installing additional detectors 6 in the living room and the kitchen, or in all of the 7 rooms in the flat. Where more than one detector and 8 alarm unit is provided in a flat, they must be 9 interlinked so that all of the units sound an alarm on 10 activation of any one device. 11 Approved Document B, section 5.36, states that all 12 escape routes should have adequate artificial lighting 13 which illuminates the route if the main supply fails. 14 For a high-rise block of flats, the common lobby and 15 stair shaft require emergency lighting. Emergency 16 lighting is connected to the main lighting circuit in 17 the building for normal power, but it is also provided 18 with a backup battery installed within the light fitting 19 with the capacity to run the light for a minimum 20 duration of three hours in case the mains supply fails. 21 The spacing of emergency lighting is controlled to give 22 a minimum light level over all parts of the escape route 23 in the event of a mains power failure. 24 Smoke control is an important provision to protect 25 escape routes. Approved Document B states it is</p> <p style="text-align: center;">Page 51</p> |
| <p>1 photos are a before and after example of a cladding fire 2 test. 3 It is essential that there are no fundamental 4 differences between the tested construction and the 5 designed for construction of an external wall. This is 6 also true of any fire-resisting feature, such as fire 7 doors, too. Such fundamental differences mean the test 8 evidence can no longer be relied upon to demonstrate 9 compliance with the provisions made in Approved 10 Document B. 11 I will now move on to active protection measures. 12 An active fire protection measure is one that must 13 undertake an action of some kind and typically requires 14 a power supply, as I said earlier. 15 In appendix G2.3 of my Phase 1 report, I describe 16 the requirements for residential detection and alarm 17 systems. The design guidance in Approved Document B is 18 to provide independent fire detection and alarm systems 19 within each flat and for the purposes of raising the 20 alarm in that flat only. 21 The minimum requirement for locations of detectors 22 within the flats is within the protected entrance hall. 23 This is intended to sound an alarm when smoke first 24 starts to enter the protected entrance hall in the flat, 25 because this is the escape route within the flat. The</p> <p style="text-align: center;">Page 50</p> | <p>1 probable that some smoke will get into the common 2 corridor or lobby from a fire in a flat, if only because 3 the entrance door will be opened when the occupants 4 escape the flat. Therefore, section 2.25 of 5 Approved Document B states that there should, therefore, 6 be some means of ventilating the common corridors or 7 lobbies to control smoke and so protect the common 8 stairs. This offers additional protection to that 9 provided by the fire doors to the stair. 10 There are two basic types of smoke control system 11 identified in section 2 of Approved Document B. These 12 are natural smoke ventilation, and, as an alternative to 13 the natural ventilation provisions, mechanical 14 ventilation to the stair or lobby. Approved Document B 15 refers on to other guidance available for the design of 16 smoke control systems using pressure differentials, this 17 guidance is BS EN 12101, part 6. 18 This diagram shows a simplified section through 19 a building. A fire has started in a flat; however, the 20 smoke has not yet passed into the common lobbies and 21 therefore the ventilation system has not yet activated. 22 When smoke enters the common lobby, either by leaking 23 through the door or if the door is opened during 24 an escape, the smoke ventilation system is activated by 25 smoke detectors in the lobby. All types of smoke</p> <p style="text-align: center;">Page 52</p> |

| | |
|--|---|
| <p>1 control systems then have common activation process. 2 The vents on the fire floor only remain open. All other 3 vents close. The vent at the top of the stair opens. 4 The fans, if present, in the system, start up. 5 If the system uses natural ventilation then fans are 6 not required. In this type of system, hot smoke rises 7 up a smoke shaft under the effects of natural buoyancy 8 and vents to outside above the roof of the building. 9 A chimney effect is created, pulling air and smoke out 10 of the lobby. 11 An alternative to the natural system is a mechanical 12 ventilation system. This type of system can be designed 13 to use the same kind of shaft as the natural system; 14 however, it relies on an extract fan at the top of the 15 shaft, pulling smoke into the lobby and up into the 16 shaft. The extract fan is signalled to start at the 17 same time as the lobby vents are signalled to open from 18 activation of a smoke detector in the lobby being 19 protected. 20 There is an alternative to this mechanical 21 ventilation system too. This is called a pressurisation 22 system. The difference is rather than pulling the smoke 23 out from the lobby, the fan instead pushes air down and 24 into the stair enclosure. The intention is this air 25 prevents the smoke in the lobby entering the stairs.</p> <p style="text-align: center;">Page 53</p> | <p>1 required until the firefighting teams are advancing into 2 the fire floor. 3 Firefighting lifts are lifts with specific 4 protection and control mechanisms to permit them to be 5 used safely by the Fire Brigade during a fire. 6 This figure identifies the key features of a modern 7 firefighting lift. The protection measures for 8 firefighting lifts I will be describing in more detail 9 later on. 10 But it is because of these protection measures to 11 firefighting lifts that Approved Document B also states: 12 "Where a firefighting lift has been provided to 13 satisfy requirement B5, this can be utilised as part of 14 a management plan for evacuating disabled people. Any 15 such plan should include a contingency for when the Fire 16 and Rescue Service arrive." 17 I will discuss this again later. 18 Fire mains are installed in a building and equipped 19 with valves, et cetera, so that the Fire Brigade may 20 connect hoses for water to fight fires inside the 21 building. Fire mains may be of the dry type, which are 22 normally empty and are supplied with water through a 23 hose from a Fire Brigade pumping appliance outside the 24 building. Alternatively, they may be of the wet type, 25 where they are kept full of water and supplied from</p> <p style="text-align: center;">Page 55</p> |
| <p>1 The smoke in the lobby is then either pushed up a shaft 2 provided for that purpose, or is pushed out of the 3 building through some other opening, such as open 4 windows. 5 Regardless of the type, all smoke control systems 6 are designed to operate for a fire on one floor only. 7 This floor is normally selected automatically by the 8 smoke control system programming, which relies on the 9 location of the detector that has first activated. In 10 addition, a manual override for use by the Fire Brigade 11 may also be provided on each floor to manually select 12 the floor to be extracted from. 13 The Fire Brigade may also change where the system is 14 running by using controls directly on the main control 15 panel. These panels are typically located at the ground 16 floor, where the Fire Brigade entered the building. 17 As well as the building requirement to provide 18 a safe air environment for the Fire Brigade using smoke 19 control, the brigade have their own equipment 20 too: protective clothing and breathing apparatus. 21 Breathing apparatus is required for firefighters to pass 22 beyond the safe air environment of the bridgehead and 23 into the fire sector. The Building Regulations require 24 buildings to incorporate adequate smoke protection to 25 the stairs and lobbies such that this equipment is not</p> <p style="text-align: center;">Page 54</p> | <p>1 tanks and pumps from inside the building. There should 2 be a facility to allow a wet system to be replenished 3 from a pumping appliance in an emergency also. 4 Regarding a dry main, there are two limiting factors 5 in this system: the ability of the fire engine pump to 6 raise water up the building, and the amount of pressure 7 that the pipe being used can withstand. With a dry 8 rising main, the further up the building the 9 firefighters are, the lower the water pressure available 10 at the outlet. This is because water pressure is 11 required to push the water up the pipe against gravity. 12 The amount of water pressure that can be introduced into 13 the pipe is limited by the strength of the pipe. 14 Therefore, eventually a height is reached where the 15 water pressure that can be delivered by a dry main 16 cannot effectively operate a fire hose. For this 17 reason, the statutory design guidance limits the use of 18 dry mains to buildings less than 50 metres in height. 19 In a building which is 50 metres or more in height, 20 there is a requirement to provide a wet fire main. 21 The key differences in a wet fire main are: 22 A tank of water is provided within the building as 23 a water supply for the system. It does not require the 24 fire service to connect the system to an external 25 hydrant.</p> <p style="text-align: center;">Page 56</p> |

| | |
|--|--|
| <p>1 A pump or set of pumps is provided within the 2 building to pump water through the vertical pipe. It 3 does not need a fire service pump appliance. 4 The pumps are automatically controlled to keep the 5 fire main filled and pressurised with water at all 6 times. Therefore, water can be drawn at any floor by 7 the fire service immediately. There is no delay as 8 occurs in a dry riser, where the fire service must 9 manually charge the fire main when they arrive at the 10 fire. 11 The pumps and the pipes are designed to deliver the 12 minimum pressure deemed required for effective 13 firefighting at the highest floors of the building. So 14 a wet rising main reduces the time required for the fire 15 service to secure firefighting water and, more 16 importantly, is designed specifically to ensure adequate 17 flow and pressure of water on every floor of the 18 building. Performance of this main type does not worsen 19 on the highest floors. 20 The standard for the fire main design, British 21 Standard 9990, states in section 6.3.1 that wet fire 22 mains systems are intended to supply two outlets at any 23 one time. Therefore, if any more than two hoses are 24 used, the water flow and pressure from any one outlet 25 will be reduced. The standard does not make any</p> <p style="text-align: center;">Page 57</p> | <p>1 blocks of flats was to place the rising main outlet in 2 the common lobby. The current guidance is for the 3 rising main outlet to be positioned in the protected 4 stair. 5 The firefighting hoses for the fire mains are not 6 provided in the building nor through design, but are the 7 Fire Brigade's own equipment. 8 This ends my description of the active fire 9 protection measures. 10 Finally, the presence of these active and passive 11 fire protection measures are intended to create 12 a layered safety approach. They provide the means for 13 early internal defend in place firefighting. They 14 provide the means to limit the fire and smoke spread 15 from a flat fire out to the lobby and help prevent fire 16 and smoke spread to the escape stair. They create the 17 high degree of compartmentation to support the stay-put 18 strategy in high-rise residential buildings. 19 Those layers of safety are required to prevent 20 reliance on the fire and rescue services for safe 21 evacuation, as so clearly stated in the statutory 22 guidance document. The terms of reference for those 23 layers of protection are to mitigate the effects of 24 a single flat fire, with minor fire and smoke spread 25 into the adjacent lobby.</p> <p style="text-align: center;">Page 59</p> |
| <p>1 specific statements on the number of firefighting jets 2 a dry main is intended to support. 3 However, as I have described, the maximum pressure 4 in the main is limited by the ability of the pipe to 5 withstand the pressure being introduced by the fire pump 6 appliance. As more hoses draw water off the main, the 7 pressure and flow to each hose will drop. Fire mains 8 are also designed for a single internal fire event. 9 Whether the main is a dry or wet main, the design 10 guidance for the location of landing valves where the 11 Fire Brigade plug in to obtain water from is that they 12 should be sited and their outlets directed such that 13 access to them is unobstructed; personnel can safely lay 14 out and charge hose lines before entering the fire 15 compartment; there is minimal risk of any discharge of 16 water from the outlets coming into contact with lift 17 controls and lift communications equipment or of flowing 18 into the lift well; there is minimal risk of exposure to 19 fire from the accommodation if a door is open; hoses can 20 be connected, charged and advanced into the 21 accommodation without excessive kinking of the hose line 22 or obstruction to fire doors and exit routes. 23 In addition, the location of the outlets presented 24 in the design guidance has changed over time. When 25 Grenfell Tower was built, the guidance for high-rise</p> <p style="text-align: center;">Page 58</p> | <p>1 Those layers of safety are not designed to protect 2 from a multi-storey building envelope fire, nor are they 3 designed to protect from a series of internal flat fires 4 occurring on multiple storeys in a building. Such 5 events are not considered as relevant design events in 6 the current terms of reference for those layers of 7 safety. 8 That ends my more general presentation and I'm now 9 going to specifically speak about Grenfell Tower for the 10 rest of the day. 11 SIR MARTIN MOORE-BICK: Yes, thank you very much. 12 DR LANE: In this next part of my opening presentation, 13 I will provide a summary of works undertaken at 14 Grenfell Tower since the building was originally 15 completed in 1974. 16 I have provided a chronology in appendix D4 of my 17 report of the design and construction of Grenfell Tower, 18 as well as the timing of any significant modifications. 19 The items in this chronology as relate to 20 refurbishment works on the tower have been identified 21 using records made available to me and specifically from 22 planning applications, Building Regulations 23 applications, fire risk assessments and other contract 24 documents, including, for example, the health and safety 25 file from the 2005 lift replacement works.</p> <p style="text-align: center;">Page 60</p> |

| | |
|---|--|
| <p>1 I carried out a detailed review of works to 2 Grenfell Tower since 1974 for two specific 3 reasons: first, because I wanted to understand if any 4 significant change to the original fire safety features 5 have been made; second, to understand the dates of any 6 such changes. This was for the purposes of 7 understanding the appropriate legislation and 8 regulations as may have applied at the time of that 9 change. This was important when analysing the 10 compliance requirements, and so the performance 11 requirements, for the active and passive fire protection 12 measures in Grenfell Tower on the night of the fire. It 13 also helped me understand the range of legislation and 14 regulation as applied to Grenfell Tower, and helped me 15 conclude on what, if any, difference in requirements 16 that range created.</p> <p>17 As I stated in section 3.4 of my preliminary Phase 1 18 report, in respect of all the fire safety measures 19 I have investigated, I have explained my understanding 20 of what was required by the regulations and the relevant 21 statutory guidance at the time of construction of 22 Grenfell Tower. I have also then explained what is 23 required under the current Building Regulations and its 24 statutory guidance.</p> <p>25 In this image, I have produced a time-line with the</p> <p style="text-align: center;">Page 61</p> | <p>1 highlighted in yellow. Specifically, these were the 2 refurbishment of lobbies on all floors in 1985, the 3 refurbishment of levels 3 and 4 in 1986 and, finally, 4 the works in the primary refurbishment.</p> <p>5 Five of the nine sets of internal layout works dealt 6 only with the non-residential floors. One set of 7 internal works undertaken in 1980 was not specific on 8 location.</p> <p>9 Whilst I have substantial detail on the most recent 10 primary refurbishment, there is little detail available 11 on the specifics of the other eight sets of internal 12 works that occurred.</p> <p>13 Four of the 19 recorded refurbishments included work 14 to the lifts in Grenfell Tower. In 2005, all three 15 lifts in the building were fully replaced. This 16 consisted of the two main lifts serving all floors and 17 a smaller hydraulic lift that was provided to access 18 level 2 and 3 from ground. To enable these works, 19 additional preparatory work was also needed separately 20 in 2004. These were works to build a new brick 21 enclosure at ground level to contain the new hydraulic 22 lift equipment for one of the three lifts.</p> <p>23 The other two sets of work on lifts in 24 Grenfell Tower were undertaken as part of the primary 25 refurbishment. First, in 2013, the low-level access</p> <p style="text-align: center;">Page 63</p> |
| <p>1 dates of the key changes made to Grenfell Tower since 2 the first recorded works in 1979. I have derived this 3 time-line presented on this slide here from the 4 information contained in a chronology of works submitted 5 by the Royal Borough of Kensington and Chelsea, and 6 through inspection of various contract documents 7 provided to me.</p> <p>8 The first recorded works on Grenfell Tower was 9 a Building Regulations application for improvement to 10 the ground floor community rooms in 1979. Between 1979 11 and 2017, there is evidence of a total of 19 different 12 sets of works undertaken to various parts of the 13 building, including the final refurbishment from 2012 to 14 2016.</p> <p>15 For the purposes of this presentation, works include 16 alterations or modifications or even replacement of 17 existing elements of the building or its services. 18 I have identified different types of refurbishment work 19 with different colours on the time-line I have provided 20 in this slide.</p> <p>21 I will now explain those works, separated into 22 types.</p> <p>23 Nine of the 19 recorded changes to the building 24 relate to its internal layout. Three of those nine 25 dealt with the residential floors of the building,</p> <p style="text-align: center;">Page 62</p> | <p>1 lift between ground and level 3 was removed as part of 2 the demolish works for the tower. Then, later, in the 3 primary refurbishment, the lift shafts were modified to 4 permit the lifts to also serve levels 1 and 3, where 5 previously they did not.</p> <p>6 Three of the 19 recorded refurbishments included 7 work to fire doors within Grenfell Tower. Fire door 8 replacements were carried out within the tower in 1985, 9 2011, and finally during the final primary 10 refurbishment. The 1985 works replaced an undetermined 11 number of flat entrance fire doors in unknown locations 12 in the building. The Building Regulations application 13 provided to me and associated with the works did not 14 define the exact number of doors.</p> <p>15 In 2011, a programme of flat entrance door 16 replacements was undertaken. This involved fitting 106 17 replacement flat entrance doors to tenanted flats. No 18 works were done to 12 leaseholder flats or two tenanted 19 flats.</p> <p>20 Finally, in the last primary refurbishment, new 21 stair doors, new flat entrance fire doors and fire doors 22 to other rooms were provided on levels ground, 1, 2 23 and 3 only.</p> <p>24 Two of the 19 refurbishments since 1974 were to the 25 external construction of the building. Specifically, in</p> <p style="text-align: center;">Page 64</p> |

| | |
|---|---|
| <p>1 2008, the flat roof coverings at roof level on top of 2 the building were replaced. Then the overcladding of 3 the whole building which took place from 2012 to 2016. 4 In 2016, one gas supply riser running vertically up 5 the building was decommissioned and replaced with a new 6 gas supply pipe. The appointed gas expert, 7 Rodney Hancox, is investigating all aspects of the gas 8 supply to Grenfell Tower and will cover these matters in 9 detail, including the history of gas supply-related 10 works for the tower. I have incorporated the most 11 recent works in 2016 only for the purposes of my fire 12 safety-related work as they relate to compartmentation. 13 As a result of my understanding of the works carried 14 out to Grenfell Tower since 1974, I provided in 15 section 4 of my report the specific refurbishment works 16 that I considered to be relevant to my investigation of 17 the active and passive systems that existed in 18 Grenfell Tower. This is due to their direct influence 19 on the eventual performance of the fire safety measures 20 on the night of the fire. These are: the lift 21 replacement works in 2005; the tenant flat entrance door 22 replacement in 2011; the refurbishment works between 23 2012 and 2016; and the new tenant gas supply, which was 24 incomplete the night of the fire. 25 I will deal with each of these in turn in the next</p> <p style="text-align: center;">Page 65</p> | <p>1 These central lifts did not serve level 1 and level 3. 2 Therefore, these passenger lifts were for the purposes 3 of accessing the floors in the tower with flats only. 4 Before describing the works undertaken to the lifts 5 in Grenfell Tower, I want to first describe the two 6 types of lift for firefighting. There are two types in 7 the context of Grenfell Tower because, since the tower 8 was built, the requirements for lifts for firefighting 9 has changed. This occurred in 1992. Therefore, 10 understanding the lift requirements for firefighting 11 before and after 1992 is relevant. 12 For lifts to be suitable for firefighting, they 13 require special features to allow the Fire Brigade to 14 access them during a fire and for the lifts to be robust 15 enough to continue operating in a fire scenario. 16 Since 1971, prior to the construction of 17 Grenfell Tower, there has been a requirement for the 18 provision of a lift which may be used by the Fire 19 Brigade within high-rise residential buildings. At that 20 time, lifts with specific firefighting provisions were 21 referred to as fire lifts. 22 In 1992, the name used to describe these lifts 23 changed to firefighting lifts, and the required safety 24 provisions to enable lifts to be safely used by 25 firefighters in a fire was changed also. This term,</p> <p style="text-align: center;">Page 67</p> |
| <p>1 series of presentations. 2 SIR MARTIN MOORE-BICK: Right. 3 DR LANE: The first of the relevant works is in relation to 4 the lifts provided in Grenfell Tower and so the status 5 of that lift provision the night of the fire. 6 Works were undertaken in 2005, as I said, with 7 further works undertaken during the primary 8 refurbishment. Both works are relevant to the fire 9 safety status of the lifts the night of the fire. 10 I will, therefore, describe the works during both 11 time-frames here. 12 The original plan drawings for Grenfell Tower 13 indicate three lifts were installed. As this image 14 shows, this included a small lift connecting ground 15 level to level 3. This small lift was located in the 16 southeast corner of the building. It was ultimately 17 removed as part of the primary refurbishment works and 18 so I have not considered it any further. 19 The remaining two lifts, as you can see, were 20 located centrally in the building, opening out into the 21 lobby between each flat and the single protected escape 22 stair. Access to the two main original passenger lifts 23 was provided from the original ground level lobby and at 24 level 2. Access to these two lifts on upper floors was 25 provided on every floor between level 4 and level 23.</p> <p style="text-align: center;">Page 66</p> | <p>1 firefighting lift, and the associated requirements for 2 such lifts are in general still in force today. 3 To understand the fire safety features for a lift, 4 it is useful to understand the basic components of 5 a lift system and the terms used to describe it. These 6 are illustrated in this image. 7 People or goods are transported within the lift car, 8 which is suspended by cables directly affixed to the 9 lift car. A lift machine, typically located in 10 a machine room at the top of the lift, drives and stops 11 the lifts. A counterweight is used for traction. The 12 lift is housed within a vertical shaft. Openings in 13 these shafts at each floor of the building allow people 14 to access the lift. The lift landing doors positioned 15 in each of these openings allow controlled access to the 16 lift car and to the shaft itself. 17 The original code of practice for fire safety as 18 applied at the time of construction of Grenfell Tower 19 is, again, CP3, dated 1971, and it describes the 20 provisions to be made for a fire lift. 21 I have illustrated the key features required for 22 a fire lift at the time of construction of 23 Grenfell Tower on this image. The requirements are that 24 the fire lift should serve every residential floor, 25 a fire switch should be provided whereby firefighters</p> <p style="text-align: center;">Page 68</p> |

| | |
|---|--|
| <p>1 can obtain and control the use of a lift without 2 interference from other persons, and the requirement of 3 a maximum distance between the stair and lift of no more 4 than 10 metres. The lift car should have a platform 5 area of not less than 1.5 metres squared, a capacity of 6 550 kilograms and reach the top floor from ground level 7 within one minute. Finally, the requirement that the 8 electrical supply to any fire lift should be provided by 9 a sub-main circuit exclusive to the lift, with the cable 10 supplying current passing through routes of negligible 11 fire risk.</p> <p>12 If we now consider the fire safety requirements for 13 a firefighting lift, there is a clear difference in 14 standard. As I have illustrated in this image, the 15 number of features required in a firefighting lift as 16 required from 1992 onwards is substantially greater.</p> <p>17 Of the 15 features required for the new firefighting 18 lift, three of those provisions were also required for 19 the historic fire lift shown here in blue. They relate 20 to the size of the lift car, the minimum travel time for 21 the lift to reach the top floor and the provision of 22 a fire switch for the Fire Brigade.</p> <p>23 Four of the 15 required features for a firefighting 24 lift were also required for a fire lift, but a higher 25 standard is now required. I have shown those features</p> <p style="text-align: center;">Page 69</p> | <p>1 of the higher standard of protection now provided to 2 firefighting lifts.</p> <p>3 I will now explain the lift replacement works.</p> <p>4 A complete replacement of the central lift system 5 was undertaken in 2005. From reviewing the 6 specification within the health and safety file prepared 7 for the works, the standard of lifts specified then was 8 consistent with the historic fire lift standard and not 9 the firefighting standard applicable in 2005.</p> <p>10 Further modification works were also undertaken 11 during the primary refurbishment. The scope of this 12 modification was to increase the number of floors served 13 by the two central lifts. During these works, the lifts 14 were not upgraded either to the applicable firefighting 15 standard.</p> <p>16 The scope of the lift refurbishment works in 2005 17 was substantial. It included replacing all associated 18 equipment and machinery. New lift cars were installed, 19 new lift landing doors were installed, call points and 20 controls. The openings in the lift shaft were also 21 increased in width. The lift was not at this time 22 upgraded to serve level 1 and 3 and, therefore, 23 continued not to serve every floor of the building, as 24 is required for a firefighting lift.</p> <p>25 Later during the primary refurbishment, new openings</p> <p style="text-align: center;">Page 71</p> |
| <p>1 in orange. For example, the lift is required to serve 2 every floor, not just residential floors. The power 3 supply is required to be fire protected, not routed 4 through areas of negligible fire risk. The minimum 5 capacity of the lift car has increased to 630 kilograms.</p> <p>6 Finally, there are eight additional fire safety 7 features required for a firefighting lift compared to 8 a fire lift, which I've shown in blue/grey here. These 9 are more substantial features. For example, two 10 independent power supplies for the lift in case of power 11 failure to the main supply; water protection to the 12 lift; the provision of an escape hatch to the lift car; 13 fire-resisting landing doors; a two-way intercom 14 communication device between access level, the lift car 15 and the machinery room. This was the standard required 16 for lifts used at the time of the lift replacement work 17 in 2005 and, subsequently, in 2012 to 2016.</p> <p>18 The standard of lift for firefighting is also 19 relevant to the use of lifts for evacuation. The 20 current version of Approved Document B which was 21 applicable at the time of the primary refurbishment 22 permits the use of lifts which meet the standard of 23 a firefighting lift to be used as an evacuation lift. 24 This provision applies to firefighting lifts only and 25 not to historic fire lifts. In general, this is because</p> <p style="text-align: center;">Page 70</p> | <p>1 in the lift shaft were created on levels 1 and 3 as 2 a way to access the new residential flats on these 3 levels. Therefore, after the primary refurbishment, 4 both lifts could be used to access every floor, as is 5 required for the firefighting lift standard.</p> <p>6 During 2005, the two lift cars were increased in 7 size and capacity. The plan drawing on the left 8 indicates the smaller, original lift car and, on the 9 right, the larger, replacement lift car. The openings 10 in the lift shaft on every floor were widened to 11 increase the clear entrance of the doors from 800 to 12 880 millimetres. The new capacity of 900 kilograms did 13 meet the minimum standard for a firefighting lift.</p> <p>14 The specification for the 2005 works also required 15 a firefighter control switch to be installed. 16 A firefighter control switch is required for both a fire 17 lift and a firefighting lift.</p> <p>18 I observed two firefighter control switches in 19 Grenfell Tower, photographs of which you can see here, 20 one at ground level, where it is required, as this is 21 the firefighter entry point to the building. I observed 22 a second switch at level 2. This is not the firefighter 23 entry point to the building.</p> <p>24 The 2016 fire risk assessment states that the 25 control switch should then be changed from level 2 to</p> <p style="text-align: center;">Page 72</p> |

| | |
|---|--|
| <p>1 ground level, indicating that, prior to 2016, the fire 2 control switch at level 2 was operational. The 2005 3 specification also included an emergency intercom system 4 which is required for a firefighting lift only; however, 5 I've not yet been able to observe whether this system 6 was installed on site. 7 Therefore, following the 2005 and 2012 to 2016 8 works, the lifts specified for Grenfell Tower contained 9 a number of fire safety features which I have 10 highlighted in green in this illustration. These 11 provisions satisfied the requirements for a historic 12 fire lift; they did not satisfy all of the requirements 13 for a firefighting lift as existed at the time of the 14 2005 and the 2012 to 2016 refurbishment works. 15 Key features that were required to meet the standard 16 but which were not specified are: a secondary power 17 supply was not specified; electrical schematics showed 18 it had an independent power supply, the exact cable 19 routing is not known; the lift landing doors were not 20 specified as requiring any fire resistance when they 21 were required to have 60 minutes' fire resistance; no 22 water protection measures were specified for electrical 23 equipment within the lift car and well; an escape hatch 24 was not specified for the replacement lift car. 25 As the lifts were not specified to meet the standard</p> <p style="text-align: center;">Page 73</p> | <p>1 I've described the role of fire doors in protecting 2 door openings in compartments. Compartmentation is the 3 primary fire protection measure for the single safety 4 condition, the stay-put strategy. 5 Where doors are required within walls requiring fire 6 resistance, those doors must be self-closing or lockable 7 fire doors according to the statutory guidance. 8 There are various performance requirements that they 9 need to achieve and must be subjected to fire testing to 10 confirm these performance requirements. 11 These requirements have changed over time since 12 1974, when the tower was built. Fire doors are tested 13 as a whole assembly, which is in the state it is 14 installed in a building. Importantly, this includes the 15 hardware, glazing, seals around the door and several 16 other components. These components are shown in the 17 next slide. 18 But before I move on, to show that a door assembly 19 meets the required standard, the door assembly should be 20 in accordance with the specification or design which has 21 been shown by test to be capable of meeting that 22 performance, or have been assessed from test evidence 23 against appropriate standards or by using relevant 24 design guides as meeting that performance. 25 These are the components of a fire door assembly.</p> <p style="text-align: center;">Page 75</p> |
| <p>1 of a firefighting lift, they could not, therefore, also 2 be relied upon for evacuation because, as it states in 3 Approved Document B, where a firefighting lift has been 4 provided to satisfy requirement B5, this can be utilised 5 as part of a management plan for evacuating disabled 6 people. Any such plan should include a contingency for 7 when the fire and rescue services arrive. 8 That ends my lift talk. 9 SIR MARTIN MOORE-BICK: Thank you very much. 10 DR LANE: Will I keep going? 11 SIR MARTIN MOORE-BICK: Well, what is your next topic and 12 how long -- 13 DR LANE: I can move on to doors now or have a break and do 14 doors later. 15 SIR MARTIN MOORE-BICK: How long do you think doors might 16 keep us going for? 17 MS GRANGE: 15 minutes. 18 DR LANE: About 12 to 15 minutes. 19 MS GRANGE: We can do the 15 minutes now and then break for 20 lunch, if that's convenient. 21 SIR MARTIN MOORE-BICK: Shall we do the doors? 22 DR LANE: Yes, I'll just do the doors. 23 SIR MARTIN MOORE-BICK: Thank you. 24 DR LANE: I will now describe the works that were undertaken 25 to fire doors in Grenfell Tower in 2011.</p> <p style="text-align: center;">Page 74</p> | <p>1 In appendix I2.2 of my report, I listed out 44 features 2 that form a fire door. Of these, the principal 3 components are: the door leaf; the doorframe; the 4 architrave, which is a trim that serves to mask the 5 joint between a doorframe and the surrounding structure; 6 a self-closing device; an intumescent fire seal; and 7 a smoke seal, which is for the purposes of restricting 8 the flow of cold smoke. 9 Fitted to the door leaf is various ironmongery, 10 which includes latches, locks, letter plates and 11 handles. As indicated in this diagram, everything 12 together is known as the door assembly and every 13 component is relevant to the fire performance of the 14 system. 15 I will now describe the location of the specific 16 doors in Grenfell Tower which were required to be fire 17 doors. These are the fire doors required to maintain 18 the compartmentation to all flats, the stairs and the 19 openings on to all the lobbies and to other risers. 20 Within the core of Grenfell Tower, on levels 4 to 21 23, all of the fire doors were installed in the 22 partitions forming the core of the tower. To indicate 23 each of these, a diagram of the protected lobby and 24 stairs is shown. 25 First, flat entrance fire doors. The front door of</p> <p style="text-align: center;">Page 76</p> |

| | |
|--|--|
| <p>1 every flat should be a fire door as it separates the 2 flat from the protected lobby. There are six of these 3 doors per floor on levels 4 to 23 and they are indicated 4 in yellow. 5 The lift shafts must also be a separate fire 6 compartment and should be separated from the protected 7 lobby as the lift doors open on to the protected lobby. 8 The two doors to the lifts of each lobby, therefore, 9 should achieve a specified fire resistance, as shown in 10 yellow here. 11 The refuse chute room is also required to be 12 a separate fire compartment, and so the single door to 13 the refuse chute room on every level is required to be 14 a fire-resisting door, and that is located at the yellow 15 marking there. 16 Finally, the single door to the protected stair at 17 each level. The protected stair is another separate 18 fire compartment and so was also required to be provided 19 with a fire door. 20 In 2011, a programme of fire door replacements at 21 Grenfell Tower was undertaken. This 3D image of 22 Grenfell Tower indicates in the model the flat entrance 23 doors on a typical level. Zooming out to the extent of 24 the full screen, you can see the doors that were 25 replaced in the tower and the doors that were not</p> <p style="text-align: center;">Page 77</p> | <p>1 only be fitted with locks readily openable from the 2 inside without a key. 3 Regarding glazing, any door containing glazing 4 should have been tested with the glazing in place, or 5 an assessment have been made to show that it would meet 6 the required performance. The glazing must have 7 insulation fire resistance in addition to integrity fire 8 resistance, because table A4, "Limitations on the use of 9 uninsulated glazed elements on escape routes", as 10 presented in Approved Document B states no part of the 11 wall or door leaf between residential sleeping 12 accommodation and a common escape route of a single 13 stairway building can contain uninsulated glazing. 14 The fire door product to replace the flat entrance 15 doors in Grenfell Tower was Suredor GRP, as manufactured 16 by Manse Masterdor limited. The brochure for Suredor 17 GRP doors describes the doors as a fibre glass composite 18 door which was successfully tested for the integrity and 19 stability criteria for 30 minutes. The brochure does 20 not state that the doors have been tested for cold smoke 21 leakage as required, nor for the insulation component of 22 fire resistance. 23 The photograph on the left shows the exact single 24 test specimen that was used to achieve those test 25 results. It does not feature any glazing or a number or</p> <p style="text-align: center;">Page 79</p> |
| <p>1 replaced as part of these works. That's their 2 locations. 3 The programme of work was undertaken by the TMO to 4 replace the front door of dwellings occupied by Royal 5 Borough of Kensington and Chelsea tenants. 106 fire 6 doors appear to have been supplied and installed by 7 Manse Masterdor to replace the main flat entrance doors. 8 This is based on their door replacement schedule, which 9 included 104 tenanted flats and two leaseholder flats. 10 Therefore, 14 fire doors that were not replaced 11 consisted 12 leaseholder flats and two tenant flats. 12 These works did not specify new doors for the lifts, 13 stairs, refuse chute room or any other riser in the 14 tower, nor any of the doors on levels ground to 3. 15 The standard for the fire safety performance for the 16 flat entrance fire doors at the time of installation is 17 described in Approved Document B. The key requirements 18 are: integrity fire resistance of 30 minutes when tested 19 to the fire resistance test, British Standard 476, 20 part 22; the doors should be fitted with smoke seals 21 restricting air leakage around head and jambs; no 22 glazing is permitted unless that glazing has been 23 demonstrated to achieve an insulation performance that 24 is equivalent to the integrity performance of the door; 25 a self-closing device is required; the fire door should</p> <p style="text-align: center;">Page 78</p> | <p>1 nameplate, for example. It does feature a specific 2 latch, lock, letter box, handle and spyhole. The 3 self-closer on the tested specimen was externally 4 mounted on the door. 5 In Grenfell Tower, the Manse Masterdor specification 6 sheet specified 58 unglazed Suredor fire doors were 7 installed, an example I observed as shown on the left. 8 48 glazed Suredor fire doors were installed, an example 9 I observed is shown on the right. 10 Sorry, I got a little bit mixed up there. On the 11 right. 12 With regard to the ironmongery, the Manse Masterdor 13 specification sheet specified different locks, different 14 letter boxes, different self-closing devices and hinge 15 types to that provided for within the fire test. 16 Regarding the 14 flat entrance doors which were not 17 replaced, there is little evidence available regarding 18 those doors as they have mostly been destroyed by the 19 fire. In considering if those doors were the originals 20 as installed in 1974, it is now useful to note that the 21 requirements were different at that time. 22 The main differences for a flat entrance door at 23 that time were: 24 Self-closing devices were different. This could be 25 achieved using what's called rising butt hinges, which</p> <p style="text-align: center;">Page 80</p> |

| | |
|--|--|
| <p>1 are the wedged-shaped hinges shown in this photograph. 2 These are no longer acceptable. 3 Integrity rating of 20 minutes. This is 10 minutes 4 less than the 2011 standard. 5 A 12-millimetre rebate was also required to prevent 6 smoke spread, which I will now explain. 7 In both 2011 and in 1974, fire doors have 8 incorporated measures to stop the spread of smoke. In 9 1974, this was in the form of an overlap between the 10 door and the frame known as a rebate. In the picture on 11 the left, the door would swing into the frame away from 12 the viewer and be stopped from swinging any further once 13 in the frame by the rebate. The depth of rebate 14 required was specified rather than a limit on the rate 15 of air passing through the door. 16 In 2011, preventing the spread of smoke was and 17 still is usually accomplished by smoke seals, which 18 could be brush-like or rubber-like strips around all 19 sides of a door that are designed specifically to seal 20 airflow around the edge of a door. 21 Regarding the stair fire doors, I have no records of 22 replacement works to the stair doors. Therefore, I have 23 assumed that the stair doors were the original doors as 24 fitted in 1974. Again, comparing the requirements for 25 stair doors in 1974 as opposed to the requirements set</p> <p style="text-align: center;">Page 81</p> | <p>1 doors as installed in 1974. 2 Fire doors are a crucial element of the stay-put 3 strategy as they represent an opportunity for weak spots 4 to form in the fire-resisting partitions that separate 5 a flat fire from occupants either on that floor where 6 the fire has started or occupants in flats above the 7 floor the fire has started. Fire doors are, therefore, 8 a Building Regulations requirement as a passive fire 9 protection measure. Faulty fire doors mean faulty 10 compartmentation and compartmentation is the primary 11 basis of the stay-put strategy. 12 Thank you. 13 SIR MARTIN MOORE-BICK: Thank you very much. 14 Now, you've been speaking almost non-stop for quite 15 a long time. Would you like a break now? 16 DR LANE: Yes, I would. 17 SIR MARTIN MOORE-BICK: Well, I'm not surprised. 18 Thank you very much, you've given us a lot to think 19 about. 20 We will break then in a moment. It's a little 21 earlier than usual. If we resume at 2 o'clock, is that 22 going to give you enough time to finish? 23 DR LANE: Absolutely fine. 24 SIR MARTIN MOORE-BICK: Thank you very much. In that case, 25 we'll rise now and resume at 2 o'clock, please.</p> <p style="text-align: center;">Page 83</p> |
| <p>1 out now in Approved Document B. 2 In both 1974 and 2011, stair doors were required to 3 be self-closing. In 1974, an integrity fire resistance 4 rating of 30 minutes was required; current standards 5 would be for a 60-minute integrity rating. In 1974 6 a 25-millimetre rebate was required; the current 7 standard would require smoke seals with prescribed 8 limits on airflow. I observed in Grenfell Tower that 9 the rebate was 12 millimetres, not 25, on the stair fire 10 doors. A 12-millimetre rebate would indicate that this 11 is a 20-minute fire door. 12 To summarise the fire door provision within 13 Grenfell Tower on 14 June 2017, 106 of the 120 flat 14 entrance doors were replaced with Suredor GRP doors. 15 The remaining 14 doors comprised of leaseholder flats 16 and two tenant flats. They are assumed to be original 17 doors; however, few remain to be investigated. The lift 18 landing doors were replaced in the 2005 lift works with 19 no specified fire resistance. The stair fire doors have 20 no documentation or records defining any replacement, so 21 it is assumed they are the original doors as installed 22 and appear to have fire resistance of 20 minutes. 23 For the refuse chute room doors, currently no 24 documentation or records of the replacements are 25 available and so it is assumed they are the original</p> <p style="text-align: center;">Page 82</p> | <p>1 (12.25 pm) 2 (The short adjournment) 3 (2.00 pm) 4 SIR MARTIN MOORE-BICK: Thank you. 5 MS GRANGE: Thank you. Dr Lane is going to continue with 6 the second half of your presentation. 7 DR LANE: Thank you. 8 Okay, I am just going to finish on works before the 9 primary refurbishment and so discuss the gas supply 10 replacement works that were underway the night of the 11 fire. 12 SIR MARTIN MOORE-BICK: Yes. 13 DR LANE: Regarding Grenfell Tower, I'm interested in gas 14 supplies for two specific fire safety-related issues 15 only. 16 First, the supply of gas through Grenfell Tower 17 penetrated multiple compartments. How those 18 penetrations were protected to maintain compartmentation 19 is therefore relevant to the stay-put strategy. 20 The second issue of interest is the provision made 21 with respect to shutting off the gas supplies during 22 a fire. This is important when considering gas as 23 a fuel source in a room or a flat during a fire. 24 Gas safety matters are the subject of investigation 25 by the gas expert appointed to the inquiry,</p> <p style="text-align: center;">Page 84</p> |

| | |
|--|--|
| <p>1 Rodney Hancox, and his work will include gas shut-off 2 issues. The inquiry will then need to understand any 3 additional fire scenarios where caused by gas supply 4 when his work is completed. 5 I investigated the gas service installations at 6 Grenfell Tower by reviewing design and construction 7 documentation and by observing evidence on site. 8 I relied on two services specialists I work with at 9 Arup, Mr Joe Wade and Mr Conor Hoey, in particular when 10 trying to decipher the gas supply routes throughout the 11 tower. During our site inspections on 7, 8 and 12 9 November 2017, my team located the gas supplies and 13 traced the pipework to understand how the systems were 14 distributed throughout Grenfell Tower. This was 15 a complex process, particularly within the basement. 16 My findings as a result, and as they relate to fire 17 safety compartmentation requirements only, are 18 summarised in the following presentation. 19 There were two original gas supplies in 20 Grenfell Tower. 21 The first gas supply I refer as to the landlord 22 supply. This served boilers that provided communal 23 heating and hot water for Grenfell Tower, as well as the 24 three finger blocks located south of Grenfell Tower. 25 The landlord gas supply entered Grenfell Tower through</p> <p style="text-align: center;">Page 85</p> | <p>1 vertically up four shafts in the building core. The 2 term used for a vertical pipe that distributes upwards 3 through a building is "riser". 4 These four gas risers continued up the building and, 5 at some point between the basement level and level 4, 6 the four risers were split into six. This split and its 7 location requires further investigation. 8 However, what is clear is these six risers continued 9 up the building to level 23. One of each of these six 10 risers passed through each flat. These original gas 11 risers connected every floor of Grenfell Tower from 12 basement level to level 23. 13 The gas risers passed through each compartment 14 floor, connecting all the compartments they passed 15 through. Therefore, these risers are also required to 16 be protected to maintain compartmentation. 17 Approved Document B requires that pipes which 18 penetrate a compartment are to be protected in one of 19 two ways: the pipe should be fire-stopped at every 20 compartment wall or floor that it penetrates, or the 21 pipe should be enclosed, with the protected shaft formed 22 with fire-resisting construction. Where gas pipes are 23 enclosed in protected shafts, they also require 24 ventilation at the top and bottom of the shaft for 25 safety reasons.</p> <p style="text-align: center;">Page 87</p> |
| <p>1 the east building elevation. 2 It entered at a high level within the basement 3 level, nearly 5 metres above finished floor level. The 4 landlord gas supply was then routed horizontally along 5 the basement level where it served the original boilers. 6 During the primary refurbishment, new boilers were 7 installed to provide a new central heating system for 8 Grenfell Tower. The original landlord gas supply was 9 therefore extended to serve these new boilers. 10 The original boilers were retained and they 11 continued to serve the three finger blocks south of 12 Grenfell Tower. The landlord gas supply doesn't leave 13 the basement and does not therefore apparently breach 14 any compartmentation. Therefore, I will not discuss the 15 landlord supply any further at this stage. 16 The second gas supply, which I refer to as the 17 residential supply, provided gas for domestic 18 appliances, such as cookers, for residential flats on 19 levels 4 to 23. I understand that just over 70 per cent 20 of the flats had a live gas supply. 21 The original residential gas supply entered 22 Grenfell Tower through the east building elevation at 23 basement level also. This residential gas supply was 24 then routed horizontally long the basement level, where 25 it then split into four gas pipes and these were routed</p> <p style="text-align: center;">Page 86</p> | <p>1 It is important to note that Approved Document B 2 states that gas service and installation pipes should 3 not be incorporated within a protected stairway unless 4 the gas installation is in accordance with the 5 requirements for installation and connection set out in 6 the Pipelines Safety Regulations and the Gas Safety 7 (Installation and Use) Regulations. 8 These specific requirements are not provided within 9 Approved Document B for fire safety and they require 10 other safety measures to be installed, for example for 11 emergency control of the gas supply to the building. 12 These provisions made for compliance with the separate 13 regulations are being dealt with by the other expert. 14 Gasworks commenced in 2016, which led to a third 15 main gas supply being installed at Grenfell Tower. 16 During an inspection by Cadent Gas on 17 30 September 2016, a small gas leak was identified in 18 one of the six risers supplying gas to the original 19 flats on levels 4 to 23. The gas riser with the gas 20 leak was disconnected. It was capped at ground level. 21 This disconnected gas riser supplied flat 2. This 22 image shows the location of flat 2, which is the flat 23 located on the southeast corner of Grenfell Tower. As 24 I said, just over 70 per cent of the original flats in 25 Grenfell Tower were supplied with gas. 13 of these</p> <p style="text-align: center;">Page 88</p> |

| | |
|--|--|
| <p>1 flats were in this flat 2 location on the southeast 2 corner. Therefore, 13 flats were affected by the gas 3 leak and subsequent decommissioning of the flat 2 4 related gas riser in 2016.</p> <p>5 The other five risers supplying gas to flats in 6 location 1, 3, 4, 5, and 6 on each floor between 7 levels 4 and 23 remained in service. The condition of 8 these five other original gas risers that remained in 9 operation and were present the night of the fire is also 10 being investigated by the other expert.</p> <p>11 However, an entirely new residential gas supply was 12 installed to replace the decommissioned riser that 13 served flats in location 2.</p> <p>14 This new residential gas supply entered 15 Grenfell Tower through the east building elevation also. 16 It entered the tower at basement level. The gas supply 17 pipe was then routed from the east elevation of the 18 building to the southeast service shaft in the core of 19 the building, where it was then routed vertically up the 20 tower.</p> <p>21 A new vertical route was chosen through the 22 protected stair from levels 2 to 21, rather than 23 directly through the flat 2 locations, as had previously 24 occurred. Horizontal pipes were installed leading out 25 from that vertical riser in the stair, exiting into each</p> <p style="text-align: center;">Page 89</p> | <p>1 appointed gas expert at this time.</p> <p>2 The horizontal pipes that supplied gas to flats in 3 location 2 therefore left this vertical riser in the 4 stair, penetrated the protected stair compartment wall 5 and then penetrated the flat compartment wall. The pipe 6 should be fire-stopped at each compartment wall it 7 penetrates or enclosed with a protected shaft.</p> <p>8 I understand that these works to the horizontal 9 pipes were planned for June 2017, although I have seen 10 no evidence that any of those works had commenced by 11 14 June 2017.</p> <p>12 On 14 June 2017 there were three gas supplies in 13 Grenfell Tower: a landlord gas supply with no impact on 14 compartmentation; an original residential gas supply, 15 the condition of which is currently being investigated; 16 and a new residential gas supply, which had incomplete 17 compartmentation works and incomplete ventilation works 18 the night of the fire.</p> <p>19 Thank you.</p> <p>20 Okay, for the remainder of the afternoon, I'm going 21 to talk about the primary refurbishment.</p> <p>22 SIR MARTIN MOORE-BICK: Thank you.</p> <p>23 DR LANE: With an overview of the whole thing first.</p> <p>24 Between 2012 and 2016, the TMO commissioned a major 25 refurbishment of Grenfell Tower. I refer to this as the</p> <p style="text-align: center;">Page 91</p> |
| <p>1 lobby outside the stair and over to serve flat 2. These 2 horizontal pipes penetrated the protected stair 3 compartment wall and the flat compartment wall on each 4 relevant storey within the tower. These horizontal 5 pipes ran under the false ceiling in each lobby and so 6 were visible from within the lobby. This was to be the 7 case at every level requiring a residential gas supply 8 in the southeast corner.</p> <p>9 Approved Document B for fire safety advises a pipe 10 is not considered to be contained within a protected 11 stair shaft if that pipe is completely separated from 12 that protected stair shaft by fire-resisting 13 construction.</p> <p>14 I observed the vertical pipe within the stair to 15 have been enclosed by construction, as shown in this 16 image in the stair at level 2. I currently have no 17 information available to me as to the fire performance 18 possible from that construction.</p> <p>19 Where a gas pipe is enclosed, Approved Document B 20 states:</p> <p>21 "8.41. A protected shaft conveying piped flammable 22 gas should be adequately ventilated direct to the 23 outside air by ventilation openings at high and low 24 level in the shaft." 25 This condition is being explored by the inquiry's</p> <p style="text-align: center;">Page 90</p> | <p>1 primary refurbishment.</p> <p>2 The refurbishment was funded by the Royal Borough of 3 Kensington and Chelsea and the funds for the 4 refurbishment were released in 2012.</p> <p>5 The primary refurbishment was substantial and 6 I would like to read the Rydon general scope of the 7 project as follows:</p> <p>8 Adaption of two lifts to include two new doors. 9 Recladding of the facade. 10 Reconfiguration of the podium levels to provide 11 additional residential accommodation (nine new flats). 12 Relocated and refurbishment of the nursery. 13 Relocation and refurbishment of the boxing club. 14 Provision of new community room. 15 Decorations to the existing lobbies. 16 Construction of a new entrance lobby (previously 17 an undercroft). 18 Modifications to the MEP systems as follows: 19 New heating system to all areas. 20 New boosted cold water distribution system to all 21 areas. 22 Refurbishment and extension of the smoke and 23 environmental ventilation systems. 24 Alterations to the dry riser system. 25 Alterations to the door entry system.</p> <p style="text-align: center;">Page 92</p> |

| | |
|--|--|
| <p>1 External hard and soft landscaping. 2 The project scope included external works. The 3 image on screen shows the contract boundary for the 4 works as defined in 2012. External works 5 included: demolition of an existing circular ramp 6 connecting the level 2 walkway to the play area to the 7 west of Grenfell Tower; demolition of an existing 8 walkway that connected level 2 to the grass area to the 9 north of the tower; and new hard and soft landscaping 10 within the contract boundary on the north, south, east 11 and west sides of the tower. 12 According to the sustainability and energy statement 13 for the primary refurbishment, improving the insulation 14 levels of the walls, roof and windows was the top 15 priority of this refurbishment. The chosen strategy is 16 to wrap the building in a thick layer of insulation and 17 then over-clad with a rainscreen to protect the 18 insulation from the weather and from physical damage. 19 The resulting works can be summarised as follows: 20 The overcladding of the building envelope at ground 21 comprised a glass reinforced concrete cladding to the 22 columns and the installation of glazed curtain walls to 23 the new entrance lobby on the southeast corner. 24 From levels 1 to 23, it consisted of the addition of 25 a drained and ventilated rainscreen cladding system,</p> <p style="text-align: center;">Page 93</p> | <p>1 level 2. At the third floor, four new flats were 2 provided, resulting in a total of nine. 3 Reconfiguring these internal spaces caused the need 4 to reconfigure the lift and stair access and so make 5 them fully available at those levels also. 6 As I have already explained this morning, the small 7 lift that originally served ground level to level 3 was 8 demolished. Access to the main lifts was then modified 9 so that these two lifts could now be accessed from 10 levels 1 and 3, as originally they were not. I have 11 explained the modifications to the lift and will not 12 explain them any further. 13 With regard to the existing stairs, modifications 14 were made to stairs between ground level and level 3. 15 No modifications were made to the central stair from 16 level 4 to roof. Three small internal stairs were 17 demolished between ground and level 3. The location of 18 these stairs is highlighted in red in the left-hand 19 image. 20 New balconies were constructed, highlighted green in 21 the right-hand image, to connect a new open stair in the 22 new multi-storey entrance lobby located in the southeast 23 corner, highlighted in blue, over to the central and 24 closed lobby at levels 1 and 2. From level 3, access 25 via the main central protected stair and lobby was</p> <p style="text-align: center;">Page 95</p> |
| <p>1 which comprised of a backing wall by means of the 2 existing tower external wall and a cavity containing 3 thermal insulation, and an outer layer formed with 4 rainscreen cladding panels. 5 Two different types of rainscreen cladding panels 6 were used at first and second floor, a product called 7 CGL wall plank, and then from levels 3 to 23, 8 a Reynobond 55 PE aluminium composite panel in two 9 colours: pure white for the horizontal panels at third 10 floor only, and smoke silver colour provided on all 11 columns and all horizontal panels on levels 4 to 23 and 12 the crown of the building. New double glazed windows 13 and insulating core panels between them were installed. 14 I have focused my analysis in my Phase 1 report on 15 the external wall construction of the original 16 residential floors. The cladding on the lower floors 17 was not involved in the fire. 18 There were many changes made to the internal layouts 19 of ground level to level 3. A new, tall entrance lobby 20 was created, with a new open staircase within it. A new 21 community room was provided at ground level. The 22 nursery was moved from the first floor down to ground. 23 At the first floor, a second community room and four new 24 flats were provided. A new flat was provided at level 2 25 and the boxing club was moved from ground level up to</p> <p style="text-align: center;">Page 94</p> | <p>1 provided. 2 The internal changes from ground to level 3 also 3 required modifications to the existing internal fire 4 main so that it became accessible at these levels. The 5 existing smoke control system was also modified to 6 incorporate the new lobbies at ground, level 1, 2 and 3. 7 The operation of the system was changed and new power 8 supplies and controls were also provided during the 9 refurbishment. 10 A new heating system and booster cold water system 11 were provided in the building. This required works in 12 all lobbies, all flats and all non-residential spaces. 13 Inside every existing flat, work was required to 14 install a new heat interface unit for individual control 15 of heating and hot water, and new low temperature hot 16 water pipes to supply that heat interface unit and new 17 cold water pipes. A total of 440 radiators were 18 installed. 19 The primary refurbishment therefore 20 included: substantial work inside the building on all 21 levels; the overcladding on all levels of the exterior 22 of the building; it included works done externally, 23 demolition of ramps and walkways and hard and soft 24 landscaping within the contract boundary. 25 I will focus in detail on the rainscreen cladding</p> <p style="text-align: center;">Page 96</p> |

| | |
|--|---|
| <p>1 component of the primary refurbishment works later, but 2 first I would like to provide more information about 3 some of the other works done to Grenfell Tower during 4 the primary refurbishment, and so I will provide more 5 information on each of the external works, the 6 reconfiguration of lower floors, the fire main works, 7 the refurbishment of the existing smoke control system, 8 the new heating and hot water system and the new cold 9 water system. This is in order to provide greater 10 clarity on how those works impacted the fire safety 11 features in Grenfell Tower.</p> <p>12 The contract boundary for the primary refurbishment 13 is outlined in red. According to the primary 14 refurbishment design documentation, external hard and 15 soft landscaping was provided within this boundary.</p> <p>16 There were changes to external pedestrian access to 17 Grenfell Tower. The external walkway that connected the 18 north side of level 2 to the grass area was demolished. 19 The external walkway that connected Grenfell Tower to 20 the finger blocks at level 2 was closed at the south 21 building envelope, and the circular ramp, as I said, 22 that connected this walkway to the play area west of the 23 tower was demolished.</p> <p>24 As a result of the circular ramp demolition, the 25 pedestrian path between the area south of</p> <p style="text-align: center;">Page 97</p> | <p>1 fire doors were provided to the modified protected stair 2 enclosure at those lower levels.</p> <p>3 Some of the existing fire safety systems in the 4 residential areas at level 4 and above were then 5 extended down to serve these reconfigured levels. These 6 fire safety systems included the firefighting lifts, dry 7 rising main and the smoke control system.</p> <p>8 According to the design guidance referenced at the 9 time of the original construction, buildings over 10 60 metres required a wet fire main. According to the 11 wording in the design guidance, the building height was 12 to be measured to any floor of the building. The plant 13 room was 65.5 metres above ground in Grenfell Tower. 14 Therefore, a wet fire main was required when the tower 15 was originally constructed. However, a dry main was 16 provided.</p> <p>17 Works were carried out to this existing dry main 18 during the primary refurbishment. The inlet valve which 19 is used by the Fire Brigade to charge the fire main with 20 water was relocated from the central core of the 21 building at ground level to the exterior of the 22 building, next to the main entrance on the south 23 elevation.</p> <p>24 New piping connected this new inlet to the existing 25 main. Vertical and horizontal piping was installed as</p> <p style="text-align: center;">Page 99</p> |
| <p>1 Grenfell Tower, where the main building entrance is 2 located, and the area west of Grenfell Tower became 3 an at-level direct pedestrian path.</p> <p>4 New hardstandings were provided on the north, south, 5 east and west sides of Grenfell Tower, immediately 6 around the tower, within the contract boundary.</p> <p>7 As I explained earlier, the primary fire vehicle 8 access to Grenfell Tower was via Grenfell Road on the 9 south side. During my site visits, I observed that the 10 fire access to the south and east elevations was 11 maintained after the primary refurbishment.</p> <p>12 The photograph on the left shows the fire vehicle 13 access route leading to the south side of 14 Grenfell Tower. The area underneath the elevated 15 concrete walkway was within the contract boundary of the 16 primary refurbishment. The photograph on the right 17 shows the hardstanding on the east side of 18 Grenfell Tower. A new hardstanding was provided to this 19 area during the primary refurbishment.</p> <p>20 Regarding the reconfiguration of the lower levels, 21 these levels were reconfigured to provide nine 22 additional flats and reconfigured non-residential 23 accommodation. A tall, multi-storey entrance foyer was 24 created with an open stair within it, and the balconies 25 created at levels 2 and levels 1. Additionally, six new</p> <p style="text-align: center;">Page 98</p> | <p>1 part of these works. I do not know the exact route or 2 length of piping added; however, the new inlet is 3 approximately 8.5 metres from the location of the 4 original dry rising main.</p> <p>5 New connections for firefighting hoses were 6 installed at the first, second and third floor, so that 7 the dry rising main served every floor above ground 8 level.</p> <p>9 At the time of the primary refurbishment, the 10 existing smoke control system was reaching the end of 11 its serviceable life. The smoke control system was 12 refurbished to improve performance and reliability, as 13 I understand matters.</p> <p>14 It was also changed from a stand-alone smoke control 15 system to a combined smoke control system and 16 environmental system. The environmental system was 17 installed to mitigate the heat gains from the new 18 communal heating system.</p> <p>19 The original smoke control system in Grenfell Tower 20 included a fresh air shaft and a smoke extract shaft 21 serving all of the residential lobbies. It had no 22 environmental air purpose. Each lobby had a fresh air 23 inlet on one side of the lobby and a smoke exhaust vent 24 on the opposite wall of the lobby. A manual so-called 25 fireman's override was located at ground level.</p> <p style="text-align: center;">Page 100</p> |

| | |
|--|--|
| <p>1 All lobbies contained four vents: two high-level 2 vents on the north wall and two low-level vents on the 3 south wall. These vents were mechanical, so they could 4 open and close to allow airflow in and out of the lobby. 5 Originally, the low-level vents connected directly 6 into two fresh air shafts on the south side of the 7 lobby. A fresh air supply fan was installed at the 8 bottom of the south shafts on level 3. 9 The high-level vents connected directly into two 10 smoke exhaust shafts on the north side of the lobby. 11 A smoke extract fan was installed at the top of the 12 north shaft at the roof. 13 There was a smoke detector in each lobby. If smoke 14 was detected in the lobby, the vents in that particular 15 lobby were intended to open. The vents on other floors 16 were intended to remain closed. 17 The south low-level vents were to supply fresh air 18 to the lobby. The north high-level vents were to 19 extract smoke from the lobby. 20 This existing smoke control system was refurbished 21 and extended during the primary refurbishment and to 22 work as both an environmental ventilation system and 23 a smoke control system. The original vent openings in 24 levels 4 to 23 lobbies were retained during the 25 refurbishment. This meant, again, each lobby had</p> <p style="text-align: center;">Page 101</p> | <p>1 set was installed in the rooftop plant room and 2 connected to the two north shafts. Both fans had dual 3 power supplies consisting of a primary power and backup 4 power supply. A weather housing was provided over the 5 top of the shaft. 6 In the event of a fire and were smoke to enter 7 a lobby, smoke detectors within the lobbies were 8 intended to trigger the control system to fire mode. 9 This is a photograph of one of the smoke detectors in 10 the level 3 lobby for smoke control activation. 11 The sequence of events in smoke mode was intended to 12 be as follows. Firstly, the vents on all other floors 13 should shut and all the vents on the floor where smoke 14 has been detected open. This is to isolate the non-fire 15 floors from the floor where the fire is located, and to 16 direct the full capacity of the smoke control system to 17 the fire floor only. 18 The roof smoke exhaust fan should turn on and pull 19 air and smoke out of the lobby vents, up the north 20 shaft, where it vents from the building at roof level. 21 The environmental fan at level 2 should shut down. 22 The separate smoke extract fan should then turn on and 23 pull air and smoke out of the lobby vents, down the 24 south shafts and vent from the building through the 25 second floor external wall.</p> <p style="text-align: center;">Page 103</p> |
| <p>1 low-level and high-level vents. The vertical shafts 2 were extended downwards to serve the newly created 3 residential lobbies on the first, second and third 4 floors and the existing lift lobby at ground. 5 At level 2, the existing connection to the outside 6 of the building was replaced, including new fan sets. 7 These new fans at level 2 were connected to the south 8 shaft by horizontal ducts. These photographs show smoke 9 exhaust fans at level 2. The smoke extract fan set at 10 level 2 had dual power supplies, a primary power supply 11 and a backup power supply in case primary power was 12 lost. The ducts connect to the outside of the building 13 by a vent above the entrance on the south elevation. 14 This photograph shows the ductwork used to connect 15 the fans to the south shaft and on to the external face 16 of the building. The ducts were positioned in the new 17 stair enclosure, directly above the escape route from 18 the internal protected stair at level 2. 19 Just like the original vents, the new vents were 20 mechanical. In environmental mode, they were intended 21 to open and close to allow air in and out of the lobby 22 in day-to-day use. In smoke mode, they were intended to 23 open and close to allow smoke into the shaft from 24 a single lobby. 25 A new combined environmental and smoke extract fan</p> <p style="text-align: center;">Page 102</p> | <p>1 As air and smoke is extracted from the lobby by all 2 the vents within it, air is drawn into the lobby from 3 the stair. A permanently open vent was also located at 4 the roof of the stair. Fresh air was intended to be 5 drawn down through the stair and into the lobby. The 6 flow of fresh air through the open stair door or through 7 the gaps around the stair door, if the stair door was 8 closed, is intended to prevent smoke entering the stair 9 from the lobby. This is the design intent, to maintain 10 the protected stair as a safe space for escape and 11 fire fighting. 12 According to design documentation, the refurbished 13 smoke control system was also designed to allow 14 firefighters to change the floor of operation of the 15 smoke control system, so change it from the current 16 floor of operation to any other floor. The smoke 17 control system was to be designed to operate on a single 18 floor at any one time. 19 Within the entrance foyer, a control panel was 20 provided. This was to enable the Fire Brigade to close 21 all vents on all floors in a single operation. I have 22 requested further information on this system. 23 According to design documentation, the smoke control 24 system was also provided with override switches on each 25 floor. I observed those switches in my site inspection.</p> <p style="text-align: center;">Page 104</p> |

| | |
|---|---|
| <p>1 Operation of the switch should allow the Fire Brigade to 2 open the vents on that floor only and lock the switches 3 on all other floors so that those vents could not be 4 accidentally opened at the same time. 5 Returning this mechanical switch to its original 6 position should close the vents on that floor and unlock 7 the switches on every other floor. This is intended to 8 enable the Fire Brigade to operate the smoke control 9 system on any chosen floor using that respective key 10 switch. 11 A new heating and hot water system and cold water 12 system was installed, and these systems served every 13 floor and every flat in Grenfell Tower. Pipes were 14 routed throughout the tower, from the basement level 15 through to the roof level, and into each and every flat 16 and non-residential accommodation. Each pipe 17 penetration through a compartment wall and floor was 18 therefore required to be protected. New boilers were 19 installed in the basement to serve this new system, and 20 the landlord gas supply, as I've explained, was extended 21 to supply those boilers. The original boilers were 22 retained and they continued to serve the three finger 23 blocks. 24 In addition to the new boilers in the basement, the 25 new heating and hot water system included a heat</p> <p style="text-align: center;">Page 105</p> | <p>1 Cold water pipes were run from water tanks on the 2 roof down through the protected lobbies also. One pipe 3 was run from the 23rd floor down to the 14th floor. 4 A second pipe was run from the 23rd floor down to the 5 third floor. This pipe then continued down to the 6 basement level and fed risers to residential flats and 7 non-residential accommodation areas on ground floor to 8 level 2. Cold water pipes were routed across the 9 ceiling of each lobby to each of the flats. 10 In every lobby between the 4th and 23rd level, a new 11 partition and doors were constructed around the vertical 12 pipes. A new ceiling was also installed in every lobby 13 below the new pipes. 14 This ends my description of some of the works within 15 the primary refurbishment. 16 I will next provide an explanation of the cladding, 17 but we might take a short break. 18 SIR MARTIN MOORE-BICK: Would you like to do that now? 19 DR LANE: Yes, I would, please. 20 SIR MARTIN MOORE-BICK: All right, we'll break for a short 21 time now. I suggest we resume at 2.55. 22 Thank you very much. 23 (2.40 pm) 24 (A short break) 25 (2.55 pm)</p> <p style="text-align: center;">Page 107</p> |
| <p>1 interface unit in each of the flats. The intention was 2 it was to provide space heating and instantaneous hot 3 water for that respective space. A pair of flow and 4 return pipes connected each heat interface unit to the 5 new boilers in the basement. I am going to refer to 6 each pair as a riser to simplify my explanation of the 7 pipe routing throughout the building. 8 Five risers connected the basement to level 2, 9 serving all flats and non-residential accommodation on 10 these levels. A sixth riser connected the basement to 11 level 23, serving all flats on levels 3 to 23. This 12 riser entered the protected stairway between levels 3 13 and 4 only. This riser then continued up the building 14 through each protected lobby from levels 4 to 23, but 15 within a riser cupboard in the lobbies. 16 The pipes appear to have been fire-stopped at each 17 floor level, but I currently have no information 18 available to me as to the fire performance possible from 19 that construction. 20 A pair of pipes then routed out of this riser 21 cupboard latterly across the ceiling, passing in through 22 the compartment wall to each flat. The pipes appear to 23 have been fire-stopped at that compartment wall also, 24 but, again, I have no information available as to the 25 fire performance possible from that construction.</p> <p style="text-align: center;">Page 106</p> | <p>1 SIR MARTIN MOORE-BICK: Yes, Dr Lane, when you're ready. 2 DR LANE: Thank you. 3 Okay, the final part of my presentation today is 4 about the external wall refurbishment. 5 During the 2012 to 2016 primary refurbishment, 6 a comprehensive recladding of the external wall of the 7 existing building was undertaken. To do this, the 8 existing external wall construction was over-clad with a 9 ventilated rainscreen system. New windows were 10 installed and new linings to those windows were 11 installed internally. 12 I will first describe the multiple components of 13 a ventilated rainscreen system and the fire safety 14 provisions required for external wall construction, 15 before describing in detail the materials and 16 arrangement of materials as I have found them at this 17 stage. 18 Today I am only describing materials; I'm not 19 presenting my Phase 1 report opinions on fire 20 performance, testing or compliance status. 21 The rainscreen cladding system was a drained and 22 ventilated system. I have referred to the British 23 Standard code of practice for stone-based rainscreen 24 cladding in describing the key components of 25 a ventilated rainscreen system.</p> <p style="text-align: center;">Page 108</p> |

| | |
|---|--|
| <p>1 This image is a correction through a ventilated 2 rainscreen system. The highlighted portion is the outer 3 layer, also referred to as the rainscreen. This outer 4 layer is intended to shelter the building from the 5 majority of direct rainfall. Some joints between panels 6 or at the edges of the rainscreen should be left open. 7 The second key part now highlighted is a cavity 8 behind this outer layer, a cavity which can include 9 insulation and which is intended to collect any water 10 which passes through the joints in the rainscreen layer, 11 and to permit such water to flow down to a point where 12 it can be collected and drained from the cavity. The 13 insulation layer should not completely fill the cavity. 14 A cavity is also defined in Approved Document B as 15 a space enclosed by elements of a building or contained 16 within an element. It can also be referred to as 17 a concealed space. 18 Where insulation is provided within the cavity, it 19 should not completely fill the cavity so as it does 20 indeed ensure water can flow down to a point where it is 21 collected and drained. 22 The third key component of a rainscreen system is 23 the backing wall which sits behind the cavity and the 24 outer layer. The backing wall is intended to provide 25 a barrier to air infiltration and water ingress into the</p> <p style="text-align: center;">Page 109</p> | <p>1 which is relevant to Grenfell Tower is shown on the 2 left-hand side of the screen now. For clarity, I have 3 changed the original Approved Document B marked dark 4 grey to a blue colour. 5 The image on the right is how diagram 40 would apply 6 to Grenfell Tower. Ground to level 5 are less than 7 18 metres above ground. Level 6 to roof level are more 8 than 18 metres above ground. A building height of 9 18 metres or more means any external wall surface above 10 18 metres must achieve either class 0, national class, 11 or class B-S3, D2, the European class, or better. 12 I have based my opinion on the fire performance of 13 the rainscreen panels installed on Grenfell Tower on the 14 basis of diagram 40. 15 Paragraph 12.7 requires any insulation product, 16 filler material -- not including gaskets, sealants and 17 similar -- et cetera used in the external wall of 18 buildings greater than 18 metres to be of limited 19 combustibility. 20 The classification "limited combustibility" is 21 defined in appendix A in Approved Document B, and 22 I refer you to all the detail in appendix F of my 23 Phase 1 report. But in the very simplest of meanings, 24 a material of limited combustibility is either 25 a non-combustible material or a material which produces</p> <p style="text-align: center;">Page 111</p> |
| <p>1 building. 2 Regarding the fire safety requirements, requirement 3 B4 makes requirements regarding external fire spread 4 and, specifically, part 1 of B4 requires the external 5 walls of the building shall adequately resist the spread 6 of fire over the wall. 7 Approved Document B also states that the provisions 8 are made in section 12 for the fire resistance of 9 external walls and to limit the susceptibility of the 10 external surfaces of walls to ignition and to fire 11 spread. 12 I will now explain section 12. 13 In paragraph 12.5, as I explained this morning, it 14 describes two methods to meet the regulation: that 15 either the construction of the external wall should meet 16 the specific guidance within paragraphs 12.6 to 12.9, or 17 meet the performance criteria given in BR 135. The test 18 described in BR 135 is the British Standard 8414 test. 19 I will explain first the method provided for in each 20 of the paragraphs 12.6 to 12.9 inclusive. 21 I consider the outer layer, the rainscreen layer, to 22 be an external surface. Paragraph 12.6 states: 23 "The external surfaces of walls should meet the 24 provisions in diagram 40." 25 The section of diagram 40 of Approved Document B</p> <p style="text-align: center;">Page 110</p> | <p>1 very little flame under heating. All of this must be 2 determined using either British or European reaction to 3 fire tests. 4 I have made the basis of my opinion clear and in 5 detail in appendix F in my Phase 1 report, that 6 Approved Document B provides no definition of filler 7 material, nor why that excludes gaskets, sealants and 8 similar, et cetera. 9 I have explained why I apply paragraph 12.7, 10 insulation materials and products, to insulation 11 products only. 12 Finally, paragraphs 12.8 and 12.9, relate to the 13 provision of cavity barriers within the external wall 14 construction. Cavity barriers are a construction 15 provided to close a concealed space against penetration 16 of smoke or flame, or they are provided to restrict the 17 movement of smoke or flame within such a space. 18 Using diagram 33 from Approved Document B, cavity 19 barriers are therefore required around the openings 20 created by the windows; at the head of the rainscreen 21 cladding system to close the top of the external wall 22 cavity; at the junctions of every compartment floor and 23 the rainscreen cladding system; at the junctions with 24 compartment walls separating flats and the external 25 rainscreen cladding system.</p> <p style="text-align: center;">Page 112</p> |

| | |
|---|--|
| <p>1 In this image, I have indicated where vertical and 2 horizontal cavity barriers are required around openings 3 created by windows in a rainscreen cladding system. 4 In this image, I have shown where horizontal cavity 5 barriers are required at the junction of the internal 6 compartment floor and the external rainscreen cladding 7 system. 8 In this image, I have shown where vertical cavity 9 barriers are required at the junction of the internal 10 compartment wall and the external rainscreen cavity, 11 which would result in the cavity behind the rainscreen 12 cladding to be subdivided like this. 13 Finally, in this image, I have shown where 14 horizontal cavity barriers are required at the head of 15 the rainscreen cladding to close the top of the cavity. 16 This is the crown at Grenfell Tower. 17 The statutory guidance document, Approved 18 Document B, also makes provisions for the construction 19 of cavity barriers. They are required to achieve at 20 least 30 minutes integrity and 15 minutes insulation 21 fire resistance. Specifically around openings, cavity 22 barriers may instead be formed of specified materials of 23 a minimum thickness. In addition, cavity barriers must 24 be tightly fitted to rigid construction. Where it is 25 not possible to tightly fit the cavity barrier,</p> <p style="text-align: center;">Page 113</p> | <p>1 of the system for testing. It requires the complete 2 cladding assembly to be tested. The complete assembly 3 is defined within as complete cladding assembly, 4 including sheeting rails, fixings, cavities, insulation 5 and membranes, coatings, flashings or joints, and these 6 are to be specified by the test sponsor and affixed to 7 the masonry test walls using their proprietary system 8 fixing. 9 The performance criteria that Approved Document B, 10 paragraph 12.5, refers to is defined in annex A of 11 BR 135. It states performance of the system is to be 12 evaluated against three criteria: external fire spread, 13 described as fire spread up the building envelope by way 14 of the surface of the external cladding system; internal 15 fire spread, described as fire which spreads unseen 16 through the external cladding system; and, finally, 17 mechanical performance. Whilst failure criteria are 18 defined for external fire spread and internal fire 19 spread, no failure criteria are defined for mechanical 20 performance. I will be considering these matters 21 separately. 22 I have taken two main actions to confirm the 23 materials and their arrangement used in the overcladding 24 and internal lining of the external wall of 25 Grenfell Tower. I carried out detailed on-site</p> <p style="text-align: center;">Page 115</p> |
| <p>1 a different protection method, called fire-stopping, 2 must be used in those locations instead. 3 Fire-stopping has a different purpose to a cavity 4 barrier. It has a higher standard of fire resistance. 5 The required fire resistance of fire-stopping for 6 a residential building greater than 30 metres is two 7 hours' integrity and insulation at the junction between 8 the compartment floors. It is one-hour integrity and 9 insulation at the junction of the internal compartment 10 walls with the external wall. 11 Therefore, if a rainscreen outer layer was not 12 interpreted by the designer as rigid construction, then 13 fire-stopping would be required instead of cavity 14 barriers. Approved Document B does not state either way 15 if rainscreen systems are considered rigid construction. 16 Now I will describe the second method referred to in 17 the Approved Document B. The second method is to meet 18 the performance criteria which are given in BRE report 19 135 using full-scale test data from British Standard 20 8414. I will be producing a separate report on this 21 matter and will not go into detail at this stage, only 22 to show this image on the left of a ventilated 23 rainscreen system installed on the test apparatus for 24 conducting a British Standard 8414 fire test. 25 The test standard specifies the size and orientation</p> <p style="text-align: center;">Page 114</p> | <p>1 inspections on 6 October, 1 November and every day 2 between 7 and 9 November. I have carried out a detailed 3 review of evidence from the relevant parties provided to 4 me by the inquiry. I will update my Phase 1 work if any 5 additional evidence becomes available. I have focused 6 my analysis on the external wall construction of the 7 original residential floors. 8 The image on the left illustrates the existing 9 construction of the external wall of Grenfell Tower, the 10 existing solid concrete perimeter beams, concrete 11 columns with decorative concrete cladding, both were 12 retained. The aluminium frame sliding windows were 13 removed. These windows were replaced with new window 14 frames containing glazed panels and insulating 15 polystyrene core panels, and a small window to 16 accommodate the kitchen extract fan. 17 The external overcladding of the existing wall was 18 to create a ventilated rainscreen cladding system and so 19 resulted in: the original building external wall used as 20 the backing wall; a new weatherproof membrane between 21 the new windows and the existing concrete structure; new 22 thermal insulation applied directly to the backing wall; 23 a rainscreen cavity drained to the exterior; and 24 rainscreen cladding panels as the outer layer. 25 We're going to show an animation of all the layers</p> <p style="text-align: center;">Page 116</p> |

| | |
|--|--|
| <p>1 now before I go through each one in turn. 2 (Pause) 3 First, I would like to talk specifically about the 4 new window frames with glazing and insulating 5 polystyrene core panels. 6 This image shows the assembly of the windows, 7 including glazing panels, larger insulating core panels 8 and smaller insulating core panels with a small fan 9 mounted in the centre. 10 The new window frames marked in blue were system 11 5-20Hi+ tilt and turn windows, which were manufactured 12 by Metal Technology Systems. The frames were made from 13 polyester powder coated aluminium alloy. Aluminium is 14 not a combustible material unless it is ground into 15 a powder. 16 The glazing in the window frames is highlighted in 17 dashed red. The glazing used was a double glazing 18 system with a 6-millimetre toughened glass pane either 19 side of a 16-millimetre argon-filled cavity. Glass is 20 not a combustible material. 21 The white panel, indicated in a dashed pink, is 22 an insulating core panel. This infill panel was 23 a product called Aluglaze manufactured by Panel Systems 24 Limited. The panels installed were 1.2 metres high and 25 1 metre wide. Aluglaze is described by its suppliers as</p> <p style="text-align: center;">Page 117</p> | <p>1 position of the window is 185 millimetres further out 2 relative to the original windows. 3 Additionally, the new position of the window frames 4 relative to the existing external wall structure also 5 introduced a gap around the edges of the new windows. 6 The design anticipated this gap to vary between 35 and 7 90 millimetres as the existing columns were not 8 perfectly straight. The gaps that I was able to observe 9 on site varied between 30 and 120 millimetres. 10 To close the gap introduced by the alterations to 11 the size and position of the new windows, a damp proof 12 course, also called a membrane of ethylene propylene 13 diene monomer rubber, referred to as EPDM, was used as 14 a weatherproof seal. EPDM is a synthetic rubber and is 15 a combustible material. 16 The photograph on screen now was taken during my 17 site investigation, viewing the new window frames where 18 they meet the columns. Highlighted with the dashed 19 line, visible in the gap once the external cladding 20 panel is removed from view, is the damp proof course. 21 In this image highlighted with the dashed line, 22 visible in the gap once the internal linings were 23 removed from view, is the black EPDM. 24 The new thermal insulation was directly fixed to the 25 perimeter beams and the vertical concrete columns.</p> <p style="text-align: center;">Page 119</p> |
| <p>1 comprising aluminium bonded to an insulating core. 2 A 25-millimetre Styrofoam core was specified for these 3 panels. Styrofoam is extruded polystyrene and extruded 4 polystyrene is combustible. 5 I have highlighted the smaller window insert 6 insulating core panels in dashed yellow. These panels 7 were 530 millimetres by 500. This panel was specified 8 to be a core of 25-millimetre Kingspan TP10 insulation. 9 TP10 is a polyisocyanurate, which is a combustible 10 material. 11 However, I did not find Kingspan in those locations 12 where I inspected them; I found more Aluglaze-type 13 panels with a polystyrene core. The foam insulation 14 observed on site was light blue, which is consistent 15 with the Styrofoam, which is extruded polystyrene, and 16 as specified for the main infill panels. 17 This whole window assembly, including the glazing 18 and the insulation core panels, was then fixed to the 19 outside face of the existing horizontal concrete 20 perimeter beams, as illustrated here. 21 I remind you the horizontal concrete above and below 22 the windows are beams which support the internal floor. 23 The window frame is bolted onto the outside of the 24 existing external wall using metal brackets at the top 25 and bottom of the window frame. Therefore, the new</p> <p style="text-align: center;">Page 118</p> | <p>1 Two layers of thermal insulation were fixed directly 2 to the face of the building above and below the windows. 3 A single layer of thermal insulation was fixed directly 4 to the face of the columns. Each were fixed using 5 a 180-millimetre stake screwed into the face of the 6 existing concrete perimeter beam or column. The 7 180-millimetre stakes pierced the insulation, therefore 8 mechanically fixing it to the existing structure. 9 On the columns, this was a single layer of 10 100-millimetre thick polymeric foam insulation with 11 an aluminium foil outer facing. The designation shows 12 that it was manufactured by Celotex. The product used 13 was Celotex RS5000, which is made from polyisocyanurate 14 foam. This is commonly shortened to PIR. PIR is 15 a combustible material. 16 On the perimeter beams, the same insulation 17 material, Celotex RS5000 PIR, was affixed in two 18 separate layers of 80 millimetres directly to the wall. 19 This photograph shows the perimeter beam area after one 20 of the two insulation boards has been removed, revealing 21 the second layer of insulation behind it. An expanding 22 foam was used as joint filler to partly fill joint gaps 23 associated with the insulation throughout the rainscreen 24 system. 25 The Harley material data sheets show this was</p> <p style="text-align: center;">Page 120</p> |

| | |
|--|--|
| <p>1 a polyurethane foam.</p> <p>2 Purchase orders show that, due to supply issues with</p> <p>3 Celotex RS5000, 276 metres squared of a Kingspan</p> <p>4 product, Kooltherm K15 rainscreen board of 80-millimetre</p> <p>5 thickness, was ordered as a substitute. These Kingspan</p> <p>6 boards were applied to the horizontal perimeter beam, as</p> <p>7 can be seen in the image on screen.</p> <p>8 The final material I will explain is the rainscreen</p> <p>9 outer layer. At Grenfell Tower, these were</p> <p>10 Reynobond 55 PE aluminium composite panels. They were</p> <p>11 installed on the vertical length of the columns and in</p> <p>12 horizontal runs above and below the windows of each</p> <p>13 floor meeting the columns. I have highlighted the</p> <p>14 location of the panels below a window in the photograph</p> <p>15 on screen. These panels were typically 1.3 by</p> <p>16 1.2 metres wide below the windows.</p> <p>17 I have also highlighted the location of the panels</p> <p>18 that were installed on the columns of the building.</p> <p>19 These panels were typically 2.5 metres high and</p> <p>20 0.55 metres wide.</p> <p>21 Arconic Reynobond 55 PE aluminium composite panels</p> <p>22 consist of 0.5-millimetre aluminium sheets either side</p> <p>23 of a 3-millimetre thick polyethylene core. Polyethylene</p> <p>24 is a combustible material.</p> <p>25 Arconic Reynobond 55 PE panels are manufactured as</p> <p style="text-align: center;">Page 121</p> | <p>1 insulation itself to support it.</p> <p>2 The photograph on the right-hand side is a close-up</p> <p>3 image of the rail. It is a U shape with metal bolts</p> <p>4 connecting the two sides. The Arconic Reynobond 55 PE</p> <p>5 panels were hung on these bolts.</p> <p>6 This photograph shows one of the rainscreen panels</p> <p>7 being removed from the building as I witnessed it. It</p> <p>8 shows the 3D shape of the panel and the slots cut into</p> <p>9 the edge to hang on the bolts within the cladding rails.</p> <p>10 This animation illustrates the application of the</p> <p>11 rainscreen cladding panels to the horizontal perimeter</p> <p>12 beam and the vertical columns.</p> <p>13 As shown on screen now, gaps were left between</p> <p>14 aluminium composite panels in their installed position.</p> <p>15 On site in the areas I inspected, I noted that the panel</p> <p>16 gaps range between 15 and 30 millimetres. At the edge</p> <p>17 of the panels in these gaps the polyethylene core is</p> <p>18 clearly visible, and polyethylene is combustible, as</p> <p>19 I said.</p> <p>20 The installation of a rainscreen cladding system to</p> <p>21 the outside of the existing building created cavities</p> <p>22 between the existing concrete wall and the new</p> <p>23 rainscreen outer layer. The cavity formed between the</p> <p>24 original concrete structure and the rainscreen cladding</p> <p>25 above and below the windows is illustrated on screen.</p> <p style="text-align: center;">Page 123</p> |
| <p>1 flat panels. These flat panels can either be screwed or</p> <p>2 riveted into the support frame as shown on the left-hand</p> <p>3 image on screen.</p> <p>4 Alternatively, the edges of the panels can be bent,</p> <p>5 making a 3D shape. Slots are cut in the edges of the</p> <p>6 panels so they can be hung on a support rail behind.</p> <p>7 Therefore, the support is then hidden behind the front</p> <p>8 face of the panel. These are called modular cassettes.</p> <p>9 This modular cassette method was the method of</p> <p>10 supporting the rainscreen cladding at Grenfell Tower.</p> <p>11 Vertical metal channels were attached to the</p> <p>12 building exterior at approximately 1.15-metre centres,</p> <p>13 as measured on site. These vertical channels were</p> <p>14 bolted to the underside of the metal brackets supporting</p> <p>15 the new window frames.</p> <p>16 These cladding rails were in turn fixed back onto</p> <p>17 the new window brackets.</p> <p>18 These photographs from my site investigation show</p> <p>19 the vertical cladding rails in place below a window.</p> <p>20 The cladding rails are highlighted in orange and the</p> <p>21 steel brackets to which they are affixed in green.</p> <p>22 My understanding is that both these brackets were</p> <p>23 manufactured by Trifab. The vertical cladding rail is</p> <p>24 bolted to the steel bracket. It therefore sits in front</p> <p>25 of the thermal insulation, but no fixings go through the</p> <p style="text-align: center;">Page 122</p> | <p>1 This cavity contained two layers of 80-millimetre</p> <p>2 either Celotex or Kingspan insulation on the perimeter</p> <p>3 beams. Therefore, the depth of cavity between the</p> <p>4 insulation and the rear face of the aluminium composite</p> <p>5 panel is 156 millimetres.</p> <p>6 The cavity was also formed between the concrete</p> <p>7 structure and the rear face of the aluminium composite</p> <p>8 panel attached to the columns. The column cavity</p> <p>9 contained 100-millimetre thick insulation. Therefore,</p> <p>10 the depth of cavity between the insulation and the rear</p> <p>11 face of the ACP here is 139 millimetres.</p> <p>12 Horizontal cavity barriers were installed on both</p> <p>13 the columns and horizontal perimeter beams at</p> <p>14 Grenfell Tower. The photograph on screen now shows</p> <p>15 a horizontal cavity barrier fixed to the front face of</p> <p>16 a column on Grenfell Tower. The cavity barrier is</p> <p>17 mechanically fixed in place using metal support</p> <p>18 brackets, which pierce the full depth of the cavity</p> <p>19 barrier. A split protruding end of the bracket should</p> <p>20 be counter-folded to retain the cavity barrier in</p> <p>21 position.</p> <p>22 In this picture, the split end has not been</p> <p>23 counter-folded and, instead, has been bent in a single</p> <p>24 direction.</p> <p>25 The cavity barriers I observed were SIDERISE RH25</p> <p style="text-align: center;">Page 124</p> |

| | |
|--|--|
| <p>1 open state horizontal cavity barriers. They come with 2 instructions to be installed with a 25-millimetre gap 3 between the front face of the cavity barrier and the 4 rear face of the rainscreen outer layer, allowing 5 drainage of any moisture within the rainscreen cladding 6 system as required and for the purposes of maintaining 7 the required airflow.</p> <p>8 This horizontal cavity barrier consists of 9 non-combustible stone wool core with reinforced 10 aluminium foil faces. The front face, highlighted in 11 orange, is a reactive intumescent strip which is bonded 12 to the barrier. In the event of exposure to fire, the 13 intumescent strip expounds outwards and is intended to 14 close the gap between the cavity barrier as installed 15 and the rear face of the rainscreen panel.</p> <p>16 These two photographs show the horizontal ventilated 17 cavity barrier installed below a window at Grenfell 18 Tower. Several notches were cut in the cavity barrier 19 to allow the cladding rail for the rainscreen panels to 20 pass through. The picture on the right-hand of the 21 screen then shows how the cladding rail passes through 22 the horizontal ventilated cavity barrier. The 23 photograph on the left-hand side of the screen shows the 24 same cavity barrier with the cladding rail removed, 25 showing the gap that was cut in the cavity barrier.</p> <p style="text-align: center;">Page 125</p> | <p>1 windows in the refurbishment, which I will describe 2 shortly, are also not considered to meet the performance 3 of a cavity barrier as defined in Approved Document B.</p> <p>4 No cavity barriers were specified at the head of the 5 external wall cavity up by the so-called crown. I have 6 yet to carry out an inspection of that area to check if 7 they were anyway.</p> <p>8 I will now move to the materials on the interior of 9 the tower.</p> <p>10 This photo from prior to the refurbishment 11 illustrates the original windows and material lining the 12 window reveals on the left. When the original windows 13 were removed, the highlighted lying materials were also 14 removed. New materials were then installed internally 15 around each of the windows. The materials highlighted 16 here are the final finished linings. As you can see, 17 the location of the new materials installed was limited 18 to the top, bottom and both sides of every window 19 opening.</p> <p>20 The materials applied internally included: 21 Existing timber, part of the original window 22 linings. This solid timber material is highlighted in 23 blue in the image of the original construction which is 24 on the left. 25 New uPVC linings around the window opening. UPVC,</p> <p style="text-align: center;">Page 127</p> |
| <p>1 Vertical cavity barriers were installed on 10 of the 2 14 columns of the tower. For the vertical cavity 3 barriers, the Harley design drawings specified SIDERISE 4 RVG full fill cavity barriers. The image on the right 5 is taken from SIDERISE product literature. It shows the 6 SIDERISE RVG full fill cavity barriers are to be 7 installed over the full depth of the cavity, leaving no 8 gap. It is a mineral wool product which is 9 non-combustible.</p> <p>10 On site I observed instead that the horizontal 11 cavity barrier product, SIDERISE RH25 open state cavity 12 barrier, had been rotated and installed vertically. It 13 had also been installed with the intumescent strip 14 facing into the existing concrete structure.</p> <p>15 This photo shows the SIDERISE RH25 cavity barrier 16 rotated and installed in the vertical position. A gap 17 was observed between the roughly cut mineral wool 18 barrier and the rainscreen panel.</p> <p>19 I observed some required cavity barriers not to have 20 been installed at Grenfell Tower. This image 21 illustrates the cavity barriers present in the external 22 wall cavity. It can be seen there are no cavity barrier 23 products installed around the openings made by the 24 windows.</p> <p>25 The installed internal material linings to the</p> <p style="text-align: center;">Page 126</p> | <p>1 plasticised polyvinyl chloride, is a solid plastic 2 combustible material. This is highlighted in orange in 3 the right-hand side image.</p> <p>4 Pieces of insulation placed between the existing 5 concrete construction and this uPVC lining. This is 6 highlighted in yellow in the right-hand image, as well 7 as other larger pieces of thermal insulation underneath 8 all four sides of the uPVC linings, which I will also 9 explain.</p> <p>10 Firstly, timber batons and, in places, timber board, 11 which formed part of the original linings to the window 12 reveals, were left directly affixed to the concrete 13 construction. I have shown the position of these 14 materials in the images on the screen here.</p> <p>15 The timber materials themselves can be seen in this 16 image, which shows the condition when all the newly 17 installed linings have been removed. Where the original 18 timber lining was retained, this was approximately 19 195 millimetres wide and, as can be seen in the image on 20 the left, does not extend out to the new window 21 position; a gap exists.</p> <p>22 While inspecting the external wall of 23 Grenfell Tower, I observed foam-type filler materials 24 placed in these gaps. This image on the right is a view 25 looking up to the top of the window at the right-hand</p> <p style="text-align: center;">Page 128</p> |

| | |
|---|--|
| <p>1 corner. In the gap above, between the window frame and 2 the existing concrete face of the building, an orange 3 foam filler material can be seen. 4 I also observed insulation material underneath the 5 uPVC lining directly, 25-millimetre thick insulation 6 foam beneath the uPVC, filling the gap between the 7 original timber window linings and the new window frame 8 location. I have found no evidence of a specific 9 insulation product or material specified for this 10 location. In this image, I have illustrated the 11 locations that it was observed; that is around all four 12 sides. 13 This image shows a polymeric insulation foam with 14 foil facing installed at the head of the window between 15 the new window frame and original timber lining. The 16 final window material has been removed by others. There 17 are no identifying logos or labels on this sample. 18 The pictures on screen now were taken during my site 19 investigation, looking right at the opening between the 20 original infill panel between windows and the new 21 Aluglaze insulating core panel. In this location, 22 I found 25-millimetre thick polymeric foam sealing the 23 edge of the void created between the old and the new 24 infill panel. The markings on the aluminium foil facing 25 of the insulation appears to indicate that it was</p> <p style="text-align: center;">Page 129</p> | <p>1 rainscreen overcladding around the openings. 2 Approved Document B, however, does permit cavity 3 barriers around openings to be formed of specific 4 materials of a minimum thickness. These include: steel, 5 at least 0.5 millimetres thick; timber, at least 6 38 millimetres thick; polyethylene sleeved mineral wool 7 or mineral wool slab under compression; 8 calcium silicate, cement-based or gypsum-based boards, 9 at least 12 millimetres thick. 10 The materials as I have just described them 11 installed internally at Grenfell Tower around the 12 openings created by the new windows do not meet these 13 requirements. As the internal materials cannot be 14 considered as cavity barriers either, no cavity barriers 15 of any kind were present around the window openings 16 within Grenfell Tower. 17 Finally, whilst inspecting the external wall of the 18 tower, I observed a soft material above each window. 19 Specifically, I observed a strip of board adjacent to 20 the head of the window. The top-right image shows it 21 was an 8-millimetre hardboard and a 12-millimetre foam. 22 I observed a portion of the board which had been removed 23 by others in flat 23. The board was labelled ICI 24 purlboard, which is a polyurethane foam and plasterboard 25 composite product, and polyurethane is also</p> <p style="text-align: center;">Page 131</p> |
| <p>1 Celotex TB4000, noting the Celotex logo highlighted with 2 the orange dashed box. TB4000 is a PIR insulation. 3 This requires formal identification via testing, 4 however, as the design drawings do not show insulation 5 in this location. 6 Further samples of insulation removed from the 7 underside of the uPVC show a different product logo. 8 The green logo, highlighted with the orange dashed 9 circle here, is consistent with the Kingspan Therma 10 range of PIR which, as I have explained, is combustible. 11 This, too, requires formal identification via testing. 12 Now turning to the uPVC lining itself. 13 I observed the uPVC lining to all four sides of each 14 window. The material is a rigid combustible plastic 15 used for a variety of construction purposes. 16 Where the uPVC lining had been removed by others, 17 I was able to observe its thickness as 10 millimetres. 18 The zigzag pattern I observed on the underside of the 19 uPVC lining was replicated on the original timber 20 linings from which they had been removed, indicating the 21 uPVC lining was glued in position. 22 These images illustrate the final finished surface 23 of the uPVC lining to the window openings. 24 I have earlier explained that no cavity barriers 25 were installed within the external cavity of the</p> <p style="text-align: center;">Page 130</p> | <p>1 a combustible plastic material. 2 This concludes my description of the materials used 3 and how they were arranged and fixed for the external 4 and internal refurbishment of the external wall of 5 Grenfell Tower. 6 Thank you. 7 SIR MARTIN MOORE-BICK: Thank you very much indeed. 8 Thank you. 9 MS GRANGE: Thank you, sir. That concludes Dr Lane's 10 presentation today and we will commence again tomorrow 11 at 10 am with the presentation of 12 Professor Niamh Nic Daeid. 13 SIR MARTIN MOORE-BICK: Yes, thank you. 14 MS GRANGE: Thank you. 15 SIR MARTIN MOORE-BICK: So we'll finish there and we'll be 16 back here at 10 o'clock tomorrow morning. 17 Thank you all very much. 18 (3.40 pm) 19 (The hearing adjourned until Tuesday, 19 June 2018 at 20 10.00 am) 21 I N D E X 22 DR BARBARA LANE (sworn)5 23 24 25</p> <p style="text-align: center;">Page 132</p> |

| A | | | | |
|--|---|--|---|--|
| A4 79:8 | action 25:11,18 41:8,11 50:13 | advanced 58:20 | Aluglaze 117:23,25 129:21 | application 62:9 64:12 123:10 |
| ability 41:24 42:15 47:10 56:5 58:4 | actions 115:22 | advancing 55:1 | Aluglaze-type 118:12 | applications 60:22 60:23 |
| able 7:5 13:17 26:19 32:2 33:22 35:5 42:20 73:5 119:8 130:17 | activate 47:20 | advice 25:3 | aluminium 15:23 94:8 116:12 117:13,13 118:1 120:11 121:10,21 121:22 123:14 124:4,7 125:10 129:24 | applied 17:15,16 49:19 61:8,14 68:18 116:22 121:6 127:20 |
| Absolutely 83:23 | activated 52:21,24 54:9 | advises 24:22 45:17 90:9 | amenity 12:20,21 | applies 22:23 24:21 25:7 70:24 |
| Academy 6:25 | activation 51:10 53:1,18 103:10 | AE 10:18 | amount 56:6,12 | apply 23:4,12 30:9 111:5 112:9 |
| acceptable 81:2 | active 1:17 5:16 8:15 20:2 27:15 28:16,21 29:19,23 30:12,14 31:1 35:14 38:21 41:3 41:10,13 50:11,12 59:8,10 61:11 65:17 | affect 47:24 | analysing 61:9 | applying 30:8 |
| access 11:1,14,22 12:6,25 13:3,11 13:14,17,18 18:14 18:15 21:24 22:6 35:5 36:5,24 58:13 63:17,25 66:22,24 67:14 68:14,15 70:14 72:2,4 95:4,8,24 97:16 98:8,10,13 | add 15:3 | affixed 68:8 115:6 120:17 122:21 128:12 | analysis 1:25 94:14 116:6 | appointed 65:6 84:25 91:1 |
| accessed 11:17 95:9 | Adaption 92:8 | afternoon 9:1 91:20 | and/or 43:15 | appreciate 7:5 |
| accessible 96:4 | added 100:2 | ahead 7:15 | Andrew 4:11 | approach 11:20,25 24:11,13 37:21 59:12 |
| accessing 67:3 | addition 54:10 58:23 79:7 93:24 105:24 113:23 | air 18:22,22,24 38:5,5 53:9,23,24 54:18,22 78:21 81:15 90:23 100:20,22,22 101:6,7,17 102:21 103:19,23 104:1,2 104:4,6 109:25 | animation 116:25 123:10 | approaching 38:7 |
| accidentally 105:4 | additional 10:22 14:25 25:3 27:17 | airflow 81:20 82:8 101:4 125:7 | animations 9:23 | appropriate 21:3,4 42:1 47:8 48:20 49:3,6 61:7 75:23 |
| accommodate 116:16 | address 1:20 8:9,12 19:23 | alarm 31:9,10,10 32:9 50:16,18,20 50:23 51:8,9 | annex 115:10 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| accommodation 58:19,21 79:12 92:11 98:23 105:16 106:9 107:7 | addressed 48:17 | alert 34:15 | apparatus 37:24 38:6 54:20,21 114:23 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| accomplished 81:17 | addresses 5:16 | alerted 31:12,13 | apparent 12:21 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| account 2:19 | addressing 6:9 | Alfie 9:20 | apparently 86:13 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| accurately 7:11 | adequate 36:4 51:12 54:24 57:16 | allow 12:6 35:8 42:22 43:2 56:2 67:13 68:13,15 101:4 102:21,23 104:13 105:1 125:19 | appear 17:10 78:6 82:22 106:16,22 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| achieve 48:17 75:9 77:9 78:23 79:24 111:10 113:19 | adequately 21:18 32:18 33:1 36:14 43:4 90:22 110:5 | allowed 11:1 | appears 11:16 17:11 129:25 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| achieved 42:9 47:13 80:25 | adjacent 14:4 17:6 42:10 59:25 131:19 | allowing 125:4 | appendices 5:14 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| achieving 24:9 | adjoining 32:8,19 | alloy 117:13 | appendix 6:1 43:22 48:18,18,21 49:21 50:15 60:16 76:1 111:21,22 112:5 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| acknowledges 24:8 | adjourned 132:19 | alterations 62:16 92:24,25 119:10 | appliance 55:23 56:3 57:3 58:6 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| ACP 124:11 | adjournment 84:2 | alternative 24:9,11 24:13 46:6 52:12 53:11,20 | appliances 12:10 22:6 35:20 86:18 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |
| Act 25:7,9,14,16,19 | | Alternatively 13:12 55:24 122:4 | applicable 70:21 71:9,14 | approved 10:12 20:18,18,20 24:1 24:1,5,15,18,20 25:24 26:17,21 27:8 28:19,25 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 50:9,17 51:11,25 52:5,11,14 55:11 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17 114:14,17 115:9 127:3 131:2 |

| | | | | |
|----------------------------|---------------------------|----------------------------|----------------------------|----------------------------|
| April 5:13 | assume 26:11 | 111:3,21 112:6,18 | basement 10:4 | 118:14 127:23 |
| architrave 76:4 | assumed 37:25 | 113:18 114:14,17 | 14:15 19:1,4,12 | blue/grey 70:8 |
| Arconic 121:21,25 | 81:23 82:16,21,25 | 115:9 127:3 131:2 | 85:15 86:2,5,13 | board 121:4 128:10 |
| 123:4 | assumption 26:14 | B-S3 111:11 | 86:23,24 87:5,12 | 131:19,22,23 |
| area 10:8,24 11:4 | 36:10 | B1 21:1 24:6 48:7 | 89:16 105:14,19 | boards 120:20 |
| 14:9 17:17 19:19 | at-level 98:3 | B2 21:8 | 105:24 106:5,8,10 | 121:6 131:8 |
| 25:10 38:1 69:5 | attached 122:11 | B2.i 47:23 | 107:6 | boilers 19:12 85:22 |
| 93:6,8 97:18,22 | 124:8 | B3 21:11 | basic 1:21 52:10 | 86:5,6,9,10 |
| 97:25 98:2,14,19 | attend 26:15 | B4 21:16 44:10 | 68:4 | 105:18,21,21,24 |
| 120:19 127:6 | attendance 9:22 | 110:3,4 | basis 26:18 30:23 | 106:5 |
| areas 11:6 12:13,15 | attention 23:25 | B5 21:23 24:6 | 35:24 36:22 83:11 | bolted 118:23 |
| 12:20,24 40:5 | audio 4:21 | 55:13 74:4 | 111:14 112:4 | 122:14,24 |
| 70:4 92:19,21 | authorities 25:10 | back 122:16 132:16 | batons 128:10 | bolts 123:3,5,9 |
| 99:4 107:7 123:15 | authority 11:8 | background 6:2 | battery 51:18 | bonded 118:1 |
| argon-filled 117:19 | 23:10,13 25:3,17 | backing 94:1 | beam 15:22 16:5,6 | 125:11 |
| arranged 7:23 | 25:17 | 109:23,24 116:20 | 17:7 120:6,19 | boosted 92:20 |
| 132:3 | automatic 18:19,23 | 116:22 | 121:6 123:12 | booster 96:10 |
| arrangement | automatically | backup 51:18 | beams 14:25 15:10 | borough 10:10 11:9 |
| 108:16 115:23 | 31:12 32:9 41:12 | 102:11 103:3 | 15:21 17:15 47:3 | 11:11,12 62:5 |
| arrival 37:14 | 54:7 57:4 | balconies 95:20 | 116:10 118:20,22 | 78:5 92:2 |
| arrive 55:16 57:9 | available 10:23 | 98:24 | 119:25 120:16 | bottom 87:24 101:8 |
| 74:7 | 33:20,24 52:15 | ballgame 12:19 | 124:3,13 | 118:25 127:18 |
| artificial 51:12 | 56:9 60:21 63:10 | Barandon 10:15 | bear 7:6 | boundary 93:3,10 |
| Arup 6:7,20 85:9 | 80:17 82:25 90:17 | Barbara 1:10 5:4,9 | belief 7:9 | 96:24 97:12,15 |
| asbestos-bearing | 95:5 106:18,24 | 132:22 | beneath 129:6 | 98:6,15 |
| 16:2 | 116:5 | barrier 109:25 | bent 122:4 124:23 | box 32:15,23 36:19 |
| ascertain 23:14 | avoid 28:2 | 113:25 114:4 | bereaved 2:14 | 42:4,5,5,6 44:9 |
| asked 7:7 | awarded 6:21 | 124:15,16,19,20 | best 7:9 | 46:22 80:2 130:2 |
| aspects 1:16 65:7 | | 125:3,8,12,14,17 | better 111:11 | boxes 42:3 80:14 |
| assembly 75:13,18 | B | 125:18,22,24,25 | beyond 26:4,9 33:2 | boxing 92:13 94:25 |
| 75:19,25 76:12 | b 20:15,16,18,20 | 126:11,12,15,18 | 38:23 54:22 | BR 45:4 46:9 49:23 |
| 115:2,2,3 117:6 | 23:19 24:1,5,15 | 126:22 127:3 | Bisby 1:11 2:2 4:13 | 110:17,18 115:11 |
| 118:17 | 24:20 25:24 26:1 | barriers 45:17 46:2 | 5:1 | bracket 122:24 |
| assessed 49:2 75:22 | 26:21 27:8 28:19 | 112:13,14,19 | bit 7:20 80:10 | 124:19 |
| assessment 24:24 | 28:25 29:14 36:23 | 113:2,5,9,14,19 | black 119:23 | brackets 118:24 |
| 24:25 72:24 79:5 | 41:22 43:6 44:15 | 113:22,23 114:14 | block 10:6 51:14 | 122:14,17,21,22 |
| assessments 60:23 | 44:23 45:7,17,25 | 124:12,25 125:1 | blocking 34:24 | 124:18 |
| assist 2:11 22:3,20 | 46:5,14 47:5,9,22 | 126:1,3,4,6,19,21 | blocks 10:13,14 | branch 38:10 |
| 25:2 30:8 | 48:18 49:2 50:10 | 127:4 130:24 | 11:1,2 12:16 14:4 | BRE 114:18 |
| assistance 26:20 | 50:17 51:11,25 | 131:3,14,14 | 24:20,22 30:6 | breach 86:13 |
| 33:13,21,23,23,25 | 52:5,11,14 55:11 | bars 47:16,17 | 41:5 59:1 85:24 | break 20:1 40:13 |
| assists 2:7 | 70:20 74:3 78:17 | base 12:22 13:2 | 86:11 97:20 | 40:16,21 74:13,19 |
| associated 64:13 | 79:10 82:1 87:17 | based 11:16 26:14 | 105:23 | 83:15,20 107:17 |
| 68:1 71:17 120:23 | 88:1,9 90:9,19 | 32:25 36:8 78:8 | blue 69:19 95:23 | 107:20,24 |
| Associates 10:11 | 109:14 110:7,25 | 111:12 | 111:4 117:10 | breaks 32:6 |

| | | | | |
|---------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|
| breathe 38:5 | 27:16,25 28:14,15 | 28:22 34:4 35:23 | 115:25 116:2 | cement-based |
| breathing 37:24 | 29:3,20,22,23 | 36:3,5,21 40:1 | carry 24:23 37:23 | 131:8 |
| 38:6 54:20,21 | 30:13,14,20 31:4 | 41:18 42:18 44:20 | 127:6 | cementitious 16:2 |
| brick 63:20 | 31:11,17 32:16 | 47:12 54:24 56:18 | carrying 22:11 | cent 86:19 88:24 |
| bridgehead 38:1 | 33:23 34:1,5,7,8,9 | 59:18 67:19 99:9 | 46:13 | centimetres 15:5,9 |
| 54:22 | 34:10 35:5,12,13 | 111:18 | cars 71:18 72:6 | 15:10,12,17 |
| brigade 8:12 29:4 | 35:15 36:4,6,7,17 | buildings' 45:1 | case 21:4 51:20 | central 13:11,15 |
| 30:11 31:12 33:25 | 37:3,9,16,17,18 | built 6:10,13 8:3 | 70:10 83:24 90:7 | 14:10 18:13 19:7 |
| 34:15 35:3,3 37:1 | 38:10,13 39:2,9 | 10:6 58:25 67:8 | 102:11 | 67:1 71:4,13 86:7 |
| 37:6,14 39:23 | 39:23 40:3,6 41:4 | 75:12 | cases 48:22 | 95:15,23,25 99:20 |
| 54:10,13,16,18,19 | 41:7,25 42:9,20 | buoyancy 53:7 | cassette 122:9 | centrally 66:20 |
| 55:5,19,23 58:11 | 43:14 44:16,24 | burning 4:20 | cassettes 122:8 | centre 14:2 18:3 |
| 67:13,19 69:22 | 45:11 46:25 47:6 | burnt-out 4:6,24 | cause 1:25 | 117:9 |
| 99:19 104:20 | 47:21 51:17 52:19 | butt 80:25 | caused 85:3 95:3 | centres 122:12 |
| 105:1,8 | 53:8 54:3,16,17 | bypassing 28:3 | cavities 16:16,16 | certain 2:2,5 3:22 |
| Brigade's 59:7 | 54:23 55:18,21,24 | | 16:19 44:19 45:19 | 51:4 |
| bring 7:5 | 56:1,6,8,19,22 | C | 45:21,23,25 49:24 | certificate 23:10,15 |
| British 26:22,22 | 57:2,13,18 59:6 | c 26:2 49:5 | 115:4 123:21 | 23:21 |
| 27:2 28:7,19,24 | 60:2,4,14,22 | cable 69:9 73:18 | cavity 45:16 46:2 | cetera 55:19 111:17 |
| 29:14 43:12 45:2 | 61:23 62:9,13,17 | cables 42:19 68:8 | 94:2 109:7,8,12 | 112:8 |
| 57:20 78:19 | 62:23,25 63:15 | Cadent 88:16 | 109:13,14,18,19 | CGL 94:7 |
| 108:22 110:18 | 64:12,12,25 65:2 | calcium 131:8 | 109:23 112:13,14 | Chairman 1:8 3:7 |
| 112:2 114:19,24 | 65:3,5 66:16,20 | call 4:10,11,25 5:1 | 112:18,22 113:2,4 | change 27:13,14 |
| broadly 45:19 | 68:13 71:23 72:21 | 5:2 34:10 39:9 | 113:8,10,11,14,15 | 54:13 61:4,9 |
| brochure 79:16,19 | 72:23 75:14 79:13 | 71:19 | 113:19,21,23,25 | 104:14,15 |
| brush-like 81:18 | 83:8 86:1,22 87:1 | called 1:15 2:13 | 114:3,13 116:23 | changed 58:24 67:9 |
| BS 27:5,17 49:25 | 87:3,4,9 88:11 | 10:14 17:14 24:3 | 117:19 123:23 | 67:23,25 72:25 |
| 52:17 | 89:15,18,19 93:16 | 26:23 27:2 53:21 | 124:1,3,6,8,10,12 | 75:11 96:7 100:14 |
| build 63:20 | 93:20 94:12 96:11 | 80:25 94:6 114:1 | 124:15,16,18,20 | 111:3 |
| building 1:17 3:23 | 96:20,22 97:21 | 117:23 119:12 | 124:25 125:1,3,8 | changes 61:6 62:1 |
| 8:2,9,19 9:3,6,7 | 98:1 99:11,12,21 | 122:8 | 125:14,17,18,22 | 62:23 94:18 96:2 |
| 10:1,3 11:17,21 | 99:22 102:6,12,16 | calling 3:17 4:3 | 125:24,25 126:1,2 | 97:16 |
| 12:14,24 13:7 | 103:20,24 106:7 | capable 21:6 43:16 | 126:4,6,7,11,11 | channels 122:11,13 |
| 14:19,20,23 16:10 | 106:13 108:7 | 47:7 48:7,25 | 126:15,19,21,22 | Chapman 9:20 |
| 16:17,18,19,21 | 109:4,15 110:1,5 | 75:21 | 126:22 127:3,4,5 | chapters 5:14 |
| 17:25 19:3 20:5,6 | 111:8 114:6 | capacity 47:10 | 130:24,25 131:2 | charge 38:14 57:9 |
| 20:6,13,16,17 | 115:13 116:19 | 51:19 69:5 70:5 | 131:14,14 | 58:14 99:19 |
| 21:2,5,6,10,13,13 | 120:2 121:18 | 72:7,12 103:16 | ceiling 17:17,19 | charged 38:12 |
| 21:18,19,21,22,23 | 122:12 123:7,21 | capped 88:20 | 90:5 106:21 107:9 | 58:20 |
| 22:1,5,6,11,13,16 | 129:2 | car 68:7,9,16 69:4 | 107:12 | chartered 6:17 |
| 22:18,19,21,22,25 | building's 40:7 | 69:20 70:5,12,14 | ceilings 47:24 48:9 | check 127:6 |
| 23:2,4,6,20,23 | buildings 8:8 10:16 | 72:8,9 73:23,24 | Celotex 120:12,13 | Chelsea 10:10 11:9 |
| 24:4,16,24 25:1,5 | 19:22 20:10,11,12 | carried 9:4 33:25 | 120:17 121:3 | 11:13 62:5 78:5 |
| 25:20,21 26:5,8 | 22:24 23:11 25:6 | 35:25 61:1 64:8 | 124:2 130:1,1 | 92:3 |
| 26:12,19 27:1,11 | 26:24,25 27:4 | 65:13 99:17 | Celsius 49:16 | children's 11:6 |

| | | | | |
|---|--|--|--|--|
| <p>chimney 53:9 chloride 128:1 choice 39:17 47:23 choices 33:20 choose 28:10 chosen 29:25 89:21 93:15 105:9 chronological 8:20 chronology 60:16 60:19 62:4 chute 77:11,13 78:13 82:23 cills 17:9 circle 130:9 circuit 51:16 69:9 circular 93:5 97:21 97:24 circulation 48:2 circumstances 28:12 51:4 cited 27:1 cladding 3:24 9:16 44:19 45:1 46:10 50:1 93:21,25 94:4,5,16 96:25 107:16 108:21,24 112:21,23,25 113:3,6,12,15 115:2,3,14,16 116:11,18,24 119:19 122:10,16 122:19,20,23 123:9,11,20,24 125:5,19,21,24 clarity 97:10 111:2 class 111:10,10,11 111:11 classes 48:19 classification 111:20 clause 48:11 clear 3:14 20:17 24:19 69:13 72:11 87:8 112:4 clearly 59:21</p> | <p>123:18 Clifford 10:11 climb 13:12 close 17:17 37:16 43:7 46:11 53:3 101:4 102:21,23 104:20 105:6 112:15,21 113:15 119:10 125:14 close-up 123:2 closed 43:14 95:24 97:20 101:16 104:8 closing 45:22 clothing 54:20 club 92:13 94:25 co-ordination 39:11 coated 117:13 coatings 115:5 code 26:24 28:7 35:18 68:17 108:23 codes 36:1 cold 9:14 76:8 79:20 92:20 96:10 96:17 97:8 105:11 107:1,8 collapse 47:10 colleagues 9:18 collect 109:9 collected 109:12,21 collectively 15:7 College 6:18 colour 94:10 111:4 colours 62:19 94:9 column 120:6 124:8,16 columns 14:12,20 14:24 15:11,15 47:3 93:22 94:11 116:11 119:7,18 119:25 120:4,9 121:11,13,18 123:12 124:8,13</p> | <p>126:2 combination 15:23 30:15 47:16 combined 100:15 102:25 combustibility 45:15 48:13 111:19,20,24 combustible 17:20 17:24 44:18 117:14,20 118:4,9 119:15 120:15 121:24 123:18 128:2 130:10,14 132:1 come 2:18 125:1 comfortable 7:19 coming 58:16 commence 132:10 commenced 8:24 10:18 88:14 91:10 commercially 10:23 commissioned 91:24 common 18:13 24:22 25:15,20 26:7 31:18 32:4 51:14 52:1,6,7,20 52:22 53:1 59:2 79:12 commonly 120:14 communal 85:22 100:18 communicate 34:8 40:4 communicates 24:5 communication 27:13 34:11 70:14 communications 58:17 community 14:2 18:2 62:10 92:14 94:21,23 company 6:8</p> | <p>compared 70:7 comparing 81:24 compartment 4:7 18:17 28:3 32:7 32:23 36:12,14 42:8,14,25 43:11 43:18 58:15 77:6 77:12,18 87:13,18 87:20 90:3,3 91:4 91:5,6 105:17 106:22,23 112:22 112:24 113:6,10 114:8,9 compartmentation 18:11 26:3 29:21 30:19,20,22 33:8 36:20 39:1,3,8 43:24 59:17 65:12 75:2 76:18 83:10 83:10 84:18 85:17 86:14 87:16 91:14 91:17 compartments 41:19,20 42:3 75:2 84:17 87:14 complete 71:4 115:1,2,3 completed 10:19 22:25 60:15 85:4 completely 90:11 109:13,19 completion 22:13 23:10 complex 85:15 compliance 24:9 50:9 61:10 88:12 108:20 complied 23:22 comply 23:8 48:6 complying 46:13 component 41:24 44:6 76:13 79:21 97:1 109:22 components 43:8 68:4 75:16,16,25</p> | <p>76:3 108:12,24 composite 4:17 79:17 94:8 121:10 121:21 123:14 124:4,7 131:25 comprehensive 108:6 compression 131:7 comprised 82:15 93:21 94:1 comprising 118:1 concealed 16:13,15 21:15 109:17 112:15 concentrating 3:23 concept 18:12 24:13 29:9 35:25 49:23 concepts 2:3 conclude 28:6 61:15 concludes 132:2,9 conclusions 2:16 conclusive 23:21 concrete 14:11,11 14:12,13,18,20,22 15:1,16,20,21 16:8 17:15,16 18:8,18 47:12,15 47:16 93:21 98:15 116:10,10,11,21 118:19,21 119:25 120:6 123:22,24 124:6 126:14 128:5,12 129:2 condition 8:11,13 20:4 29:12,16 31:4 39:25 40:10 47:21 75:4 89:7 90:25 91:15 128:16 conditions 25:10 27:10 46:11 conducting 114:24 confirm 75:10</p> |
|---|--|--|--|--|

| | | | | |
|---|--|---|--|---|
| 115:22 conform 49:6 connect 24:16 38:9 55:20 56:24 95:21 102:12,14 connected 15:15 20:11 51:16 58:20 87:11 93:8 97:17 97:19,22 99:24 101:5,9 102:7 103:2 106:4,8,10 connecting 14:4 66:14 87:14 93:6 123:4 connection 88:5 102:5 connections 100:5 Conor 85:9 consider 7:7 40:7 69:12 110:21 consideration 4:19 46:1 considered 2:25 20:23 24:11 35:21 48:15 60:5 65:16 66:18 90:10 114:15 127:2 131:14 considering 80:19 84:22 115:20 consist 16:1 121:22 consisted 10:12 15:20 63:16 78:11 93:24 consistent 71:8 118:14 130:9 consisting 103:3 consists 5:14 125:8 constructed 19:19 21:2 22:2 39:19 41:20 44:11 46:17 48:12 95:20 99:15 107:11 construction 6:14 8:1 10:1,17 16:19 | 16:22 18:11 21:14 22:19 23:1 26:8 26:24 28:1 29:20 30:4,14 32:17 33:10 34:20 36:13 39:22 41:7,24 45:14 46:2,8 50:4 50:5 60:17 61:21 64:25 67:16 68:18 68:22 85:6 87:22 90:13,15,18 92:16 94:15 99:9 106:19 106:25 108:8,14 110:15 112:14,14 113:18,24 114:12 114:15 116:6,9 127:23 128:5,13 130:15 construction-rela... 24:17 consult 25:17 consultants 6:8 contact 34:6 58:16 contain 3:21 4:5,23 33:7 42:18 63:21 79:13 contained 13:21 16:17 17:21 18:1 24:4 36:11 62:4 73:8 90:10 101:1 109:15 124:1,9 containing 32:11 38:8 79:3 94:2 116:14 contains 20:13 content 3:19 31:5 context 1:14 2:11 10:24 40:9 67:7 contingency 55:15 74:6 continuation 14:3 continue 67:15 84:5 continued 71:23 86:11 87:4,8 | 105:22 106:13 107:5 contract 60:23 62:6 93:3,10 96:24 97:12 98:6,15 contractors 10:17 contrast 41:10 contributed 5:19 47:3 control 5:18 9:13 18:19 19:13 27:19 29:24 31:25 33:9 37:6,10,22 39:4,8 51:24 52:7,10,16 53:1 54:5,8,14,19 55:4 69:1 72:15 72:16,18,25 73:2 88:11 96:5,14 97:7 99:7 100:10 100:11,14,15,19 101:20,23 103:8 103:10,16 104:13 104:15,17,19,23 105:8 controlled 28:2 51:21 57:4 68:15 controls 22:15 32:4 54:14 58:17 71:20 96:8 convenient 40:15 74:20 conventional 14:18 conveying 37:8 90:21 cookers 86:18 core 3:7 13:12,15 14:11,19,23 15:7 15:8 18:7,13 76:20,22 87:1 89:18 94:13 99:20 116:15 117:5,7,8 117:22 118:1,2,6 118:8,13,18 121:23 123:17 125:9 129:21 | corner 11:22 18:6 66:16 88:23 89:2 90:8 93:23 95:23 129:1 correct 5:21,25 6:16,19 correction 109:1 corridor 52:2 corridors 52:6 Council 11:9 counter-folded 124:20,23 counterweight 68:11 course 119:12,20 court 5:24 cover 65:8 covered 17:13 coverings 65:1 CP3 28:8 30:2 68:19 create 20:3 35:2 59:11,16 116:18 created 14:1 42:22 53:9 61:16 72:1 94:20 98:24,25 102:2 112:20 113:3 123:21 129:23 131:12 creating 28:2 32:12 crews 37:23 criteria 42:1 43:16 43:21 44:23 79:19 110:17 114:18 115:9,12,17,19 critical 36:18 43:23 cross 14:13 15:1 18:8 crown 94:12 113:16 127:5 crucial 83:2 cupboard 106:15 106:21 current 26:25 59:2 60:6 61:23 69:10 | 70:20 82:4,6 104:15 currently 10:22 15:4,25 23:20 40:6 82:23 90:16 91:15 106:17 curtain 93:22 cut 122:5 123:8 125:18,25 126:17 <hr/> D <hr/> d 26:7 132:21 D2 111:11 D4 60:16 Daaid 1:11 4:4,11 132:12 Daaid's 1:20 damage 93:18 damp 119:11,20 Daniel 9:20 dark 111:3 dashed 117:17,21 118:6 119:18,21 130:2,8 data 45:2 114:19 120:25 date 22:13 29:15 dated 5:13 68:19 dates 61:5 62:1 day 60:10 116:1 day-to-day 102:22 days 1:9 3:15 deal 65:25 dealing 3:4 7:6 deals 21:1,8,11,24 dealt 20:5,15 44:14 62:25 63:5 88:13 decide 27:11 decipher 85:10 declaration 5:22 decommissioned 65:5 89:12 decommissioning 89:3 Decorations 92:15 |
|---|--|---|--|---|

| | | | | |
|--|--|---|---|--|
| <p>decorative 116:11 dedicate 9:1 dedicated 37:8 deemed 57:12 Deeny 9:19 defend 30:1,18 43:25 59:13 define 64:14 defined 22:18 43:12 93:4 109:14 111:21 115:3,10 115:18,19 127:3 defines 41:22 43:6 47:9 defining 82:20 definition 112:6 degree 26:2 30:19 36:19 59:17 degrees 49:16 delay 57:7 deliver 57:11 delivered 56:15 demolish 64:2 demolished 95:8,17 97:18,23 demolition 93:5,7 96:23 97:24 demonstrate 42:15 50:8 demonstrated 78:23 demonstrating 43:20 depicting 4:15 deploy 12:11,12 depth 47:14,15 81:13 124:3,10,18 126:7 derived 8:18 62:2 describe 2:4 16:21 18:12 41:16 50:15 66:10 67:5,22 68:5 74:24 76:15 108:12 114:16 127:1</p> | <p>described 47:2 48:14 58:3 75:1 78:17 110:18 115:13,15 117:25 131:10 describes 46:9 48:19 68:19 79:17 110:14 describing 9:2 55:8 67:4 108:15,18,24 description 8:23 9:5 15:3 23:6 59:8 107:14 132:2 design 8:11 11:16 17:21 19:23 22:19 23:1 24:17,25 26:12,23 27:3 30:23 31:1 32:10 32:21 35:12 36:1 36:9 37:13,24 39:22,25 43:8 48:25 49:3 50:17 52:15 56:17 57:20 58:9,24 59:6 60:5 60:17 75:20,24 85:6 97:14 99:8 99:11 104:9,12,23 119:6 126:3 130:4 designation 120:11 designed 8:3 10:11 11:14 19:19,25 21:2 22:1 30:25 32:2 35:24 38:3 47:4 49:10 50:5 53:12 54:6 57:11 57:16 58:8 60:1,3 81:19 104:13,17 designer 114:12 designers 6:8 24:23 designing 28:16 destroyed 80:18 detail 6:6 9:2 15:3 49:21 55:8 63:9 63:10 65:9 96:25 108:15 111:22</p> | <p>112:5 114:21 detailed 2:18 3:22 4:5,18 8:6 9:15 61:1 115:25 116:2 detected 101:14 103:14 detection 31:8 50:16,18 51:4 detector 51:7 53:18 54:9 101:13 detectors 50:21 51:5 52:25 103:7 103:9 determine 49:13 determined 46:8 49:9 112:2 development 4:8 device 51:10 70:14 76:6 78:25 devices 34:11 80:14 80:24 devolved 11:12 diagram 45:9 52:18 76:11,23 110:24 110:25 111:5,14 112:18 diene 119:13 difference 53:22 61:15 69:13 differences 50:4,7 56:21 80:22 different 42:18 48:19 62:11,18,19 80:13,13,14,21,24 94:5 114:1,3 130:7 differentials 52:16 direct 37:22 65:18 90:22 98:3 103:16 109:5 directed 58:12 direction 124:24 directly 14:22,24 16:8 17:15 24:16 28:23 34:8 54:14</p> | <p>68:8 89:23 101:5 101:9 102:17 116:22 119:24 120:1,3,18 128:12 129:5 director 6:7 disabled 55:14 74:5 discharge 58:15 disconnected 88:20 88:21 discuss 55:17 84:9 86:14 distance 69:3 distress 4:22 distributed 85:14 distributes 87:2 distribution 92:20 document 20:18,20 20:21 24:1,5,14 24:15,19,20 25:24 26:17,21 27:8 28:19,19,25 29:13 29:14 36:23 41:22 43:6 44:15,23 45:7,17 46:5,14 47:5,9,22 48:18 49:6 50:10,17 51:11,25 52:5,11 52:14 55:11 59:22 70:20 74:3 78:17 79:10 82:1 87:17 88:1,9 90:9,19 109:14 110:7,25 111:3,21 112:6,18 113:17,18 114:14 114:17 115:9 127:3 131:2 documentation 82:20,24 85:7 97:14 104:12,23 documents 29:1,3 60:24 62:6 doing 19:22 domestic 86:17 door 31:14 34:20</p> | <p>34:22 43:12,13,23 49:13 52:3,23,23 58:19 64:7,15 65:21 75:2,15,18 75:19,25 76:2,3,9 76:12,25 77:1,12 77:14,16,19,20 78:4,8,24,25 79:3 79:11,14,18 80:4 80:22 81:10,11,15 81:19,20 82:11,12 92:25 104:6,7,7 doorframe 76:3,5 doors 3:25 8:23 31:24 41:21 43:10 43:21 44:1,3,3,3,4 49:9 50:7 52:9 58:22 64:7,11,14 64:17,21,21,21 68:14 70:13 71:19 72:11 73:19 74:13 74:14,15,21,22,25 75:1,5,6,7,12 76:16,17,17,21,25 77:3,7,8,23,24,25 78:6,7,10,12,14 78:16,20 79:15,17 79:17,20 80:6,8 80:16,18,19 81:7 81:21,22,23,23,25 82:2,10,14,14,15 82:17,18,19,21,23 83:1,2,7,9 92:8 99:1 107:11 dotted 16:4 double 94:12 117:17 downwards 102:2 Dr 1:10,16 3:17,20 4:3 5:2,4,7,9,15 5:21,25 6:4,11,16 6:19,23 7:2,4,10 7:13,14,17,20,22 9:22 40:17,23,24 60:12 66:3 74:10</p> |
|--|--|---|---|--|

| | | | | |
|---|---|---|---|---|
| 74:13,18,22,24 83:16,23 84:5,7 84:13 91:23 107:19 108:1,2 132:9,22 drainage 125:5 drained 93:25 108:21 109:12,21 116:23 draw 23:25 58:6 drawing 72:7 drawings 11:16 66:12 126:3 130:4 drawn 10:21 31:6 57:6 104:2,5 drives 68:10 driving 11:23 drop 58:7 dry 55:21 56:4,7,15 56:18 57:8 58:2,9 92:24 99:6,15,17 100:4,7 dual 102:10 103:2 Dublin 6:18 ducts 42:19 102:8 102:12,16 ductwork 102:14 due 3:15 51:3 65:18 121:2 duration 51:20 duties 22:24 24:17 dwellings 13:22 27:22 32:8 78:4 | edge 81:20 123:9 123:16 129:23 edges 45:22 109:6 119:5 122:4,5 Edinburgh 7:1 effect 53:9 effective 43:1 57:12 effectively 21:6 48:7 56:16 effects 33:16 47:7 53:7 59:23 eight 63:11 70:6 either 34:6 41:11 44:21 46:13 52:22 54:1 71:14 83:5 110:15 111:10,24 112:2 114:14 117:18 121:22 122:1 124:2 131:14 electrical 19:2 69:8 73:17,22 element 1:22 16:17 43:1,3,5,8 45:22 83:2 109:16 elements 16:17 47:6 62:17 79:9 109:15 elevated 98:14 elevation 86:1,22 89:15,17 99:23 102:13 elevations 98:10 embedded 15:16 47:15 emergency 26:18 51:15,15,21 56:3 73:3 88:11 empty 55:22 EN 52:17 enable 22:5 27:13 63:18 67:24 104:20 105:8 enables 30:21 enclose 11:3 | enclosed 16:16 18:10,17 19:7 87:21,23 90:15,19 91:7 109:15 enclosing 15:5 42:4 42:5,5,6 44:9 enclosure 19:10,11 34:19 42:25 44:2 44:7 53:24 63:21 99:2 102:17 enclosures 43:11 end-use 46:11 ends 19:18 43:17 59:8 60:8 74:8 107:14 energy 93:12 enforcing 25:2 engine 56:5 engineer 6:17 engineering 6:12 6:25 engineers 6:8 England 6:14 8:8 19:22 40:1 enhanced 51:5 ensure 39:20 57:16 109:20 enter 37:18 50:24 103:6 entered 54:16 85:25 86:2,21 89:14,16 106:12 entering 34:21 53:25 58:14 104:8 enters 52:22 entirely 14:3 16:10 36:9 89:11 entrance 8:23 31:16,19 34:22 36:25 44:2,4 50:22,24 51:2 52:3 64:11,15,17 64:21 65:21 72:11 76:25 77:22 78:7 78:16 79:14 80:16 | 80:22 82:14 92:16 93:23 94:19 95:22 98:1,23 99:22 102:13 104:19 entry 13:9 36:6 72:21,23 92:25 envelope 44:16 60:2 93:20 97:21 115:13 environment 6:10 6:13 35:3,4,7 38:5 54:18,22 environmental 92:23 100:16,16 100:22 101:22 102:20,25 103:21 EPDM 119:13,14 119:23 Equally 33:4 equipment 34:5 37:23 38:2 39:16 54:19,25 58:17 59:7 63:22 71:18 73:23 equipped 55:18 equivalent 78:24 escape 18:16,16 21:1,4 26:19,21 27:7 30:4 31:18 32:6,20 33:14,21 33:21 35:21 42:7 48:6 50:25 51:12 51:22,25 52:4,24 59:16 66:21 70:12 73:23 79:9,12 102:17 104:10 escaped 2:14 escaping 48:5 essential 30:7 50:3 Establishment 44:24 estate 10:7,9,10 14:5 et 55:19 111:17 112:8 | ethylene 119:12 European 111:11 112:2 evacuate 27:11 29:8 32:9,10 51:2 evacuated 40:5 evacuating 55:14 74:5 evacuation 26:5 28:15 31:15 33:22 34:14 59:21 70:19 70:23 74:2 evaluated 115:12 event 30:21 31:8 32:6,12 39:21,24 51:23 58:8 103:6 125:12 events 4:23 40:9 60:5,5 103:11 eventual 65:19 eventually 56:14 evidence 1:14,23 2:7,12,15,18,20 3:10,13,16 23:21 24:10 49:2 50:8 62:11 75:22 80:17 85:7 91:10 116:3 116:5 129:8 exact 64:14 73:18 79:23 100:1 example 3:24 38:19 47:2 50:1 60:24 70:1,9 80:1,7,8 88:10 exceptional 6:21 excessive 58:21 excludes 112:7 exclusive 69:9 exhaust 18:20,21 100:23 101:10 102:9 103:18 exist 14:15 existed 65:17 73:13 existing 9:12 62:17 92:15 93:5,7 94:2 |
| E | | | | |
| E 132:21 earlier 47:2 50:14 83:21 98:7 130:24 early 4:8 10:7 21:3 30:9,9,11 35:6 59:13 east 11:4 12:13 13:4 86:1,22 89:15,17 93:10 98:5,10,17 | | | | |

| | | | | |
|---|--|--|--|--|
| <p>95:13 96:3,5,13 97:7 99:3,17,24 100:10 101:20 102:4,5 108:7,8 116:8,10,17,21 118:19,24 119:4,7 120:6,8 123:21,22 126:14 127:21 128:4 129:2 exists 25:7 128:21 exit 58:22 exiting 89:25 expanding 120:21 expected 35:9 experience 6:2,13 7:6 expert 1:6,9,13 2:10 3:15,19 65:6 84:25 88:13 89:10 91:1 expertise 7:5 experts 2:17,20,24 3:9 explain 8:14,18 9:8 10:20 19:24 20:2 25:22 31:1 40:7 62:21 71:3 81:6 95:12 110:12,19 121:8 128:9 explained 10:2 49:20 61:19,22 95:6,11 98:7 105:20 110:13 112:9 130:10,24 explaining 2:2 7:25 8:20 explains 49:23 explanation 9:15 19:18 28:9 30:24 106:6 107:16 explicitly 25:12 explored 90:25 exposed 15:20 exposure 58:18 125:12</p> | <p>expounds 125:13 expressed 2:22 extend 11:2 14:15 17:24 128:20 extended 86:9 99:5 101:21 102:2 105:20 extension 92:22 extensive 35:11 44:19 45:25 extent 5:18 46:3 77:23 exterior 2:8 3:1 9:7 25:21 96:21 99:21 116:23 122:12 external 4:15 8:4 9:9 10:20 12:8 13:13 15:19 16:9 16:12,14,22 17:17 21:16,17 26:1,13 26:20 27:24 28:1 29:21 31:3 32:16 32:17,25 33:2,10 33:11 36:13,15,18 44:6,8,10,12,16 44:21,25 45:8,14 46:8,10,15,17,18 46:20,22 49:20,24 50:5 56:24 64:25 93:1,2,4 94:2,15 97:5,14,16,17,19 102:15 103:25 108:4,6,8,14 110:3,4,9,10,15 110:22,23 111:9 111:17 112:13,21 112:24 113:6,10 114:10 115:12,14 115:16,18,24 116:6,9,17,19 118:24 119:4,19 126:21 127:5 128:22 130:25 131:17 132:3,4 externally 80:3</p> | <p>96:22 extinguished 30:10 extinguishing 38:8 extract 53:14,16 100:20 101:11,19 102:9,25 103:22 116:16 extracted 54:12 104:1 extracting 32:1 extruded 118:3,3 118:15</p> <hr/> <p style="text-align: center;">F</p> <p>F 49:21 111:22 112:5 fabric 26:9 facade 2:5,25 92:9 face 27:25 102:15 118:19 120:2,4,5 122:8 124:4,7,11 124:15 125:3,4,10 125:15 129:2 faced 17:12 faces 125:10 facilities 21:25 22:2 facility 56:2 facing 15:13,14 120:11 126:14 129:14,24 factors 56:4 factual 1:14 2:12 2:19 3:13 7:8 9:18 failed 5:18 40:8 fails 51:13,20 failure 51:23 70:11 115:17,19 false 90:5 fan 53:14,16,23 101:7,11 102:6,9 102:25 103:18,21 103:22 116:16 117:8 fans 18:24 53:4,5</p> | <p>102:7,9,15 103:2 faulty 83:9,9 feature 50:6 79:25 80:1 features 3:24 37:6 55:6 61:4 67:13 68:3,21 69:15,17 69:23,25 70:7,9 73:9,15 76:1 97:11 fed 107:6 fellow 6:20,24 fibre 79:17 fifth 21:23 fight 55:20 fighting 104:11 figure 55:6 file 60:25 71:6 fill 109:13,19 120:22 126:4,6 filled 15:22 16:4 17:7 57:5 filler 45:12 111:16 112:6 120:22 128:23 129:3 filling 129:6 final 23:9 32:15 34:13 39:18 62:13 64:9 108:3 121:8 127:16 129:16 130:22 finally 4:13 6:24 27:23 39:14 45:16 49:22 59:10 63:3 64:9,20 69:7 70:6 77:16 112:12 113:13 115:16 131:17 find 118:11 findings 85:16 fine 83:23 finger 10:14 11:1,2 12:16 85:24 86:11 97:20 105:22 finish 83:22 84:8</p> | <p>132:15 finished 86:3 127:16 130:22 finishes 17:3 fire 1:18,19,22,22 1:23,24 2:1,9,14 3:1,2,6,21,23,25 3:25 4:6,8,16,20 4:22,24 5:17,19 5:20 6:12,17 8:7 8:11,15,23,25 9:12 11:14,17,20 12:6,9 13:1,18 19:21 20:3,5,15 20:16,18,23 21:4 21:4,9,12,15,17 21:19,21,25 22:5 22:8,10,12,17,22 22:24 23:3,11,18 24:1,6,18,21,24 24:25 25:2,8,12 25:15,17,25 26:4 26:13,15,23 27:2 27:10,15,20,24 28:2,11,13,16,21 29:4,7,10,19,23 30:8,8,10,10,11 30:13,14,21,25 31:2,3,8,8,11,13 31:18,20,22,24 32:5,6,11,11,12 32:18,22,24,25 33:1,2,3,5,6,7,12 33:16,25 34:8,12 34:15,16,18,22,24 34:25 35:3,3,6,6 35:10,14,16,18 36:9,11,14,15,18 36:24 37:1,1,6,7 37:14,23,25 38:3 38:4,8,9,10,12,13 38:16,17,19,19,20 38:21,22,23 39:5 39:10,15,19,21,23 39:24 41:1,3,6,10</p> |
|---|--|--|--|--|

| | | | | |
|---|--|--|---|--|
| 41:16,20,21,21,22 42:10,14,15,24 43:1,5,6,9,10,12 43:15,21,21,23 44:1,2,3,5,12,17 44:25 45:24 46:7 46:9,12,19,23,25 47:4,7,11,13,18 47:18,24 48:3,10 48:14,16 49:8,13 49:18,24,25 50:1 50:6,12,18 51:3 52:2,9,19 53:2 54:6,10,13,16,18 54:23 55:2,5,5,15 55:18,19,21,23 56:5,16,20,21,24 57:3,5,7,8,9,10,14 57:20,21 58:5,7,8 58:11,14,19,22 59:5,7,8,11,14,15 59:15,20,24,24 60:2,23 61:4,11 61:12,18 64:7,7 64:11,21,21 65:11 65:19,20,24 66:5 66:8,9 67:13,14 67:15,18,21,25 68:3,17,20,22,24 68:25 69:8,11,12 69:19,22,22,24 70:3,4,6,8,25 71:8 72:16,24 73:1,9 73:12,20,21 74:7 74:25 75:1,3,5,7,9 75:12,25 76:2,6 76:13,16,17,21,25 77:1,5,9,12,18,19 77:20 78:5,10,15 78:16,18,19,25 79:7,7,14,22 80:6 80:8,15,19 81:7 81:21 82:3,9,11 82:12,19,19,22 83:2,5,6,7,7,8,9 | 84:11,14,22,23 85:3,16 88:9 89:9 90:9,17 91:18 94:17 96:3 97:6 97:10 98:7,10,12 99:1,3,6,10,14,19 99:19 103:6,8,15 103:17 104:11,20 105:1,8 106:18,25 108:13,19 110:2,3 110:6,8,10 111:12 112:3 113:21 114:4,5,24 115:12 115:13,15,15,18 115:18 125:12 fire-resisting 18:10 18:18 21:14 31:22 31:23,25 32:13,15 34:19,21 41:19 42:3,12,25 43:11 44:9 49:11 50:6 70:13 77:14 83:4 87:22 90:12 fire-separating 45:22 fire-stopped 87:19 91:6 106:16,23 fire-stopping 43:4 43:19 114:1,3,5 114:13 firefighter 36:25 72:15,16,18,21,22 firefighters 2:13 13:5,11,17 18:24 22:3 31:5 34:1 35:17 36:5,17 37:4,21 38:2,3,7 38:11,16,18 39:1 39:3,16 54:21 56:9 67:25 68:25 104:14 firefighting 4:9 12:7,9 30:1,5,12 30:15,18 33:24 35:24 36:2,8,21 | 36:22 37:2,4,4,7,8 37:11,14,15,17,20 37:21 39:14 44:1 48:12 55:1,3,7,8 55:11,12 57:13,15 58:1 59:5,13 67:6 67:8,10,12,20,23 68:1 69:13,15,17 69:23 70:7,18,23 70:24 71:2,9,14 71:24 72:5,13,17 73:4,13 74:1,3 99:6 100:5 fireman's 100:25 fires 26:7 55:20 60:3 firm 6:22 first 1:9,21 2:13 4:10,25 7:25 22:9 27:7 28:7,8 31:15 31:18 35:18 41:16 45:6 48:1 50:23 54:9 61:3 62:2,8 63:25 66:3 67:5 76:25 84:16 85:21 91:23 94:6,22,23 97:2 100:6 102:3 108:12 110:19 117:3 Firstly 103:12 128:10 fit 39:20 43:2,7 113:25 fitted 76:9 78:20 79:1 81:24 113:24 fitting 51:18 64:16 five 3:14 20:24,25 23:19 24:6 43:22 63:5 89:5,8 106:8 fixed 16:7 118:18 119:24 120:1,3,4 122:16 124:15,17 132:3 fixing 17:5 46:2 115:8 120:8 | fixings 115:4 122:25 flame 2:3,8 4:15,17 4:19 27:25 112:1 112:16,17 flames 45:19 flammability 2:3 flammable 90:21 flashings 115:5 flat 2:1,8 4:1,6,6,9 8:23 14:13,21 16:25 17:18 18:9 18:10 25:25 26:4 29:7,8 30:21 31:8 31:9,10,14,15,16 31:18,22 32:6,11 32:12,14 33:2,5,6 33:7,12,14,16 34:12,22 35:5,6 35:10 36:11,19 38:8,16,23 42:5 44:2,4,7,9 46:16 46:22 50:19,20,24 50:25 51:1,7,8 52:2,4,19 59:15 59:24 60:3 64:11 64:15,17,21 65:1 65:21 66:21 76:25 77:1,2,22 78:7,16 79:14 80:16,22 82:13 83:5 84:23 87:10 88:21,22,22 89:1,3,23 90:1,3 91:5 94:24 96:13 105:13,15 106:22 122:1,1 131:23 flats 13:21 15:2,17 18:5,6,6,8,14,17 19:16 24:20,22 25:16 26:22 28:7 29:15 30:7 32:19 32:23 33:8,12 35:19 37:12 41:5 42:10 50:22 51:14 59:1 64:17,18,19 | 67:3 72:2 76:18 78:9,9,11,11 82:15,16 83:6 86:18,20 88:19,24 89:1,2,5,13 91:2 92:11 94:24 95:1 96:12 98:22 106:1 106:9,11 107:6,9 112:24 flexible 13:25 Flint 9:21,22 floor 13:22 14:9,21 14:24 15:1,4 17:7 17:8 18:2 28:10 28:11 32:8,20 33:4 34:25 37:10 38:4,12,20,20 39:16 49:11 53:2 54:6,7,11,12,16 55:2 57:6,17 62:10 66:25 68:13 68:24 69:6,21 70:2 71:23 72:4 72:10 77:3 83:5,7 86:3 87:11,14,20 89:6 94:6,10,22 94:23 95:1 99:12 100:6,7 103:13,15 103:17,25 104:14 104:16,16,18,25 105:2,6,7,9,13,17 106:17 107:3,3,4 107:5,7 112:22 113:6 118:22 121:13 floors 14:11 18:9 19:17 28:3,12 32:13 33:4 37:9 37:25 41:21 42:8 42:12,13,14,17 43:19 47:3 49:8 57:13,19 62:25 63:2,6,16 66:24 67:3 70:2 71:12 94:16,16 97:6 |
|---|--|--|---|--|

| | | | | |
|---|--|---|---|--|
| 101:15 102:4 103:12,15 104:21 105:3 114:8 116:7 flow 57:17,24 58:7 76:8 104:6 106:3 109:11,20 flowing 58:17 flues 19:11 foam 118:13 120:10,14,22 121:1 129:3,6,13 129:22 131:21,24 foam-type 128:23 focus 96:25 focused 32:10 94:14 116:5 focusing 9:25 foil 120:11 125:10 129:14,24 follow 2:12 30:3 49:14 following 9:9 37:3 37:13 46:6 73:7 85:18 follows 7:24 13:3 41:23 92:7,18 93:19 103:12 force 68:2 form 8:2 13:1 15:13 17:2 30:11 43:10 45:21 47:1 76:2 81:9 83:4 formal 130:3,11 formed 87:21 94:3 113:22 123:23 124:6 128:11 131:3 forming 9:16 44:8 49:19 76:22 forthcoming 3:19 found 9:16 38:25 108:16 118:12 129:8,22 foundation 30:16 four 13:23 27:6 | 63:13 69:23 86:25 87:1,4,6 94:23 95:1 101:1 128:8 129:11 130:13 four-storey 10:16 fourth 16:9 foyer 98:23 104:19 frame 17:5 43:13 81:10,11,13 116:12 118:23,25 122:2 129:1,7,15 framed 17:4 frames 15:23 16:7 116:14 117:4,10 117:12,16 119:3 119:17 122:15 framework 2:11 free 28:13 fresh 18:21,22,24 100:20,22 101:6,7 101:17 104:4,6 front 76:25 78:4 122:7,24 124:15 125:3,10 fuel 84:23 full 5:8 13:3 17:18 23:5 41:3 55:25 77:24 103:16 124:18 126:4,6,7 full-scale 45:2 114:19 fully 16:4 17:6 19:6 63:15 95:5 function 30:25 41:15 fundamental 50:3 50:7 funded 92:2 funds 92:3 furnace 49:9,10,12 49:14 further 3:12 15:3 18:12 21:11 22:3 23:2 26:11 27:9 41:8 56:8 66:7,18 | 71:10 81:12 86:15 87:7 95:12 104:22 119:1 130:6 <hr/> G <hr/> G2.3 50:15 gain 22:6 gains 100:17 gap 119:5,6,10,19 119:22 125:2,14 125:25 126:8,16 128:21 129:1,6 gaps 104:7 119:8 120:22 123:13,16 123:17 128:24 gas 8:24 19:2,12 49:13 65:4,6,6,7,9 65:23 84:9,13,16 84:21,22,24,25 85:1,3,5,10,12,19 85:21,25 86:4,8 86:12,16,17,20,21 86:23,25 87:4,10 87:13,22 88:2,4,6 88:11,15,16,17,18 88:19,19,21,25 89:2,4,5,8,11,14 89:16 90:7,19,22 91:1,2,12,13,14 91:16 105:20 gases 3:5 gaskets 45:13 111:16 112:7 Gasworks 88:14 general 22:7 60:8 68:2 70:25 92:6 generally 25:25 give 2:15,18 3:15 3:17,18 5:8 7:16 22:12 51:21 83:22 given 1:10 26:16 44:22,24 46:1 49:7 83:18 110:17 114:18 glass 79:17 93:21 | 117:18,19 glazed 79:9 80:8 93:22 94:12 116:14 glazing 15:20 75:15 78:22,22 79:3,3,4 79:6,13,25 117:4 117:7,16,17,17 118:17 glued 130:21 go 7:15 37:25 114:21 117:1 122:25 goes 27:8 30:6 going 1:4 5:10 40:13,25 60:9 74:10,16 83:22 84:5,8 91:20 106:5 116:25 good 1:3 7:22 goods 68:7 graduated 6:18 Graeme 9:21 Grange 1:7,8 5:7 5:10,16,22 6:1,5 6:12,17,20,24 7:3 7:11,14 40:13 74:17,19 84:5 132:9,14 grass 93:8 97:18 grassy 12:14 gravity 14:21 56:11 greater 69:16 97:9 111:18 114:6 green 11:3,5 73:10 95:20 122:21 130:8 Grenfell 8:2,17 9:10 10:3,17,21 10:25 11:3,5,8,10 11:15,21 13:10,20 14:6,9,18 15:19 19:18 24:12 47:1 47:12 58:25 60:9 60:14,17 61:2,12 | 61:14,22 62:1,8 63:14,24 64:7 65:8,14,18 66:4 66:12 67:5,7,17 68:18,23 72:19 73:8 74:25 76:16 76:20 77:21,22 79:15 80:5 82:8 82:13 84:13,16 85:6,14,20,23,24 85:25 86:8,12,22 87:11 88:15,23,25 89:15 91:13,25 93:7 97:3,11,17 97:19 98:1,2,5,8,8 98:14,18 99:13 100:19 105:13 111:1,6,13 113:16 115:25 116:9 121:9 122:10 124:14,16 125:17 126:20 128:23 131:11,16 132:5 grey 111:4 ground 9:11 10:4 12:18 13:7,10,19 13:25 14:16 18:1 18:1 45:12 54:15 62:10 63:18,21 64:1,22 66:14,23 69:6 72:20 73:1 78:14 88:20 93:20 94:19,21,22,25 95:7,14,17 96:2,6 99:13,21 100:7,25 102:4 107:7 111:6 111:7,8 117:14 growth 47:25 GRP 79:15,17 82:14 guidance 20:21 24:3,6,14 28:18 29:1,3,13 34:4 37:19 40:2 44:21 46:6,14 50:17 |
|---|--|---|---|--|

| | | | | |
|---|--|--|--|--|
| 52:15,17 56:17 58:10,24,25 59:2 59:22 61:21,24 75:7 99:8,11 110:16 113:17 guide 49:23 guides 49:4 75:24 guiding 30:2 gypsum-based 131:8 | heat 32:1 42:16 44:14 46:21 96:14 96:16 100:17 105:25 106:4 heating 9:13 19:2 85:23 86:7 92:19 96:10,15 97:8 100:18 105:11,25 106:2 112:1 height 12:1 14:8 21:20 56:14,18,19 99:11 111:8 held 15:23 help 9:24 10:20 59:15 helped 61:13,14 hidden 122:7 high 14:6,7 26:2 30:6,18 36:19 59:17 86:2 90:23 117:24 121:19 high-level 101:1,9 101:18 102:1 High-reach 12:10 high-rise 8:7 19:22 25:6 28:22 30:19 35:23 36:2,21 39:25 41:1,5 51:14 58:25 59:18 67:19 higher 69:24 71:1 114:4 highest 57:13,19 highlighted 12:25 16:3 63:1 73:10 95:18,20,23 109:2 109:7 117:16 118:5 119:18,21 121:13,17 122:20 125:10 127:13,15 127:22 128:2,6 130:1,8 hinge 80:14 hinges 80:25 81:1 historic 69:19 | 70:25 71:8 73:11 history 1:17 65:9 Hoey 85:9 honorary 6:20 hope 5:11 hoped 2:10 horizontal 32:20 42:6 89:24 90:2,4 91:2,8 94:9,11 99:25 102:8 113:2 113:4,14 118:19 118:21 121:6,12 123:11 124:12,13 124:15 125:1,8,16 125:22 126:10 horizontally 16:7 86:4,24 hose 38:9,12,15 55:23 56:16 58:7 58:14,21 hoses 37:23 55:20 57:23 58:6,19 59:5 100:5 hot 9:14 53:6 85:23 96:15,15 97:8 105:11,25 106:2 hour 49:16 hours 51:20 hours' 114:7 house 13:24 housed 68:12 housing 11:11,12 25:7,9,9,10,16,19 103:4 hung 122:6 123:5 Hurstway 10:15 hydrant 37:16 56:25 hydraulic 63:17,21 | 130:3,11 identified 25:15 52:11 60:20 62:18 88:17 identifies 43:22 55:6 identify 1:17 identifying 129:17 ignited 48:1 ignition 2:25 44:11 46:18 110:10 illuminates 51:13 illustrate 130:22 illustrated 68:6,21 69:14 118:20 123:25 129:10 illustrates 116:8 123:10 126:21 127:11 illustration 73:10 illustrations 9:23 image 12:24 44:8 49:10,12 61:25 66:13 68:6,23 69:14 77:21 88:22 90:16 93:3 95:19 95:21 109:1 111:5 113:1,4,8,13 114:22 116:8 117:6 119:21 121:7 122:3 123:3 126:4,20 127:23 128:3,6,16,19,24 129:10,13 131:20 images 3:21,22 4:5 4:8,15,24 49:22 128:14 130:22 immediate 9:9 11:4 11:6 26:10 28:12 33:15 35:10 immediately 57:7 98:5 impact 91:13 impacted 97:10 impaired 43:5 | impassable 51:3 imperfection 43:2 43:7 important 12:4 25:19,23 28:4 39:1 48:2 51:24 61:9 84:22 88:1 importantly 57:16 75:14 improve 100:12 improvement 62:9 improving 93:13 incident 26:15 include 4:7,14,16 4:21 15:12 25:20 55:15 62:15 74:6 85:1 92:8 109:8 131:4 included 15:4 49:6 63:13 64:6 66:14 71:17 73:3 78:9 93:2,5 96:20,22 99:6 100:20 105:25 127:20 includes 9:5 31:2 38:14,20 75:14 76:10 including 2:12 3:5 29:20 34:20,22 37:10 39:23 45:13 60:24 62:13 65:9 102:6 111:16 115:4 117:7 118:17 inclusive 10:5 14:14 24:7 110:20 incomplete 65:24 91:16,17 incorporate 54:24 96:6 incorporated 36:16 65:10 81:8 88:3 increase 27:20 40:5 71:12 72:11 increased 70:5 |
| H | | | | |
| half 13:4 49:17 84:6 hall 31:16 44:4 50:22,24 51:2 Hancox 65:7 85:1 handle 80:2 handles 76:11 hang 123:9 happening 36:18 hard 12:15 93:1,9 96:23 97:14 hardboard 131:21 hardstanding 98:17,18 hardstandings 98:4 hardware 43:13 75:15 Harley 120:25 126:3 hatch 70:12 73:23 hazard 25:13 hazards 25:12,15 head 17:10 78:21 112:20 113:14 127:4 129:14 131:20 health 14:2 18:2 20:9 44:18 60:24 71:6 hear 2:23 3:3 heard 2:19 3:13 hearing 1:5 132:19 hearings 1:4 | | | | |
| | | I | | |
| | | I2.2 76:1 ICI 131:23 identical 27:7 identification | | |

| | | | | |
|---|---|---|--|---|
| 71:21 72:6 indefinite 33:18 independent 6:7 50:18 70:10 73:18 indicate 5:22 66:13 76:22 82:10 129:25 indicated 76:11 77:3 113:1 117:21 indicates 72:8 77:22 indicating 73:1 130:20 individual 96:14 individuals 6:21 industry 6:14 infill 15:24,25 16:9 17:6,11,22 117:22 118:16 129:20,24 infiltration 109:25 influence 65:18 information 8:4 10:22 16:18 22:10 22:12,17,18 23:18 62:4 90:17 97:2,5 104:22 106:17,24 informed 3:7 ingress 109:25 inherent 41:7 inhibit 21:9 initial 2:1 inlet 99:18,24 100:2,23 inlets 37:1 inquiry 1:6 2:23 3:9,11 5:8,12 6:3 7:7,12 9:17 84:25 85:2 116:4 inquiry's 90:25 insert 118:5 inside 13:17 16:21 16:24 37:3 55:20 56:1 79:2 96:13 96:20 inspected 118:12 | 123:15 inspecting 128:22 131:17 inspection 62:6 88:16 104:25 127:6 inspections 85:11 116:1 install 96:14 installation 78:16 88:2,4,5,7 93:22 123:20 installations 85:5 installed 43:14 46:11 47:20 51:18 55:18 66:13 71:18 71:19 72:15 73:6 75:14 76:21 78:6 80:7,8,20 82:21 83:1 86:7 88:10 88:15 89:12,24 94:13 96:18 99:25 100:6,17 101:7,11 103:1 105:12,19 107:12 108:10,11 111:13 114:23 117:24 121:11,18 123:14 124:12 125:2,14,17 126:1 126:7,12,13,16,20 126:23,25 127:14 127:17 128:17 129:14 130:25 131:11 installing 51:5 instantaneous 106:2 instructed 1:6 instructions 125:2 insulating 47:15 94:13 116:14 117:4,7,8,22 118:1,6 129:21 insulation 17:14 44:25 45:12 78:23 | 79:7,21 93:13,16 93:18 94:3 109:9 109:13,18 111:15 112:10,10 113:20 114:7,9 115:4 116:22 118:8,13 118:18 119:24 120:1,3,7,10,16 120:20,21,23 122:25 123:1 124:2,4,9,10 128:4,7 129:4,5,9 129:13,25 130:2,4 130:6 integrity 78:18,24 79:7,18 81:3 82:3 82:5 113:20 114:7 114:8 intended 4:1 13:24 19:25 33:1,17 34:17 41:9,13 42:22 43:14 46:14 50:23 57:22 58:2 59:11 101:15,16 102:20,22 103:8 103:11 104:4,8 105:7 109:4,9,24 125:13 intent 32:22 104:9 intention 51:1 53:24 106:1 intercom 70:13 73:3 interest 84:20 interested 84:13 interface 96:14,16 106:1,4 interference 69:2 interior 9:5 17:2 127:8 interlinked 51:9 internal 9:12 12:7 13:16 17:21 21:9 21:10,12 29:21 32:24 36:2,9,11 | 36:22 37:2 42:8 58:8 59:13 60:3 62:24 63:5,7,11 94:18 95:3,16 96:2,3 102:18 113:5,9 114:9 115:14,18,24 118:22 119:22 126:25 131:13 132:4 internally 16:23 108:11 127:14,20 131:11 internationally 6:15 interpreted 114:12 intervention 41:9 intrinsic 47:20 introduced 56:12 58:5 119:5,10 introducing 1:16 intumescent 76:6 125:11,13 126:13 invested 32:24 investigate 25:11 investigated 61:19 82:17 85:5 89:10 91:15 investigating 65:7 investigation 1:22 65:16 84:24 87:7 119:17 122:18 129:19 investigations 9:19 involved 26:9 64:16 94:17 ironmongery 76:9 80:12 isolate 103:14 issue 16:19 84:20 issues 2:22 3:4 9:25 84:14 85:2 121:2 items 60:19 | jamb 17:9 78:21 jets 58:1 Joe 85:9 joint 43:2 76:5 120:22,22 joints 109:5,10 115:5 Jose 2:24 junction 113:5,9 114:7,9 junctions 112:22 112:23 June 1:1 82:13 91:9 91:11,12 132:19 |
| <hr/> K <hr/> | | | | |
| K 5:14 K15 121:4 Kebede 4:10 keep 25:10 57:4 74:10,16 Kensington 10:8,10 11:9,13 62:5 78:5 92:3 kept 55:25 key 1:16 2:2,21 6:6 55:6 56:21 62:1 68:21 73:15 78:17 79:2 105:9 108:24 109:7,22 kilograms 69:6 70:5 72:12 kind 41:11 50:13 53:13 131:15 Kingspan 118:8,11 121:3,5 124:2 130:9 kinking 58:21 Kinnier 4:11 kitchen 2:1 51:6 116:16 know 100:1 knowledge 7:9 known 18:11 73:19 76:12 81:10 | | | | |
| <hr/> J <hr/> | | | | |

| | | | | |
|---|---|---|--|---|
| Kooltherm 121:4 | 116:24 120:3,9,21 121:9 123:23 125:4 | 45:12 51:22 63:18 63:21 64:1 65:1 66:15,15,23,24,25 66:25 67:1,1 69:6 70:14 71:22 72:20 72:22,25 73:1,2 77:13,17,23 86:2 86:3,3,5,23,24 87:5,5,9,12,12 88:20 89:16 90:7 90:16,24 93:6,8 94:19,19,21,24,25 95:1,7,7,14,14,16 95:17,24 96:2,6 97:18,20 99:4,21 100:8,25 101:8 102:5,7,9,10,18 103:10,20,21 105:14,15 106:8 106:11,17 107:6,8 107:10 111:6,7,7 | 68:14,14,16,20,22 68:24 69:1,3,4,8,9 69:13,15,18,19,20 69:21,24,24 70:1 70:5,7,8,10,12,12 70:14,16,18,23,23 71:3,4,8,16,18,19 71:20,21,24 72:1 72:5,6,8,9,10,13 72:17,17 73:4,12 73:13,19,23,24 74:1,3,8 77:5,7 82:17,18 95:4,7 95:11 102:4 | lining 17:22 115:24 127:11 128:5,18 129:5,15 130:12 130:13,16,19,21 130:23 linings 21:10 48:3 108:10 119:22 126:25 127:16,22 127:25 128:8,11 128:17 129:7 130:20 list 41:3 listed 20:14 76:1 literature 126:5 little 63:10 80:10 80:17 83:20 112:1 live 86:20 living 51:6 load 14:22 load-bearing 47:5 loads 14:21,23 lobbies 15:6 34:22 39:12 48:9 52:7 52:20 54:25 63:2 76:19 92:15 96:6 96:12 100:21 101:1,24 102:3 103:7 106:15 107:2 lobby 18:13,14,16 18:20,23 31:19,22 31:23 32:1,4,4,21 33:8,9,14,15,17 33:19 34:13 35:1 35:7 37:9,20,25 38:1,3 39:4,6,9,13 42:5 51:14 52:2 52:14,22,25 53:10 53:15,17,18,23,25 54:1 59:2,15,25 66:21,23 76:23 77:2,7,7,8 90:1,5 90:6 92:16 93:23 94:19 95:22,24,25 100:22,23,24 |
| L | | | | |
| labelled 131:23 | layered 59:12 | | | |
| labels 129:17 | layers 29:17,17,18 29:25 59:19,23 60:1,6 116:25 120:1,18 124:1 | | | |
| ladder 12:11 19:9 | layout 8:2 10:1 18:4 62:24 63:5 | | | |
| ladders 35:21 | layouts 94:18 | | | |
| Lancaster 10:7,9 11:5 14:4 | leading 89:24 98:13 | | | |
| landing 58:10 68:14 70:13 71:19 73:19 82:18 | leaf 76:3,9 79:11 | | | |
| landlord 85:21,25 86:4,8,12,15 91:13 105:20 | leak 88:17,20 89:3 | | | |
| landscape 8:4 | leakage 78:21 79:21 | | | |
| landscaping 12:15 12:20,22 93:1,9 96:24 97:15 | leaking 52:22 | | | |
| Lane 1:10,16 3:17 3:20 4:3 5:2,4,7,9 5:9,15,21,25 6:4 6:11,16,19,23 7:2 7:4,10,13,14,17 7:20,22 40:17,23 40:24 60:12 66:3 74:10,13,18,22,24 83:16,23 84:5,7 84:13 91:23 107:19 108:1,2 132:22 | leaseholder 64:18 78:9,11 82:15 | | | |
| Lane's 132:9 | leave 31:13 86:12 | | | |
| large 4:14 11:3 | leaving 126:7 | | | |
| largely 12:22 | led 88:14 | | | |
| larger 72:9 117:7 128:7 | left 14:2 72:7 79:23 80:7 81:11 91:3 98:12 109:6 114:22 116:8 123:13 127:12,24 128:12,20 | levels 13:25 18:1,4 63:3 64:4,22 72:1 72:3 76:20 77:3 78:14 86:19 88:19 89:7,22 92:10 93:14,24 94:7,11 95:5,10,24 96:4 96:21,21 98:20,21 98:25,25 99:2,5 101:24 106:10,11 106:12,14 | lifts 8:21 13:11,16 18:15 39:14 55:3 55:3,8,11 63:14 63:15,16,22,23 64:4 66:4,9,13,19 66:22,24 67:1,2,4 67:8,12,14,20,21 67:22,23,24 68:2 68:11 70:16,19,22 70:24,25 71:2,7 71:13,13 72:4 73:8,25 77:8 78:12 92:8 95:8,9 99:6 | light 51:18,19,22 118:14 lighting 51:12,15 51:16,16,21 limit 59:14 81:14 110:9 Limitations 79:8 limited 45:14 48:13 56:13 58:4 79:16 111:18,20,24 117:24 127:17 limiting 56:4 limits 56:17 82:8 line 16:4 58:21 119:19,21 lined 17:10 lines 58:14 |
| Lane's 132:9 | left-hand 95:18 111:2 122:2 125:23 | Leyton 10:18 | | |
| large 4:14 11:3 | legislation 22:23 61:7,13 | lies 11:7 | | |
| largely 12:22 | length 100:2 121:11 | life 22:3 30:3,16 100:11 | | |
| larger 72:9 117:7 128:7 | let's 40:18 | lift 15:6 19:13,14 33:22,24 37:5,5 37:20,21,22 44:3 55:7,12 58:16,17 58:18 60:25 63:17 63:22 64:1,3 65:20 66:5,14,15 67:6,10,18 68:1,3 68:5,7,9,9,10,12 | | |
| latch 80:2 | letter 3:8 76:10 80:2,14 | | | |
| latches 76:10 | level 9:11,11 10:4,4 10:5,6,25 11:23 12:19 13:7,10,14 13:14,19 14:2,7,8 14:14,14,15,16 15:6 17:19 18:2,3 18:9,9 19:6,6,6 | | | |
| late 10:11 | | | | |
| lateral 14:19 | | | | |
| lay 58:13 | | | | |
| layer 17:16 93:16 94:3 109:3,4,8,10 109:13,24 110:21 110:21 114:11 | | | | |

| | | | | |
|--|--|--|---|---|
| 101:4,7,10,13,14 101:15,18,19,25 102:4,21,24 103:7 103:10,19,23 104:1,2,5,9 106:14 107:9,10 107:12 local 11:8 23:10,13 25:9,16,17 32:3 localised 46:12 located 10:5,7,9 12:17 19:11 54:15 66:15,20 68:9 77:14 85:12,24 88:23 95:22 98:2 100:25 103:15 104:3 location 54:9 58:10 58:23 63:8 76:15 87:7 88:22 89:1,6 89:13 91:3 95:17 100:3 121:14,17 127:17 129:8,10 129:21 130:5 locations 27:6 42:4 50:21 64:11 78:2 89:23 114:2 118:11 129:11 lock 80:2 105:2 lockable 75:6 locks 76:10 79:1 80:13 logistics 39:11 logo 130:1,7,8 logos 129:17 London 10:8,18 11:9 long 74:12,15 83:15 86:24 longer 26:25 50:8 81:2 looking 128:25 129:19 loss 40:10 47:8 lost 102:12 | lot 83:18 low 26:3 44:14 46:21 90:23 96:15 low-bearing 47:10 low-level 63:25 101:2,5,17 102:1 low-rise 10:13 lower 56:9 94:16 97:6 98:20 99:2 Luke 1:11 lunch 74:20 lying 127:13 <hr/> M <hr/> machine 68:9,10 machinery 70:15 71:18 mailbox 3:11 main 9:12 11:14 13:9 19:10 37:1,7 38:10,13 44:2 48:3 51:13,16 54:14 56:4,8,15 56:20,21 57:5,9 57:14,18,20 58:2 58:4,6,9,9 59:1,3 63:16 66:22 70:11 78:7 80:22 88:15 95:8,25 96:4 97:6 98:1 99:7,10,14 99:15,17,19,22,25 100:4,7 115:22 118:16 mains 51:20,23 55:18,21 56:18 57:22 58:7 59:5 maintain 22:21 38:4 47:10 76:17 84:18 87:16 104:9 maintained 39:20 98:11 maintaining 36:19 43:24 125:6 maintenance 39:22 major 91:24 | majority 8:22 109:5 making 44:13 46:20 122:5 management 11:11 11:13 27:3,14 33:23 34:1,7 55:14 74:5 manipulative 35:20 Manse 78:7 79:16 80:5,12 manual 54:10 100:24 manually 41:12 54:11 57:9 manufactured 79:15 117:11,23 120:12 121:25 122:23 mapping 10:23 12:21 marked 13:7 111:3 117:10 marking 77:15 markings 1:23 129:24 MARTIN 1:3 5:3,5 7:18,21 40:15,18 40:23 60:11 66:2 74:9,11,15,21,23 83:13,17,24 84:4 84:12 91:22 107:18,20 108:1 132:7,13,15 mask 76:4 masonry 115:7 Masterdor 78:7 79:16 80:5,12 material 2:4 3:19 4:19 15:25 16:2 17:20,24 21:7 45:12 48:8,22 111:16,24,25,25 112:7 117:14,20 118:10 119:15 | 120:15,17,25 121:8,24 126:25 127:11,22 128:2 129:3,4,9,16 130:14 131:18 132:1 materials 2:5,25 3:6 8:1 9:15 26:8 32:4 44:19 46:20 47:23 48:1,10,12 48:15 49:19 108:15,16,18 112:10 113:22 115:23 127:8,13 127:14,15,17,20 128:14,15,23 131:4,10,13 132:2 matter 114:21 matters 6:3 7:6,8 7:12 20:11 24:11 29:3,4 65:8 84:24 100:13 115:20 maximum 58:3 69:3 mean 23:16 50:7 83:9 meanings 111:23 means 12:5 18:16 20:23 21:1,4 23:6 26:21 30:4,12 37:16 38:13 40:4 40:4 48:3,6 52:6 59:12,14 94:1 111:9 meant 16:12 101:25 measure 41:10 46:23 47:19 50:12 75:3 83:9 measured 99:12 122:13 measures 1:18 5:17 8:15 20:3 26:2 27:15 28:17,21 29:20,23 30:13 | 31:2,20 33:6,17 35:1,15 36:16 38:22 39:19 41:4 41:13,17 48:15 50:11 55:7,10 59:9,11 61:12,18 65:19 73:22 81:8 88:10 mechanical 42:21 52:13 53:11,20 101:3 102:20 105:5 115:17,19 mechanically 120:8 124:17 mechanism 14:17 mechanisms 55:4 medium 44:17 meet 44:21,23 45:8 70:22 72:13 73:15 73:25 79:5 110:14 110:15,17,23 114:17 119:18 127:2 131:12 meeting 43:16 49:1 49:4 75:21,24 121:13 meets 75:19 member 47:14 membrane 116:20 119:12 membranes 115:5 mention 24:13 28:24 MEP 92:18 metal 15:16 16:7 17:4 117:12 118:24 122:11,14 123:3 124:17 method 110:19 114:1,16,17 122:9 122:9 methods 43:20 48:20 110:14 metre 117:25 metres 12:3 13:20 |
|--|--|--|---|---|

| | | | | |
|--|---|--|--|---|
| 14:6,7,8,10 36:25 56:18,19 69:4,5 86:3 99:10,13 100:3 111:7,8,9 111:10,18 114:6 117:24 121:3,16 121:19,20 middle 14:19 Millett 1:12 4:18 5:1 millimetres 72:12 82:9 118:7 119:1 119:7,9 120:18 123:16 124:5,11 128:19 130:17 131:5,6,9 mineral 126:8,17 131:6,7 minimal 58:15,18 minimum 50:21 51:19,22 57:12 69:20 70:4 72:13 113:23 131:4 minor 59:24 minute 69:7 minutes 74:17,18 74:19 78:18 79:19 81:3,3 82:4,22 113:20,20 minutes' 73:21 mitigate 59:23 100:17 mitigating 36:15 mixed 80:10 mixture 12:14 mobile 35:21 mode 102:20,22 103:8,11 model 11:20 77:22 models 10:24 modern 36:1 49:12 55:6 modification 71:10 71:12 modifications | 60:18 62:16 92:18 95:11,13,15 96:3 modified 64:3 95:8 96:5 99:1 modular 122:8,9 moisture 125:5 moment 83:20 Monday 1:1 3:11 monomer 119:13 MOORE-BICK 1:3 5:3,5 7:18,21 40:15,18,23 60:11 66:2 74:9,11,15 74:21,23 83:13,17 83:24 84:4,12 91:22 107:18,20 108:1 132:7,13,15 morning 1:3 7:22 7:25 47:2 95:6 110:13 132:16 motor 19:13 mounted 80:4 117:9 move 7:20 8:17 12:10 16:21 37:17 39:6,12 50:11 74:13 75:18 127:8 moved 13:2 94:22 94:25 movement 112:17 Moving 44:6 multi-storey 45:1 60:2 95:22 98:23 multiple 19:3 29:16 42:4 60:4 84:17 108:12 multitude 49:18 muster 38:2 | natural 52:12,13 53:5,7,11,13 nearly 86:3 necessary 23:7 25:4 26:6 45:18 need 3:14,18 6:5 12:10 27:17 30:9 30:10 33:13 40:5 42:18,20,23 51:5 57:3 75:9 85:2 95:3 needed 11:19 39:5 63:19 negligible 69:10 70:4 neighbours 34:2 new 9:13,14 63:20 63:21 64:20,21 65:5,23 69:17 71:18,19,25 72:2 72:12 78:12 86:6 86:7,9 89:11,14 89:21 91:16 92:8 92:11,14,16,19,20 93:9,23 94:12,19 94:20,20,23,24 95:1,20,21,22 96:6,7,10,14,15 96:16 97:8,8 98:4 98:18,25 99:24,24 100:2,5,17 102:6 102:7,16,19,25 105:11,18,19,24 105:25 106:5 107:10,12,13 108:9,10 116:13 116:20,21,21 117:4,10 118:25 119:3,5,11,17,24 122:15,17 123:22 127:14,17,25 128:20 129:7,15 129:20,23 131:12 newly 102:2 128:16 Niamh 1:11 132:12 | Nic 1:11,20 4:4,11 132:12 night 2:9 3:6 4:16 8:25 61:12 65:20 65:24 66:5,9 84:10 89:9 91:18 nine 62:23,24 63:5 92:11 95:2 98:21 non-combustible 15:24 16:11 111:25 125:9 126:9 non-fire 103:14 non-residential 13:23 63:6 96:12 98:22 105:16 106:9 107:7 non-stop 83:14 non-structural 15:24 normal 51:17 normally 54:7 55:22 north 10:8 11:7,18 12:13 13:4 18:20 18:21 93:9,10 97:18 98:4 101:2 101:10,12,18 103:2,19 notches 125:18 note 23:13,20 24:8 25:19,23 28:23 80:20 88:1 noted 17:5 123:15 noting 130:1 notional 49:5 November 85:12 116:1,2 number 4:15,23 5:10 58:1 64:11 64:14 69:15 71:12 73:9 79:25 nursery 12:19 14:1 18:1 92:12 94:22 | O o'clock 83:21,25 132:16 observe 73:5 119:8 130:17 observed 72:18,21 80:7,9 82:8 90:14 98:9 104:25 118:14 124:25 126:10,17,19 128:23 129:4,11 130:13,18 131:18 131:19,22 observing 85:7 obstacle 12:8 obstruction 58:22 obtain 58:11 69:1 occasions 27:9 occupants 26:18 27:21 28:9,11 29:7,8 31:10,13 31:21 34:12 35:16 39:23 42:9 48:5 51:1 52:3 83:5,6 occupied 22:25 23:4 25:4 78:4 occur 26:7 35:24 36:12 occurred 12:1 40:9 63:12 67:9 89:24 occurring 36:9 60:4 occurs 28:11 57:8 October 2:18 116:1 offer 48:3 offers 52:8 offices 14:2 Okay 7:17 40:24,25 84:8 91:20 108:3 old 129:23 on-site 115:25 once 2:19 23:4 31:13 33:14 34:12 34:14 37:3 47:20 81:12 119:19,22 |
| | <hr/> N <hr/> N 132:21 name 5:8 67:22 nameplate 80:1 narrate 30:24 national 111:10 | | | |

| | | | | |
|----------------------------|----------------------------|----------------------------|--------------------------|---------------------------|
| one- 13:21 | operations 37:2 | 13:24 17:4 60:14 | 122:8 123:8,15 | 83:4 |
| one-bedroom 18:8 | opinion 111:12 | 95:7,10 99:15 | 124:5,8 125:15 | partly 120:22 |
| one-hour 114:8 | 112:4 | 101:5 | 126:18 129:20,21 | parts 3:22 13:6 |
| ongoing 39:22 | opinions 2:21 7:12 | originals 80:19 | 129:24 | 24:22 25:16,20 |
| online 10:23 12:20 | 108:19 | outer 94:3 109:2,3 | panels 15:24,25 | 26:7 51:22 62:12 |
| onwards 69:16 | opportunity 83:3 | 109:8,24 110:21 | 17:6 54:15 94:4,5 | pass 42:20,23 43:3 |
| open 12:14 13:13 | opposed 81:25 | 114:11 116:24 | 94:9,11,13 109:5 | 54:21 125:20 |
| 13:25 14:3 19:8 | opposite 100:24 | 120:11 121:9 | 111:13 116:14,15 | passage 42:15 43:9 |
| 19:14 53:2,17 | oral 3:10,15 7:16 | 123:23 125:4 | 116:24 117:5,7,7 | 43:15 |
| 54:3 58:19 77:7 | orange 70:1 122:20 | outlet 56:10 57:24 | 117:8,24 118:3,6 | passed 52:20 87:10 |
| 94:20 95:21 98:24 | 125:11 128:2 | 59:1,3 | 118:6,13,16,18 | 87:13,14 |
| 101:4,15 102:21 | 129:2 130:2,8 | outlets 19:11,12,13 | 121:10,14,15,17 | passenger 8:21 |
| 102:23 103:14 | order 8:20 9:9,24 | 57:22 58:12,16,23 | 121:19,21,25 | 66:22 67:2 |
| 104:3,6 105:2 | 22:23 23:3,12 | outline 7:4 | 122:1,1,4,6 123:5 | passes 109:10 |
| 109:6 125:1 | 24:18,21 25:8 | outlined 1:12 6:2 | 123:6,11,14,17 | 125:21 |
| 126:11 | 27:13 31:1 35:4 | 97:13 | 125:19 | passing 69:10 |
| openable 79:1 | 41:12,14 42:21 | output 19:15 | paragraph 45:5 | 81:15 106:21 |
| opened 52:3,23 | 97:9 | outside 10:21 12:18 | 110:13,22 111:15 | passive 1:18 5:17 |
| 105:4 | ordered 7:24 121:5 | 13:6 17:24 21:5 | 112:9 115:10 | 8:15 20:3 27:15 |
| opening 1:12 4:18 | orders 121:2 | 35:25 37:15 53:8 | paragraphs 44:22 | 28:16,21 29:19 |
| 7:23 15:21 43:2 | Organisation 11:13 | 55:23 90:1,23 | 110:16,20 112:12 | 30:13 31:2 35:14 |
| 43:11 54:3 60:12 | orientate 12:15 | 102:5,12 118:19 | parallel 25:7 | 38:21 41:3,6,16 |
| 66:20 127:19,25 | orientation 114:25 | 118:23 123:21 | Parker 9:20 | 46:23 47:18 48:14 |
| 129:19 | origin 1:24,25 4:6 | outwards 125:13 | parking 36:24 | 59:10 61:11 65:17 |
| openings 42:13,22 | 26:4 31:23 32:12 | over-clad 93:17 | part 8:9,14 9:3 | 83:8 |
| 42:23 46:3 68:12 | original 8:1,1 10:1 | 108:8 | 11:10 20:1,15,16 | path 97:25 98:3 |
| 68:15 71:20,25 | 11:16 13:1,16 | overall 46:24 | 23:19 24:24 26:18 | pathway 45:21 |
| 72:9 75:2 76:19 | 15:19 16:22 17:2 | overcladding 65:2 | 26:23 28:14 30:5 | pattern 2:7 130:18 |
| 90:23 101:23 | 17:11,21 18:19 | 93:20 96:21 | 32:5 34:13 40:25 | Pause 117:2 |
| 112:19 113:2,21 | 61:4 66:12,22,23 | 115:23 116:17 | 41:7 47:20 52:17 | PE 94:8 121:10,21 |
| 126:23 130:23 | 68:17 72:8 81:23 | 131:1 | 55:13 60:12 63:24 | 121:25 123:4 |
| 131:1,3,12,15 | 82:16,21,25 85:19 | overlap 81:9 | 64:1 66:17 74:5 | pedestrian 13:9 |
| opens 53:3 | 86:5,8,10,21 | override 54:10 | 78:1,20 79:10 | 97:16,25 98:3 |
| operate 4:2 9:22 | 87:10 88:18,24 | 100:25 104:24 | 100:1 108:3 109:7 | Pedestrians 13:5 |
| 18:25 19:25 22:20 | 89:8 91:14 94:15 | overview 9:8 91:23 | 110:4 127:21 | penetrate 32:2 |
| 42:21 54:6 56:16 | 99:9 100:4,19 | owned 11:8 | 128:11 | 87:18 |
| 104:17 105:8 | 101:23 102:19 | owns 22:15 | participants 3:7 | penetrated 84:17 |
| operated 37:5 | 105:5,21 111:3 | | particular 1:23 | 90:2 91:4,5 |
| operating 38:18 | 116:7,19 119:2 | P | 2:24 5:16 85:9 | penetrates 87:20 |
| 67:15 | 123:24 127:11,12 | pair 106:3,6,20 | 101:14 | 91:7 |
| operation 89:9 96:7 | 127:21,23 128:11 | pane 117:18 | particularly 28:4 | penetration 34:18 |
| 104:14,16,21 | 128:17 129:7,15 | panel 16:9 17:11,22 | 48:2 85:15 | 105:17 112:15 |
| 105:1 | 129:20 130:19 | 54:15 94:8 104:19 | parties 116:3 | penetrations 84:18 |
| operational 27:9 | originally 11:14 | 117:21,22,22,23 | partition 107:11 | people 13:25 32:8 |
| 73:2 | 12:18 13:7,9,20 | 118:7 119:20 | partitions 76:22 | 32:19 33:4,12 |

| | | | | |
|--|--|---|---|---|
| 55:14 68:7,13 74:6 perfectly 119:8 perform 41:9,12,14 performance 3:5 21:22 27:24 32:25 43:16,18,20 44:23 44:25 46:7,15 48:16,17,19 49:1 49:4,5,19 57:18 61:10 65:19 75:8 75:10,22,24 76:13 78:15,23,24 79:6 90:17 100:12 106:18,25 108:20 110:17 111:12 114:18 115:9,11 115:17,20 127:2 perimeter 14:12,20 14:23,25 15:10,11 15:21,22 16:5 17:7,15,18 19:8 116:10 118:20 119:25 120:6,16 120:19 121:6 123:11 124:2,13 period 41:25 47:8 periods 27:21 permanently 15:15 19:14 104:3 permit 37:6 55:4 64:4 109:11 131:2 permits 70:22 permitted 78:22 person 22:11,12,15 22:15,20 23:19 31:17 33:13,19,20 34:9 personal 34:10 personnel 58:13 persons 4:21 20:10 34:5 69:2 Peter 9:19 Phase 1:15 2:17,20 2:22 5:13 10:3,12 | 30:1 41:2 43:22 49:21 50:15 61:17 94:14 108:19 111:23 112:5 116:4 phone 34:15 photo 126:15 127:10 photograph 16:3 16:24 17:2 79:23 81:1 98:12,16 102:14 103:9 119:16 120:19 121:14 123:2,6 124:14 125:23 photographs 11:24 72:19 102:8 122:18 125:16 photos 9:23 49:25 50:1 physical 3:23 93:18 physically 34:18 pick 6:6 picture 81:10 124:22 125:20 pictures 129:18 pieces 128:4,7 pierce 124:18 pierced 120:7 pink 117:21 pipe 19:16 56:7,11 56:13,13 57:2 58:4 65:6 87:2,19 87:21 89:17 90:9 90:11,14,19 91:5 105:16 106:7 107:2,4,5 piped 90:21 Pipelines 88:6 pipes 42:19 57:11 86:25 87:17,22 88:2 89:24 90:2,5 91:2,9 96:16,17 105:13 106:4,16 106:20,22 107:1,8 | 107:12,13 pipework 85:13 piping 99:24,25 100:2 PIR 120:14,14,17 130:2,10 pitch 12:19 place 3:20 4:5,14 8:22 21:5 27:22 28:5 30:1,18 44:1 59:1,13 65:3 79:4 122:19 124:17 placed 26:13 128:4 128:24 places 128:10 plan 14:9 23:5 55:14,15 66:12 72:7 74:5,6 plank 94:7 planned 91:9 planners 6:8 planning 60:22 plans 23:7 plant 10:5 19:1,7 19:10,10 99:12 103:1 plasterboard 17:13 131:24 plastic 128:1 130:14 132:1 plasticised 128:1 plates 76:10 platform 12:12 69:4 play 11:6 12:19 30:5 93:6 97:22 played 4:18 playing 4:9,17,25 please 7:15 40:17 83:25 107:19 plug 58:11 plus 10:5 pm 84:1,3 107:23 107:25 132:18 podium 92:10 | point 36:6 40:14 72:21,23 87:5 109:11,20 points 6:6 39:18 71:19 policy 8:12 29:5 polyester 117:13 polyethylene 121:23,23 123:17 123:18 131:6 polyisocyanurate 118:9 120:13 polymeric 17:14 120:10 129:13,22 polystyrene 116:15 117:5 118:3,4,13 118:15 polyurethane 121:1 131:24,25 polyvinyl 128:1 portion 19:7 46:22 109:2 131:22 position 21:20 105:6 119:1,3,11 123:14 124:21 126:16 128:13,21 130:21 positioned 12:19 59:3 68:14 102:16 possible 13:15 25:18 30:9 46:12 90:18 106:18,25 113:25 potential 45:23 potentially 34:2 powder 117:13,15 power 41:8,14 47:19 50:14 51:17 51:23 70:2,10,10 73:16,18 96:7 102:10,10,11,11 103:3,3,4 practical 24:3,5 practice 26:24 28:7 35:18 68:17 | 108:23 precast 14:25 15:13 precautions 26:23 preliminary 1:25 2:6 5:12 10:2 24:23 61:17 preparatory 63:19 prepare 37:2 prepared 26:17 71:6 prescribed 82:7 presence 12:4 59:10 present 1:18 2:5 3:6 25:12 31:9 34:7,9 44:20 47:1 49:10,22 53:4 89:9 126:21 131:15 presentation 1:20 3:18,20 4:4,13,23 7:16,23 8:6 9:24 16:20 20:2,22 29:2 31:6 60:8,12 62:15 84:6 85:18 108:3 132:10,11 presentations 1:5 1:10,13 2:10 66:1 presented 58:23 62:3 79:10 presenting 16:18 108:19 pressure 52:16 56:6,9,10,12,15 57:12,17,24 58:3 58:5,7 pressurisation 53:21 pressurised 57:5 prevent 26:9 32:2,5 33:2 34:18,20,23 38:22 41:19 42:15 42:24 48:4 59:15 59:19 81:5 104:8 preventing 21:14 |
|--|--|---|---|---|

| | | | | |
|---|---|--|---|--|
| 32:24 42:10 81:16 prevents 53:25 previously 64:5 89:23 92:16 primary 9:3 63:4 63:10,24 64:3,9 64:20 66:7,17 70:21 71:11,25 72:3 75:3 83:10 84:9 86:6 91:21 92:1,5 93:13 96:19 97:1,4,12 97:13 98:7,11,16 98:19 99:18 100:9 101:21 102:10,11 103:3 107:15 108:5 principal 1:21 76:2 principle 30:2 prior 3:17 67:16 73:1 127:10 priority 93:15 probability 26:3 probable 52:1 process 24:25 37:14 53:1 85:15 produced 61:25 produces 111:25 producing 114:20 product 17:14 45:12 48:22 79:14 94:6 111:15 117:23 120:12 121:4 126:5,8,11 129:9 130:7 131:25 production 3:4 products 48:15 112:10,11 126:23 professional 6:9 Professor 1:11,11 1:20 2:2,24 3:3 4:4,11,13 5:1 132:12 profile 49:15 | programme 64:15 77:20 78:3 programming 54:8 progress 8:25 project 92:7 93:2 proof 119:11,20 properties 2:4 proposed 23:6 propositions 5:10 proprietary 115:7 propylene 119:12 protect 31:21 38:3 38:15 42:8 51:24 52:7 60:1,3 93:17 protected 13:15 15:5 31:16,23,24 32:1,21 33:5 34:24 35:8 37:9 37:11,20 38:11 39:6,12 43:4 44:2 44:3,4,5 46:4 48:9 50:22,24 53:19 59:3 66:21 70:3 76:23 77:2,6,7,16 77:17 84:18 87:16 87:18,21,23 88:3 89:22 90:2,10,12 90:21 91:4,7 95:25 99:1 102:18 104:10 105:18 106:12,14 107:2 protecting 42:12 75:1 protection 5:17 8:15 20:3 22:3 27:15,18 28:17,21 29:17,18,19,23 30:13 31:2,20 32:3 33:11,16,18 34:17 35:1,15 36:16 38:6,21 39:19 41:3,6,10 41:13,17 43:10 46:23 47:19 48:14 50:11,12 52:8 | 54:24 55:4,7,10 59:9,11,23 61:11 70:11 71:1 73:22 75:3 83:9 114:1 protective 54:20 protruding 124:19 provide 3:9 8:4,6 8:10 9:8 19:24 22:2,10 23:10 26:2 28:20 30:15 33:11,17 34:5 35:14 37:13 44:17 46:15 47:17 50:18 54:17 56:20 59:12 59:14 60:13 86:7 92:10 97:2,4,9 98:21 106:2 107:16 109:24 provided 3:14 5:12 5:23,24 8:13,16 9:24 11:22 13:19 14:13 15:1 18:14 18:15,24 19:9,15 22:17 23:18 28:8 28:16,25 29:12,17 29:18 30:12 31:20 32:13 33:7 34:17 35:2,11 36:17 37:3 38:12 39:14 39:21,25 40:10 41:2 43:7 46:2 51:8,17 52:9 54:2 54:11 55:12 56:22 57:1 59:6 60:16 62:7,19 63:17 64:13,22 65:14 66:4,23,25 68:25 69:8 71:1 74:4 77:18 80:15 85:22 86:17 88:8 94:10 94:21,24,24 95:2 96:1,8,11 97:15 98:4,18 99:1,16 103:4 104:20,24 109:18 110:19 | 112:15,16 116:3 provides 12:8 22:24 31:3 36:23 37:19 112:6 providing 23:6 25:3 32:3 provision 9:13 11:10 15:16 22:4 27:15,18 30:7 34:3,6,19,21 38:14 40:2 42:11 44:13 46:20,21,24 51:24 66:5 67:18 69:21 70:12,24 82:12 84:20 92:14 112:13 provisions 21:3 25:4 26:11 27:12 36:2,8,10 38:14 45:9,18 50:9 52:13 67:20,24 68:20 69:18 73:11 88:12 108:14 110:7,24 113:18 proximity 37:17 public 42:11 published 29:1,3 35:19 pull 103:18,23 pulling 53:9,15,22 pump 56:5 57:1,2,3 58:5 pumping 55:23 56:3 pumps 56:1 57:1,4 57:11 Purchase 121:2 pure 94:9 purlboard 17:14,16 17:23 131:24 purpose 1:13 20:8 39:20 41:9,13 45:20 54:2 100:22 114:3 purposes 12:7 | 13:24 20:19 24:2 46:3 50:19 61:6 62:15 65:11 67:2 76:7 125:6 130:15 Purser 3:3 push 56:11 pushed 54:1,2 pushes 53:23 put 4:1 5:10 25:23 28:23 <hr/> Q <hr/> QC 4:11 questioned 2:21 questions 3:9,12 quite 12:14 83:14 <hr/> R <hr/> radiators 96:17 rail 122:6,23 123:3 125:19,21,24 rails 115:4 122:16 122:19,20 123:9 rainfall 109:5 rainscreen 9:16 93:17,25 94:4,5 96:25 108:9,13,21 108:23,25 109:2,3 109:6,10,22 110:21 111:13 112:20,23,25 113:3,6,10,11,15 114:11,15,23 116:18,23,24 120:23 121:4,8 122:10 123:6,11 123:20,23,24 125:4,5,15,19 126:18 131:1 raise 31:9 56:6 raising 50:19 ramp 93:5 97:21,24 ramps 96:23 ran 17:18 90:5 range 31:20 61:13 61:16 123:16 |
|---|---|--|---|--|

| | | | | |
|---|---|---|--|--|
| 130:10 rapid 28:2 32:5 48:4 rate 44:14 47:25 81:14 rates 46:21 rating 81:3 82:4,5 reach 13:6 28:13 69:6,21 reached 56:14 reaching 49:15 100:10 reaction 49:18 112:2 reactive 125:11 read 92:6 readily 79:1 ready 40:23 108:1 rear 124:4,7,10 125:4,15 reason 56:17 reasonable 20:9 22:2,4,21 23:14 reasons 61:3 87:25 rebate 81:5,10,13 81:13 82:6,9,10 received 32:9 recladding 92:9 108:6 recommendations 30:3 reconfiguration 9:10,11 92:10 97:6 98:20 reconfigure 95:4 reconfigured 98:21 98:22 99:5 Reconfiguring 95:3 recorded 8:19 62:2 62:8,23 63:13 64:6 records 60:21 81:21 82:20,24 red 13:1 95:18 97:13 117:17 | reduced 57:25 reduces 57:14 reducing 45:23 refer 16:15 20:21 24:14 27:5 29:1 29:25 85:21 86:16 91:25 106:5 111:22 reference 4:1 27:12 46:9 59:22 60:6 referenced 25:13 28:23 99:8 references 27:23 referred 15:7 28:8 45:4 67:21 108:22 109:3,16 114:16 119:13 refers 26:21 27:9 27:17 52:15 115:10 Reform 22:22 23:3 23:11 24:18,21 25:8 refuges 34:11 refurbished 100:12 101:20 104:12 refurbishment 8:24 9:4,12 12:1 16:25 60:20 62:13 62:18 63:2,3,4,10 63:25 64:3,10,20 65:15,22 66:8,17 70:21 71:11,16,25 72:3 73:14 84:9 86:6 91:21,25 92:1,2,4,5,12,13 92:22 93:13,15 96:9,19 97:1,4,7 97:12,14 98:11,16 98:19 99:18 100:9 101:21,25 107:15 108:4,5 127:1,10 132:4 refurbishments 63:13 64:6,24 | refuse 77:11,13 78:13 82:23 regard 21:20 27:14 80:12 95:13 regarding 8:19 21:16 23:17 27:7 27:20,24 56:4 79:3 80:16,17 81:21 84:13 98:20 110:2,3 Regardless 54:5 regulated 40:6 regulation 22:10 23:17 44:10 48:7 61:14 110:14 regulations 8:9 20:6,7,13,16,17 20:20 22:18,25 23:8,20,24 24:4 24:16 25:1 27:1 29:4 32:17 35:14 36:1,4 41:4 54:23 60:22 61:8,20,23 62:9 64:12 83:8 88:6,7,13 Regulatory 22:22 23:3,11 24:17,21 25:8 rehearse 6:5 reinforced 14:11 14:11,12,12,22 18:8 93:21 125:9 reinforcing 47:16 47:17 relate 22:25 45:16 60:19 62:24 65:12 69:19 85:16 112:12 related 89:4 relates 21:9,12 relating 3:4 22:8,19 24:12 relation 66:3 relative 119:2,4 release 44:14 46:21 | released 92:4 relevant 2:3 3:8,15 6:3 7:12 23:15,16 25:13 31:25 42:2 49:3 60:5 61:20 65:16 66:3,8 67:11 70:19 75:23 76:13 84:19 90:4 111:1 116:3 reliability 100:12 reliance 26:1,12 35:20 59:20 relied 35:15 50:8 74:2 85:8 relies 28:25 30:18 30:22 53:14 54:8 relocated 92:12 99:20 Relocation 92:13 rely 32:20 35:7 39:3,5,8,12,23 remain 28:10 29:9 29:10 33:19 53:2 82:17 101:16 remainder 91:20 remained 89:7,8 remaining 27:22 66:19 82:15 remains 27:1 47:20 remind 118:21 reminder 28:6 removed 64:1 66:17 116:13 119:20,23 120:20 123:7 125:24 127:13,14 128:17 129:16 130:6,16 130:20 131:22 replace 78:4,7 79:14 89:12 replaced 63:15 64:10 65:2,5 77:25 78:1,10 80:17 82:14,18 102:6 116:13 | replacement 8:21 8:22 60:25 62:16 64:17 65:21,22 70:16 71:3,4 72:9 73:24 78:8 81:22 82:20 84:10 replacements 64:8 64:16 77:20 82:24 replacing 71:17 replenished 56:2 replicated 49:22 130:19 report 5:13,16,23 5:24 6:1 7:8,11 10:3,22 15:4 17:1 20:22 30:1 31:7 40:7 41:2 43:22 44:24 45:4 49:21 50:15 60:17 61:18 65:15 76:1 94:14 108:19 111:23 112:5 114:18,20 reports 2:17,22 represent 83:3 represents 49:25 reproduced 20:24 22:14 requested 104:22 require 20:8 35:4 36:1,4 41:8,14 51:15 54:23 56:23 67:13 82:7 87:23 88:9 required 8:13,14 12:9 18:25 20:3 22:17 23:17 29:19 30:11 31:4,16 32:18,25 34:3,11 36:20 37:16 38:15 38:22 39:7,11 41:4,16,18,21 42:4,25 43:19,24 46:15 48:8,16 53:6 54:21 55:1 56:11 57:12,14 |
|---|---|---|--|--|

| | | | | |
|---|--|---|---|--|
| 59:19 61:20,23 67:23 68:21 69:15 69:16,17,18,23,24 69:25 70:1,3,7,15 71:24 72:5,14,16 72:20 73:4,15,21 75:5,19 76:16,17 77:11,13,18 78:25 79:6,21 81:5,14 82:2,4,6 87:15 96:3,11,13 99:10 99:14 105:18 108:14 112:19 113:2,5,9,14,19 114:5,13 125:6,7 126:19 | requiring 33:13,21 73:20 75:5 90:7 rescue 26:1,13,13 26:15 27:10 35:9 55:16 59:20 74:7 Research 44:24 residential 8:7 10:6 10:13 18:15 19:22 25:6 26:25 27:3 28:22 30:19 34:4 35:23 36:3,21 40:1 50:16 59:18 62:25 67:19 68:24 70:2 72:2 79:11 86:17,18,21,23 89:11,14 90:7 91:14,16 92:11 94:16 99:4 100:21 102:3 107:6 114:6 116:7 residents 31:4 34:25 35:9,16 resist 21:18 32:18 36:14 110:5 resistance 27:20 41:21,22 43:5 47:9,13,18 49:8 49:11,13 73:20,21 75:6 77:9 78:18 78:19 79:7,8,22 82:3,19,22 110:8 113:21 114:4,5 resisting 33:1 respect 24:3 61:18 84:21 respective 105:9 106:3 response 31:3 responsible 22:12 22:15,20 23:19 rest 9:1 60:10 restrict 43:9,15 45:18 48:10 112:16 restricted 44:13 | 46:19 restricting 76:7 78:21 result 65:13 85:16 97:24 113:11 resulted 116:19 resulting 93:19 95:2 results 79:25 resume 40:18 83:21 83:25 107:21 retain 124:20 retained 12:23 86:10 101:24 105:22 116:12 128:18 retaining 18:7 retrospect 12:5 return 106:4 Returning 105:5 revealing 120:20 reveals 127:12 128:12 review 25:11 61:1 116:3 reviewing 71:5 85:6 Reynobond 94:8 121:10,21,25 123:4 RH25 124:25 126:11,15 ridge 15:13 ridged 15:14 right 40:19 66:2 72:9 80:9,11 98:16 107:20 111:5 126:4 128:24 129:19 right-hand 95:21 123:2 125:20 128:3,6,25 rigid 113:24 114:12 114:15 130:14 rise 83:25 | riser 57:8 65:4 78:13 87:3 88:19 88:21 89:4,12,25 91:3 92:24 106:6 106:10,12,13,15 106:20 risers 76:19 87:4,6 87:8,10,11,13,15 88:18 89:5,8 106:8 107:6 risers 53:6 rising 19:4 56:8 57:14 59:1,3 80:25 99:7 100:4 100:7 risk 24:24,25 44:11 44:18,20 46:18 58:15,18 60:23 69:11 70:4 72:24 riveted 122:2 road 11:7,15,18,21 12:2 36:23 98:8 robust 67:14 Rodney 65:7 85:1 role 75:1 roof 10:6 19:6,9,9 19:10 21:22 53:8 65:1,1 93:14 95:16 101:12 103:18,20 104:4 105:15 107:2 111:7 rooftop 103:1 room 10:5 17:12,18 17:23 19:13 51:6 68:10 70:15 77:11 77:13 78:13 82:23 84:23 92:14 94:21 94:23 99:13 103:1 rooms 18:2 51:7 62:10 64:22 rotated 126:12,16 roughly 126:17 route 11:25 28:2 32:6,20 35:8 | 50:25 51:13,22 79:12 89:21 98:13 100:1 102:17 routed 70:3 86:4,24 86:25 89:17,19 105:14 106:20 107:8 routes 13:10 51:12 51:25 58:22 69:10 79:9 85:10 routing 73:19 106:7 Royal 6:24,25 10:9 62:5 78:4 92:2 RS5000 120:13,17 121:3 rubber 119:13,14 rubber-like 81:18 run 51:19 107:1,3,4 running 54:14 65:4 runs 121:12 RVG 126:4,6 Rydon 92:6 |
| S | | | | |
| | | | | sacrificial 15:13 safe 29:8,9 33:18 35:2,4,7 36:20 38:4,5 54:18,22 59:20 104:10 safely 21:6 26:19 28:10 39:6,13,15 48:7 55:5 58:13 67:24 safety 1:18 6:12,17 8:7,13 19:21 20:4 20:5,9,15,16,18 20:23 21:5 22:8 22:10,12,17,21,23 22:24 23:3,11,18 24:1,6,18,21 25:2 25:8 27:2 28:13 29:12,16,18,25 30:3,14,16 31:3 35:18 37:6 39:24 |

| | | | | |
|--|--|--|---|---|
| 40:10 41:1 44:18 47:21 59:12,19 60:1,7,24 61:4,18 65:19 66:9 67:23 68:3,17 69:12 70:6 71:6 73:9 75:3 78:15 84:24 85:17 87:25 88:6 88:6,9,10 90:9 97:10 99:3,6 108:13 110:2 safety-related 65:12 84:14 sample 129:17 samples 130:6 satisfied 23:16 73:11 satisfy 41:25 55:13 73:12 74:4 says 27:25 28:4 scenario 33:2 36:18 67:15 scenarios 85:3 schedule 78:8 schematics 73:17 science 1:21 scientific 2:3 scope 71:11,16 92:6 93:2 screen 77:24 93:3 111:2 119:16 121:7,15 122:3 123:13,25 124:14 125:21,23 128:14 129:18 screwed 120:5 122:1 seal 43:7 76:6,7 81:19 119:14 sealants 45:13 111:16 112:7 sealed 42:24 sealing 43:4 129:22 seals 75:15 78:20 81:17 82:7 | search 39:4,7 second 1:22 20:1 38:15 40:25 61:5 72:22 84:6,20 86:16 94:6,23 100:6 102:3 103:25 107:4 109:7 114:16,17 120:21 secondary 73:16 Secondly 27:17 Secretary 20:19 24:2 section 5:22 6:1 10:2 17:1 25:9,13 26:2 30:6 31:5,6,7 44:15 45:7,10,16 46:5 51:11 52:4 52:11,18 57:21 61:17 65:15 110:8 110:12,25 sector 38:19,20,24 39:5,10,10,13 54:23 sectors 39:2,5,7 secure 37:15 57:15 securing 20:9 30:4 see 16:3 66:19 72:19 77:24 127:16 seen 91:9 121:7 126:22 128:15,19 129:3 select 54:11 selected 54:7 self-closer 80:3 self-closing 75:6 76:6 78:25 80:14 80:24 82:3 separate 14:13 18:17 77:5,12,17 83:4 88:12 103:22 114:20 120:18 separated 18:9 33:15 62:21 77:6 | 90:11 separately 63:19 115:21 separates 77:1 separating 43:1 112:24 September 2:15 3:11 88:17 sequence 103:11 series 7:24 9:22 11:24 20:13 60:3 66:1 serve 64:4 67:1 68:24 70:1 71:22 71:23 86:9,11 90:1 99:5 102:2 105:19,22 served 71:12 85:22 86:5 89:13 95:7 100:7 105:12 serves 76:4 service 26:14,15 27:10 30:8 34:9 44:5 55:16 56:24 57:3,7,8,15 85:5 88:2 89:7,18 serviceable 100:11 services 6:10 10:23 12:21 19:3 21:25 42:19,20,21,23 43:3 59:20 62:17 74:7 85:8 serving 19:16 63:16 100:21 106:9,11 session 9:2 set 1:13 2:6 7:8,11 19:21 28:18 39:4 39:9 43:21 46:7 46:14 57:1 63:6 81:25 88:5 102:9 103:1 sets 62:12 63:5,11 63:23 102:6 setting 2:11 shaft 19:14 44:3 | 51:15 53:7,13,15 53:16 54:1 68:12 68:16 71:20 72:1 72:10 87:21,24 89:18 90:11,12,21 90:24 91:7 100:20 100:20 101:12 102:8,15,23 103:5 103:20 shafts 15:6 18:21 18:22 19:3 42:6 44:5 64:3 68:13 77:5 87:1,23 101:6,8,10 102:1 103:2,24 shape 122:5 123:3 123:8 shared 42:11 sharp 40:19 sheet 80:6,13 sheeting 115:4 sheets 120:25 121:22 shelter 109:4 short 20:1 40:21 84:2 107:17,20,24 shortened 120:14 shortly 1:14 127:2 show 23:7 75:18 79:5 102:8 114:22 116:25 120:25 121:2 122:18 125:16 130:4,7 showed 73:17 showing 4:7 125:25 shown 11:20,25 48:25 49:15 69:19 69:25 70:8 75:16 75:21 76:24 77:9 80:7,9 81:1 90:15 111:1 113:4,8,13 122:2 123:13 128:13 shows 4:20 17:2 44:8 49:12,23 | 52:18 66:14 79:23 88:22 93:3 98:12 98:17 102:14 117:6 120:11,19 123:6,8 124:14 125:21,23 126:5 126:15 128:16 129:13 131:20 shut 31:14 103:13 103:21 shut-off 85:1 shutting 84:21 side 11:3,7 12:13 12:16 13:3,4,4 16:9 17:4,12,23 18:7,21 32:15 44:8 97:18 98:9 98:13,17 100:23 101:6,10 111:2 117:19 121:22 123:2 125:23 128:3 SIDERISE 124:25 126:3,5,6,11,15 sides 16:8 17:9 81:19 93:11 98:5 123:4 127:18 128:8 129:12 130:13 signal 32:10 signalled 53:16,17 significant 60:18 61:4 significantly 38:23 47:24 Silchester 11:7,18 silicate 131:8 silver 94:10 similar 45:13 111:17 112:8 simplest 111:23 simplified 52:18 simplify 106:6 simulation 3:25 simultaneous 26:5 |
|--|--|--|---|---|

| | | | | |
|---|---|--|--|--|
| single 8:12 14:10 16:12 18:16 29:7 29:12,16 30:21 31:17 32:12 33:2 33:6 36:11,24 38:23 39:24 58:8 59:24 66:21 75:3 77:12,16 79:12,23 102:24 104:17,21 120:3,9 124:23 sir 1:3 5:3,5 7:18 7:21 40:15,18,23 60:11 66:2 74:9 74:11,15,21,23 83:13,17,24 84:4 84:12 91:22 107:18,20 108:1 132:7,9,13,15 sit 5:5 7:18 site 22:5 73:6 85:7 85:11 98:9 104:25 118:14 119:9,17 122:13,18 123:15 126:10 129:18 sited 58:12 sits 109:23 122:24 six 13:22 18:5 77:2 87:6,8,9 88:18 98:25 sixth 106:10 size 69:20 72:7 114:25 119:11 slab 14:22 131:7 slabs 15:4 sleeping 79:11 sleeved 131:6 slide 20:14 22:14 62:3,20 75:17 slides 20:25 sliding 15:23 17:4 116:12 slots 122:5 123:8 small 17:17 66:14 66:15 88:17 95:6 95:16 116:15 | 117:8 smaller 63:17 72:8 117:8 118:5 smoke 3:2 5:19 9:13 18:19,20,21 18:24 19:12 21:15 27:18 29:24 31:25 32:1,2 33:9 34:18 34:20,22,24 37:10 38:4 39:4,8 43:9 43:15 45:19 50:23 51:3,24 52:1,7,10 52:12,16,20,22,24 52:25,25 53:6,7,9 53:15,18,22,25 54:1,5,8,18,24 59:14,16,24 76:7 76:8 78:20 79:20 81:6,8,16,17 82:7 92:22 94:10 96:5 97:7 99:7 100:10 100:11,14,15,19 100:20,23 101:10 101:11,13,13,19 101:20,23 102:8,9 102:22,23,25 103:6,7,9,10,11 103:13,16,18,19 103:22,23 104:1,8 104:13,15,16,23 105:8 112:16,17 so-called 100:24 127:5 social 11:10,11 Society 6:25 soft 93:1,9 96:23 97:15 131:18 sole 37:5 solicitor's 3:11 solid 15:21 116:10 127:22 128:1 Sorry 80:10 sound 31:11 50:23 51:9 source 44:12 46:18 | 84:23 south 11:2,15,21 12:16 13:3 18:23 85:24 86:11 93:10 97:20,25 98:4,9 98:10,13 99:22 101:3,6,8,17 102:7,13,15 103:24 southeast 11:22 66:16 88:23 89:1 89:18 90:8 93:23 95:22 southern 11:24 space 16:5,13 17:7 19:2,7 36:24 37:11 104:10 106:2,3 109:15,17 112:15,17 spaces 10:20 11:4 14:1 16:15,16,16 21:15 42:11 48:2 95:3 96:12 spacing 51:21 speak 60:9 speaking 83:14 special 67:13 specialise 6:12 specialists 6:9 85:8 specific 15:25 20:24 27:6,12 43:20,23 46:12 47:15 55:3 58:1 61:2 63:7 65:15 67:20 76:15 80:1 84:14 88:8 110:16 129:8 131:3 specifically 8:17 19:23 21:17,25 22:8 27:23 57:16 60:9,21 63:1 64:25 81:19 110:4 113:21 117:3 131:19 specification 48:24 | 49:7 71:6 72:14 73:3 75:20 80:5 80:13 specifics 63:11 specified 23:15,22 42:1 43:16 71:7 73:8,16,17,20,22 73:24,25 77:9 80:6,13 81:14 82:19 113:22 115:6 118:2,7,16 126:3 127:4 129:9 specifies 114:25 specify 78:12 specimen 79:24 80:3 speed 5:19 split 39:1 86:25 87:6,6 124:19,22 sponsor 115:6 spots 83:3 spread 2:4,8 3:1,2 4:16,17,19 5:19 5:20 21:9,12,15 21:17,18 26:4 27:25 28:3 32:5 32:18,24 33:1 34:23 36:14 41:19 42:24 44:12,17 45:19,24 46:19 47:24 48:4,10 49:24 59:14,16,24 81:6,8,16 110:3,5 110:11 115:12,13 115:15,18,19 spreading 36:15 38:23 42:10 spreads 48:4 115:15 spyhole 80:2 square 15:12 squared 69:5 121:3 stabilisation 12:12 stability 14:17,19 21:13 29:22 46:24 | 47:4,8,17 79:19 stacks 19:16 staff 34:1 stage 2:23 31:15 33:20 86:15 108:17 114:21 stages 23:1 stair 13:16 31:17 31:19 34:19,20,21 34:24 35:1 37:4 38:9,11 42:7 44:2 51:15 52:9,14 53:3,24 59:4,16 64:21 66:22 69:3 77:16,17 81:21,22 81:23,25 82:2,9 82:19 89:22,25 90:1,2,11,12,14 90:16 91:4,4 95:4 95:15,21,25 98:24 99:1 102:17,18 104:3,4,5,6,7,8 104:10 staircase 27:18 28:14 29:24 94:20 stairs 13:13 15:6 18:16 19:15 31:24 32:3 33:8,22 34:1 34:14,14,17 35:8 37:11 39:6,12 48:10,12 52:8 53:25 54:25 76:18 76:24 78:13 95:13 95:14,16,18 stairway 79:13 88:3 106:12 stake 120:5 stakes 120:7 stand 7:18 stand-alone 100:14 standard 26:22,22 27:2,12 28:7 42:2 43:12 45:2 49:9 49:11 57:20,21,25 69:14,25 70:15,18 |
|---|---|--|--|--|

| | | | | |
|---|--|--|---|---|
| 70:22 71:1,7,8,9 71:15 72:5,13 73:15,25 75:19 78:15,19 81:4 82:7 108:23 110:18 114:4,19 114:24,25 standards 20:9 28:19,24 29:15 49:3 75:23 82:4 start 7:25 40:25 53:4,16 started 33:5 52:19 83:6,7 starts 50:24 state 11:25 20:7,19 23:21 24:2 30:6 75:13 79:20 114:14 125:1 126:11 stated 41:25 59:21 61:17 statement 93:12 statements 58:1 states 24:20 25:20 25:24 26:11 30:2 35:19 44:15 45:7 45:10 46:5 47:5 47:22 48:21 51:11 51:25 52:5 55:11 57:21 72:24 74:2 79:10 88:2 90:20 110:7,22 115:11 status 66:4,9 108:20 statutory 20:21 24:14 28:18 29:13 34:3 37:19 40:2 56:17 59:21 61:21 61:24 75:7 113:17 stay 4:1 25:23 28:23 stay-put 8:10,16 19:24 20:4 25:22 27:5,19,23 28:4,9 | 29:6,10 30:16,22 30:25 35:13 39:21 40:3,8 43:25 59:17 75:4 83:2 83:11 84:19 stays 32:22 steel 47:16 122:21 122:24 131:4 steps 23:14 stone 125:9 stone-based 108:23 stop 43:6 81:8 stopped 81:12 stops 68:10 storey 14:6 18:5 19:4,8 45:11 90:4 storeys 13:22,23 18:5 60:4 straight 119:8 strategy 8:10,16 19:24 20:4 25:22 27:5,19,24 28:5,9 29:6,11 30:17,22 30:25 35:13 39:21 40:3,8 43:25 59:18 75:4 83:3 83:11 84:19 93:15 strength 56:13 strip 125:11,13 126:13 131:19 strips 81:18 structural 14:17 15:17 21:12 29:22 47:1,13,18 structure 12:3 16:8 25:21 27:21 42:17 47:6,13 48:22 76:5 116:21 119:4 120:8 123:24 124:7 126:14 structures 48:16 Styrofoam 118:2,3 118:15 sub-main 69:9 subdivided 41:18 | 113:12 subdividing 21:13 45:20,25 subject 46:12 84:24 subjected 75:9 subjects 7:24 submission 23:5 25:1 submissions 1:12 submitted 3:10 62:4 subsequent 89:3 subsequently 70:17 substantial 49:20 63:9 70:9 71:17 92:5 96:20 substantially 69:16 substantive 2:16 substitute 121:5 successfully 79:18 sufficient 38:13 51:2 suggest 3:8 107:21 suitable 36:23 67:12 summarise 82:12 summarised 85:18 93:19 summary 1:24 8:18 60:13 superseded 27:2 supplied 18:22 55:22,25 78:6 88:21,25 91:2 suppliers 117:25 supplies 70:10 84:14,21 85:12,19 91:12 96:8 102:10 103:3 supply 8:24 37:15 41:14 50:14 51:13 51:20 56:23 57:22 65:4,6,8,23 69:8 70:3,11 73:17,18 84:9,16 85:3,10 | 85:21,22,25 86:4 86:8,12,15,16,17 86:20,21,23 88:11 88:15 89:11,14,16 90:7 91:13,14,16 96:16 101:7,17 102:10,11 103:4 105:20,21 121:2 supply-related 65:9 supplying 69:10 88:18 89:5 support 12:25 14:25 31:14 43:24 43:25 58:2 59:17 118:22 122:2,6,7 123:1 124:17 supporting 14:21 122:10,14 suppress 35:6 suppressing 38:17 Suredor 79:15,16 80:6,8 82:14 surface 12:2 46:19 110:22 111:9 115:14 130:22 surfaces 15:20 44:13 45:8 48:9 110:10,23 surprised 83:17 surrounding 10:24 19:19 76:5 surroundings 9:10 surrounds 17:21 survivors 2:14 Susan 9:19 susceptibility 110:9 suspended 68:8 sustainability 93:12 swing 81:11 swinging 81:12 switch 68:25 69:22 72:15,16,22,25 73:2 105:1,5,10 | switches 72:18 104:24,25 105:2,7 sworn 5:4 132:22 Symes 10:18 synthetic 119:14 system 9:13,14 16:12 17:5 18:19 19:13 29:22 31:9 31:25 37:8,10 41:6 44:19 46:24 47:4,17 51:4 52:10,21,24 53:4 53:5,6,11,12,12 53:13,21,22 54:8 54:13 56:2,5,23 56:24 68:5 71:4 73:3,5 76:14 86:7 92:19,20,24,25 93:25 96:5,7,10 96:10 97:7,8,9 99:7 100:10,11,15 100:15,16,16,18 100:19 101:20,22 101:23 103:8,16 104:13,15,17,22 104:24 105:9,11 105:12,19,25 108:9,13,21,22,25 109:2,22 112:21 112:23,25 113:3,7 114:23 115:1,7,11 115:14,16 116:18 117:10,18 120:24 123:20 125:6 systems 9:14 12:12 19:3,14 30:15 34:23 45:2 46:10 49:12 50:17,18 52:16 53:1 54:5 57:22 65:17 85:13 92:18,23 99:3,6 105:12 114:15 117:12,23 |
| <hr/> T <hr/> | | | | |

| | | | | |
|--|---|--|---|---|
| <p>table 41:2 79:8 tables 49:5,7 take 3:20 4:5,14 25:11 37:21 40:13 107:17 taken 2:19 17:1 115:22 119:16 126:5 129:18 talk 74:8 91:21 117:3 tall 12:5 13:20 44:20 94:19 98:23 tank 56:22 tanks 56:1 107:1 tasked 38:7 TB4000 130:1,2 team 85:12 teams 37:17 55:1 technical 6:9 9:25 Technology 117:12 tell 1:23 temperature 49:15 96:15 temperatures 49:14 tenant 11:13 65:21 65:23 78:11 tenanted 64:17,18 78:9 82:16 tenants 78:5 term 25:23 38:19 67:25 87:2 terms 2:16 17:20 59:22 60:6 68:5 test 42:2 46:10,13 48:20 49:2,12,25 50:2,7 75:21,22 78:19 79:24,24 80:15 110:17,18 114:19,23,24,25 115:6,7 tested 2:17 42:14 43:18 50:4 75:12 78:18 79:4,18,20 80:3 115:2</p> | <p>Testerton 10:14 testing 43:21 49:11 75:9 108:20 115:1 130:3,11 tests 48:25 49:18 112:3 text 27:8 thank 1:8 5:3,5,7 7:3,14,17 40:12 40:17,19,24 60:11 74:9,23 83:12,13 83:18,24 84:4,5,7 91:19,22 107:22 108:2 132:6,7,8,9 132:13,14,17 Therma 130:9 thermal 4:8 44:25 94:3 116:22 119:24 120:1,3 122:25 128:7 thick 15:5,11,18 93:16 120:10 121:23 124:9 129:5,22 131:5,6 131:9 thickness 15:8 47:14 113:23 121:5 130:17 131:4 thing 91:23 think 74:15 83:18 third 1:24 88:14 94:9 95:1 100:6 102:3 107:5 109:22 Thirdly 27:20 three 1:9,21 10:13 12:16 13:9,13 16:8 22:7,9 49:22 51:20 62:24 63:14 63:22 64:6 66:13 69:18 85:24 86:11 91:12 95:16 105:22 115:12 three- 10:15</p> | <p>three-quarters 13:3 tightly 113:24,25 tilt 117:11 timber 17:10,12,21 17:22 127:21,22 128:10,10,15,18 129:7,15 130:19 131:5 time 1:19 2:20 3:13 7:15 8:5 26:16 28:15 35:8 40:9 41:25 49:15 51:2 53:17 57:14,23 58:24 61:8,21 67:20 68:18,22 69:20 70:16,21 71:21 73:13 75:11 78:16 80:21,23 83:15,22 91:1 99:9 100:9 104:18 105:4 107:21 time-frames 66:11 time-line 8:18 61:25 62:3,19 times 21:7 29:2 48:8 57:6 timing 60:18 title 6:21 TMO 78:3 91:24 today 3:21 4:3 6:6 9:25 15:14 29:2 68:2 108:3,18 132:10 today's 3:17 tolerance 43:8 Tom 9:20 tomorrow 4:5,12 132:10,16 tools 37:24 top 16:5 19:15 53:3 53:14 65:1 68:10 69:6,21 87:24 93:14 101:11 103:5 112:21</p> | <p>113:15 118:24 127:18 128:25 top-right 131:20 topic 74:11 topics 1:21 Torero 2:24 total 28:15 40:10 62:11 95:2 96:17 toughened 117:18 tower 1:19 2:6,9,15 3:1,2,6,21 4:20,24 5:17 8:2,5,17,19 9:10 10:3,13,17 10:19,21,25 11:2 11:3,5,8,10,15,18 11:22 12:18,22 13:2,10,13,18,20 14:6,9,18 15:15 15:19 19:5,18 24:12 47:1,12 58:25 60:9,14,17 60:20 61:2,12,14 61:22 62:1,8 63:14,24 64:2,7,8 65:8,10,14,18 66:4,12 67:3,5,7,7 67:17 68:18,23 72:19 73:8 74:25 75:12 76:16,20,22 77:21,22,25 78:14 79:15 80:5 82:8 82:13 84:13,16 85:6,11,14,20,23 85:24,25 86:8,12 86:22 87:11 88:15 88:23,25 89:15,16 89:20 90:4 91:13 91:25 93:7,9,11 94:2 97:3,11,17 97:19,23 98:1,2,5 98:6,8,14,18 99:13,14 100:19 105:13,14 111:1,6 111:13 113:16 115:25 116:9</p> | <p>121:9 122:10 124:14,16 125:18 126:2,20 127:9 128:23 131:11,16 131:18 132:5 toxic 3:5 toxicity 3:5 TP10 118:8,9 traced 85:13 traction 68:11 transferred 14:24 transferring 14:22 transport 39:15 transported 68:7 travel 35:5,9 69:20 travelling 31:21 Trifab 122:23 trigger 3:18 103:8 trim 76:4 Trinity 6:18 true 7:8 50:6 trying 85:10 Tuesday 132:19 turn 45:5 65:25 103:18,22 117:1 117:11 122:16 turning 130:12 two 11:3 18:7 37:25 39:18 49:24 52:10 56:4 57:22,23 61:2 63:16,23 64:18,24 66:19,22 66:24 67:5,6 70:9 71:13 72:6,18 77:8 78:9,11 82:16 84:14 85:8 85:19 87:19 92:8 92:8 94:5,8 95:9 101:1,2,6,9 103:2 110:14 114:6 115:22 120:1,17 120:20 123:4 124:1 125:16 two-bedroom 13:21 16:24 18:6</p> |
|--|---|--|---|---|

| | | | | |
|---|---|--|---|--|
| <p>two-way 70:13 type 53:6,12 54:5 55:21,24 57:18 types 34:5,10 35:20 43:23 52:10,25 62:18,22 67:6,6 80:15 94:5 typical 46:11 77:23 typically 41:13 50:13 54:15 68:9 121:15,19</p> <hr/> <p style="text-align: center;">U</p> <hr/> <p>U 123:3 ultimately 66:16 uncontroversial 5:11 undercroft 92:17 underneath 12:6 12:11 98:14 128:7 129:4 underside 12:2 16:6 122:14 130:7 130:18 understand 9:25 16:1 38:25 61:3,5 61:13 68:3,4 85:2 85:13 86:19 91:8 100:13 understanding 2:7 61:7,19 65:13 67:10 122:22 undertake 41:11 49:10 50:13 undertaken 9:3 16:25 60:13 62:12 63:7,24 64:16 66:6,7 67:4 71:5 71:10 74:24 77:21 78:3 108:7 underway 84:10 undetermined 64:10 unfolding 4:22 unglazed 80:6</p> | <p>uninsulated 79:9 79:13 unit 51:8 96:14,16 106:1,4 units 51:9 unknown 16:1 64:11 unlock 105:6 unobstructed 58:13 unplanned 12:8 unsatisfactory 35:22 unseen 21:14 45:23 115:15 update 116:4 upgraded 71:14,22 upper 37:9 66:24 uPVC 127:25,25 128:5,8 129:5,6 130:7,12,13,16,19 130:21,23 upwards 87:2 use 18:2 21:20 26:24 27:3 33:22 33:24 34:24 38:11 44:18 53:13 54:10 56:17 69:1 70:19 70:22 79:8 88:7 102:22 useful 12:15 24:23 38:25 68:4 80:20 uses 14:1 40:6 53:5 usual 83:21 usually 81:17 utilised 55:13 74:4</p> <hr/> <p style="text-align: center;">V</p> <hr/> <p>valve 99:18 valves 55:19 58:10 varied 119:9 variety 42:18 130:15 various 1:5 19:2 62:6,12 75:8 76:9</p> | <p>vary 15:8 119:6 vehicle 11:14 12:25 13:18 36:24 98:7 98:12 vehicles 11:17,20 12:6 13:1 36:5 vent 19:15 53:3 100:23 101:23 102:13 103:24 104:3 ventilated 90:22 93:25 108:9,13,22 108:25 109:1 114:22 116:18 125:16,22 ventilating 52:6 ventilation 19:14 34:23 52:12,13,14 52:21,24 53:5,12 53:21 87:24 90:23 91:17 92:23 101:22 vents 18:20,23 19:15 53:2,3,8,17 101:1,2,2,3,5,9,14 101:15,17,18 102:1,19,19 103:12,13,19,20 103:23 104:2,21 105:2,3,6 version 70:20 versions 29:14 vertical 42:6 57:2 68:12 87:2 89:21 89:25 90:14 91:3 99:25 102:1 107:11 113:1,8 119:25 121:11 122:11,13,19,23 123:12 126:1,2,16 vertically 16:5 65:4 87:1 89:19 126:12 vicinity 26:10 28:13 35:10 video 4:17</p> | <p>videos 4:7,15,21 view 119:20,23 128:24 viewer 81:12 viewing 119:17 visible 15:14 90:6 119:19,22 123:18 visits 98:9 void 16:13 129:23</p> <hr/> <p style="text-align: center;">W</p> <hr/> <p>Wade 85:9 walk 10:14,15,15 38:11 walkway 10:25 11:23 12:2,4,7,8 12:11 13:14,18 14:3 19:8 93:6,8 97:17,19,22 98:15 walkways 96:23 wall 15:19 16:9,12 16:14,23 17:17 18:20,23 21:19 28:1 31:3 32:16 32:25 33:10,11 36:13 44:6,8 45:14 46:15,17,20 49:20,24 50:5 79:11 87:20 90:3 90:3 91:4,5,6 94:1 94:2,7,15 100:24 101:2,3 103:25 105:17 106:22,23 108:4,6,8,14 109:23,24 110:6 110:15 111:9,17 112:13,21 113:10 114:10 115:24 116:6,9,17,19,20 116:22 118:24 119:4 120:18 123:22 126:22 127:5 128:22 131:17 132:4 walls 14:13,14,15</p> | <p>15:1,5,7,8,17 18:8 18:18 21:17 28:3 29:21 31:22,23,25 32:13,17 41:20 42:8,12,13,14,17 43:18 44:10,21 45:1,8 46:8 47:3 47:23 48:9 49:8 75:5 93:14,22 110:5,9,10,23 112:24 114:10 115:7 want 6:6 67:5 wanted 61:3 warning 21:1,3 40:4 warnings 3:18 waste 19:16 water 9:14 19:2 30:8,9 37:8,15,16 38:13 55:20,22,25 56:6,9,10,11,12 56:15,22,23 57:2 57:5,6,15,17,24 58:6,11,16 70:11 73:22 85:23 92:20 96:10,15,16,17 97:8,9 99:20 105:11,11,25 106:3 107:1,1,8 109:9,11,20,25 way 5:23 34:13 72:2 114:14 115:13 ways 24:9 87:19 we'll 83:25 107:20 132:15,15 We're 1:4 116:25 weak 83:3 Wearden 10:11 weather 93:18 103:4 weatherproof 116:20 119:14 wedged-shaped</p> |
|---|---|--|---|--|

| | | | | |
|--|--|--|---|---|
| 81:1 Wednesday 4:14 week 1:5 3:8 week's 1:4 welcome 1:4 west 10:7,9 11:6 12:13 13:4 14:4 93:7,11 97:22 98:2,5 wet 55:24 56:2,20 56:21 57:14,21 58:9 99:10,14 whichever 7:19 whilst 12:5 28:23 63:9 115:17 131:17 white 94:9 117:21 wide 117:25 121:16 121:20 128:19 widened 72:10 width 71:21 window 16:7,22 17:3,9,9,10,23 116:13,15 117:4 117:10,16 118:5 118:17,23,25 119:1,3,17 121:14 122:15,17,19 125:17 127:12,18 127:21,25 128:11 128:20,25 129:1,7 129:7,14,15,16 130:14,23 131:15 131:18,20 windows 2:5 3:24 15:23 16:4 17:3,3 17:4,6,13 54:4 93:14 94:12 108:9 108:10 112:20 113:3 116:12,13 116:21 117:6,11 118:22 119:2,5,11 120:2 121:12,16 123:25 126:24 127:1,11,12,15 | 129:20 131:12 wires 15:16 wish 3:8 withstand 56:7 58:5 withstanding 47:7 witnessed 123:7 witnesses 1:6 witnessing 4:22 Woodburn 9:19 wooden 17:5 wool 125:9 126:8 126:17 131:6,7 wording 99:11 work 9:5,17 15:14 22:11,14 23:7,7 62:18 63:13,19,23 64:7 65:12 70:16 78:3 85:1,4,8 96:13,20 101:22 116:4 working 3:14 9:18 35:2,4,7 works 8:19,24 9:2,6 9:9,16 12:1 16:25 60:13,20,25 61:1 62:2,4,8,12,15,21 63:4,5,7,12,18,20 64:2,10,13,18 65:10,11,13,15,21 65:22 66:3,6,7,8 66:10,17 67:4 71:3,7,10,13,16 72:14 73:8,14 74:24 78:1,12 81:22 82:18 84:8 84:10 91:8,10,17 91:17 93:2,4,4,19 96:11,22 97:1,3,5 97:6,10 99:17 100:1 107:14 worsen 57:18 would've 13:17 wrap 93:16 | <hr/> X <hr/> X 132:21 <hr/> Y <hr/> years' 6:13 yellow 16:4 63:1 77:4,10,14 118:6 128:6 <hr/> Z <hr/> zigzag 130:18 Zooming 77:23 <hr/> 0 <hr/> 0 111:10 0.5 131:5 0.5-millimetre 121:22 0.55 121:20 <hr/> 1 <hr/> 1 1:15 2:17,20,22 5:13 8:9 10:3,12 13:25 18:1,2 26:23 30:1 41:2 43:22 49:21 50:15 61:17 64:4,22 67:1 71:22 72:1 89:6 93:24 94:14 95:10,24 96:6 98:25 108:19 110:4 111:23 112:5 116:1,4 117:25 1,000 49:16 1.1 6:1 1.15-metre 122:12 1.2 117:24 121:16 1.26 40:8 1.3 121:15 1.5 69:5 10 25:13 69:4 81:3 126:1 130:17 132:11,16 10.00 1:2 132:20 100-millimetre | 120:10 124:9 104 78:9 106 64:16 78:5 82:13 11 5:14 11.00 40:20 11.15 40:18,22 12 5:13 64:18 74:18 78:11 82:9 110:8 110:12 131:9 12-millimetre 81:5 82:10 131:21 12.25 84:1 12.5 44:15 46:5 110:13 115:10 12.6 44:22 45:5,7 46:6 110:16,20,22 12.7 45:10 111:15 112:9 12.8 45:16 112:12 12.9 44:22 45:5,16 46:7 110:16,20 112:12 120 13:21 82:13 119:9 12101 52:17 13 88:25 89:2 135 45:4 46:9 49:23 110:17,18 114:19 115:11 139 124:11 14 78:10 80:16 82:13,15 91:11,12 126:2 14th 107:3 15 69:17,23 74:17 74:18,19 113:20 123:16 15-minute 40:13 156 124:5 16 2:1,8 4:6,9 16-millimetre 117:19 18 1:1 31:7 36:25 111:7,8,9,10,18 | 180-millimetre 120:5,7 185 119:1 18m 45:11 19 62:11,23 63:13 64:6,24 132:19 195 128:19 1960s 10:12 1962 28:8,20 30:2 1967 8:3 19:20 1970 10:12 1970s 10:7 1971 67:16 68:19 1972 10:18 1974 8:3,20 10:19 19:1,20 60:15 61:2 64:24 65:14 75:12 80:20 81:7 81:9,24,25 82:2,3 82:5 83:1 1979 62:2,10,10 1980 63:7 1985 63:2 64:8,10 1986 63:3 1992 67:9,11,22 69:16 1996 11:12 <hr/> 2 <hr/> 2 8:14 10:25 11:23 13:14,14 14:2,7 52:11 63:18 64:22 66:24 72:22,25 73:2 83:21,25 88:21,22 89:1,3 89:13,22,23 90:1 90:16 91:3 93:6,8 94:24 95:1,24 96:6 97:18,20 98:25 102:5,7,9 102:10,18 103:21 106:8 107:8 2.00 84:3 2.25 52:4 2.40 107:23 |
|--|--|--|---|---|

| | | | |
|----------------------------|----------------------------|---------------------------|--------------------------|
| 2.5 121:19 | 25 15:10 82:9 | 40 45:9 110:24,25 | 8.4 17:1 |
| 2.55 107:21,25 | 25-millimetre 82:6 | 111:5,14 | 8.41 90:21 |
| 2.6 14:6 | 118:2,8 125:2 | 44 76:1 | 8.5 100:3 |
| 20 6:13 13:22 15:5 | 129:5,22 | 440 96:17 | 80 120:18 |
| 15:8,17 81:3 | 25-storey 10:3 | 476 78:19 | 80-millimetre |
| 82:22 | 276 121:3 | 48 80:8 | 121:4 124:1 |
| 20-minute 82:11 | | 4th 107:10 | 800 72:11 |
| 2000 20:19 | 3 | | 8144 49:25 |
| 2004 25:19 63:20 | 3 3:11 9:11 10:2 | 5 | 8412 43:12 |
| 2005 8:22 25:7 | 13:25 14:8,16 | 5 86:3 89:6 111:6 | 8414 45:3 110:18 |
| 60:25 63:14 65:21 | 18:1,3 25:9 63:3 | 132:22 | 114:20,24 |
| 66:6 70:17 71:5,9 | 63:18 64:1,4,23 | 5-20Hi 117:11 | 880 72:12 |
| 71:16 72:6,14 | 66:15 67:1 71:22 | 5.19 48:11 | |
| 73:2,7,14 82:18 | 72:1 78:14 89:6 | 5.36 51:11 | 9 |
| 2008 65:1 | 94:7,19 95:7,10 | 50 56:18,19 | 9 85:12 116:2 |
| 2011 8:23 64:9,15 | 95:14,17,24 96:2 | 500 118:7 | 9.2 45:18 |
| 65:22 74:25 77:20 | 96:6 101:8 103:10 | 530 118:7 | 90 119:7 |
| 81:4,7,16 82:2 | 106:11,12 | 55 94:8 121:10,21 | 900 72:12 |
| 2012 9:4 12:23 | 3-millimetre | 121:25 123:4 | 999 4:10,25 34:10 |
| 62:13 65:3,23 | 121:23 | 550 69:6 | 34:15 |
| 70:17 73:7,14 | 3.1 41:2 | 5588 26:22 | 9990 57:21 |
| 91:24 92:4 93:4 | 3.2 31:6 | 58 80:6 | 9991 27:2,5,17 |
| 108:5 | 3.3 31:6 | | |
| 2013 63:25 | 3.4 31:6 61:17 | 6 | |
| 2016 8:25 9:4 62:14 | 3.40 132:18 | 6 52:17 89:6 111:7 | |
| 65:3,4,11,23 | 3.9 14:8 | 116:1 | |
| 70:17 72:24 73:1 | 30 15:9 78:18 79:19 | 6-millimetre | |
| 73:7,14 88:14,17 | 82:4 88:17 113:20 | 117:18 | |
| 89:4 91:24 108:5 | 114:6 119:9 | 6.3.1 57:21 | |
| 2017 62:11 82:13 | 123:16 | 60 73:21 99:10 | |
| 85:12 91:9,11,12 | 33 112:18 | 60-minute 82:5 | |
| 2018 1:1 3:11 5:13 | 35 119:6 | 600 13:24 | |
| 132:19 | 38 22:10 23:17 | 630 70:5 | |
| 21 5:14,22 89:22 | 131:6 | 65.5 99:13 | |
| 22 14:10,10 78:20 | 3D 11:20 77:21 | 67.3 13:20 | |
| 23 10:4,5 14:14 | 122:5 123:8 | | |
| 18:4,9 66:25 | | 7 | |
| 76:21 77:3 86:19 | 4 | 7 85:11 116:2 | |
| 87:9,12 88:19 | 4 14:14 18:4,9 63:3 | 70 15:12 86:19 | |
| 89:7 93:24 94:7 | 65:15 66:25 76:20 | 88:24 | |
| 94:11 101:24 | 77:3 86:19 87:5 | 701 30:6 | |
| 106:11,11,14 | 88:19 89:6,7 | | |
| 131:23 | 94:11 95:16 99:4 | 8 | |
| 23rd 107:3,4,10 | 101:24 106:13,14 | 8 26:2 85:11 | |
| 24 13:22 19:6 | 4.3 14:7 | 8-millimetre | |
| | 4.8 12:3 | 131:21 | |