



Grenfell Tower Inquiry

Day 288

June 8, 2022

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(10.00 am)

SIR MARTIN MOORE—BICK: Good morning, everyone. Welcome to today's hearing. Today we're going to hear some expert evidence on the provision of water for firefighting purposes.

Yes, Mr Kinnier.

MR KINNIER: Sir, may I call Dr Ivan Stoianov.

SIR MARTIN MOORE—BICK: Thank you.

DR IVAN STOIANOV (sworn)

SIR MARTIN MOORE—BICK: Thank you very much. Now, please sit down and make yourself comfortable.

THE WITNESS: Thank you.

(Pause)

SIR MARTIN MOORE—BICK: All right?

Yes, Mr Kinnier.

Questions from COUNSEL TO THE INQUIRY

MR KINNIER: Thank you, sir.

Would you please confirm your name for the record.

A. Yes, my full name is Ivan Iordanov Stoianov.

Q. Good morning, Dr Stoianov. Thank you very much for attending to give evidence this morning. It's much appreciated.

Now, my questions are intended to be short and simple; sometimes it doesn't play out that way. If they

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are in any way unclear, please say so and I'll rephrase them.

Secondly, if at any stage during the giving of your evidence you require a break, please say so, that's not a problem.

Thirdly, could you please remember that the stenographer is trying to capture everything you say and everything you say accurately, so if you could go at her pace, that would be much appreciated.

Also, please, where you mean to indicate "Yes" or "No", say "Yes" or "No", rather than nod or shake your head as the case may be.

A. Yes.

Q. Now, you have provided two reports to the Inquiry. Your report entitled, "The provision and use of water for fighting the fire at Grenfell Tower on 14 June 2017", dated 20 July 2021, can be found at {ISTRP00000001}.

Is that your report?

A. That's correct, yes.

Q. And you provided a supplementary report dated 29 March 2022, which can be found at {ISTRPS00000001}.

A. Yes, correct.

Q. And that's your supplemental report?

A. Yes.

Q. Can you confirm that the facts and matters set out in

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those two reports are true to the best of your knowledge and belief?

A. Yes, I confirm so.

Q. Is it correct that you have provided the reports in the same way that you would have provided an expert report to a court?

A. Yes, correct.

Q. Do your reports set out your opinions on the matters that are relevant to this Inquiry?

A. Yes, correct.

Q. Now, if we can go to {ISTRP00000001/6}, we see here, at section 1.2, you set out your expertise. If I could briefly just go through some of those matters.

First of all, you hold a diploma, a Bachelor of Engineering and an MSc, in civil engineering from the Faculty of Hydrotechnics at the University of Architecture, Civil Engineering and Geodesy in Sofia, Bulgaria, and those degrees were awarded in 1995; is that right?

A. That's correct.

Q. And in 1998, you were awarded an MSc in environmental engineering by the Imperial College of Science, Technology and Medicine here in London; is that right?

A. Correct.

Q. And in 2003, you were awarded a PhD in civil and

3

environmental engineering by Imperial College; is that also right?

A. Correct.

Q. Can you help us, what was the subject of your doctoral research?

A. My work was very much focused on a phenomena in water supply networks known as pressure transients, so the work was based on mathematical modelling of this phenomena and also an extensive experimental work, and part of that work was in collaboration with Thames Water at the time.

Q. Thank you.

Is it right that you are currently a reader in water systems engineering at Imperial, and you hold a five-year fellowship in water systems engineering from the Engineering and Physical Sciences Research Council?

A. Correct.

Q. Now, if we look at the bottom of page 6 {ISTRP00000001/6} at line 28, you say that your expertise covers four things, and I quote:

"1. The design, operation and control of water distribution systems.

"2. Applied and fundamental research in the hydraulic modelling, pressure control and optimisation methods for water distribution networks.

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1 "3. Pressure transients analysis in water
2 distribution networks."
3 Turning over the page {ISTRP00000001/7}:
4 "4. Experimental research in water distribution
5 networks that combines laboratory experiments and field
6 studies in complex networks."
7 Is that a fair summary of your expertise?
8 A. Yes, it is.
9 Q. You also lead a research group at Imperial called
10 InfraSense Labs, which you founded in 2009, which
11 focuses on the design, optimisation and control of water
12 supply networks; is that right?
13 A. That's right.
14 Q. Am I right that you have no expertise in relation to
15 firefighting, emergency planning or incident response?
16 A. Correct.
17 Q. If we could go to {ISTRP00000001/5}, we see, midway down
18 the page at line 13, section 1.1.2, where we find the
19 heading "My Instructions". There you describe the
20 questions which you were asked to address in your
21 report, and I'll read them into the record so that they
22 are known to everyone:
23 "1. How much water did London Fire Brigade (LFB) use
24 during the Grenfell Tower fire both internally and
25 externally, including:

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1 "a. the type of equipment available, the flow rate
2 needed for optimal operation of each piece of equipment
3 and the difficulties encountered in achieving the
4 necessary flow rate.
5 "b. the number of water jets.
6 "c. their time of use.
7 "d. the duration of use.
8 "2. What were the locations of fire hydrants from
9 which LFB supplied water for firefighting and their flow
10 rate, discharge characteristics and conditions? Were
11 there alternative water sources that might have been
12 utilised by LFB?
13 "3. Based on evidence gathered in the context of
14 questions 1 and 2, and using simulations created using
15 that evidence, what was the water flow and pressure in
16 Thames Water (TWUL)'s water supply network on the
17 [night] of the 14th of June 2017? Was operational
18 pressure consistent with the minimum pressure
19 requirements?
20 "4. What was the response of TWUL, and was it
21 effective?"
22 Is that a complete summary of your instructions?
23 A. Yes, it is.
24 Q. Your supplementary report addresses two particular
25 matters: first, your understanding of a meaning of

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1 a British Standards document referred to in your main
2 report; and, secondly, the conclusions of an LFB report
3 testing some of its equipment. In broad terms, is that
4 right?
5 A. That's right.
6 Q. Now, it's clear from these instructions, and it will
7 become clear throughout your evidence, that your report
8 inevitably touches upon actions taken by and decisions
9 made by the LFB on 14 June 2017. Is it right that,
10 while your report comments and draws conclusions about
11 the Brigade's actions from a water or hydraulic
12 perspective, you do not seek to draw conclusions on
13 matters of operational firefighting or strategy, as
14 these are outside your expertise and so outside the
15 scope of your instructions?
16 A. That is correct. I made observations but, as you point
17 out, these observations are by no means conclusions on
18 the necessary actions for firefighting.
19 Q. Could we go to {ISTRP00000002/5}, and line 24. You see
20 there you say this:
21 "Where relevant to my instructions, investigation
22 and conclusions, I have commented on the actions and
23 statements of a number of individuals, including LFB
24 firefighters and officers, Network Service Technicians
25 and other TWUL employees. None of this analysis is

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1 intended, nor should it be taken, as personal criticism
2 of the individuals concerned. I have no doubt that they
3 acted to the best of their ability in the extremely
4 difficult circumstances on 14 June 2017."
5 Am I right in understanding that's a point you'd
6 particularly wish to emphasise before starting your
7 evidence?
8 A. That's correct.
9 Q. Could we stay on this page, and we see in section 2.2,
10 at the foot, you summarise there the various materials
11 that you relied upon for the purposes of producing your
12 report. I won't go through everything, but is it right
13 to say that the materials identified in section 2.2,
14 which starts at page 5 and goes over to page 6
15 {ISTRP00000002/5-6}, is the accurate summary of the
16 evidence you've considered in reaching the conclusions
17 set out in your report?
18 A. Yes, it is.
19 Q. Now those preliminaries are dealt with, Dr Stoianov, can
20 I turn to deal with some basics that we probably need to
21 establish before we turn to more of the detail.
22 The first element of the basics I'd like to discuss
23 with you today is the water distribution network itself.
24 A. Yes.
25 Q. Now, if we can go to {ISTRP00000003/5}. Now, in this

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1 chapter, in broad terms, you describe the water
 2 distribution network and its functions.
 3 Now, in summary, is the water distribution system
 4 a complex network of pipes and valves used to transport
 5 water from storage, such as reservoirs and water towers,
 6 to customers and hydrants, either by force of gravity
 7 and/or with the assistance of pumps?
 8 A. Yes, it is. It is a complex system.
 9 Q. And the emphasis on the word "complex"?
 10 A. Correct, and "system" as well.
 11 Q. Secondly, the water distribution network's purpose is to
 12 provide water in an appropriate quantity at the
 13 appropriate pressure and of the appropriate quality,
 14 with minimal water leakage; is that, again, a fair
 15 summary of its purpose?
 16 A. Yes, absolutely, with a slight correction: at minimum
 17 cost. Clearly leakage is part of these components of
 18 wastage we are trying to minimise, but actually the
 19 provision of these key variables needs to be done at
 20 minimum cost.
 21 Q. Finally, your report refers variously to the water
 22 distribution network, to the water distribution system
 23 and to the water supply system. Am I right in
 24 understanding those to be interchangeable terms meaning
 25 the same thing?

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1 A. Not entirely, because we have a certain hierarchical
 2 structure within the systems. The systems include the
 3 bulk transmission of water, for example from reservoirs
 4 to treatment works to certain kind of service
 5 reservoirs. We call this the water transmission
 6 network. Then, from the water transmission networks,
 7 the pipes go into the streets to deliver water to
 8 individual customers, so this is what we refer to
 9 generally as water distribution. Then we have the
 10 supply pipes which go to the individual customers.
 11 So "water supply system" is the overarching term
 12 which combines both the transmission and the
 13 distribution.
 14 Q. Thank you.
 15 Now, if we can stay in this chapter of your report
 16 but go to page 8 {ISTRP00000003/8}, and we see at the
 17 top of that page figure 3—2. In broad terms, this
 18 illustrates how water is delivered from the water
 19 distribution system to a Fire Brigade during a fire. In
 20 broad terms, is that a correct summary?
 21 A. Yes, it is.
 22 Q. If we can first identify the various components of this
 23 diagram, the blue symbol to the left is a water tank or
 24 reservoir, ie the water source; is that right?
 25 A. Correct.

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1 Q. And the water source could also be a pumping station; is
 2 that right?
 3 A. That's right.
 4 Q. The blue lines represent the water pipes or mains; is
 5 that right?
 6 A. That's right.
 7 Q. The black symbol with a red dot at its centre is
 8 a fire hydrant?
 9 A. Correct.
 10 Q. We can see the red pumping appliance, which people would
 11 ordinarily know as the fire engine; is that right?
 12 A. That's right.
 13 Q. At the top right we can see a building, a building with
 14 a dry rising main through which water is made available
 15 for internal firefighting; is that right?
 16 A. That's right.
 17 Q. And, finally, we can see in the bottom right
 18 a firefighter holding a handheld firefighting jet, which
 19 is known as a branch; is that right?
 20 A. Correct.
 21 Q. Again, this is an example, and you might instead have
 22 depicted, for example, an aerial appliance or
 23 a ground monitor, which we will come on to discuss later
 24 in your evidence.
 25 A. Absolutely. The purpose of this diagram schematic was

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1 very, very broad, just to highlight the different
 2 appliances, and, as you said, branches can be fed from
 3 the pump appliance.
 4 Q. Thank you.
 5 Now, in simple terms — and apologies if this is too
 6 simplistic — water travels from the source, through the
 7 system of pipes to a hydrant; the Fire Brigade can then
 8 use hoses to supply water from the hydrant to that
 9 pumping appliance, from which the water can then be
 10 pumped on through further hoses to firefighting
 11 equipment; is that a fair summary?
 12 A. Correct.
 13 Q. You describe the water distribution network at Grenfell
 14 in chapter 6 of your principal report. For that
 15 purpose, could we go to {ISTRP00000008/8}, and look at
 16 line 17. There you say this:
 17 "Grenfell Tower is located within the Barrow Hill
 18 Zone ... which is part of the London Water Resources
 19 Zone operated by Thames Water Utilities Ltd (TWUL).
 20 TWUL is the statutory water undertaker for a large
 21 geographic region, which includes the whole of Central
 22 and Greater London ..."
 23 First of all, does that remain a correct summary?
 24 A. That's right.
 25 Q. Now, if we can stay in this chapter but go to page 10

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1 {ISTRP00000008/10}, we can see there, in the top part of
2 that page, you list five sources of water which can
3 supply water to the Barrow Hill zone in which the tower
4 was found: we have the Barrow Hill reservoir, the
5 Willesden reservoir, the Hammersmith pumping station,
6 the Holland Park shaft and the Barrow Hill shaft.

7 Now, is it right that the two reservoirs supply
8 water by gravity; in other words, they store water at
9 a higher altitude than the buildings and customers they
10 supply, so there is no pumping arrangement required?

11 A. Yes. The set-up is a little bit more complex, and
12 I have another figure which explains this. The way this
13 set-up operates in that particular system is water is
14 pumped from a pumping station in Hammersmith. From
15 there, it supplies water during the day, both in terms
16 of the very large set of water transmission mains and
17 distribution mains, and during periods of low demands,
18 the reservoir balances that supply and demand. So it
19 could be that sometimes it's pumped water, so it's
20 pressurised; it could be that, at nighttime, when the
21 pumps are turned off, then the actual water from the
22 reservoirs is fed by gravity into the same distribution
23 networks.

24 So there is this notion of flow reversals across
25 these water transmission mains. It depends on

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1 balancing, again, that supply and demand.

2 Q. Apologies, again, I may be making matters too crudely
3 simple, but, in essence, the Hammersmith pumping
4 station, the Holland Park shaft and the Barrow Hill
5 shaft supply water by pumping it from the Thames Water
6 ring main; is that essentially correct?

7 A. Yes, and again, a slight sort of distinction here.
8 I know these are small technical details probably, but
9 the actual Hammersmith pumping station can feed water
10 from the London ring main, but equally directly through
11 a set of transmission mains from the pumping station in
12 the west of London.

13 Q. Now, could I turn on to the three key factors for the
14 provision of water for firefighting.

15 To that end, could we go to {ISTRP00000003/17}. We
16 can see, at section 3.1.4, you say that:

17 "From a hydraulic perspective, three key factors
18 affect the provision of water for firefighting ..."

19 Is it right that you include the qualification "from
20 a hydraulic perspective" because there may well be other
21 factors outside your knowledge and expertise which are
22 relevant for a fire service from an operational
23 perspective?

24 A. Correct.

25 Q. Whereas here you focus strictly on the physical

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1 requirements for the supply of water; is that right?

2 A. That's right, yes. There are other factors which, as
3 you highlighted, is beyond the hydraulic control.

4 Q. Thank you.

5 Now, the first key factor you identify for this
6 purpose is at point 1, and it is the available quantity
7 of water; put bluntly, the amount of water that is
8 stored in tanks or elevated reservoirs within the water
9 distribution network accessible through hydrants.
10 Again, essentially, is that correct?

11 A. That's right.

12 Q. Now, you have mentioned water from tanks and reservoirs
13 here, but presumably that would also include water
14 available from pumping stations?

15 A. That's right. I mean, it's a complex system of all
16 these storage facilities, such as reservoirs, service
17 reservoirs, et cetera, but equally they are supplied by
18 pumping stations, treatment works, et cetera. So it's
19 part of this large complex system.

20 Q. Again, at its simplest, in relation to the water
21 distribution system at Grenfell, this would include
22 water available from all the sources we have been
23 discussing: Barrow Hill and Willesden reservoirs,
24 Hammersmith pumping station, and the Holland Park and
25 Barrow Hill shafts; is that right?

15

1 A. That's right.

2 Q. Is it right that the available quantity of water is
3 fundamental because, in plain terms, if there is not
4 enough water available, that diminishes the adequacy of
5 firefighting efforts?

6 A. That's right. One of the components is the
7 availability. Clearly, as we see, there is other
8 components later probably in the discussion, but yes,
9 availability is number one.

10 SIR MARTIN MOORE-BICK: When we're talking about quantity
11 available here, are we really looking at the total
12 volume of water in the system?

13 A. So generally we try to satisfy particular physical laws,
14 and these physical laws for us is the conservation of
15 mass, so I need to have a certain volume of water which
16 I need to use. The second question is: can I use it at
17 the right time and the right place? But as far as the
18 storage is concerned, that system had infinitely larger
19 storage than it was required for firefighting.

20 SIR MARTIN MOORE-BICK: Well, that's rather what I had in
21 mind, but all right, you have explained that. Thank you
22 very much.

23 MR KINNIER: Now, the second key factor you identify there,
24 at point 2 on page 17 {ISTRP00000003/17}, is the water
25 flow rate delivered from fire hydrants to pump

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1 appliances.
 2 In layman's terms, when we talk about flow rate from
 3 a hydrant, we are referring to how much and how quickly
 4 that hydrant can supply water to the pump appliance; is
 5 that right?
 6 A. Correct.
 7 Q. If we stay on page 17, you highlight three particular
 8 things on which the flow rate from a hydrant to a pump
 9 appliance depends. We can see a, starting at line 17
 10 there. First of all, the water pressure in the pipe
 11 which supplies the hydrant.
 12 Can you help us, what is the difference between
 13 water flow rate and water pressure?
 14 A. Well, these are fundamentally different variables. So
 15 pressure, in our case, this is the force which the water
 16 would apply on the pipe wall, and that force we
 17 generally — we define as water pressure. We can
 18 express water pressure in different terms, in different
 19 units.
 20 Flow rate will be the volume of water going across
 21 a section over a certain period of time. So if I, in
 22 a very simplistic term, open a tap at home to have
 23 a shower, the flow rate will be, let's say, 100 litres
 24 per minute or so, and that is kind of the volumetric
 25 flow going over a particular time over that particular

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1 cross-section.
 2 So these are two fundamentally different variables.
 3 SIR MARTIN MOORE-BICK: Well, presumably you can have a high
 4 pressure and a very low flow rate, as when you puncture
 5 a garden hose, (inaudible) —
 6 A. Yes. Let me explain with this bottle, for example. If
 7 I squeeze this bottle, I will increase the pressure into
 8 the bottle. If I have a very tiny hole into that
 9 bottle, I will get a very little flow rate, irrespective
 10 of how much I squeeze this. So the actual flow
 11 discharge, whether it's through a fire hydrant, whether
 12 it's through a branch, whether it's through a leak,
 13 they're all governed by the same physical phenomena,
 14 which is a discharge through an orifice, and that
 15 discharge through an orifice depends on the discharge
 16 characteristics of that orifice and the differential
 17 pressure. In other words, if I'm discharging to the
 18 atmosphere, that will depend at the pressure at the
 19 inlet to that nozzle or pipe or fire hydrant, et cetera.
 20 SIR MARTIN MOORE-BICK: Thank you.
 21 MR KINNIER: Thank you. I'm relieved the top was on your
 22 bottle as you demonstrated that.
 23 A. Yes, no, I made sure that that's the case.
 24 Q. The higher the water pressure in the pipe serving the
 25 hydrant, the higher the flow rate from the hydrant; is

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1 that too simple or is it for present purposes correct?
 2 A. It is correct.
 3 Q. The second point you identify at point 2b at line 19 is
 4 the flow coefficient of the hydrant. We will return to
 5 flow coefficients in detail later on, but in layman's
 6 terms, is it right to say that a hydrant's flow
 7 coefficient is a measure of how great a flow rate the
 8 hydrant can provide, given the pressure of water it
 9 receives?
 10 A. Correct. This is very much as I just mentioned about
 11 these fundamental principles of flow discharge through
 12 an orifice. It depends on the characteristics of this
 13 orifice, which in this case will be expressed by the
 14 flow coefficient, and the differential pressure across
 15 that orifice.
 16 Q. Again, just to sort of flow from that point, for want of
 17 a better phrase, the flow coefficient is important
 18 because if a hydrant has a very low flow coefficient,
 19 even if it is provided with good water pressure, it will
 20 provide a low water rate. In essence, is that right?
 21 A. That is correct. I mean, if you look at the flow
 22 discharge across an orifice, we would have this kind of
 23 flow coefficient multiplied by the square root of this
 24 differential pressure, or the pressure. That means
 25 that, in very simple mathematical terms, if I increase

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1 the pressure twice, that will be the square root of this
 2 number 2, which would be — so it gives me 40% increase
 3 in the flow rate across that orifice. So, consequently,
 4 the flow coefficient is a very key part for me to reach
 5 the final objective, reaching particular discharge
 6 across that hydrant or branch or whatever.
 7 Q. Thank you.
 8 The third point we see at point c at line 21 is the
 9 energy or pressure losses between the hydrant and the
 10 pump appliance, and pressure losses can be caused,
 11 for example, by kinked hoses due to increased friction;
 12 is that right?
 13 A. Correct. I mean, the other — as I earlier stated, you
 14 know, water in a conduit or a flow in a conduit will be
 15 governed by certain physical laws, and part of it is
 16 this kind of notion of pressure loss or pressure head
 17 loss. That is a lot to do with the conditions of the
 18 pipe and the conduit, there will be a lot to do with
 19 a certain additional turbulence that might be occurring.
 20 So in the example you just highlighted, for example
 21 kinked hoses or even hoses with a larger length with
 22 a lot of interconnections, couplings, that can introduce
 23 additional head loss into that particular system.
 24 Q. Thank you.
 25 If we could stay in this chapter but go to page 20

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1 {ISTRP00000003/20}, at the top of the page, at
 2 section 3.2.5, you explain the concept of continuity of
 3 flow. In lay terms, the flow rate delivered from the
 4 hydrant to the pump appliance is important, because if
 5 it is not high enough to maintain continuity of flow,
 6 the pump's tank will gradually empty, which means that
 7 the water supply to firefighting equipment will be
 8 paused whilst waiting for the tank to refill. Again, is
 9 that a fair summary?

10 A. Yes. I mean, water is not compressible, so, as a result
 11 of that, whatever we get into that tank, that's the same
 12 volume we'll be able to get out of that tank, and the
 13 actual pump appliance has a storage tank which is not
 14 very large, it's only about roughly 1.4 cubic metres of
 15 water, so it's about 1,400 litres storage capacity, and
 16 you have to balance. Whatever comes into that tank
 17 needs to be equal or greater to whatever comes out of
 18 that tank which goes through the centrifugal pump
 19 installed on the pump appliance.

20 Q. Thank you.

21 If we can go back to page 17 {ISTRP00000003/17}, we
 22 see at line 25 the third key factor you identify which
 23 is the provision of water for firefighting is the flow
 24 rate and pressure at the branch, nozzle, monitor, aerial
 25 appliance or dry rising main.

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1 Again, in simple terms, that means the flow rate and
 2 pressure at the end piece of the firefighting equipment;
 3 in other words, whatever it is that actually projects
 4 the jet of water; is that right?

5 A. That's right.

6 Q. And the higher the pressure and the higher the flow rate
 7 of the water going into a piece of equipment, the higher
 8 the volume and/or distance of water it can project;
 9 again, in its basics, is that right?

10 A. It is. I mean, the water jet, ultimately, we need to
 11 kind of transform certain kinetic energy into that water
 12 jet, and that kinetic energy will be a function of the
 13 volumetric mass of a certain confined volume, and
 14 equally the velocity of that flow rate. So that's why
 15 any forms of branch or a nozzle has these optimal
 16 operational specifications, and this operational
 17 specification takes this trade-off between safety, safe
 18 operation of that nozzle, and equally maximising flow
 19 rate and reach of the jet projected from that nozzle.

20 Q. Thank you.

21 I now want to turn to the second part of the
 22 examination today, which is water deployment on
 23 14 June 2017.

24 Now, this subject is addressed in chapter 5 of your
 25 report {ISTRP00000006}, where you set out a detailed

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1 chronology of the deployment of water jets at
 2 Grenfell Tower from the first arrival of LFB crews at
 3 00.59 to approximately 1 o'clock in the afternoon. Is
 4 that right?

5 A. That's right.

6 Q. If we can go to {ISTRP00000006/3}, here you explain that
 7 your report identifies, first of all, at paragraph 1a,
 8 the equipment used and available to LFB to project those
 9 jets; secondly, at paragraph 1b, the timing and duration
 10 of their use, along with their estimated vertical reach;
 11 thirdly, at paragraph 1c, the location and status of the
 12 hydrants and pump appliances used to supply the water;
 13 at paragraph 2, the utilisation of the equipment in
 14 relation to their rated water pressure and flow rate.

15 Now, looking at paragraph 2, you say here, from the
 16 end of the second line, this:

17 "'Rated' water flow rate or 'rated' pressure is the
 18 maximum flow rate or pressure for which a branch, a
 19 monitor/nozzle, and the complete water supply setup
 20 (a pump appliance, fire hoses, fittings and a branch or
 21 a monitor) can be safely operated."

22 Is that correct?

23 A. That's right.

24 Q. So, put in layman's terms, each piece of equipment will
 25 have a pressure rating and a flow rating which describe

23

1 the maximum water pressure and the maximum flow rate at
 2 which the equipment can be safely used. Is that right
 3 in its essentials?

4 A. It is right, because that balances the notion of the
 5 maximum effectiveness of the use of that equipment and
 6 its safe operation.

7 Q. Where do the rated pressure and flow figures come from?
 8 What's the source of that information?

9 A. So generally the source of that information is based on
 10 the manufacturer's specifications. Ultimately, the
 11 manufacturer, it's their obligation to be able to
 12 identify, through testing and validation, the balance of
 13 these trade-offs, and probably there will be some safety
 14 factors, so in other words these figures might not fully
 15 represent the actual capabilities of this equipment
 16 because they need to allocate for some unsafe potential
 17 use of that equipment, and the safety factors take into
 18 account those particular conditions.

19 Q. Is it right that the rated flow and pressure figures are
 20 also sometimes referred to as the nominal or optimal
 21 flow or pressure figures?

22 A. That's the general use in the engineering language and
 23 kind of applications, but I have not been able to
 24 identify that into the LFB documents.

25 Q. Now, in your report, you calculate the utilisation rate

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1 of firefighting equipment by comparing the flow rate
 2 that the equipment received on the night with its rated
 3 flow figure; is that right?
 4 A. Correct. So I strongly believe in this sort of notion
 5 of cumulative gains. So, in other words, if you want
 6 the final outcome, which is to project a water jet at
 7 its maximum reach and its maximum flow rate, because
 8 that will be the best chance to offset particular heat
 9 release rate, that means that that equipment needs to be
 10 operated as close as possible to the specified rated
 11 values.
 12 Q. Just giving a practical example in layman's terms of the
 13 point you have made, if a particular piece of
 14 firefighting equipment had a rated flow of, say,
 15 1,000 litres per minute, but received an actual flow
 16 rate of 500 litres per minute, you would describe that
 17 handheld branch as being 50% utilised or as having
 18 received 50% of its rated flow. Is that a practical
 19 example of the point you're making?
 20 A. It is, because that will have ultimately the impact on
 21 the reach which that water jet can reach, and equally it
 22 will have an impact on the ability to stop certain heat
 23 flux occurring on a particular ignited surface.
 24 Q. Now, if we can go back to the page on the screen, which
 25 is page 3 {ISTRP00000006/3}, and we see, at line 22,

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1 paragraph 3, you there identify difficulties encountered
 2 in supplying water for firefighting from the water
 3 distribution network. Finally, at paragraph 4, you deal
 4 with alternative water supply sources that might have
 5 been used by the LFB.
 6 Is that a fair summary of the structure of
 7 chapter 5?
 8 A. That's right. So in chapter 5 I tried to systematically
 9 look at the utilisation of water jets, as the first
 10 instance, so I had access to a number of visual —
 11 Q. I'm sorry to interrupt.
 12 A. Yes.
 13 Q. We'll come on to that.
 14 A. I apologise, yes.
 15 Q. I was really inviting you just to confirm that was the
 16 structure.
 17 A. I confirm, yes.
 18 Q. Okay.
 19 If we can go to {ISTRP00000006/4}, over the page,
 20 the report states, and I think this is the point you
 21 were coming on to:
 22 "The evidence presented in this Chapter has been
 23 gathered from sources including witness statements,
 24 video footage provided by the National Police Air
 25 Service ... video footage from body-worn cameras

26

1 provided by the Metropolitan Police Service ... and
 2 other sources as referenced in the report."
 3 Is that a fair summary of the materials you have
 4 relied upon?
 5 A. Correct, and that material provides very high
 6 granularity in terms of time on the utilisation of the
 7 water —
 8 Q. Now, you refer to other sources in addition to those
 9 listed here. Those other sources include documents,
 10 disclosure from the LFB and from manufacturers relating
 11 to firefighting equipment; is that right?
 12 A. Correct.
 13 Q. You also refer to evidence given by firefighters during
 14 Phase 1 of this Inquiry; is that right?
 15 A. Correct.
 16 Q. Is it right that there are also some limited instances
 17 where you've relied upon photographs of the tower taken
 18 by members of the public or press on the day of the fire
 19 which have been published online?
 20 A. Correct.
 21 Q. Now, taking those sources together with those listed at
 22 the top of page 4 of chapter 5, does that represent
 23 a comprehensive summary of all the sources you reviewed
 24 for these purposes?
 25 A. It does.

27

1 Q. Now, if we can stay in this chapter but go to page 7
 2 {ISTRP00000006/7}, we can see, starting at line 16
 3 onwards, you list the external jets, which you have
 4 labelled jets A through to J, which were deployed by the
 5 LFB on 14 June from the first arrival of the Brigade
 6 until about 1 o'clock in the afternoon; is that right?
 7 A. That's correct.
 8 Q. Now, what I'll do, Dr Stoianov, is I'll go through each
 9 of these jets with you.
 10 A. Okay.
 11 Q. First of all, jet A, which was a handheld branch on the
 12 east side of the tower which was first projected at
 13 01.15 hours.
 14 Now, a handheld branch is simply what one might
 15 describe as a handheld firefighting hose; is that right?
 16 A. That's right.
 17 Q. Now, we can see an example in your report of handheld
 18 branches used.
 19 Before we look at that, I should say that there is
 20 a trigger warning for people in the room and who are
 21 watching. We are about to see some still images which
 22 show the fire on the exterior of the tower, so anybody
 23 who feels uncomfortable about that should take steps to
 24 leave the room or the live stream now, or otherwise
 25 protect themselves. I will wait a few moments to allow

28

1 people to do that if needed.
 2 (Pause)
 3 So if we can go to figure 5—17 on page 27 of this
 4 chapter, which is page 37 with the Opus reference
 5 {ISTRP00000006/37}, we can see, in figure c, there is
 6 a green oval symbol at the bottom right of that, and
 7 that is a photograph of a handheld branch being held by
 8 two firefighters ; is that right?
 9 A. Correct.
 10 Q. This is what you refer to as jet A?
 11 A. Correct.
 12 Q. If we can turn over the page to page 38
 13 {ISTRP00000006/38}, we find figure 5—19, which is the
 14 second set of images on that page, and here we see three
 15 types of handheld branch used by the Brigade; is that
 16 right?
 17 A. Correct. The video and any evidence I have come across
 18 very much indicates the first two branches. I have not
 19 seen any evidence that the third one, Delta Attack
 20 400—S—Pro, has been used.
 21 Q. Thank you.
 22 Now, if we could go back to page 7 {ISTRP00000006/7}
 23 and the list of jets you helpfully provided, we see
 24 at b, at line 17, jet B, which you describe as the
 25 Alpha 213 turntable ladder east, was utilised

29

1 continuously between 01.47 hours and 02.05 hours, with
 2 about 60% of its rated water flow of 2,000 litres per
 3 minute.
 4 Now, am I right in understanding that this was the
 5 first of the three aerial appliances deployed by the LFB
 6 at Grenfell?
 7 A. Correct. Again, we need to be careful by stating three,
 8 because the second aerial appliance, A245, actually was
 9 never deployed as a — the monitor of that aerial
 10 appliance was not deployed. There was a high—pressure
 11 hose stuck to that particular appliance. So just to
 12 kind of be very accurate with that statement, I would
 13 say out of the probably two deployed aerial ladder
 14 platforms.
 15 Q. Okay.
 16 Now, again, just dealing with basics, aerial
 17 appliances are fire engines with a ladder or a cage
 18 which is capable of being extended; is that right?
 19 A. Correct.
 20 Q. Now, you noted here that Alpha 213 received only
 21 approximately 60% of its rated flow. We will come on to
 22 that later, but I just want to sort of put a place
 23 marker for that particular point here now.
 24 Next, jet C, which you describe as a ground monitor
 25 on Grenfell Walk, which you note is to the south and

30

1 east of the tower, which was used intermittently between
 2 02.41 hours and 11.30 hours.
 3 Now, just looking at basics for these purposes at
 4 the moment, Dr Stoianov, a ground monitor is a water
 5 nozzle which sits in a frame, enabling it to be placed
 6 on the ground and aimed in a particular direction
 7 without the need for firefighters to hold it as if they
 8 were holding a normal firefighting branch. Is that
 9 an accurate description?
 10 A. Correct.
 11 Q. We can see an illustration of a ground monitor to remind
 12 people, which is at page 21 in this chapter
 13 {ISTRP00000006/21}, at figure 5—6. Thank you. That's
 14 what we're referring to here.
 15 A. Yes, and just for clarity, that ground monitor can be
 16 used with different nozzles, and that sort of figure
 17 also indicates the use of these different nozzles. One
 18 of them is the Mercury adjustable flow nozzle, and the
 19 other one is the plain deluge tip, or what we refer to
 20 normally as a smooth bore nozzle.
 21 Q. Thank you.
 22 Could we go back to page 7 {ISTRP00000006/7}, and if
 23 we could look at d, which is at line 22, you identify
 24 jet D, and you describe it thus:
 25 "A245 Aerial Ladder Platform ([on the] East [side of

31

1 the tower]) was utilised for less than one minute at
 2 02:13 hrs, and then continuously between 03:28 hrs and
 3 09:45 hrs (with a pause between 06:57 hrs and
 4 07:14 hrs)."
 5 Aerial ladder platform, or ALP, 245 was, I think,
 6 the second of the three aerial appliances deployed, and
 7 if you could bear with me in saying there were three
 8 deployed just for the sake of clarity in establishing
 9 basics first, before going into detail.
 10 Is that right?
 11 A. Correct.
 12 Q. Now, at the bottom of page 7, at paragraph 1e, it says
 13 this:
 14 "Jet E: S13A1 Surrey Aerial Ladder Platform ([on
 15 the] East [side of the tower]) was utilised after
 16 10:47 hrs ..."
 17 Now, jet E is, I think, another aerial appliance,
 18 which you refer to as the Surrey aerial appliance; is
 19 that right?
 20 A. Correct.
 21 Q. If we turn over the page to page 8 {ISTRP00000006/8},
 22 line 3, we have:
 23 "Jets [as in the plural] F: multiple handheld
 24 branches for extinguishing burning debris on the East
 25 side (utilised intermittently)."

32

1 Here again, apologies for asking you about what may
 2 be the obvious, but burning debris refers to ignited
 3 material that was falling from the tower to the ground;
 4 is that right?
 5 A. That's right.
 6 Q. So these jets were aimed not at the tower, as such, but
 7 at burning debris on the ground surrounding the tower;
 8 is that right?
 9 A. Correct.
 10 Q. We have next:
 11 "Jet G: a handheld branch for burning debris on the
 12 South side."
 13 We then have, going down the page to line 11:
 14 "Jet H: a covering water jet from a handheld branch
 15 initially, which was later (after ~05:00 hrs) replaced
 16 with a ground monitor (Northwest corner). The water jet
 17 was projected intermittently between ~02:43 hrs and
 18 ~10:52 hrs."
 19 Can you help us here, what do you mean by a covering
 20 water jet?
 21 A. So that's a water jet which was projected from the
 22 ground monitor onto the tower, and that specific one,
 23 it's the water jets on the northwest corner.
 24 Q. Next, jet I, which is dealt with at line 15:
 25 "A covering water jet from a handheld branch

33

1 (West side). The water jet was projected intermittently
 2 between ~02:45 hrs and 03:45 hrs."
 3 Is that right?
 4 A. Correct.
 5 Q. Finally:
 6 "Jet J: a covering water jet from a handheld branch
 7 (West side [again]). The water jet was projected
 8 intermittently between ~03:20 hrs and ~10:52 hrs."
 9 Is that all the jets that you have identified for
 10 the purpose of the report?
 11 A. Correct, and just to say I believe I have high
 12 confidence into that list based on the very high
 13 granularity of the visual data which was provided to me.
 14 Q. Now, these ten jets, A through to J, describe all of the
 15 external water jets deployed at Grenfell from the start
 16 of the fire until about 1.00 in the afternoon; is that
 17 right?
 18 A. Correct.
 19 Q. Just going back to basics, so we know what we're dealing
 20 with in this chapter, this chapter also describe the
 21 supply of water to the dry rising main, as we can see at
 22 page 8 {ISTRP00000006/8}, point k, a hose you refer to
 23 as supply K, which was also used to supply water to the
 24 inside of the tower.
 25 Is it right, though, that the focus of your analysis

34

1 is water jets deployed to the exterior of the tower?
 2 A. Correct. So supply K, I think we have to -- this was --
 3 particular emphasis was the north and west sides of
 4 Grenfell Tower. Clearly, the supply of the dry riser
 5 main was done through the south side, where the actual
 6 breeching valve was placed, so that's not explicitly
 7 mentioned into this list.
 8 Q. Thank you.
 9 Now, each of the jets deployed at Grenfell, whether
 10 a handheld branch, a ground monitor or aerial appliance,
 11 was supplied by a pump appliance; is that right?
 12 A. Correct.
 13 Q. Now, we don't need to go to them, but at pages 10
 14 through to 11 of this chapter {ISTRP00000006/10-11}, you
 15 identify the six pump appliances which were used to
 16 supply the jets deployed, and they were pumps Golf 271,
 17 Golf 272, Alpha 241, Sierra 13 Police 1, Hotel 421 and
 18 Alpha 431; is that a fair summary?
 19 A. That's right.
 20 Q. Those pump appliances were, in turn, supplied with water
 21 from a total of four hydrants. First of all, let's deal
 22 with the basics: is that right?
 23 A. Yes, it is.
 24 Q. Now, if we can stay in this chapter but go to page 6
 25 {ISTRP00000006/6}, and if the map could be expanded,

35

1 that is a map of the area immediately surrounding
 2 Grenfell Tower, and the tower itself is the bright green
 3 box labelled "GT". Is that right?
 4 A. Correct.
 5 Q. The four larger circles highlighted in yellow show the
 6 four hydrants used to supply water on the night; is that
 7 right?
 8 A. Correct.
 9 Q. If we can take these in turn.
 10 First of all, H1 is a fire hydrant located to the
 11 southeast of the tower under Grenfell Walk; is that
 12 right?
 13 A. Correct.
 14 Q. H3 is a fire hydrant located on the intersection of
 15 Grenfell and Bomore Roads; is that right?
 16 A. That's right.
 17 Q. H8 is a fire hydrant located on Bramley Road; is that
 18 right?
 19 A. That's right.
 20 Q. And hydrant WO/H5, seen here to the right of the tower,
 21 is located next to the Kensington Leisure Centre; is
 22 that right?
 23 A. That's right, it's between the Kensington Leisure Centre
 24 and the Aldridge Academy.
 25 Q. Just so people understand, the letters WO are important

36

1 here, and we will discuss their importance later, but WO
 2 stands for wash-out; is that right?
 3 A. That's right.
 4 Q. Finally, this figure also shows, with the smaller red
 5 and blue circles, other fire hydrants in red and
 6 wash-out hydrants, which are in blue, situated in the
 7 vicinity of Grenfell Tower, but which were not used on
 8 the night; is that right?
 9 A. That's right.
 10 Q. Now --
 11 A. Just going one -- I apologise. One extra thing here
 12 I just wanted to emphasise is the private hydrant which
 13 is in close proximity to H1. That private hydrant was
 14 labelled the most appropriate hydrant in the ORD for the
 15 pre-determined attendance specification.
 16 Q. Thank you. We will come on to these matters in due
 17 course.
 18 Can we first, though, before we come on to those
 19 other topics, low flow rates, and I'd like to turn in
 20 particular to your conclusions about that topic and the
 21 flow rates delivered to aerial appliances and ground
 22 monitors on 14 June.
 23 If we can go in this chapter to page 236
 24 {ISTRP00000006/236}, at point 2 you conclude as follows:
 25 "Of the three aerial appliances and two ground

37

1 monitors which projected water jets onto Grenfell Tower
 2 on 14 June 2017, none were supplied with their rated
 3 water flow rate."
 4 If we go on further, between pages 236 and 238
 5 {ISTRP00000006/236-238}, you go on to describe the
 6 specific details of each aerial appliance and ground
 7 monitor's rated flow figure compared with the flow rates
 8 which you estimate that they received on the night.
 9 We don't need to go through all of that detail which
 10 is set out on the next three pages, but can I summarise
 11 that content and see whether you agree with the summary
 12 or not.
 13 First of all, Alpha 213 received about 60% of its
 14 rated flow; is that right?
 15 A. Correct.
 16 Q. Alpha 245 received between 16% and 20% of its rated
 17 flow; is that right?
 18 A. That's right.
 19 Q. Thirdly, Sierra 13 Alpha 1 received between 12% and 19%
 20 of its rated flow.
 21 A. Correct, but for Sierra 13A1, we should also bear in
 22 mind that the actual monitor has a minimum flow rate,
 23 and that minimum flow rate was not reached. So although
 24 I can provide a value of whatever percentage was
 25 delivered, we should bear in mind that the actual flow

38

1 rate was below the operational minimum threshold for
 2 that particular appliance.
 3 Q. The ground monitor on the south and east sides received
 4 between 63% and 86% of its rated flow; is that right?
 5 A. Correct.
 6 Q. And the ground monitor deployed from the northwest
 7 corner received between 21% and 37% of its rated flow.
 8 A. Correct. Again, another thing -- probably I might be
 9 jumping here a little bit -- is about the timeliness of
 10 this.
 11 Q. If we can just deal with -- what I'm trying to do --
 12 A. Yes, I understand.
 13 Q. -- first of all is establish basics as a clear figure in
 14 people's minds --
 15 A. That's fine.
 16 Q. -- and then if we can get into some of the detail later
 17 on where it's necessary and relevant.
 18 A. Thank you.
 19 Q. Now, what I'd like to deal with next is how you
 20 calculated the flow rate figures.
 21 Now, first of all, the mathematical model was
 22 provided by Thames Water, which you then validated with
 23 practical testing carried out in 2018 and with data
 24 available from the night of the fire to ensure that it
 25 could accurately predict the flow and pressure

39

1 conditions in the network at different times and
 2 locations during the fire. That in turn allowed you to
 3 estimate the flow rates delivered to the various pieces
 4 of firefighting equipment.
 5 Now, that's high level, but is that, in its essence,
 6 a correct summary of the approach you took?
 7 A. It is, and I just want to add to that that clearly these
 8 mathematical models, as we call them, hydraulic models,
 9 we have very high confidence into these models. These
 10 are not just some abstract, highly uncertain -- we
 11 commonly use them in a number of incident management and
 12 it's commonly used by the UK water industry as a whole.
 13 Q. Modelling has its critics.
 14 A. Yes.
 15 Q. Can you briefly -- I emphasise the word "briefly" --
 16 describe why you think the results are reliable, or at
 17 least tolerably reliable?
 18 A. Because in terms of the actual model, I have taken
 19 a very robust approach towards the validation through --
 20 used a lot of experimental work, so I have very high
 21 confidence in the model, in the hydraulic model, and
 22 equally through the testing of the flow coefficients of
 23 the hydrants, I have now very good understanding about
 24 their discharge characteristics. In combination with
 25 understanding of the pressure and flow within the

40

1 network and the flow coefficients of the hydrants, I can
2 derive very — pretty accurate estimates of the flow
3 rates coming out of these hydrants.

4 Q. Now, can I turn on to the next topic, which is the
5 consequences of low flow rates.

6 A. Sure.

7 Q. Now, your report describes three consequences of low
8 flow rates delivered to the aerial appliances and the
9 ground monitors, and I just want to identify them at the
10 start, Dr Stoianov, and then we'll come to deal with the
11 detail in due course.

12 First of all, they limited the vertical reach of the
13 jets projected onto the tower; is that right?

14 A. Correct.

15 Q. Secondly, the low flow rates caused interruptions to the
16 jets; is that right?

17 A. Correct, so the jets were not consistent.

18 Q. Thirdly, the low flow rates meant that some equipment
19 could not be deployed as intended; is that correct?

20 A. Correct.

21 Q. Can I deal with the first one of those consequences,
22 which is limited vertical reach.

23 Now, as you've confirmed, the low flow rates limited
24 the vertical reach of jets. Now, before we go any
25 further, again dealing with basics, vertical reach

41

1 simply refers to the maximum height reached by the
2 projected water jet; is that right?

3 A. Correct.

4 Q. Your analysis identified that the three aerial
5 appliances deployed at Grenfell Tower — I use that
6 phrase advisedly, but for the sake of clarity — which
7 were able to reach higher than any other jets, achieved
8 maximum vertical reach of approximately 35 metres, which
9 is 13th floor; 47 metres, the 17th floor; and 52 metres,
10 the 19th floor, respectively; is that right?

11 A. That was on the night of the fire, yes, as used.

12 Q. Now, if we can go to page 238 {ISTRP00000006/238} and
13 look at paragraph 3, you conclude this:

14 "A213 [turntable ladder], A245 [aerial ladder
15 platform] and S13A1 [aerial ladder platform] were
16 capable of projecting water jets to the full height of
17 the tower (64.5m) if supplied with their rated flow and
18 nozzle pressure from the pump appliances."

19 Now, if we could turn back to page 52 in this
20 chapter {ISTRP00000006/52}, we find, at figure 5—29,
21 an annotated graph, and this graph is provided by the
22 manufacturer of one of the aerial appliances, I think
23 Alpha 213, and you have added the writing in blue. Are
24 those points correct?

25 A. They are.

42

1 Q. Now, we don't need to go through the graph in detail,
2 but I'd like to look in particular at your blue markings
3 and comments on the graph.

4 A. Yes.

5 Q. Now, you note that the graph shows that, when provided
6 with the correct flow rate of 2,000 litres per minute,
7 this appliance can project water to a maximum height of
8 35 metres from the nozzle, and adding the maximum height
9 of 30 metres at which the nozzle can be positioned using
10 the appliance's cage, that comes to a total of
11 approximately 65 metres. That is the basis for your
12 conclusion that this particular aerial appliance,
13 Alpha 213, had a maximum possible vertical reach of
14 65 metres, which you note is to the top or thereabouts
15 of Grenfell Tower.

16 Is that a fair summary of your conclusion annotated
17 there?

18 A. Correct.

19 Q. Now, Grenfell Tower is 65.4 metres high, slightly more
20 than 65 metres. Is it right, put differently and in lay
21 terms, that the maximum vertical reach of Alpha 213 is
22 there or thereabouts the total height of the tower?

23 A. Correct. Just to add to that, clearly, is that the
24 manufacturer provides what they call the effective
25 reach, clearly, and that effective reach is based on,

43

1 again, specific consideration about safety and
2 et cetera. That's an orifice discharge. So if we can
3 actually provide 10.5, 11 bars, even a very small
4 deviation on that particular appliance or that
5 particular monitor, that can even reach a little bit
6 higher.

7 The other thing is that that water jet will be
8 affected by environmental conditions. We know that on
9 the night of the fire the wind was very low, we have the
10 information from the weather stations. So as far as the
11 environmental conditions go, my assumption is, my
12 hypothesis is, that they had very little impact.

13 So, in summary, yes, 65 metres is my estimate, but
14 that sort of 40 centimetres you're referring to here,
15 it's certainly probably within the maximum reach, not
16 the effective reach. The effective reach is normally
17 about 10% of the maximum reach.

18 Q. Just picking up the variables that are in play here,
19 achieving the maximum possible height depends not just
20 on supplying the appliance with the rated flow rate, but
21 also on the jet itself being projected at the optimal
22 angle. Is that right?

23 A. That's correct, yes, and equally, I'm sure we'll touch
24 later, but the actual experimental results which I have
25 been provided very much substantiate these results.

44

1 Q. Just looking at this graph, what we see is the tallest
 2 blue line — or, rather, I think this is what it
 3 shows — is for a jet aimed at a 30-degree angle, but if
 4 the jet is pitched at a shallower angle, for example
 5 40 degrees, the green line on this graph, the maximum
 6 height reached by the jet falls, at least to the lay
 7 eye, quite significantly; is that right?
 8 A. Correct.
 9 SIR MARTIN MOORE—BICK: Can we just make sure we've
 10 understood this correctly. The angle of attack is the
 11 angle at which you are directing the jet; is that right?
 12 A. Correct.
 13 SIR MARTIN MOORE—BICK: And it looks to me as though the
 14 blue line is an angle of attack at 75 degrees; is that
 15 right?
 16 A. Well, it depends how we measure the angle, but yes. So
 17 I think you're absolutely right, the angle of attack
 18 here on the blue line would be 75 degrees.
 19 SIR MARTIN MOORE—BICK: So you've got to point it as high as
 20 possible —
 21 A. Correct.
 22 SIR MARTIN MOORE—BICK: — to get that extent of jet reach
 23 in the vertical plane?
 24 A. That's right. But when you look at just very basic
 25 trigonometry here in terms of angle, distance, where the

45

1 actual aerial appliance was positioned, I don't think
 2 that was an obstacle, to project that water jet at that
 3 particular angle.
 4 SIR MARTIN MOORE—BICK: Well, you may well be right, I just
 5 wanted to ensure that we'd understood the colours
 6 correctly.
 7 A. Yes.
 8 SIR MARTIN MOORE—BICK: But since I've now broken into
 9 Mr Kinnier's line of questioning, I might ask one
 10 further question.
 11 The horizontal reach shown on the graph —
 12 A. Yes.
 13 SIR MARTIN MOORE—BICK: — what is that telling us?
 14 A. So clearly that shows us what is the furthest away reach
 15 which a jet can outreach. So if, let's say, this
 16 monitor is deployed in a situation where potentially the
 17 objective is to outreach the fire on an industrial
 18 estate or whatever, you probably want to be at a safe
 19 distance but have that outreach in terms of horizontal
 20 distance and consider that horizontal distance. So
 21 that's the variations between the angle of projection
 22 and also the reach and the trajectory of that water jet.
 23 SIR MARTIN MOORE—BICK: Is this graph telling us that in
 24 order to project a jet 35, let's say, metres above the
 25 nozzle —

46

1 A. Yes.
 2 SIR MARTIN MOORE—BICK: — you've got to be only 20 metres
 3 horizontally from the point at which you want that to be
 4 achieved? Is it telling us that?
 5 A. No, no. This is —
 6 SIR MARTIN MOORE—BICK: Ah.
 7 A. No. So if you want to project it as — so that's why
 8 I'm saying it's very basic trigonometry. So if you take
 9 a triangle and I want to project at — and I have the
 10 angle and I have the distance, I can very much
 11 sort of — the calculation in that particular case is
 12 probably about 8 to 9 metres distance, in answer to your
 13 question, I can achieve — from the object where I want
 14 to project it, I'll be able to achieve that 75% angle.
 15 SIR MARTIN MOORE—BICK: Well, let me ask my question in
 16 a slightly more practical way.
 17 How close to the building would you need to be in
 18 order to project a jet 35 metres from the top of the
 19 ladder?
 20 A. About 8 metres.
 21 SIR MARTIN MOORE—BICK: Ah.
 22 A. But, equally, if you bear in mind that the way Alpha 213
 23 was positioned, it was positioned very close to the
 24 building, but equally the projection was not done in
 25 that direction (indicated), most of the time the

47

1 projection was done along the building. In other words,
 2 we didn't have that exact constraint. The actual ladder
 3 could have been even pulled a little bit more along the
 4 east side and, again, the projection could reach to the
 5 top of the building without these constraints. And
 6 equally, A245, in terms of distance, was the ideal
 7 distance to achieve that projection.
 8 SIR MARTIN MOORE—BICK: Yes, that's helpful. Thank you very
 9 much.
 10 Yes, Mr Kinnier.
 11 MR KINNIER: Just flowing from the Chairman's questioning,
 12 can we go to {LFB00123672}. As we can see on the
 13 screen, this is a report prepared by the LFB dated
 14 12 November 2021, entitled, "Flow tests conducted on
 15 aerial appliance types used at Grenfell Tower fire".
 16 If we go to page 2 of this document {LFB00123672/2},
 17 we see, in the third paragraph, the report says this:
 18 "The flow tests summarised within this report were
 19 designed to assess the operational capability and
 20 performance of LFB equipment within the optimal working
 21 parameters as provided within the Dr Stoianov Report, to
 22 ascertain whether the calculated provision of water
 23 could be achieved in an optimised working environment
 24 (with equipment in service at the time of the
 25 Grenfell Tower Fire)."

48

1 Now, in simple terms, the report seeks to test
 2 whether your theoretical estimates for the maximum
 3 vertical reach of the aerial appliances could be
 4 achieved in practice. Was that your understanding of
 5 the overall point of the LFB's tests?
 6 A. Correct.
 7 Q. Now, if we can go to the final paragraph of this
 8 introduction on page 2, which is immediately above the
 9 emboldened heading "Turntable Ladder ... and monitor",
 10 it explains that the testing was carried out on
 11 25 August and 6 September 2021 and, looking at the
 12 middle of the second line of that paragraph, and
 13 I quote:
 14 "All of the equipment assessed as part of the
 15 performance tests was produced by the same manufacturer
 16 and of the same model as that which attended the
 17 Grenfell Tower Fire on 14 June 2017."
 18 We can see from the bottom of page 2 that the LFB
 19 tested a turntable ladder, and if we go over to page 3
 20 {LFB00123672/3}, what's described there is an aerial
 21 lift platform, sometimes described as an aerial ladder
 22 platform as well, and an Akron Mercury quick attack
 23 monitor, otherwise known as a ground monitor; is that
 24 right?
 25 A. Correct. The only thing I would like to add to this —

49

1 Q. Yes.
 2 A. — is that all of this equipment is described, the
 3 report does not explicitly specify the serial numbers of
 4 the monitors and the nozzles used into these tests.
 5 Q. And why is that important?
 6 A. Well, generally we can even further validate with the
 7 manufacturer whether these specific serial numbers have
 8 gone through the kind of testing which the manufacturer
 9 provides, and that gives additional reassurance. Also,
 10 it's important for us to really cross-reference the
 11 tests which LFB have done, which I think implicitly, the
 12 statement is, the assumption is, that these are exactly
 13 the same equipment, or very similar equipment, similar
 14 branches, as used during the Grenfell Tower fire.
 15 I would have liked to see the serial numbers of the
 16 equipment used on the Grenfell Tower fire and the serial
 17 numbers and exact models of the equipment, of branches
 18 and nozzles, used into these particular tests.
 19 Q. Thank you.
 20 Now, can we go to page 16 {LFB00123672/16}, which
 21 sets out the results of the tests under the heading
 22 "Conclusion", roughly a third of the way down that page.
 23 It sets out the maximum jet height that was achieved for
 24 each piece of equipment tested, which for the aerial
 25 appliances were 49, 60 and 62.3 metres respectively.

50

1 The report then concludes in the paragraph below in the
 2 following terms:
 3 "For all of the flow tests undertaken within
 4 optimised practical working conditions, the maximum
 5 throw of water achieved, using equipment available at
 6 the time of the Grenfell Tower incident, it was not
 7 possible to exceed 62.3 meters[sic] in vertical water
 8 throw."
 9 Now, put differently, the LFB concludes that the LFB
 10 aerial appliances' theoretical maximum vertical reach
 11 figures were not achievable in practice, and that those
 12 aerial appliances were not capable of reaching the top
 13 of the tower.
 14 Now, before we turn to your response, was that your
 15 understanding of the LFB conclusions in this report?
 16 A. That's very much my understanding of what LFB concluded,
 17 yes.
 18 Q. Now, you address the LFB's testing in page 21 of your
 19 supplementary report, which we can find at
 20 {ISTRPS00000001/21}. We can see at paragraph 47, which
 21 is in the bottom third of that page, you conclude thus:
 22 "Save for Performance test 3b [which we don't need
 23 to go into for present purposes], I do not agree that
 24 the LFB test results above are representative of the
 25 maximum achievable vertical reach of a projected water

51

1 jet for the equipment tested. In relation to
 2 Performance tests 1, 2 and 3a, the LFB did not supply
 3 the tested monitors/nozzles with their rated inlet
 4 pressure and/or flow rate. Consequently, the vertical
 5 reach of projected water jets observed by LFB in those
 6 performance tests is lower than the maximum achievable
 7 vertical reach of the tested monitors/nozzles."
 8 Now, you say at the beginning of that paragraph,
 9 "Save for Performance ... 3b". Just so people know,
 10 that was one of the LFB's tests of the ground monitor;
 11 is that right?
 12 A. That's right, and just to note, the ground monitor here
 13 has achieved 41.2 metres vertical reach, which actually
 14 exceeds my conservative estimates of about 35 metres.
 15 Q. You have excluded performance test 3b from your
 16 conclusion because that is the only test which you say
 17 did actually supply the correct pressure and flow rate.
 18 A. Correct.
 19 Q. Yes.
 20 Now, if we can put that ground monitor test to one
 21 side, is it right that you do not accept the LFB's
 22 conclusions in relation to the aerial appliances because
 23 the appliances — and I put this in lay terms — weren't
 24 supplied with the correct water pressure and flow rate
 25 that would have allowed them to achieve their maximum

52

1 jet height?
 2 A. That's correct, and this to me was very surprising,
 3 given the fact that LFB had my recommendations in place.
 4 Q. Now, could we stay in this report but go to page 22
 5 {ISTRPS00000001/22}. We can see — and we don't need to
 6 go through it in detail now — at pages from 22 through
 7 to 25, you set out your detailed analysis about why the
 8 correct pressure and flow wasn't provided to the aerial
 9 appliances.

10 Can you help the panel, in brief, what is your
 11 essential conclusion on that point, why the correct
 12 pressure and flow wasn't provided to the ALPs?
 13 A. Well, as you said, the most critical variables here is
 14 the nozzle inlet pressure and the flow rate which these
 15 monitors and nozzles needs to be provided, and this
 16 nozzle inlet pressure will depend on the pump discharge
 17 pressure and also the pressure head losses across the
 18 connections, the hoses, the different connections for
 19 these hoses. So, consequently, if one does not have the
 20 right set of hoses which we would expect LFB to take
 21 these into a place, there's no way they can provide the
 22 actual nozzle inlet pressure required to perform these
 23 tests which achieves that rated nozzle inlet pressure.

24 The other thing, my view is that we do a lot of
 25 experimental research, and experimental research is

53

1 extremely critical to be able to go in a systematic way
 2 to validate your measurement equipment, make sure that
 3 specific measurement is put in place, and, to my view,
 4 LFB did not follow even basic standards in performing
 5 experimental tests. For example, one very simple
 6 approach would have been, as I highlighted in my
 7 response, to just measure the nozzle inlet pressure at
 8 that particular point, and that would have given us
 9 a lot of confidence in the repeatability and analysis of
 10 these tests, and that was not done.
 11 SIR MARTIN MOORE—BICK: So, to put it simply, is it your
 12 view that, to put this rather crudely, I suppose, LFB
 13 used the wrong nozzles?
 14 A. No, that's not the case. They used the right nozzles,
 15 because the nozzle is the actual part of the monitor,
 16 but what they did is they didn't supply the nozzle inlet
 17 pressure which I specified in my recommendation, which
 18 is part of this rated nozzle inlet pressure. So, in
 19 other words, the pressure at the inlet to that nozzle
 20 was significantly lower, and I've kind of justified
 21 that, than that they should have provided for the
 22 purpose of these tests.
 23 SIR MARTIN MOORE—BICK: So they used the right nozzle but
 24 without the maximum input pressure?
 25 A. Correct, to that nozzle.

54

1 SIR MARTIN MOORE—BICK: I see.
 2 A. So, to me, I wasn't — I can't say whether this is —
 3 it's really puzzling, from my perspective, whether that
 4 was lack of basic knowledge in pipe hydraulics or there
 5 were other factors in place.
 6 SIR MARTIN MOORE—BICK: Thank you.
 7 MR KINNIER: For that reason, the contents of the LFB's
 8 testing does not cause you to doubt or qualify or amend
 9 the conclusions you reached?
 10 A. Not at all. Even if I look at the ground monitor, if
 11 you go back to the LFB results and if you look
 12 specifically at the ground monitor, the ground monitor
 13 with the Mercury nozzle, even though it doesn't get the
 14 nozzle inlet pressure, has a much higher performance
 15 than the actual performance test 1a which is coming from
 16 the LFB, and broadly they have very similar nozzles, and
 17 that sort of very clearly indicates to me — again,
 18 reaffirms my hypothesis that simply they didn't provide
 19 the correct nozzle inlet pressure.
 20 Q. Just to give people a bite—size summary —
 21 A. Okay.
 22 Q. — you don't agree because the LFB testing failed to
 23 account for various pressure losses due to friction and
 24 gravity which occurred between the pump and the
 25 appliance where the LFB monitored the pressure and flow

55

1 rate and the nozzle of the aerial appliance being
 2 tested?
 3 A. Correct, and to me that has a big impact on any policies
 4 LFB can derive from these tests.
 5 Q. Secondly, the LFB didn't use state—of—the—art equipment
 6 to monitor pressure or flow and instead relied on
 7 physically looking at mechanical gauges and manual
 8 recording.
 9 A. Correct.
 10 Q. Thirdly, the testing was carried out using a single
 11 fire hydrant as a water source with a flow rate of
 12 2,000 litres per minute, which was less than the
 13 required flow rate of 2,400 litres per minute; is that
 14 right?
 15 A. Correct.
 16 Q. I don't want to take this too crudely or simplistically,
 17 but those are the three principal reasons why you are
 18 not persuaded by the results the LFB gathered as
 19 a result of their testing.
 20 A. That's right.
 21 Q. Can we look at matters slightly differently, from
 22 a different perspective now, and look at the issues that
 23 arise out of your own estimates of the jets' vertical
 24 reach. I'd like really to discuss and identify the
 25 limitations of your own estimates.

56

1 A. Sure.
 2 Q. First of all, your estimates are just that: they're
 3 estimates based on desktop calculations which have not
 4 been replicated in the practical, real-life situations;
 5 is that a fair point to make?
 6 A. It is a fair point.
 7 Q. Secondly, there could be other factors which are not
 8 included in your calculations and which may lie outside
 9 your expertise, but which may affect an aerial
 10 appliance's achievable vertical reach; again, is that
 11 a fair, generic observation?
 12 A. I would like to know how you describe these other
 13 factors, so --
 14 Q. Shall we go through --
 15 A. -- for me to be able to agree.
 16 Q. Well, let's go through them, because some of the ones
 17 you identified earlier in your evidence.
 18 First of all, weather conditions.
 19 A. Correct. But, again, as stated, I cross-referenced the
 20 weather conditions from the Meteorological Office
 21 stations, and, equally, that was done by other experts,
 22 such as Professor Luke Bisby, and the impact on the
 23 weather conditions and wind on, let's say, the
 24 fire spread, and their conclusion is that that was
 25 minimal, and equally the same conclusion I can draw for

57

1 the projection of the water jet.
 2 Q. Dr Stoianov, could I ask you to take matters more
 3 slowly.
 4 A. Okay.
 5 Q. The stenographer is finding it difficult just to keep
 6 up.
 7 A. Thank you.
 8 Q. Another factor which may need to be put into the balance
 9 here is the performance of the appliance itself, which
 10 may have declined to some extent since factory
 11 conditions due to continuing use. Is that a legitimate
 12 point to bear in mind as well?
 13 A. So we have several factors here, clearly. We have the
 14 pump discharge pressure, and I specifically asked for
 15 all maintenance records for the centrifugal pumps to be
 16 made available to me, and these maintenance records
 17 indicate that the performance of these pumps were well
 18 within the expected specifications of these pumps. So
 19 any other equipment that might deteriorate somehow is
 20 the actual nozzle geometry or some of the components of
 21 the nozzle. But, again, I would find that difficult to
 22 believe. So my assumption is that, actually, this
 23 equipment should have performed to its operational
 24 specification.
 25 Q. Perhaps, as your answer indicates, performance of the

58

1 appliance and the various supplemental bits of equipment
 2 is a legitimate factor to bear in mind when considering
 3 maximum vertical reach?
 4 A. It is.
 5 Q. Yes.
 6 There may also be operational firefighting reasons
 7 which factor into decisions about the use, placement or
 8 projection angle of an aerial appliance at a
 9 firefighting incident; to give a practical example,
 10 burning debris falling off a building and having to
 11 avoid that.
 12 A. Correct, I fully agree, but equally we see the example
 13 of Alpha 245, which clearly was at a distance to the
 14 building.
 15 Q. We don't necessarily have to go to it, but the LFB
 16 report noted that water at the highest peak of the
 17 maximum jet height fell very sharply downwards and
 18 created a significantly wider, more dispersed cone of
 19 water with reduced energy. That, in the report author's
 20 professional judgement as a firefighter, would have
 21 significantly reduced the effect on firefighting
 22 operations due to the dispersed nature of water at that
 23 height. That is a legitimate consideration to bear in
 24 mind; would you accept that proposition?
 25 A. Yes, I would. However, again, probably that will go

59

1 beyond the scope of my investigation, but it seems that
 2 we do have evidence to suggest that even small amounts
 3 of water can very effectively deal with the heat flux on
 4 these specific ACM panels.
 5 MR KINNIER: Sir, that is the end of my questions on the
 6 first consequence of low flow rate, which is probably
 7 a reasonable place to stop for the moment.
 8 SIR MARTIN MOORE-BICK: I think it is, yes.
 9 Well, Dr Stoianov, we have a break during the
 10 morning in any event, and this is a good time to take
 11 it. So we'll stop there. We'll resume, please, at
 12 11.35, and I have to ask you, while you're out of the
 13 room, not to discuss your evidence or anything relating
 14 to it with anyone else. All right?
 15 THE WITNESS: Thank you.
 16 SIR MARTIN MOORE-BICK: Thank you very much. Would you go
 17 with the usher, please.
 18 THE WITNESS: Thank you.
 19 (Pause)
 20 SIR MARTIN MOORE-BICK: Thank you very much. 11.35, please.
 21 MR KINNIER: Thank you, sir.
 22 (11.20 am)
 23 (A short break)
 24 (11.35 am)
 25 SIR MARTIN MOORE-BICK: All right. Ready to carry on?

60

1 THE WITNESS: I am, thank you.
 2 SIR MARTIN MOORE-BICK: Good, thank you very much.
 3 Yes, Mr Kinnier.
 4 A. Mr Kinnier, before we continue, may I just revisit your
 5 question before the break with regards to the
 6 uncertainties associated?
 7 MR KINNIER: Yes.
 8 A. I would just — again, on reflection, I mean,
 9 absolutely, I think all these uncertainties you have
 10 identified, rightfully they should be raised. But this
 11 is, again, the reason why this experimental validation
 12 is supposed to address these uncertainties and bring
 13 better clarification. In the examples which, let's say,
 14 Thames Water — we ran these experiments jointly, we had
 15 an agreed protocol of how to run the experiments on
 16 collecting hydraulic data from the network, on the basis
 17 of which we can have the discussion. Unfortunately,
 18 with LFB, we did not have that interactions in terms of
 19 running the test and agreeing on processes, procedures
 20 and measurements, so at the end of the day it's very
 21 difficult for me to use these validation results to
 22 really address some of the uncertainties you mentioned.
 23 Q. Please don't worry, Dr Stoianov, you have made your
 24 point very clear and you have re-emphasised it now.
 25 A. Thank you.

61

1 Q. Could I now turn to the second consequence of the low
 2 flow rates you identified in your report, and that was,
 3 in broad terms, interruption to jets.
 4 If we can go to {ISTRP00000006/236}, this sets out
 5 some of your conclusions from chapter 5 of your report.
 6 If we could look at the end of line 10 in paragraph 2,
 7 you say this:
 8 "The insufficient flow rates into the on-board tanks
 9 of pump appliances also resulted in frequently stopping
 10 the operation of the on-board centrifugal pumps to allow
 11 the tanks of the supplying pump appliances to be
 12 refilled. Managing the water deficit between the inlet
 13 flow rate into an on-board water tank of a pump
 14 appliance and the outlet flow for a projected water jet
 15 resulted in continuous variations in the jets' flow and
 16 reach."
 17 Now, earlier we discussed the concept of continuity
 18 of flow, and that is what was essentially lacking here,
 19 in broad terms. Is that the point in a nutshell?
 20 A. Yes.
 21 Q. Less water was going into some pump appliance tanks than
 22 was being pumped out of them to firefighting equipment,
 23 so the tanks would repeatedly empty, the jets had to be
 24 stopped to allow refilling, and then start up again, and
 25 that's the essence of the problem.

62

1 A. Correct, and I believe we have very good cross-reference
 2 of this by firefighters on the night in their witness
 3 statements.
 4 Q. Now, in some cases, jets could be deployed for less than
 5 a minute before the pump tank ran out, requiring the jet
 6 to be paused for 20 seconds or so before the tank
 7 refilled and the jet could be restarted; is that right?
 8 A. Correct.
 9 Q. One partial solution which firefighters were able to
 10 improvise to prevent these interruptions was to turn
 11 down the pump settings so that less water was pumped out
 12 to the firefighting equipment to match the limited flow
 13 of water coming into the tank. It's right that that's
 14 what was attempted on the night, wasn't it?
 15 A. That's right, and we can look very closely at the pump
 16 characteristics to see that behaviour, and the moment
 17 you start reducing the flow rate, you're reducing the
 18 pump discharge pressure, and that has an impact on the
 19 nozzle inlet pressure.
 20 Q. That's the big downside to that particular approach,
 21 isn't it, because in order to ensure continuous or near
 22 continuous supply of water, you would have a much
 23 weaker, diminished jet of water?
 24 A. Correct, and this is very much — these are variable
 25 speed pumps, the pump appliances have very powerful

63

1 variable speed pumps, and the relationship between pump
 2 discharge pressure and flow rate is very well
 3 represented there.
 4 Q. Can we now turn to the third consequence of low flow
 5 rate that you identified, which was, in essence, that
 6 some equipment could not be deployed.
 7 Now, as you identified in earlier evidence, and
 8 I said we'd come on to, there were problems with
 9 Alpha 245, an aerial appliance, in that the water flow
 10 rate it received was insufficient effectively to project
 11 a jet of water from its higher capacity nozzle. In
 12 a nutshell, is that right?
 13 A. Correct.
 14 Q. Again, to use a horticultural analogy, it's a bit like
 15 a large garden hose receiving only a small stream of
 16 water, such that the water dribbles out and isn't
 17 projected any distance from the hose.
 18 A. I agree, although I would like to use a more scientific
 19 explanation, but yes.
 20 Q. In essence, that's the problem?
 21 A. That's right.
 22 Q. Firefighters again had to improvise, which they did by
 23 strapping a lower capacity fire hose to the cage of the
 24 aerial appliance to produce a jet which could reach the
 25 tower; is that a fair summary of what was attempted on

64

1 the night?
 2 A. That's right.
 3 Q. Again, apologies for using the garden hose analogy, but
 4 that's equivalent to pinching the opening of the hose
 5 with your thumb to produce the longer but necessarily
 6 narrower stream of water?
 7 A. Correct.
 8 Q. Having identified those consequences, can we now turn to
 9 the topic of the causes. For that purpose, can we stay
 10 in chapter 5 but go to page 238 {ISTRP00000006/238}, and
 11 in particular could we look at paragraph 6. Here you
 12 provide a neat summary of the causes for us, and you
 13 said this:
 14 "The reasons for the low flow rate extracted from
 15 the hydrants at Grenfell Tower include:
 16 "a. The low flow (discharge) coefficient of the used
 17 hydrants (see Chapter 6).
 18 "b. In the case of A245 ALP and S13A1 ALP, the use
 19 of a wash-out hydrant (H5), which was wrongly labelled
 20 fire hydrant. A wash-out hydrant is not designed for
 21 the supply of water for firefighting ...
 22 "c. Lack of coordination between LFB and TWUL. This
 23 also included the continued pressure reduction in the
 24 water distribution system by TWUL ...
 25 "d. Pressure losses between the hydrants and pump

65

1 appliances."
 2 Now, what I'd like to do, Dr Stoianov, is go through
 3 each of those causes with you.
 4 First of all, can we deal with the hydrants' low
 5 flow coefficients, which will necessarily bring in
 6 a question of interpretation of the relevant
 7 British Standard.
 8 Now, if we can go to {ISTRP00000008/72}. Now, at
 9 lines 19 to 20 at page 72, you explain that:
 10 "... the flow coefficient of a hydrant is a measure
 11 of the flow rate that a hydrant can provide in relation
 12 to the pressure at that point in a distribution
 13 network."
 14 Now, in layman's terms, is the flow coefficient
 15 essentially a measure of how efficient the hydrant is,
 16 in that it measures how good a flow rate the hydrant can
 17 supply, given the pressure of the water the hydrant
 18 receives from the network?
 19 A. Correct.
 20 Q. So the higher the flow coefficient of a hydrant, the
 21 better?
 22 A. Absolutely. I mean, if you scroll up that page, we
 23 can — it's no more than GCSE maths here, but if you
 24 scroll up that page, you would very much see the flow
 25 discharge equation from an orifice, and clearly if that

66

1 coefficient is higher — so this is the equation 6.2,
 2 for example. This is the actual calculation of the flow
 3 coefficient, but equally —
 4 Q. Dr Stoianov, I don't think we need to go into —
 5 A. Okay.
 6 Q. Possibly to save my blushes about GCSE maths, but just
 7 for —
 8 A. Okay.
 9 SIR MARTIN MOORE-BICK: Likewise.
 10 MR KINNIER: — conveying the essential of the consequence
 11 we need here.
 12 A. That's fine.
 13 Q. I think we agree —
 14 A. I shall follow your advice.
 15 Q. Your report sometimes refers to the flow discharge
 16 coefficient of hydrants. Is that because the terms
 17 "flow coefficient" and "discharge coefficient" are both
 18 used and are interchangeable, at least in this context?
 19 A. That's right.
 20 Q. Now, your report distinguishes between the flow
 21 coefficient of a standalone hydrant — and I'd like to
 22 emphasise that word "standalone" — and the composite
 23 flow coefficient of a hydrant. In lay terms, can you
 24 explain for us the difference between the two?
 25 A. So the difference between the two is that one is — if

67

1 one looks at the flow coefficient of discharge of
 2 a hydrant, one could imagine that this just correlates
 3 to the hydrant in isolation. So, in other words, I can
 4 take a hydrant, put it on a pipe rig at Imperial, and
 5 I can test this hydrant and look at specific flow
 6 coefficient or discharge characteristics of that
 7 fire hydrant. Now, if I take this fire hydrant and
 8 install it in an operational network, the connecting
 9 pipeline or the connecting piping around that hydrant
 10 might significantly differ than these kind of ideal
 11 piping arrangements under which I've tested that
 12 particular fire hydrant.
 13 That becomes very important in urban environments
 14 where, you know, when you dig a street to install
 15 a fire hydrant, there is a whole set of different
 16 infrastructure, and in order to avoid that
 17 infrastructure — and I have shown pictures of actually
 18 excavation of hydrants in London — you might have
 19 a number of elbows, different connecting pipe and
 20 et cetera, so suddenly that hydrant which performed
 21 extremely well in my lab, when I actually put it in real
 22 operational conditions, because of the connecting
 23 pipework, might have very different performance
 24 characteristics as a whole, and ultimately that impacts
 25 the outcome of how much flow I can discharge.

68

1 So that's why I sort of make that difference between
 2 the kind of almost standalone hydrant versus that sort
 3 of composite flow coefficient.
 4 Q. So composite flow coefficient is the flow coefficient of
 5 an installed hydrant, including the pipes and bends
 6 which connect that hydrant to the rest of the network?
 7 A. Correct.
 8 Q. Whereas a standalone coefficient is just that, the clue
 9 is in the title: the flow coefficient of only the
 10 hydrant tested in factory settings without the
 11 connecting pipework?
 12 A. So in general, yes, but again, as we saw in my response,
 13 even the testing of these hydrants under any forms of
 14 standard includes a small section of connecting
 15 pipework, and they are explicitly taken into account.
 16 So we're not just testing the hydrant as a hydrant; the
 17 test, even according to British Standards, they include
 18 certain connecting pipework, and that's very explicitly
 19 described.
 20 Q. Can we say that a hydrant's composite coefficient is
 21 likely to be lower than its standalone coefficient due
 22 to inevitable pressure losses introduced by pipes and
 23 bends connecting the hydrant to the rest of the network?
 24 A. Correct, it would be equal or less than.
 25 Q. Now, you touched in your answer and I touched in the

69

1 introduction to British Standard 750:2012, which is
 2 entitled "Specification for underground fire hydrants
 3 and surface box frames and covers". We find that
 4 standard at {BSI00001767}.
 5 Can we go to paragraph 10.2, which is on page 13
 6 {BSI00001767/13}. We will see here, under the
 7 subheading "Hydraulic characteristics", paragraph 10.2
 8 stipulates that:
 9 "When fitted with a standard round thread outlet ...
 10 the fire hydrant shall have a Kv value of not less than
 11 92."
 12 Now, the reference to Kv value here is shorthand for
 13 flow coefficient; is that right?
 14 A. Correct.
 15 Q. Now, you say in chapter 4 of your report — and it might
 16 be useful to go to it. {ISTRP00000005/19}. Thank you.
 17 If we could look at line 9, bearing in mind that
 18 Kv value, you said this:
 19 "It is not entirely clear whether the 92 [units] ...
 20 flow coefficient requirement in BS:750:2012 refers to
 21 the hydrant as a standalone valve or when installed in
 22 a water distribution network."
 23 In other words, it is not entirely clear whether the
 24 92 requirement relates to the standalone flow
 25 coefficient or the composite flow coefficient of

70

1 a hydrant. Is that the essential query you're raising
 2 here?
 3 A. Correct.
 4 Q. You go on to say that your view is that it refers to the
 5 composite flow coefficient; is that right?
 6 A. That's right.
 7 Q. Now, if we can just look at the British Standard,
 8 because it's a topic which you considered in your
 9 supplemental report.
 10 Can we go to that report, {ISTRPS00000001/6}. If we
 11 look at paragraph 17, you set out here your belief that
 12 the 92 requirement in the standard refers to the
 13 installed hydrant with connecting pipework, in other
 14 words to the composite flow coefficient, for four
 15 reasons, and you go through these reasons at length over
 16 the next 15 pages. I don't want to go through those
 17 points in detail, but could I summarise them and see
 18 whether you agree that I've summarised them correctly.
 19 The four reasons you rely upon for your
 20 interpretation of the standard are these:
 21 First, it follows an integral principle in systems
 22 engineering, ie that, in engineering, you're less
 23 concerned with individual performance of an isolated
 24 part of a system, and you are more concerned with the
 25 performance of the system as a whole; is that a fair

71

1 summary of that reason?
 2 A. Yes, it is.
 3 Q. Secondly, you refer to BS EN 60534—2—1, which is
 4 a related standard which describes that the process of
 5 testing and certifying the flow coefficient, that's the
 6 Kv value, of a valve — a hydrant's a valve — includes
 7 the connected pipework; is that the second reason you
 8 rely upon for your interpretation?
 9 A. Correct.
 10 Q. Thirdly, you note that evidence from relevant
 11 stakeholders suggests a common understanding that the Kv
 12 requirement of 92 refers to an installed hydrant and
 13 connecting pipework; again, is that a fair summary of
 14 the third reason you rely upon?
 15 A. That's right, because a lot of the stakeholders, they
 16 refer to a particular pressure and particular flow rate
 17 for a hydrant on the basis of which we can then refer
 18 back to that value of 92.
 19 Q. Finally, you refer to the absence of a meaningful
 20 standard if an alternative view is taken. Again, have
 21 I summarised at least the essence of that correctly?
 22 A. That's true, because if we don't have that understanding
 23 of the composite values, and that needs to be
 24 interpreted by a professional who understands these
 25 pitfalls and the ambiguity of the standard, then we have

72

1 no alternative. I can connect that hydrant with
2 a garden hose, using your example, and I would still
3 pass all the British Standards.
4 Q. Now, can I examine your reasoning in more detail of that
5 latter, fourth point, and it's something you set out in
6 detail at page 15 of your supplemental report
7 {ISTRPS00000001/15}, if we could go to that. In
8 essence, what you say is that if the 92 requirement
9 refers to a standalone hydrant in factory conditions,
10 there would be no standard or requirement governing the
11 performance of an installed hydrant, and hydrants could
12 therefore be installed very poorly without breaching any
13 relevant standards. I put that crudely, but is that the
14 essence of what you're saying?

15 A. Yes, it is.

16 Q. Now, your supplemental report acknowledges factors which
17 may be read as pointing in the opposite direction and
18 for an alternative interpretation of the standard. To
19 this end, can we turn over the page to page 16
20 {ISTRPS00000001/16} and look at paragraphs 38 and 39.
21 Dr Stoianov, it's probably easier if I read these
22 out. Paragraph 38 reads thus:
23 "38. I have described above my reasons for adopting
24 what, in my judgement, appears to be the most
25 appropriate interpretation of the requirement, that it

73

1 relates to an installed hydrant with connecting pipework
2 in a water distribution network. I have also explained
3 that the alternative 'standalone' (manufacturing only)
4 interpretation would lead to a surprising absence of
5 legal requirements relating to the installation and
6 real-world efficiency of hydrants.
7 "39. However, given the ambiguity in the wording of
8 BS 750, I cannot go so far as to say that the standalone
9 interpretation is a wholly unreasonable interpretation
10 of BS 750. Elements of the wording of BS 750 may be
11 taken to lend some support to that interpretation. The
12 scope section of BS 750 states that: 'This British
13 Standard applies to underground fire hydrants to be
14 installed in a water supply system ...' ... Following
15 the description of the Kv requirement of 92, BS 750
16 adds: 'The Kv value of the fire hydrant shall be
17 specified in the manufacturer's literature' and there
18 are a number of other references to the manufacturer.
19 These references may be taken to mean that the standard
20 applies to standalone hydrants in manufacturing or
21 factory conditions."

22 Now, bearing in mind what you say there, would you
23 also agree that the absence of a minimum standard
24 relating to a hydrant's flow coefficient, which would
25 exist if the standalone interpretation of BS 750 is

74

1 adopted, while perhaps unsatisfactory, does not mean
2 that we should read British Standard 750 in such a way
3 to bridge that gap?

4 A. I agree. It's ... yes. If I look at it, scrutinise
5 from a very, as you said, legal perspective, yes, the
6 description is very ambiguous. If I look at it from the
7 perspective of a hydraulic engineer, I would have
8 sufficient knowledge to recognise that ambiguity and
9 take it into account.

10 Q. Looking at what you say in paragraph 39, and where you
11 say that the standalone interpretation is not a wholly
12 unreasonable interpretation of that standard, could we
13 look at it slightly differently, ignore the double
14 negative, and accept that the standalone interpretation
15 is a reasonable one, albeit one with which you don't
16 agree?

17 A. Well, as I said, if I am not technically competent,
18 I would find this as a reasonable explanation.

19 Q. Thank you.

20 Can we now look at a separate topic, which is the
21 flow coefficients of the hydrants at Grenfell Tower.

22 As part of your investigation into the water supply
23 to the tower, you carried out testing in July and
24 September 2018 which enabled you to calculate the
25 composite flow coefficients of some of the hydrants at

75

1 the tower, including those that were used to supply
2 firefighting efforts on the night. Is that correct?

3 A. Correct.

4 Q. We can see the detailed results of those calculations at
5 {ISTRP00000008/100}. If that table could be slightly
6 expanded.

7 Hydrant H1 had a flow coefficient of 74; is that
8 right?

9 A. Correct.

10 Q. H3 had a flow coefficient of 50; is that right?

11 A. Correct.

12 Q. Wash-out hydrant H5 had a flow coefficient of 31; is
13 that right?

14 A. Correct.

15 Q. And hydrant H8 had a flow coefficient of 50; is that
16 correct?

17 A. Correct.

18 Q. Now, if your preferred interpretation of BS 750 is
19 adopted, those hydrants should have a composite flow
20 coefficient of no less than 92, so that each of the four
21 on these figures fell well short of that standard; would
22 that be right?

23 A. That's right.

24 Q. However, if the alternative interpretation is adopted,
25 that the 92 requirement refers only to the standalone

76

1 hydrant, is it right to say that you wouldn't be able to
 2 conclude from your testing that the hydrants fell short
 3 of that standard because you were only able to test
 4 their composite flow coefficient?
 5 A. That's right, but the ultimate goal here is to deliver
 6 water for firefighting, so, you know, having
 7 a coefficient of a hydrant which delivers no water is of
 8 no use to anyone.
 9 Q. Can we go back to your supplemental report,
 10 {ISTRPS00000001/16}, and we can see at paragraph 40,
 11 which is at the very foot of that page, you say this,
 12 and it just flows from the point that you have made:
 13 "Even if the alternative view were adopted, that the
 14 Kv [flow coefficient] standard of 92 in BS 750 relates
 15 to a standalone hydrant, one would expect the
 16 installation of hydrants to be carried out in such a way
 17 that the Kv [the flow coefficient] of the hydrant
 18 installed in the water distribution network remains as
 19 close as possible to (or exceeds) 92, by minimising any
 20 possible performance loss from the installation setup
 21 and connected pipework."
 22 Mindful of what you have said there, regardless of
 23 which interpretation of the British Standard is
 24 preferred, would you have expected the flow coefficients
 25 of the hydrants installed at Grenfell to be higher than

77

1 they turned out to be on the basis of the figures you've
 2 identified?
 3 A. This is correct, because, again, that has an implication
 4 on the flow rate which can be delivered to the London
 5 Fire Brigade to perform their duties.
 6 SIR MARTIN MOORE-BICK: I think what we would find it
 7 helpful to know, and I think this is the thrust of
 8 Mr Kinnier's question, is: if we look at the figures
 9 we've got in the table we had up a little earlier, are
 10 they, in your experience, typical?
 11 A. Well, so let me take a step back. The only way we can
 12 identify whether it's typical or not is by doing flow
 13 tests of hydrants, and flow tests of hydrants are not
 14 carried out by the water utilities or by the London Fire
 15 Brigade.
 16 I would like to refer to a paper which was published
 17 a year before the Grenfell Tower fire which was by
 18 a firefighter in southwest London. He did carry out
 19 something along the lines of 600 flow tests to fire
 20 hydrants in southwest London, and his conclusion was
 21 that about 20% of these tests almost were inoperable,
 22 and a very large percentage, almost like over 30%,
 23 I believe, based on memory, had flow rates less than
 24 500 litres per minute.
 25 So, in answer to your question, it seems to be —

78

1 you know, my sample is not representative out of these
 2 five hydrants to draw an exact conclusion, although all
 3 these results show much lower values. But if
 4 I extrapolate this to the kind of publications of
 5 an active firefighter who has gone and done that test,
 6 it seems that this is a very representative sample of
 7 what's happening in London, that most of these
 8 fire hydrants do not have the discharge characteristics
 9 which we expect them to have.
 10 SIR MARTIN MOORE-BICK: Is it possible to say whether the
 11 discrepancies between the standalone coefficients and
 12 the composite coefficients are likely to be due to the
 13 state of the pipework?
 14 A. It's the installation conditions of this, and because we
 15 do not — you know, there is no obligation to flow test
 16 these fire hydrants once these are commissioned, we have
 17 no information. And the regular testing of these
 18 fire hydrants of London Fire Brigade does not include
 19 flow testing of these fire hydrants. It's a lottery.
 20 We don't know what their discharge coefficients and
 21 characteristics would be until LFB have to deliver the
 22 required flow rates.
 23 SIR MARTIN MOORE-BICK: One of the things that seems to me
 24 to come out of this, possibly, relates to the
 25 construction of the British Standard that you were

79

1 referring to a moment ago, because unless there are
 2 factors at work which we're not aware of, if you look at
 3 these figures, it suggests that there can be
 4 a difference of almost 50% between the rated flow rate,
 5 so to speak —
 6 A. Correct.
 7 SIR MARTIN MOORE-BICK: — and the actual flow rate.
 8 A. Correct.
 9 SIR MARTIN MOORE-BICK: Now, I don't know how you can
 10 accommodate that within a standard-setting document,
 11 because if the operational conditions can have that
 12 degree of influence over performance, then how are you
 13 going to know whether you've got hydrants which have
 14 a coefficient of 92? You won't, will you?
 15 A. That was my point, you wouldn't. Unless you test them,
 16 you wouldn't know.
 17 SIR MARTIN MOORE-BICK: But you've got to test all of them
 18 in operation because they've got to have the connected
 19 pipework.
 20 A. Correct, and that's one of my points I made in
 21 chapter 4. In a lot of countries around the world, fire
 22 rescue services have this periodic flow test, full flow
 23 test of hydrants, because it's not just about the
 24 installation conditions, but over a period of time,
 25 these things can deteriorate, and that's why this

80

1 periodic flow test of hydrants becomes extremely
 2 important. And as I pointed out in my results, if
 3 I know the flow discharge characteristics of
 4 fire hydrants — for example, I point out that in France
 5 they do them every five or three years, depends on
 6 certain conditions — and I know the hydraulic
 7 conditions of this system, I can be very definite in the
 8 kind of flow rates the water utility can provide to the
 9 fire rescue service.
 10 SIR MARTIN MOORE—BICK: But this might in turn have
 11 an implication for how one reads the British Standard —
 12 A. Huge, yes.
 13 SIR MARTIN MOORE—BICK: — because, well, it may be more
 14 doubtful that the British Standards Institution is
 15 setting out to prescribe minimum requirements which
 16 themselves are dependent on operating conditions. Do
 17 you see what I mean?
 18 A. This is where, in my response, I tried to track back to
 19 kind of where these values are coming from, and if you
 20 start seeing these kind of variations of British
 21 Standards, I think the overall meaning was lost. So
 22 clearly we need to define that that component has
 23 certain specifications, but that we also need to
 24 recognise that that component, as part of the whole
 25 system, needs to preserve these specifications, because

81

1 ultimately a firefighter expects, let's say,
 2 2,000 litres per minute to come out of a fire hydrant in
 3 London, and that's the ultimate goal we need to deliver.
 4 SIR MARTIN MOORE—BICK: Of course, the British Standard
 5 refers to the flow rate being stated by the
 6 manufacturer. Now, the manufacturer cannot possibly
 7 state a flow rate which is dependent on operational
 8 circumstances, can he?
 9 A. No, he can't, but that's why I was going back to the
 10 notion of performance of components.
 11 SIR MARTIN MOORE—BICK: Yes.
 12 A. So that's a very much component performance. But then
 13 the person who puts that component into the system needs
 14 to be qualified and technically knowledgeable to
 15 recognise the pitfalls what might happen with that
 16 particular component, and that's why ultimately we also
 17 need to have this flow test. So once that hydrant is
 18 installed and commissioned, we need to understand what
 19 actually happened out there, because there's all sorts
 20 of other human factors. I mean, a lot of these
 21 installations are done by subcontractors, probably with
 22 a very low level of supervision, and I've seen many
 23 examples of horrendous installations in that respect.
 24 SIR MARTIN MOORE—BICK: Well, that's helpful, thank you very
 25 much.

82

1 I'm sorry, I have been responsible for a bit of
 2 a digression there.
 3 MR KINNIER: No, it's useful. Thank you, sir.
 4 Can I now turn to another reason for the low flow
 5 rate, which was the use of a wash-out hydrant. It's
 6 a topic we've touched upon earlier, but I'd like now to
 7 turn to it in more detail.
 8 To this end, can we go to {ISTRP00000006/238}, and
 9 paragraph 6. This is what we looked at slightly
 10 earlier, but just to sort of reorientate yourself in
 11 your report. The second reason you identified for low
 12 flow rates was:
 13 "In the case of A245 ALP and S13A1 ALP, the use of
 14 a wash-out hydrant (H5), which was wrongly labelled fire
 15 hydrant. A wash-out hydrant is not designed for the
 16 supply of water for firefighting ..."
 17 If we can go to chapter 6 of your report, which we
 18 find at {ISTRP00000008/79}, we find, at the beginning of
 19 line 10, a sort of more detailed explanation of
 20 a wash-out hydrant and its differences from
 21 a fire hydrant, and you say this:
 22 "H5 is a wash-out hydrant, which is different from
 23 a fire hydrant. As explained in Chapter 4, wash-out
 24 hydrants are used for operational and maintenance
 25 purposes, and enable water companies to flush sediments

83

1 and stagnant water from specific locations. The
 2 flushing is generally done at flow rates significantly
 3 lower than the flow rates expected from fire hydrants
 4 for firefighting. Wash-out hydrants are not aimed and
 5 installed to supply water for firefighting. Wash-out
 6 hydrants look identical to fire hydrants and should be
 7 clearly marked (e.g. with a 'W') to distinguish them."
 8 Now, although they have a different purpose to
 9 fire hydrants, a wash-out hydrant may be structurally
 10 the same as a fire hydrant and connected to the water
 11 network in exactly the same way as a fire hydrant; is
 12 that right?
 13 A. Correct.
 14 Q. If we go to the table at page 100 of chapter 6, which we
 15 find at {ISTRP00000008/100}, we see, if we look for H5,
 16 which is at column 5, that it has the lowest composite
 17 flow coefficient of all the hydrants you tested. That's
 18 presumably something you would have expected due to its
 19 different function and design?
 20 A. Correct, and I've demonstrated a photograph which shows
 21 the installation of hydrants and wash-out hydrants, and
 22 we can visually observe the different pipework
 23 associated with that.
 24 Q. Are you looking for the photograph?
 25 A. Yes, I don't have the document in front of me, so my

84

1 memory (inaudible) —

2 Q. I don't have the reference. I can turn expectantly to
3 someone behind me. I don't have that reference
4 immediately to mind.

5 A. Okay.

6 Q. If we could maybe just move on with some text before we
7 find that photograph.

8 If we can go back to page 79 of chapter 6, which is
9 at {ISTRP00000008/79}, and if we can see in the next
10 paragraph, from line 16 onwards, you say this:

11 "Wash-out H5 is owned by [Thames Water] and it was
12 installed in February 2014. As I detail in Chapter 5,
13 wash-out hydrant H5 was mistakenly labelled 'FH' (fire
14 hydrant) on the metal lid of the hydrant chamber ...

15 Firefighters would not have known that they were
16 connecting a pump appliance to a wash-out hydrant on
17 14 June 2017. However, the digital maps of the TWUL's
18 Network Service Technicians had the information that
19 wash-out hydrant H5 is a wash-out hydrant ..."

20 Now, having been mislabelled "FH", and as wash-out
21 hydrants and fire hydrants otherwise look identical, was
22 there any way for firefighters to identify that H5 was
23 a wash-out, not a fire hydrant?

24 A. Not really. I mean, there was a number of factors which
25 were identified through the witness statements. First

85

1 of all, the mobile data terminal of the pump appliance
2 in close proximity was not working. Secondly, we have
3 witness statements which demonstrate that they tried to
4 attach a standpipe to one of the nearby fire hydrants,
5 which I have also identified was inoperable. And then
6 probably in the night, my assumption is that they just
7 stumbled across this additional hydrant which was
8 labelled fire hydrant, so in the urgency of the
9 situation, it would be extremely difficult, I would
10 imagine, to extensively test that this was actually not
11 a fire hydrant but a wash-out hydrant.

12 Q. Which wasn't practical.

13 A. Was not practical, that's right.

14 Q. Going back to your earlier request, if we can stay in
15 this chapter and go forward to page 81
16 {ISTRP00000008/81}, this is a series of photographs of
17 H5, the wash-out hydrant. Was this what you had in
18 mind?

19 A. Correct. I mean, during my experimental tests,
20 I noticed that — we sort of went through all the kind
21 of hydrants in the area, and I noticed that, clearly
22 from the evidence, this was the hydrant used by London
23 Fire Brigade on 14 June, and I noticed that that was
24 labelled fire hydrant, while my records in the GIS
25 provided by Thames Water, that was labelled as

86

1 a wash-out hydrant. And the other impact of that is
2 that, clearly, LFB would not have been doing any tests
3 on that fire hydrant, even the very basic mechanical
4 tests they were doing.

5 That sort of brings me to the other hypothesis,
6 that, as we know, London Fire Brigade had problems
7 opening that fire hydrant — that hydrant fully, and the
8 network service technicians opened that hydrant fully at
9 about 5.30, and even then the flow rate was very low.

10 So my interpretation of that is because of these
11 mishaps of labelling that hydrant, it was not just the
12 issue of the flow rate, but also there was the issue
13 that there were certain mechanical potential issues with
14 the stem of that particular hydrant.

15 Q. Thank you. Now —

16 A. Sorry, I apologise, just to add up. So I kind of
17 notify — because Thames Water was on site, they were
18 overseeing my work and shadowing my work, I've notified
19 them that this should be a wash-out hydrant, and it
20 seems shortly afterwards that was replaced with
21 a W plate.

22 Q. Thank you. We're going to come on later to the
23 involvement of Thames Water.

24 A. Sure.

25 Q. But could I turn to a further reason for low flow rate,

87

1 and that was pressure losses between the hydrants and
2 the pump appliances.

3 If I can just start off with something basic so we
4 know what we're talking about here, are you referring to
5 pressure losses caused by friction in the hoses used to
6 transport water from the hydrant to the pump appliance?

7 A. That's right.

8 Q. Now, is it right that some degree of pressure loss is
9 inevitable, but that this can be exacerbated by longer
10 hose distances and by bends and kinks in the hoses
11 themselves?

12 A. Correct.

13 Q. To what extent did the long distance between some of the
14 hydrants and the tower add to pressure loss on the night
15 of the fire?

16 A. Well —

17 Q. Are you able to answer that scientifically, if I can put
18 it that way?

19 A. Okay. I mean, clearly, as you said, there is a length
20 of hose which certainly impacts the pressure head losses
21 into that system, and therefore it's extremely important
22 to set up, like, a tandem of pumping. In other words,
23 you're boosting your pressure. You have one appliance
24 very close to the source of water, to the hydrant, which
25 then pumps to another appliance, and that was done on

88

1 the northwest side, but it wasn't done on the east side,
 2 on the hydrant H3, which was on Grenfell Road and
 3 Bomore Road, until very late into the incident, and that
 4 had a significant impact. I mean, the empirical
 5 evidence for us is that this probably, for that
 6 particular — had an impact of probably another
 7 200/300 litres per minute flow rate into the pump
 8 appliance.
 9 Q. Now, we can see, just to give a bit of a practical
 10 example, if we turn to chapter 5 of your report, which
 11 we can find at {ISTRP00000006/21}, at line 7 onwards
 12 a section describing the deployment of the ground
 13 monitor on Grenfell Walk.
 14 If we turn over the page to page 22
 15 {ISTRP00000006/22}, and beginning at line 17, you say
 16 this, and what I think is a practical illustration of
 17 the point you've just made. But what your report says
 18 is this:
 19 "As with A213 TL, this low flow rate was because of
 20 the flow discharge characteristics of the fire hydrant
 21 and the long length (~115m) of fire hoses between fire
 22 hydrant H3 and Pump G272. The pressure losses in the
 23 long length of fire hoses between fire hydrant H3 and
 24 Pump G272 reduced the flow into the tank of Pump G272 by
 25 around 20% of the available flow rate from fire hydrant

89

1 H3. Consequently, the setup of a pump relay between
 2 fire hydrant H3 and Pump G272 at around 06:00 hrs
 3 increased the flow rate in the tank of Pump G272 from
 4 ~1,200 l/min (20 l/s) to approximately 1,500 l/min
 5 (25 l/s); or ~86% of the ground monitor's rated flow
 6 rate of 1,750 l/min (29 l/s)."
 7 Now, there is a lot of technical detail in that
 8 quote, but is the key point that the long length of hose
 9 needed to connect the hydrant to the pump appliance over
 10 100 metres away had the effect of reducing the flow rate
 11 by about 20% or so?
 12 A. Correct.
 13 Q. You also note in this paragraph that, at about
 14 06.00 hours, the LFB was able to mitigate these losses
 15 by setting up a pump relay.
 16 First of all, what is a pump relay?
 17 A. It's a way to boost the pressure within that sort of
 18 system of delivering the water for firefighting. So
 19 pump relay would be you have multiple pumps which might
 20 be, for example, in series or parallel, depending
 21 whether you want to boost your pressure or flow rate in
 22 that particular case. So if I want to boost my pressure
 23 to negate the impact of these pressure head losses, you
 24 would be setting up this operation of pumps in series.
 25 So you have the first pump pumping, in that particular

90

1 case, into the reservoir of the second pump, and that
 2 guarantees a higher flow rate into the second pump to
 3 then deliver the pump discharge pressure.
 4 Q. So it's a boost between the hydrant and the primary pump
 5 appliance?
 6 A. That's right.
 7 Q. Now, the first three reasons you identified for the low
 8 flow rates relate to low flow rates extracted from
 9 hydrants, whereas this fourth one relates to losses in
 10 pressure between hydrants and pump appliances.
 11 A. Correct.
 12 Q. That's a fair summary, isn't it, I think?
 13 A. Correct.
 14 Q. Is it a fair summary of your analysis to say that while
 15 these losses between the hydrants and pump appliances
 16 were also a significant factor, the principal cause of
 17 the low flow rates was the low flow rates extracted from
 18 hydrants?
 19 A. That's right.
 20 Q. Thank you.
 21 I'd now like to move away from some of these
 22 technical matters and to look at the role of
 23 Thames Water itself.
 24 Now, chapter 7 of your report gives a detailed
 25 chronology of the actions taken by Thames Water and its

91

1 employees throughout the incident, including
 2 communications and other interactions between
 3 Thames Water and the LFB.
 4 Is that a fair summary of chapter 7?
 5 A. Correct.
 6 Q. That chapter was based on your review of evidence,
 7 including statements and documents provided to
 8 the Inquiry by Thames Water and the LFB, and transcripts
 9 of calls between Thames Water and LFB personnel; is that
 10 right?
 11 A. Correct.
 12 Q. Now, the LFB first made contact with Thames Water by
 13 telephone at 01.28; is that right?
 14 A. That's right.
 15 Q. We can see an extract of the transcript of that
 16 particular call at {ISTRP00000009/9}. We can at lines 7
 17 to 10 of the table in the top half of that page that the
 18 LFB made a request for a water technician to attend and
 19 for Thames Water remotely to increase the pressure; is
 20 that a fair summary?
 21 A. That's right.
 22 Q. If we stay in this chapter but turn to page 95
 23 {ISTRP00000009/95}, we can see, at paragraph 25, that
 24 before 11.00 am, Thames Water deployed a total of six
 25 network service technicians, NSTs, to attend the

92

1 incident ground at Grenfell; is that a fair summary?
 2 A. That's right.
 3 Q. You refer to the first two as NST1L and NST2D, who
 4 arrived at 02.15 hours; NHS4N and NST3A, who arrived
 5 later at about 04.15; and, finally, NST5M and NST6R, who
 6 arrived at about 07.30 hours; is that right?
 7 A. That's right.
 8 Q. Now, can I next turn to control interventions effected
 9 by Thames Water.
 10 If we can stay in this chapter but go to page 85
 11 {ISTRP00000009/85} and, in particular, section 7.8.1 of
 12 your report.
 13 Now, you say in subparagraph 1 that Thames Water
 14 carried out two control interventions on the night.
 15 First of all, so we understand basic terms, what is
 16 your understanding of a control intervention?
 17 A. This is a very broad term, but in that particular case
 18 means the opening of a valve, and these are specifically
 19 manually operated gate valves.
 20 Q. Now, you identify two control interventions: first of
 21 all, the opening of district boundary valve DBV214263,
 22 which connected pressure reduced area PBARHT08 with
 23 a neighbouring pressure reduced area, PBARHT07, through
 24 a 100-millimetre pipe at about 03.09 hours.
 25 The second intervention was:

93

1 "The opening of district boundary valve DBV214521,
 2 which provides an additional hydraulic connection within
 3 pressure reduced area PBARHT08 through a 100 mm pipe at
 4 11:05 hrs ..."
 5 Now, a district boundary valve is a valve which
 6 connects two different areas of the water network.
 7 Essentially is that correct?
 8 A. This is correct, and I think it would be really helpful
 9 if we can bring some of the schematics I have in
 10 chapter 6 —
 11 Q. If we can take it —
 12 A. — to really visualise this.
 13 Q. I think if we just take it stage by stage, Dr Stoianov,
 14 for these purposes.
 15 A. Okay.
 16 Q. Now, is the rationale for opening boundary valves
 17 between different areas to increase the pressure and/or
 18 reduce the energy losses in the target area by
 19 connecting it to another part of the water network which
 20 has its own inlet from water sources, thereby spreading
 21 pressure losses more broadly across a larger area?
 22 A. That's the intuition, but this is just an intuition. In
 23 reality, that decision cannot be made just by eyeballing
 24 a valve and making that decision. That decision needs
 25 to be made based on a more rigorous hydraulic analysis

94

1 on the operation of the network.
 2 Q. Now, it's really flowing from that point, if we can take
 3 things again stage by stage. Stay on this page,
 4 page 85, and look at line 22. You say this:
 5 "The hydraulic analysis carried out in Chapter 6
 6 indicates that the opening of the two district boundary
 7 valves by TWUL had minimal (no material) impact on
 8 increasing the pressure at wash-out hydrant location H5,
 9 and consequently, the opening of the two district
 10 boundary valves had minimal (no material) impact on
 11 increasing the flow rate from wash-out hydrant H5 into
 12 the on-board tanks of the connected pump appliances;
 13 namely, Pump A241 and later in the incident, Pump S13P1.
 14 Both of these interventions by TWUL were made in
 15 response to requests by LFB for an increase in the flow
 16 rate from wash-out hydrant H5.
 17 "The same conclusion can be extended to all four
 18 hydrants used by LFB to provide water for fighting the
 19 fire; namely that the interventions by TWUL (e.g. the
 20 opening of the two boundary valves by TWUL) had minimal
 21 (no material) impact on increasing the flow rates from
 22 the four hydrants used by LFB into the on-board tanks of
 23 the connected pump appliances."
 24 Now, in layman's terms, you conclude that
 25 Thames Water's actions on 14 June resulted in no

95

1 material improvement in the water supply provided to the
 2 LFB's firefighting equipment; as a lay summary, would
 3 you accept that?
 4 A. I do.
 5 Q. That is based on the analysis you carried out using the
 6 mathematical model of the water distribution network
 7 which we discussed earlier in your evidence.
 8 A. That's right.
 9 Q. Now, can we look at other actions taken by Thames Water
 10 and, in particular, the actions taken by the network
 11 service technicians. I'm going to call them NSTs.
 12 A. That's right.
 13 Q. If we can turn over the page to go to page 86 of your
 14 report {ISTRP00000009/86}, and if we could look at
 15 paragraph 4, which is at the head of that page, there
 16 you describe two further actions taken by the NSTs
 17 during the incident:
 18 "a. between approximately 06:00 hrs and 06:30 hrs,
 19 four NSTs ... assisted with cleaning drains which were
 20 causing flooding around Grenfell Tower and preventing
 21 LFB firefighters from gaining safe access to the
 22 building.
 23 "b. at approximately 06:30, NST4N fully opened a
 24 hydrant in use by LFB (most likely wash-out hydrant H5)
 25 after noticing it had only been opened half a turn. This

96

1 action increased the flow rate from around 380 l/min
2 (flow rate reported by WM Beale ...) to a flow rate of
3 450 l/min to 500 l/min (flow rate reported by
4 SM Payton ...)"

5 Now, again, in lay terms, does that mean that the
6 wash-out hydrant was like a half-open tap with a reduced
7 amount of water coming out of it before the NST noticed
8 it and fully opened it?

9 A. Correct, and I refer to my previous comment, it's
10 because that hydrant was not inspected by LFB, it was
11 not what we call exercised, et cetera, most likely the
12 stem of that valve couldn't operate fully, might have
13 jammed at that point, and that was noticed later by the
14 network service technicians, who opened it a little bit
15 more. Nevertheless, the total flow coefficient of this
16 hydrant remains very low.

17 Q. Now, given your conclusion about the minimal impact of
18 opening the boundary valves, is it right to say that
19 this action by NST4N was likely the most effective
20 intervention by Thames Water, in your view, during the
21 incident in terms of increasing the flow rate?

22 A. I mean, this is where I really struggle to derive
23 a conclusion without referring back to the hydraulic
24 model. You know, these are actions taken by the network
25 service technicians without understanding the hydraulics

97

1 of the system. That's not something we expect from
2 them, to know in great detail. That's kind of the roles
3 of the network management centre. And we've seen from
4 these examples that they received no feedback and
5 guidance from the network management centre to run these
6 what-if scenarios and provide a competent engineering
7 knowledge of these control actions. So at the end of
8 the day, the control action was pure improvisation on
9 behalf of this network service technician, to the best
10 of his knowledge, but that improvisation had no impact
11 and, secondly, he would have no knowledge to judge what
12 impact that would have had.

13 Q. Can we leave that topic and come on to a separate one,
14 which is the communications between LFB and
15 Thames Water. It's linked to the points that you have
16 made.

17 Now, I put this broadly, in chapter 7 you criticise
18 the quality and substance of the communication between
19 the LFB and Thames Water. The summary of your point can
20 possibly be most usefully found at page 93 in this
21 chapter {ISTRP00000009/93}. If we look at paragraph 21,
22 you say this — and forgive me for reading it out, but
23 it's possibly quite useful to, bearing in mind what
24 you've said:

25 "Communication between LFB and the TWUL's NSTs

98

1 occurred on an ad-hoc basis and, consequently, the
2 communication was qualitative, imprecise and lacked
3 technical rigour. LFB Control/Incident Command did not
4 articulate, quantify and communicate their water supply
5 and flow rate needs to the TWUL's NMC."

6 So that's network management centre that you
7 referred to earlier?

8 A. Correct.

9 Q. "Such quantitative requests could have included:

10 "a. A clear statement about the required flow rate
11 for a particular appliance: e.g. the aerial appliance at
12 the East side requires a flow rate of 2,400 l/min
13 (40 l/s), and how can this be achieved?"

14 Then if we can turn over the page
15 {ISTRP00000009/94}, looking at the first b at the top of
16 that page, you say LFB requests could also have included
17 the following:

18 "Periodic updates by the LFB Control to TWUL's
19 [network management centre] as the mobilisation of
20 appliances with significant water flow requirements
21 progressed. Such updates could have included the
22 required water flow rate on the incident ground: e.g.
23 'LFB requires "X" l/min in this area, and this includes
24 an aerial appliance on the East side of Grenfell Tower
25 (2,400 l/min), a ground monitor on the South side

99

1 (~1,900 l/min), a water supply to the dry fire main
2 (~1,500 to 2,000 l/min) ... These are the approximate
3 locations of the mobilised appliances and equipment; can
4 this flow rate be achieved and how?"

5 "22. Furthermore, the TWUL's NSTs do not appear to
6 have requested clear quantitative indications of LFB
7 water supply and flow needs which, if not forthcoming
8 from LFB, NSTs could have proactively requested
9 themselves."

10 Now, having set that out, would you agree that your
11 suggestions here amount to a counsel of perfection, and
12 that you cannot safely comment on whether it was
13 operationally feasible for the Brigade or indeed
14 Thames Water to have detailed quantitative discussions
15 given everything that was going on on the fire ground?

16 A. I disagree with that assessment. I mean, we know very
17 well from, for example, Watch Manager Beale and a lot of
18 the statements, first of all they had a very good
19 understanding of the flow requirements for their
20 appliances. They also knew exactly where they're
21 connected, certainly they could describe that. So that
22 information presents an opportunity to really kind of
23 have the kind of dialogue I'm describing there.

24 On the other hand, it's very common — I mean,
25 I work with many water utilities in England. Their

100

1 incident management procedures include the hydraulic
 2 modeller. That hydraulic modeller is on standby for
 3 that purpose to be able to simulate particular demand
 4 conditions on the network and very quickly provide
 5 a guidance, and that guidance is also taken into account
 6 for fire incidents such as this one. In that particular
 7 case, I see no examples that any forms of hydraulic
 8 modelling has been carried out from these discussions,
 9 and any consideration of any data available to
 10 Thames Water through their telemetry system was taken
 11 into account. So I don't agree with that assessment.
 12 Q. Pushing it slightly further, obviously you have made
 13 a number of observations on the effectiveness and
 14 efficiency of the communication and co-ordination
 15 between the Brigade and TWUL. Now, would you accept
 16 that those are largely matters of operational and
 17 organisational competence for those bodies which don't
 18 obviously fall within the scope of your own experience
 19 and expertise?
 20 A. Yes, I broadly agree with that statement. However, we
 21 also cannot decouple kind of the hydraulics what we
 22 observe without taking into account some of these human
 23 factor interactions, and as someone who has worked both
 24 as an academic and researcher and practitioner into the
 25 water industry in the UK for over 20 years, I find this

101

1 highly inadequate, to have that level of discussion to
 2 define key requirements for making incident-based
 3 decisions.
 4 Q. But the points you raise are points which you would
 5 actively encourage both the LFB and Thames Water to
 6 consider carefully?
 7 A. I think they're absolutely essential if both of these
 8 organisations needs to provide safe and secure supply of
 9 water for firefighting, yes.
 10 Q. Now, can we turn to page 102 of this chapter
 11 {ISTRP00000009/102}, where you discuss alternative
 12 control options that were potentially available to
 13 Thames Water on 14 June, and you've set out four in
 14 particular at paragraph 45. They include the following:
 15 "a. Increasing the pressure in PBARHT08 by switching
 16 on the Hammersmith pumps and turning off the pressure
 17 reduction control for PBARHT08."
 18 I will call that just "08", just for clarity:
 19 "b. Increasing the pressure in [08] by turning off
 20 the pressure reduction control (e.g. by-passing the
 21 pressure reducing valves or fully opening these valves).
 22 "c. Opening boxed/closed inlets such as DM18631.
 23 "d. The utilisation of multiple hydrants to provide
 24 water for firefighting."
 25 Now, could we go through each of those four options

102

1 briefly in turn.
 2 First, you refer to the option of switching on the
 3 Hammersmith pumps. Now, just remind those following, we
 4 saw earlier that the Hammersmith pumping station was one
 5 of the available sources of water in the Barrow Hill
 6 zone, the water network area in which the tower was
 7 found; is that right?
 8 A. That's correct. Again, I would appreciate it if you can
 9 keep to one of these figures, because it can tell fully
 10 the picture what I'm trying to convey.
 11 Q. Okay. We'll just go through and deal with the basics
 12 first.
 13 If we look at paragraph 46 on this page, the normal
 14 cycle in June 2017, which was also followed on 14 June,
 15 was that these pumps operated during the day, but were
 16 automatically turned off at some point between
 17 00.30 hours and 00.45 hours before being automatically
 18 turned on again at 05.30 hours; is that right?
 19 A. Correct.
 20 Q. Now, in layman's terms, can you help us, why would
 21 turning the Hammersmith pumps back on during that time
 22 have increased the water supply to the LFB?
 23 A. Because, again, we are discussing here marginal gains,
 24 cumulative gains into the — increasing the pressure
 25 into the network, and that, as we discussed, might have

103

1 a small impact on the discharge of water from the
 2 fire hydrants. But, nevertheless, we need to put that
 3 into the context: if that discharge of additional 300,
 4 400, 500 litres per minute on a ground monitor allows us
 5 to reach another three floors, that has a significant
 6 impact on the night. That's the reason why I'm trying
 7 to raise this issue, is that the system continued to be
 8 pressure reduced throughout the incident and, in my
 9 view, there was absolutely no justification for that
 10 pressure reduction to continue during that particular
 11 incident.
 12 Q. Bearing in mind your reference in answer there to
 13 marginal gains —
 14 A. Yes.
 15 Q. — are you able to say how significant a difference
 16 turning on the Hammersmith pumps would have made to the
 17 flow rates delivered from the four hydrants to the
 18 firefighting equipment?
 19 A. I would be able to, based on the figures which
 20 I present, demonstrate what the pressure at the inlet to
 21 these pressure-managed areas is and would be, certainly
 22 I can do that, and equally, by turning off the pressure
 23 reduction system in place, we can quantify how much
 24 extra pressure there will be at these particular
 25 hydrants. Then, with regards to the impact of pressure

104

1 and discharge, I would be able to tell you how much
 2 additional flow rate we can get from these hydrants by
 3 doing that particular control intervention.
 4 Q. Bearing in mind your reference to marginal gains, can we
 5 look at matters adjectivally: is it fair to say that any
 6 increase would have been modest at best?
 7 A. That's right. That's a fair assessment. It would be
 8 modest, but another 10 metres of pressure head would
 9 have increased, as I said, again, the flow rate with
 10 the current — with the existing use of hydrants, but
 11 another 2, 3 ... litres per minute, and again, if that
 12 means that marginal gain refers to another two/three
 13 floors of impeding the spread of fire, to me that was
 14 the price worth paying.
 15 Q. Can we look at the second option you refer to in
 16 paragraph 45 on page 102 {ISTRP00000009/102}, and that
 17 was switching off the pressure reduction control which
 18 was in place at the time.
 19 Now, if I can just deal with some basic propositions
 20 first, Dr Stoianov.
 21 First of all, the tower was situated within
 22 a pressure—managed area; is that right?
 23 A. That's right. They are normally —
 24 Q. If we just take it in stages —
 25 A. That's right.

105

1 Q. Good.
 2 Secondly, a pressure—managed area is an area of the
 3 water network in which water companies reduce the water
 4 pressure to reduce the risk of water leaks and pipe
 5 bursts; is that right?
 6 A. They don't reduce the risk, they reduce the leaks,
 7 because it's again orifice discharge.
 8 Q. Thank you.
 9 If we could go to {ISTRP00000008/231}, we can see at
 10 the end of line 11, going through to line 13, you
 11 concluded that the pressure reduction scheme in
 12 operation during the Grenfell Tower fire resulted in
 13 a reduction of pressure of between 7 to 13 metres or,
 14 put differently, 0.7 to 1.3 bar throughout the incident;
 15 is that correct?
 16 A. Correct.
 17 Q. Is that the basis for your conclusion, which we touched
 18 on earlier, that one of the reasons for the low flow
 19 rate extracted from hydrants was "the continued pressure
 20 reduction in the water distribution system by
 21 [Thames Water]"?
 22 A. Correct. But, again, this is the marginal gains that
 23 was relatively — you know, even that sort of 1.3 bar
 24 has a small impact, but then if you take a small impact
 25 from the pressure reduction, a small impact increasing

106

1 the pumps and et cetera, that marginal gain suddenly
 2 becomes more tangible and more beneficial for the
 3 Fire Brigade, particularly in a situation where you're
 4 trying to really maximise both your equipment resources,
 5 outreach, et cetera.
 6 Q. I think you have impliedly given the answer to this
 7 question, but I will ask it explicitly to get the
 8 benefit of your evidence: does it follow that turning
 9 off the pressure reduction control during the incident
 10 would have resulted in a corresponding increase of 7 to
 11 13 metres or 0.7 to 1.3 bar in pressure?
 12 A. That's my estimate, yes.
 13 Q. Again, you have been very fair in saying we're looking
 14 here at marginal increases. Again, would that increase
 15 in pressure have been at the modest end of the spectrum?
 16 A. That's right, but you have to take that into two
 17 particular directions: one of them is the use of the
 18 hydrants as used by London Fire Brigade, and the other
 19 one is it demonstrated if London Fire Brigade, with the
 20 guidance of Thames Water, was starting using multiple
 21 hydrants, that would have had a much bigger impact.
 22 Q. In relation to each of these two options we have been
 23 discussing, turning on Hammersmith pumps and turning off
 24 the pressure reduction control, you observed in your
 25 report that Thames Water did not follow those options

107

1 because of concerns that the resulting increase in
 2 pressure could lead to pipe bursts. We don't need to go
 3 to it, but it's at {ISTRP00000009/101}.
 4 Now, if we can go and look at —
 5 A. May I just say that there were two conflicting
 6 statements.
 7 Q. If you can just wait for the question, rather than
 8 giving the answer to a question that hasn't yet been
 9 asked.
 10 Can we go to {ISTRP00000009/106}, and if we could
 11 look at section 7.8.7 which, as you will see, is under
 12 the emboldened headline, "The risk of pipe breaks from
 13 turning on the Hammersmith pumps and/or turning off the
 14 pressure reduction control".
 15 You conclude, if we look at line 7:
 16 "... there was a minimal risk of pipe breaks from
 17 turning the pumps on at Hammersmith Pumping Station and
 18 turning off the pressure reduction control in [08]."
 19 So 08, that's the pressure—managed area in which
 20 Grenfell Tower is found; is that right?
 21 A. That's right.
 22 Q. Sorry, that's a point I should have put to you earlier.
 23 Just so we're absolutely clear about terms that have
 24 been used here, "pipe breaks" and "pipe bursts" are
 25 synonymous terms, aren't they? They're describing the

108

1 same thing.
 2 A. Yes, they are.
 3 Q. Now, your reasoning to support this conclusion is found
 4 in the next paragraph. Essentially, to summarise the
 5 position — and please disagree if I've not done this
 6 fairly or completely — (a) the pipes had been in place
 7 for a number of years before the pressure—reduction
 8 areas were introduced, meaning they already had a track
 9 record of operating successfully without pressure
 10 reduction; secondly, that the increased pressure would
 11 still have been within the rated or recommended levels
 12 for those pipes, 82% of which were relatively new.
 13 Have I fairly summarised your reasons for the
 14 conclusion which we've just looked at?
 15 A. That's right. I mean, the network was fairly new. It
 16 was part of the Victorian renovation mains programme
 17 Thames Water has been running for a while, and that's
 18 very unique, in a way. We had pipes — high—density
 19 polyethylene pipes with age less than ten years, so they
 20 were certainly within the — very much their pressure
 21 rating was within the pressure operating there. But the
 22 other thing is that the pressure—managed scheme was only
 23 implemented in April 2017, or two months before the
 24 actual incident. So if the pipes had been operated
 25 under these conditions for a good eight/ten years, there

109

1 is no reason suddenly to believe that by turning back to
 2 the pressure management conditions which were in place
 3 just two months ago, suddenly it will increase the risk
 4 of pipe failures.
 5 Q. Bearing that in mind, would you agree that increased
 6 pressure in the network that would have resulted from
 7 turning on the Hammersmith pumps or turning off the
 8 pressure reduction control would have increased the
 9 stress experienced by pipes in the network, which
 10 brought a risk, even if small, of causing a burst in the
 11 more vulnerable parts of the network which had older,
 12 unreplaced pipes?
 13 A. Again, just referring that clearly these pipes were
 14 subjected to this kind of stress just two months before
 15 the fire. And the other thing you have to bear in mind
 16 is that one phenomena which we haven't accounted for is
 17 during the pumping, the operation of these pumps, as we
 18 discussed, they were continuously on and off. That
 19 sudden discharge was creating a huge level of pressure
 20 transients into the system itself. So, as a result of
 21 that, these pipes had already been subjected to quite
 22 a lot of stress, and my engineering judgement, having
 23 dealt with a lot of pipe failures, would be that the
 24 risk is actually minimal to go back to a pressure
 25 management scheme which was in place just two months

110

1 ago.
 2 Q. Just bearing in mind the question that you're asked,
 3 would you accept that the increased pressure from
 4 turning on Hammersmith pumps, turning off pressure
 5 reduction control, would have brought a risk, even if
 6 small, of causing a burst in the more vulnerable parts?
 7 Could I have an answer to the question?
 8 A. Yes, how can we quantify this?
 9 Q. Well, I think it was put to you as small. Would you
 10 accept that?
 11 A. Yes.
 12 Q. Would you agree that a burst in one of the distribution
 13 pipes could have led to the loss of substantial volumes
 14 of water and wider spread depressurisation of the
 15 surrounding network?
 16 A. Yes.
 17 Q. And would you agree that such an event occurring on the
 18 night of the fire would have put at risk the entire
 19 water supply to the tower?
 20 A. Correct.
 21 Q. Now, the third alternative intervention option you
 22 identified at page 102 {ISTRP00000009/102}, and if we
 23 could go back to that page, please — apologies for
 24 jumping round, Dr Stoianov — you identified there, we
 25 can see at line 10:

111

1 "c. Opening boxed/closed inlets such as DM18631."
 2 Again, a technical term, but is the opening of
 3 a boxed/closed inlet similar to the opening of
 4 a district boundary valve, which we discussed earlier,
 5 with the key difference that while the boundary valves
 6 opened by Thames Water simply connected the water
 7 network at the tower to other areas which were also
 8 undergoing pressure reduction, and here you refer to the
 9 opening of a valve or inlet which would have helped to
 10 bypass the pressure reduction?
 11 A. That's right. But can I just again point out —
 12 Q. Please do.
 13 A. — that in my correspondence with Thames Water and
 14 questioning Thames Water, we received two contradictory
 15 statements. One of the statements was very clearly
 16 identified by Thames Water that pumps could have been
 17 turned on and pressure reduction could have been turned
 18 offer, but a request for that was not received. So it
 19 seems that Thames Water contradicts its own assessment
 20 post—Grenfell, that one of the responses is, "Yes, we
 21 could have done it, we just didn't get the request", and
 22 the second version of events or explanation was
 23 supporting the logbook on the night of the fire, which
 24 basically says, "We perceive a higher risk of pipe burst
 25 if we actually implement this control operation in

112

1 place". So even from a point of view of Thames Water,
 2 it seems that there is a lot of contradiction, and again
 3 it's an issue which is very difficult for us to assess.
 4 I don't think anyone could really assess small risk in
 5 that space.
 6 Q. No. That's possibly a matter for the panel in due
 7 course.
 8 A. Yes.
 9 Q. Now, the final option you refer to in paragraph 45 on
 10 page 102 is the utilisation of multiple hydrants to
 11 provide water for firefighting. Now, that refers to the
 12 use of more than one hydrant to supply a single pump
 13 appliance to maximise the flow rate delivered from the
 14 network to the pump appliance. Am I right about that?
 15 A. Correct.
 16 Q. Would you accept that Thames Water staff aren't experts
 17 in operational firefighting? Presumably you do.
 18 A. Absolutely.
 19 Q. Would you accept that Thames Water staff don't have
 20 detailed knowledge of the workings and set-up of pump
 21 appliances and other firefighting equipment?
 22 A. Can I just again, the caveat is probably not — I would
 23 not expect the network service technicians to have that
 24 knowledge, but I would expect the network management
 25 control centre to actually have that knowledge, or at

113

1 least have some understanding of how this provision of
 2 water for firefighting can be done with the utilisation
 3 of multiple hydrants.
 4 Q. When you say "some understanding" ...
 5 A. Yes, I mean, the request is to extract large volumes of
 6 water from your water distribution network, and that's
 7 subject to, again, running a hydraulic model with
 8 a specific loading condition, and it's a very
 9 computationally efficient way to do it. One can do it
 10 literally within a few minutes.
 11 Q. Would you accept, just looking at it slightly
 12 differently, that Thames Water are not well placed to
 13 advise a fire and rescue service on what equipment to
 14 use, how to deploy it, et cetera?
 15 A. I — so, yes, and I totally agree with the overall gist
 16 of that message. But, equally, as an operator, if you
 17 get a request for increase in pressure, et cetera, my
 18 engineering kind of training would prompt me to ask
 19 questions: what exactly do you want? How much do you
 20 want? What flow rate do you want? Et cetera. These
 21 are very basic engineering questions to ask to quantify
 22 so that I can assess to what extent my system can
 23 respond to that and advise you accordingly.
 24 Q. Really your criticism is focused on asking those basic
 25 questions, isn't it, and nothing more than that?

114

1 A. That's right.
 2 Q. Can I turn now on to a separate topic, which is
 3 an assessment of higher flow rates and whether they
 4 could have been achieved.
 5 To this end, can we go to {ISTRP00000008/216}. If
 6 we can look at line 8, you explain your assessment in
 7 the following terms:
 8 "This Assessment investigates whether a higher water
 9 flow rate could have been provided from the water
 10 distribution network, based on the mathematical
 11 modelling of pressure and flow in the water distribution
 12 network using the validated hydraulic model of the water
 13 described in this chapter.
 14 "The analysis for this Assessment includes the
 15 formulation of an optimisation problem, which selects an
 16 optimum number of fire hydrants for LFB to connect to,
 17 in order to deliver target water flow rates from the
 18 water distribution network to efficiently (100%) utilise
 19 firefighting appliances and equipment. The formulated
 20 optimisation problem considers the hydraulic (flow and
 21 pressure) conditions in the water distribution network,
 22 the available fire hydrant locations, their discharge
 23 characteristics (flow coefficients) together with the
 24 control settings of pressure reducing valves (PRVs) at
 25 the inlets of the water distribution network as decision

115

1 variables."
 2 Now, the rest of section 6.8 explains in far greater
 3 detail how you carried out the assessment.
 4 In broad terms, is it right to say that the
 5 assessment used mathematical modelling to calculate
 6 whether, given the hydraulic conditions on the night of
 7 the fire, there was an optimum combination of hydrants
 8 that could have delivered greater flow rates to
 9 firefighting equipment?
 10 A. That's right.
 11 Q. Now, the results of the assessment are set out at the
 12 top of page 226 in this chapter {ISTRP00000008/226},
 13 which I'd be grateful if we could go to. We can see at
 14 the top of the page you say this, starting at line 3:
 15 "1. It was possible to achieve a flow rate of
 16 7,460 l/min (124 l/s) without changing the control
 17 settings for the pressure reduction scheme on 14 June
 18 2017 providing that LFB utilised multiple hydrants (e.g.
 19 fire hydrants 1, 3, 8, 4 and 7 ...).
 20 "2. It was possible to achieve a flow rate of
 21 12,000 l/min (200 l/s) by changing the control settings
 22 for the pressure reduction scheme on 14 June 2017 and
 23 providing that LFB utilised multiple hydrants (e.g. fire
 24 hydrants 1, 2, 3, 4, 5, 7, 8, 11, 13 and 14 ...)."
 25 Now, taking a step back from that, that seems to

116

1 show — and please say if this is not a correct
 2 summary — that your modelling showed that a total flow
 3 rate of 7,400 litres per minute could theoretically have
 4 been achieved without turning off the pressure reduction
 5 in the network or, alternatively, 12,000 litres per
 6 minute if the pressure reduction had been turned off; is
 7 that fair?
 8 A. That's right.
 9 Q. For context, the peak flow rate actually delivered on
 10 14 June 2017 was about 4,320 litres per minute; is that
 11 correct?
 12 A. That's right.
 13 MR KINNIER: Could we go to page 218 in this chapter
 14 {ISTRP00000008/218}, please.
 15 SIR MARTIN MOORE—BICK: Mr Kinnier, can I just ask you,
 16 sorry, on the page we've just left {ISTRP00000008/226},
 17 it suggested that the LFB could have used, what, ten
 18 hydrants?
 19 MR KINNIER: Yes.
 20 A. That's right.
 21 SIR MARTIN MOORE—BICK: How far away would they be from the
 22 site of the fire? Would it be worth looking at the
 23 little diagram?
 24 MR KINNIER: I'm trying to find ... if I can be given the
 25 reference to the map of the area.

117

1 A. So, just for context, clearly here what we've done is
 2 we've used the mathematical model, which simulates the
 3 distribution of flow and pressure —
 4 SIR MARTIN MOORE—BICK: Yes.
 5 A. — and also the formulation of this optimisation problem
 6 to say — find, given the flow coefficient — we assume
 7 that we know the flow coefficient of hydrants, that's
 8 why it's so important. Given the flow coefficient of
 9 hydrants, extract that maximum flow rate with a minimum
 10 distance to hydrants. So that was the formulation of
 11 the optimisation problem.
 12 SIR MARTIN MOORE—BICK: Right.
 13 A. But, equally, one does not need to run that more
 14 sophisticated optimisation problem; one can go and just
 15 pick up hydrants and say, "I'm going to fully open that
 16 hydrant, and if I get these things, what impact does it
 17 have?" And that is kind of the importance of having
 18 this technical knowledge and analysis available in
 19 almost near real time, which I see no reason why
 20 Thames Water couldn't have performed that duty.
 21 The other option is what happened on the night
 22 where, as I highlight in chapter 7, there is this
 23 complete mismatch of communication. You know, you have
 24 a representative from the London Fire Brigade who says,
 25 "Give me more pressure", and at the same time you have

118

1 a technician from Thames Water who looks and, in their
 2 mindset, pressure in the network is pretty good, and
 3 they say, "We can't deliver any more", and then the
 4 intuition of making the decision on behalf of the fire
 5 rescue service is, "We can't get any more flow, so let's
 6 just keep whatever we are doing".
 7 SIR MARTIN MOORE—BICK: All right.
 8 MR KINNIER: Could I go to the diagram, just before the
 9 break, if it would help you, sir?
 10 SIR MARTIN MOORE—BICK: Well, I'd just be interested to see
 11 it, to be honest.
 12 MR KINNIER: Could we go to {ISTRP00000006/6}, which should
 13 give us figure 5—2, and if that could be expanded.
 14 A. If it's more helpful, I have the solution of this
 15 specifically with the diagram of hydrants which were
 16 identified into ... I don't have the report in front of
 17 me, but certainly there was a diagram of that.
 18 MR KINNIER: It might be.
 19 Given the time, sir, if we could see the particular
 20 diagram — we can find the diagram to which Dr Stoianov
 21 is referring and maybe draw it up when we return at
 22 2.00.
 23 SIR MARTIN MOORE—BICK: Would that be convenient?
 24 MR KINNIER: Yes.
 25 SIR MARTIN MOORE—BICK: All right.

119

1 Well, Dr Stoianov, we will look at the diagram, but
 2 after lunch. All right? So we will stop there. We
 3 will resume, please, at 2 o'clock, and again, while
 4 you're out of the room, please don't talk to anyone
 5 about your evidence or anything relating to it. All
 6 right?
 7 THE WITNESS: Thank you very much.
 8 SIR MARTIN MOORE—BICK: Thank you very much.
 9 (Pause)
 10 Thank you, Mr Kinnier. 2 o'clock, please.
 11 MR KINNIER: Thank you, sir.
 12 SIR MARTIN MOORE—BICK: Thank you.
 13 (1.01 pm)
 14 (The short adjournment)
 15 (2.00 pm)
 16 SIR MARTIN MOORE—BICK: Right, Dr Stoianov, ready to carry
 17 on?
 18 THE WITNESS: Yes, I am, thank you.
 19 SIR MARTIN MOORE—BICK: Thank you very much.
 20 Yes, Mr Kinnier.
 21 MR KINNIER: Thank you, sir.
 22 Before the break, Dr Stoianov, we were searching for
 23 a diagram which showed all the hydrants. We think we
 24 have found the diagram to which you were referring, so
 25 could we look at {ISTRP00000008/219}. If the diagram,

120

1 figure 6—114, could be expanded.
 2 (Pause)
 3 Sometimes these things take time, so don't worry.
 4 A. I appreciate this.
 5 (Pause)
 6 Q. Thank you.
 7 That shows, I think, the hydrants which we were
 8 discussing before lunch, and I think in the centre we
 9 see FH1, and immediately below that is a circle with two
 10 bits coming off it. That's the private hydrant; is that
 11 right?
 12 A. Correct. Just, first of all, what this figure shows is
 13 the hydrants which are within the area of
 14 Grenfell Tower. All the hydrants which I considered in
 15 my analysis are within 300 metres from Grenfell Tower on
 16 this diagram, and the assumption was that these hydrants
 17 could be accessed with a pump relay, with a single pump
 18 relay, very much as LFB has done.
 19 Just a little bit more context to this diagram and
 20 the analysis. Clearly the diagram also assumes, and the
 21 analysis also assumes, that we have some estimates about
 22 the flow coefficients of hydrants which normally should
 23 be a regular practice of flow testing, so that's one
 24 aspect.
 25 The second aspect, what it does is it runs the

121

1 analysis for loading conditions or for demand, which
 2 first of all take into account a standard PDA procedure
 3 of LFB, you know, pre-determined attendance procedure,
 4 which includes a single aerial appliance for high-rise
 5 buildings. So, in other words, what I assume for these
 6 7,500 litres per minute is that I have one aerial
 7 appliance of about 4,200 litres per minute, let's assume
 8 that they have to deploy also a ground monitor of about
 9 1,600 litres per minute, then there needs to be about
 10 1,500 litres per minute for internal firefighting, so
 11 this is very much, I would imagine, a reasonable
 12 assumption, to assume that if a PDA includes that
 13 appliances, we need to have sufficient flow rate to
 14 fully deploy these appliances, and that's where the
 15 7,500 litres per minute come from for this first
 16 analysis.
 17 The second —
 18 Q. Sorry, Dr Stoianov, my question, some time ago now —
 19 A. Okay.
 20 Q. — was simply to confirm the diagram.
 21 A. It is.
 22 Q. Thank you.
 23 I want to sort of return back to where we were,
 24 doctor, and deal with the assessment of whether higher
 25 flow rates could have been achieved. I think some of

122

1 the points you are adverting to now we can better
 2 address in a more focused way as we go through that
 3 particular topic.
 4 A. Okay.
 5 Q. Now, could we go back to {ISTRP00000008/218}. This is
 6 an extract from your report, and it sets out some points
 7 which are relevant to the assumptions that you made in
 8 the assessment which we were discussing before the break
 9 and which you have been touching upon again.
 10 What it sets out there, under the heading "6.8.1.2
 11 Assessment 2: assumptions", is this:
 12 "It is important to note the limitations for this
 13 Assessment. The estimated flow figures scenarios above
 14 [the flow rates of 7,400 and 12,000 which the assessment
 15 tested] are for illustrative purposes only, to assess
 16 from the perspective of the water distribution network
 17 whether it would have been possible to supply those flow
 18 rates given the hydraulic conditions in the network.
 19 "None of the above should be interpreted as any
 20 suggestion on my part as to which appliances or
 21 equipment LFB could or should have deployed on the night
 22 of the fire, those being questions far beyond both my
 23 expertise and the scope of this report.
 24 "The Assessment further relies on the following
 25 factors:

123

1 "1. LFB having up-to-date knowledge of the
 2 operational status and flow discharge characteristics of
 3 fire hydrants based on flow tests of fire hydrants (this
 4 does not appear to have been the case at Grenfell
 5 Tower ...);
 6 "2. LFB using multiple fire hydrants to supply water
 7 to individual aerial appliances (e.g. LFB setting up
 8 pump relays as done for fire hydrant H8 ...)
 9 "3. TWUL [Thames Water] providing expert
 10 engineering guidance and support to LFB, including the
 11 use of a hydraulic model and near real time hydraulic
 12 telemetry data ..."
 13 Now, in addition to the factors and assumptions
 14 listed there, is it also important to make clear that
 15 you don't know about and cannot comment on whether it
 16 would have been logistically possible or operationally
 17 feasible for the LFB to have used the specific optimum
 18 combination of the specific ten hydrants identified by
 19 this assessment in order to achieve those flow figures?
 20 A. Correct.
 21 Q. So, for example, some of the hydrants identified may not
 22 have been in operationally suitable locations due to
 23 access problems or other difficulties which are
 24 understandably beyond your knowledge and expertise?
 25 A. Correct. As I said, this is an illustrative example of

124

1 a process that — analytics that could have been
 2 deployed.
 3 Q. This assessment was calculated using a complex
 4 mathematical model which you validated and refined
 5 following physical testing carried out after the fire ;
 6 is that right?
 7 A. That is correct, but I also have expectations that water
 8 utilities should and they do that sort of level of
 9 analysis on a regular basis.
 10 Q. Now, the mathematical modelling you used also factored
 11 in the flow coefficients of the hydrants at or near the
 12 tower which you were able to calculate following
 13 a series of tests you carried out in 2008; is that
 14 right?
 15 A. 2018, yes.
 16 Q. 18, apologies, yes. That data, of course, wasn't
 17 available to anyone on 14 June 2017.
 18 A. No, that's absolutely correct, but as an engineering
 19 judgement, I can make certain assumptions about these
 20 flow coefficients if I'm faced with the need to run that
 21 sort of level of analysis.
 22 Q. Whatever data was available at the time of the fire, for
 23 quite proper reasons, you're not in a position to
 24 comment on whether it would have been practically
 25 possible for Thames Water to carry out these kind of

125

1 complex mathematical modelling and hydrant optimisation
 2 calculations in real time in the midst of the incident
 3 in the early hours of 14 June 2017; would you agree with
 4 that proposition?
 5 A. Not entirely, no.
 6 Q. Let's take it in stages. What do you agree with, then?
 7 A. I agree that running probably a complex — formulating
 8 this as an optimisation problem might have been beyond
 9 the scope and knowledge of Thames Water on the night of
 10 the fire. But, equally, the problem what I'm describing
 11 could have been enumerated manually. In other words,
 12 Thames Water had access to a hydraulic model, they had
 13 access to near real-time telemetry coming from their
 14 system, and that would have been sufficient to run the
 15 hydraulic model and manually almost pick up hydrants and
 16 demonstrate that larger flow rates could have been
 17 extracted. They might not have been optimal, as optimal
 18 defined in mathematical terms, but they would have been
 19 far greater than what was achieved on the night of the
 20 fire.
 21 Q. If Thames Water had been able, for example, to carry out
 22 an exercise in mathematical modelling and hydrant
 23 optimisation calculations in real time in the middle of
 24 the incident, and were indeed able to communicate the
 25 ideal combination of hydrants to the LFB, that would

126

1 likely have required the LFB to completely reorganise
 2 its water supply set-up midway through the incident,
 3 which of itself would have caused disruption and delay.
 4 Again, would you agree with that proposition?
 5 A. I agree that that would have required the LFB to change
 6 their operational strategies, but I wouldn't go as far
 7 as stating that this would delay activities. So I don't
 8 know how that conclusion can be drawn, that this would
 9 delay activities, because if you look — and I'm just
 10 observing facts here, by no means this is part of my
 11 competence, but if I look at the statements made by
 12 Incident Commander Roe and O'Loughlin, they completely
 13 dismissed the role of the use of water in the
 14 firefighting operations.
 15 Q. But is it fair to say that, looking at the assumptions
 16 you yourself have set out in the report and the
 17 limitations you have fairly conceded there, the answers
 18 you have, again, fairly given to the points I've put to
 19 you just now, that the results of the assessment about
 20 flow rates are what theoretically could have been
 21 delivered from the water distribution network in optimum
 22 hydraulic conditions, and they don't allow us to draw
 23 any safe conclusions about what flow rates the LFB and
 24 Thames Water could or should have achieved on the night?
 25 A. I guess, yes.

127

1 Q. Can I now turn to a separate topic, which —
 2 A. Just before we move away, can I just also note that the
 3 analysis I carried out was carried out for peak demand,
 4 and that prompted me because the network management
 5 centre of Thames Water raised serious concern that as
 6 demand picks up, they will have significant problems.
 7 So I ran that analysis on the worst-case scenario, which
 8 was the morning peak demand at 8 o'clock in the morning.
 9 Q. Thank you.
 10 The next section I'd like to turn to is whether
 11 regulatory standards relating to the supply of water
 12 were met.
 13 For this purpose, if we could turn to
 14 {ISTRP00000005/48}. In this part of your report, you
 15 provide, usefully, an overview of the relevant statutory
 16 and regulatory standards that apply to the provision of
 17 water. I'd like to go through those standards that
 18 apply to various aspects, such as water pressure, flow
 19 rate and the rest of it.
 20 Turning, first, though, to water pressure, you set
 21 out at paragraph 2, which starts at line 7 on that page,
 22 this:
 23 "The Water Supply and Sewerage Services (Customer
 24 Service Standards) Regulations 2008 (the
 25 GSS Regulations) require a minimum pressure of 7 m

128

(0.7 bar) static head (pressure) in the communication pipe supplying premises with water. Ofwat [the water regulator] also refers to a 'reference level of service' of 10 m pressure on the customer's side of the main stop tap. Due to the practical difficulties of measuring pressure there, Ofwat suggests that water companies instead use a 'surrogate' measure of 115 m pressure head in the adjacent distribution main and this is common industry practice."

If we could go to page 234 of chapter 6, which we find at {ISTRP00000008/234}, at paragraph 6.9.6 you set out your conclusions in relation to the pressure levels on 14 June 2017, and we can see, at paragraph 29 at the foot of that page, this:

"I mathematically simulated the pressure heads at each hydrant used by LFB to supply water for firefighting on the 14 June 2017. The lowest estimated pressure head is 25 m (2.5 bar) for the fire hydrant H8 ... The pressure head at hydrants H1 (a fire hydrant), H3 (a fire hydrant) and H5 (a wash-out hydrant) varied between 29.4 m and 35.8 m pressure head (2.9 bar to 3.5 bar)."

You go on to say these minimum pressure figures on 14 June exceeded, indeed comfortably exceeded, both the 0.7 bar and the 1.5 bar regulatory standards. Is that

129

a fair summary of your position?

A. It is.

Q. Thank you.

Can I now turn to water flow rate.

For this purpose, can we go to {ISTRP00000005/48}, and if we could look at paragraph 3 in particular.

If we could look at paragraph 3, you note there that:

"Section 38(1) of the Fire and Rescue Services Act 2004 states that a 'fire and rescue authority must take all reasonable measures for securing that an adequate supply of water will be available for the authority's use in the event of fire.'"

Elsewhere in this chapter {ISTRP00000005/11} you note that:

"The statute provides no further detail on what constitutes an 'adequate' supply and there is no minimum flow rate figure explicitly stipulated in the Fire and Rescue Services Act 2004."

Now, there is guidance, I think you identify in your report, and if we continue in paragraph 3 on the page that's on the screen, we see at the end of line 21 you say this:

"The National Guidance Document on the Provision of Water for Fire Fighting ... recommends a flow rate of

130

20 l/s to 35 l/s (1,200 l/min to 2,100 l/min) for multi occupied housing developments of more than two floors (such as Grenfell Tower)."

Now, that's a long run—up to a question, which is: looking at flow rate that was actually delivered to the tower, we referred to this briefly and earlier in your evidence, and can we go to page 231 of chapter 6, which is at {ISTRP00000008/231}, and we can see at paragraph 14 you state there:

"The estimated peak fire flow used on Wednesday 14 June 2017 was approximately 72 l/s (4,320 l/min)."

Apologies for a very long run—up, but necessary to this question: the flow rate at Grenfell comfortably exceeded the recommended flow rate in the national guidance document; is that a fair conclusion?

A. Yes, with a lot of caveats, but yes.

Q. But essentially yes?

A. Yes.

MR KINNIER: If we can go to —

SIR MARTIN MOORE—BICK: That sounded like a rather guarded reply. You say with a lot of caveats; I think possibly we ought to know what you say about that.

A. I mean, I find a lot of these documents — first of all, they are not regulatory documents, they just provide recommendations in that respect, and they have —

131

there's a lot of ambiguity between these numbers. So if I take the number of the national guideline document for the provision of water, first of all, I've identified a number of limitations. It gives a certain flow rate between 1,200 to 2,400 litres per minute, so this is a very wide range.

At the same time, that wide range, it doesn't really seem to match the pre-determined attendance, again going back to my point that if the London Fire Brigade has pre-determined attendance to deploy an aerial — and as we learned from the press recently, they've purchased a whole set of new aerial ladder platforms — does that mean that you're purchasing a Rolls Royce and you're driving this Rolls Royce in first gear because purely you don't have the capacity to utilise that equipment? And that's the kind of — that's the caveats I want to put around. There are these numbers, but actually the meaning of these numbers, it's hugely questionable.

SIR MARTIN MOORE—BICK: All right, thank you.

MR KINNIER: I was going to draw you now to the points which you would want to caveat that with —

A. Okay.

Q. — so I was going to come to those questions now.

If we can go to {ISTRP00000005/14}, I think really I want to take you through the issues which you say the

132

1 guidance document doesn't take account of but it should
2 in order to provide, I think, a more satisfactory or
3 tolerably reliable figure.

4 In essence, we can see from the underlined
5 subheadings on that page the facts and matters which you
6 think ought to be accounted for which aren't: first of
7 all, the size of the building; secondly, the building
8 materials used and the extent of compliance with
9 Building Regulations; thirdly, the presence of fire
10 protection systems, such as sprinklers; finally, whether
11 or not an aerial appliance is required.

12 Are those the particular points which you feel the
13 national guidance document ought to consider but it
14 doesn't?

15 A. Correct.

16 Q. The final matter I would like to take you to is the
17 quantity of water and compliance with regulatory
18 standards in that regard.

19 To this end, can we stay in this particular chapter
20 but go to page 48 {ISTRP00000005/48}, and if we look at
21 paragraph 4 at line 28 on that page, dealing here, as
22 the subheading indicates, with quantity of water, is it
23 right to say that quantity of water is simply about
24 there being enough in the system, so it's not going to
25 run out, whereas flow rate is about how much water can

133

1 be delivered at any particular given time?

2 A. Correct.

3 Q. Now, your report addresses the available quantity of
4 water on 14 June on page 229 of chapter 6, which we find
5 at {ISTRP00000008/229}. If we look at paragraph 2, the
6 report lists the sources of water which reply the
7 Barrow Hill zone in which the tower is found. At
8 paragraph 3 you say this:

9 "The average daily demand for the Barrow Hill Zone
10 in 2017 was estimated at 116.58 megalitres per day, or
11 the equivalent of 80,958 l/min (1,349 l/s). In
12 comparison, the maximum flow rate used by LFB for
13 firefighting on the 14 June 2017 did not exceed
14 4,320 l/min (~72 l/s), and this water flow rate for
15 firefighting peaked at hours of minimum water
16 consumption."

17 Then if we go slightly further down the page to
18 paragraph 5, you concluded thus:

19 "The Barrow Hill zone had no water storage and/or
20 water availability constraints to be able to meet, and
21 significantly exceed, the water demand for fighting the
22 fire at Grenfell Tower."

23 Now, in your view, therefore, is it safe to say that
24 the quantity of water available for firefighting was
25 more than adequate?

134

1 A. Yes, definitely.

2 MR KINNIER: Dr Stoianov, those are all the questions I have
3 for you now.

4 Sir, might I ask for the usual break of, say —

5 SIR MARTIN MOORE—BICK: Yes.

6 MR KINNIER: — quarter of an hour to see whether I have
7 missed anything or to see whether there are any
8 particular points that anyone else would like me to
9 raise.

10 SIR MARTIN MOORE—BICK: Yes. Very well.

11 Well, Dr Stoianov, when we get to this stage and
12 counsel thinks he's asked all the questions he ought to
13 ask, we always have a short break to give him a chance
14 to check that he has not overlooked anything —

15 THE WITNESS: Okay.

16 SIR MARTIN MOORE—BICK: — and also to give other people who
17 are following the proceedings from elsewhere the chance
18 to suggest questions which perhaps ought to be put to
19 you.

20 So we're going to break now. We'll resume at 2.40,
21 please, and at 2.40 we'll see if there are any more
22 questions for you. All right?

23 THE WITNESS: Okay, thank you.

24 SIR MARTIN MOORE—BICK: Thank you very much.

25 (Pause)

135

1 Thank you very much, Mr Kinnier. 2.40.

2 MR KINNIER: Thank you, sir.

3 SIR MARTIN MOORE—BICK: Thank you.

4 (2.23 pm)

(A short break)

6 (2.40 pm)

7 SIR MARTIN MOORE—BICK: All right, Dr Stoianov. Let's see
8 if there are any more questions for you, shall we?

9 Yes, Mr Kinnier.

10 MR KINNIER: Sir, thank you for the further time.

11 I have no further questions for you, Dr Stoianov, so
12 it just leaves me to say thank you very much for
13 providing such a comprehensive report and, indeed,
14 a further supplemental report, and for attending to give
15 evidence today. It's very, very much appreciated.

16 THE WITNESS: Thank you.

17 SIR MARTIN MOORE—BICK: Yes, and it's right that I should
18 say thank you as well, Dr Stoianov, on behalf of all
19 three members of the panel. You have done an awful lot
20 of work on this matter, with great care, as we can tell
21 from your report, and it's been very interesting to have
22 the chance to hear you in person as well. So thank you
23 very much, we have benefitted greatly from your
24 evidence, and we're very grateful to you for coming to
25 give it. So thank you very much.

136

1 THE WITNESS: Thank you very much for the opportunity as
2 well. Thank you.
3 SIR MARTIN MOORE—BICK: You're free to go, thank you.
4 THE WITNESS: Bye—bye.
5 (The witness withdrew)
6 SIR MARTIN MOORE—BICK: Yes, Mr Kinnier. Well, that's all
7 we have for today; is that right?
8 MR KINNIER: That's right, sir.
9 SIR MARTIN MOORE—BICK: So we shall finish at that point,
10 but tomorrow we have another expert witness coming to
11 give us his evidence, and we shall look forward to
12 seeing him, I think it is — Professor Bisby, isn't
13 it? —
14 MR KINNIER: Yes.
15 SIR MARTIN MOORE—BICK: — tomorrow. Good, and we'll do
16 that at 10 o'clock tomorrow morning.
17 MR KINNIER: Thank you, sir.
18 SIR MARTIN MOORE—BICK: Thank you very much.
19 10 o'clock tomorrow morning. Thank you.
20 (2.43 pm)
21 (The hearing adjourned until 10 am
22 on Thursday, 9 June 2022)
23
24
25

137

1 INDEX
2 DR IVAN STOIANOV (sworn)1
3 Questions from COUNSEL TO THE INQUIRY1
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

138

139

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47:17,23 77:19 86:2 88:24 closely (1) 63:15 clue (1) 69:8 coefficient (50) 19:4,7,14,17,18,23 20:4 65:16 66:10,14,20 67:1,3,16,17,17,21,23 68:1,6 69:3,4,4,8,9,20,21 70:13,20,25,25 71:5,14 72:5 74:24 76:7,10,12,15,20 77:4,7,14,17 80:14 84:17 97:15 118:6,7,8 coefficients (14) 19:5 40:22 41:1 66:5 75:21,25 77:24 79:11,12,20 115:23 121:22 125:11,20 collaboration (1) 4:10 collecting (1) 61:16 college (2) 3:22 4:1 colours (1) 46:5 column (1) 84:16 combination (4) 40:24 116:7 124:18 126:25 combines (2) 5:5 10:12 come (15) 11:23 24:7 26:13 19:17 30:21 37:16,18 41:10 64:8 79:24 82:2 87:22 98:13 122:15 132:23 comes (3) 21:16,17 43:10 comfortable (1) 1:12 comfortably (2) 129:24 131:13 coming (10) 26:21 41:3 55:15 63:13 81:19 97:7 121:10 126:13 136:24 137:10 command (1) 99:3 commander (1) 127:12 comment (4) 97:9 100:12 124:15 125:24 commented (1) 7:22 comments (2) 7:10 43:3 commissioned (2) 79:16 82:18 common (3) 72:11 100:24 129:8 commonly (2) 40:11,12 communicate (2) 99:4 126:24 communication (6) 98:18,25 99:2 101:14 118:23 129:1 communications (2) 92:2 98:14 companies (3) 83:25 106:3 129:6 compared (1) 38:7 comparing (1) 25:1 comparison (1) 134:12 competence (2) 101:17 127:11 competent (2) 75:17 98:6 complete (3) 6:22 23:19 118:23 completely (3) 109:6 127:1,12 complex (10) 5:6 9:4,8,9 13:11 15:15,19 125:3 126:1,7 compliance (2) 133:8,17 component (5) 81:22,24 82:12,13,16 components (6) 9:17 10:22 16:6,8 58:20 82:10 composite (13) 67:22 69:3,4,20 70:25 71:5,14 72:23 75:25 76:19 77:4 79:12 84:16 comprehensive (2) 27:23 136:13 compressible (1) 21:10 computationally (1) 114:9 conceded (1) 127:17 concept (2) 21:2 62:17 concern (1) 128:5 concerned (4) 8:2 16:18	71:23,24 concerns (1) 108:1 conclude (6) 37:24 42:13 51:21 77:2 95:24 108:15 concluded (3) 51:16 106:11 134:18 concludes (2) 51:1,9 conclusion (17) 43:12,16 50:22 52:16 53:11 57:24,25 78:20 79:2 95:17 97:17,23 106:17 109:3,14 127:8 131:15 conclusions (13) 7:2,10,12,17,22 8:16 37:20 51:15 52:22 55:9 62:5 127:23 129:12 condition (1) 114:8 conditions (28) 6:10 20:17 24:18 40:1 44:8,11 51:4 57:18,20,23 58:11 68:22 73:9 74:21 79:14 80:11,24 81:6,7,16 101:4 109:25 110:2 115:21 116:6 122:1 123:18 127:22 conducted (1) 48:14 conduit (3) 20:14,14,18 cone (1) 59:18 confidence (4) 34:12 40:9,21 54:9 confined (1) 22:13 confirm (6) 1:19 2:25 3:3 26:15,17 122:20 confirmed (1) 41:23 conflicting (1) 108:5 connect (4) 69:6 73:1 90:9 115:16 connected (9) 72:7 77:21 80:18 84:10 93:22 95:12,23 100:21 112:6 connecting (13) 68:8,9,19,22 69:11,14,18,23 71:13 72:13 74:1 85:16 94:19 connection (1) 94:2 connections (2) 53:18,18 connects (1) 94:6 consequence (4) 60:6 62:1 64:4 67:10 consequences (4) 41:5,7,21 65:8 consequently (6) 20:3 52:4 53:19 90:1 95:9 99:1 conservation (1) 16:14 conservative (1) 52:14 consider (3) 46:20 102:6 133:13 consideration (3) 44:1 59:23 101:9 considered (3) 8:16 71:8 121:14 considering (1) 59:2 considers (1) 115:20 consistent (2) 6:18 41:17 constitutes (1) 130:17 constraint (1) 48:2 constraints (2) 48:5 134:20 construction (1) 79:25 consumption (1) 134:16 contact (1) 92:12 content (1) 38:11 contents (1) 55:7 context (6) 6:13 67:18 104:3 117:9 118:1 121:19 continue (3) 61:4 104:10 130:21 continued (3) 65:23 104:7 106:19 continuing (1) 58:11 continuity (3) 21:2,5 62:17 continuous (3) 62:15 63:21,22 continuously (3) 30:1 32:2 110:18 contradiction (1) 113:2 contradictory (1) 112:14 contradicts (1) 112:19 control (27) 4:21,24 5:11	15:3 93:8,14,16,20 98:7,8 99:18 102:12,17,20 105:3,17 107:9,24 108:14,18 110:8 111:5 112:25 113:25 115:24 116:16,21 controlincident (1) 99:3 convenient (1) 119:23 convey (1) 103:10 conveying (1) 67:10 coordination (2) 65:22 101:14 corner (3) 33:16,23 39:7 correct (136) 2:19,22 3:4,7,10,20,24 4:3,17 5:16 7:16 8:8 9:10 10:20,25 11:9,20 12:12,23 14:6,24 15:10 17:6 19:1,2,10,21 20:13 23:22 25:4 27:5,12,15,20 28:7 29:9,11,17 30:7,19 31:10 32:11,20 33:9 34:4,11,18 35:2,12 36:4,8,13 38:15,21 39:5,8 40:6 41:14,17,19,20 42:3,24 43:6,18,23 44:23 45:8,12,21 49:6,25 52:17,18,24 53:2,8,11 54:25 55:19 56:3,9,15 57:19 59:12 63:1,8,24 64:13 65:7 66:19 69:7,24 70:14 71:3 72:9 76:2,3,9,11,14,16,17 78:3 80:6,8,20 84:13,20 86:19 88:12 90:12 91:11,13 92:5,11 94:7,8 97:9 99:8 103:8,19 106:15,16,22 111:20 113:15 117:1,11 121:12 124:20,25 125:7,18 133:15 134:2 correction (1) 9:16 correctly (4) 45:10 46:6 71:18 72:21 correlates (1) 68:2 correspondence (1) 112:13 corresponding (1) 107:10 cost (2) 9:17,20 couldnt (2) 97:12 118:20 council (1) 4:16 counsel (4) 1:17 100:11 135:12 138:3 countries (1) 80:21 couplings (1) 20:22 course (5) 37:17 41:11 82:4 113:7 125:16 covering (4) 33:14,19,25 34:6 covers (2) 4:20 70:3 created (2) 6:14 59:18 creating (1) 110:19 crews (1) 23:2 critical (2) 53:13 54:1 criticise (1) 98:17 criticism (2) 8:1 114:24 critics (1) 40:13 crossreference (2) 50:10 63:1 crossreferenced (1) 57:19 crossection (1) 18:1 crudely (4) 14:2 54:12 56:16 73:13 cubic (1) 21:14 cumulative (2) 25:5 103:24 current (1) 105:10 currently (1) 4:13 customer (1) 128:23 customers (5) 9:6 10:8,10 13:9 129:4 cycle (1) 103:14	dated (3) 2:17,20 48:13 day (6) 13:15 27:18 61:20 98:8 103:15 134:10 dbv214263 (1) 93:21 dbv214521 (1) 94:1 deal (12) 8:20 26:3 35:21 39:11,19 41:10,21 60:3 66:4 103:11 105:19 122:24 dealing (4) 30:16 34:19 41:25 133:21 dealt (3) 8:19 33:24 110:23 debris (5) 32:24 33:2,7,11 59:10 decision (5) 94:23,24,24 115:25 119:4 decisions (3) 7:8 59:7 102:3 declined (1) 58:10 decouple (1) 101:21 deficit (1) 62:12 define (3) 17:17 81:22 102:2 defined (1) 126:18 definite (1) 81:7 definitely (1) 135:1 degree (2) 80:12 88:8 degrees (4) 3:18 45:5,14,18 delay (3) 127:3,7,9 deliver (7) 10:7 77:5 79:21 82:3 91:3 115:17 119:3 delivered (15) 10:18 16:25 21:3 37:21 38:25 40:3 41:8 78:4 104:17 113:13 116:8 117:9 127:21 131:5 134:1 delivering (1) 90:18 delivers (1) 77:7 delta (1) 29:19 deluge (1) 31:19 demand (9) 13:18 14:1 101:3 122:1 128:3,6,8 134:9,21 demands (1) 13:17 demonstrate (3) 86:3 104:20 126:16 demonstrated (3) 18:22 84:20 107:19 depend (2) 18:18 53:16 dependent (2) 81:16 82:7 depending (1) 90:20 depends (7) 13:25 17:9 18:15 19:12 44:19 45:16 81:5 depicted (1) 11:22 deploy (4) 114:14 122:8,14 132:10 deployed (20) 28:4 30:5,9,10,13 32:6,8 34:15 35:1,9,16 39:6 41:19 42:5 46:16 63:4 64:6 92:24 123:21 125:2 deployment (3) 22:22 23:1 89:12 depressurisation (1) 111:14 derive (3) 41:2 56:4 97:22 describe (16) 5:19 9:1 12:13 23:25 25:16 28:15 29:24 30:24 31:24 34:14,20 38:5 40:16 57:12 96:16 100:21 described (6) 49:20,21 50:2 69:19 73:23 115:13 describes (2) 41:7 72:4 describing (4) 89:12 100:23 108:25 126:10 description (3) 31:9 74:15 75:6 design (3) 4:21 5:11 84:19 designed (3) 48:19 65:20 83:15 desktop (1) 57:3 detail (17) 8:21 19:5 32:9 38:9 39:16 41:11 43:1 53:6 71:17 73:4,6 83:7 85:12 90:7 98:2 116:3 130:16 detailed (7) 22:25 53:7 76:4 83:19 91:24 100:14 113:20 details (2) 14:8 38:6 deteriorate (2) 58:19 80:25 developments (1) 131:2 deviation (1) 44:4	diagram (16) 10:23 11:25 117:23 119:8,15,17,20,20 120:1,23,24,25 121:16,19,20 122:20 dialogue (1) 100:23 didn't (5) 48:2 54:16 55:18 56:5 112:21 differ (1) 68:10 difference (7) 17:12 67:24,25 69:1 80:4 104:15 112:5 differences (1) 83:20 different (19) 12:1 17:14,18,18 18:2 31:16,17 40:1 53:18 56:22 68:15,19,23 83:22 84:8,19,22 94:6,17 differential (3) 18:16 19:14,24 differently (6) 43:20 51:9 56:21 75:13 106:14 114:12 difficult (6) 8:4 58:5,21 61:21 86:9 113:3 difficulties (4) 6:3 26:1 124:23 129:5 dig (1) 68:14 digital (1) 85:17 digression (1) 83:2 diminished (1) 63:23 diminishes (1) 16:4 diploma (1) 3:14 directing (1) 45:11 direction (3) 31:6 47:25 73:17 directions (1) 107:17 directly (1) 14:10 disagree (2) 100:16 109:5 discharge (33) 6:10 18:11,14,15,15 19:11,22 20:5 40:24 44:2 53:16 58:14 63:18 64:2 65:16 66:25 67:15,17 68:1,6,25 79:8,20 81:3 89:20 91:3 104:1,3 105:1 106:7 110:19 115:22 124:2 discharging (1) 18:17 disclosure (1) 27:10 discrepancies (1) 79:11 discuss (6) 8:22 11:23 37:1 56:24 60:13 102:11 discussed (5) 62:17 96:7 103:25 110:18 112:4 discussing (5) 15:23 103:23 107:23 121:8 123:8 discussion (3) 16:8 61:17 102:1 discussions (2) 100:14 101:8 discussions (1) 127:13 dispersed (2) 59:18,22 disruption (1) 127:3 distance (13) 22:8 45:25 46:19,20,20 47:10,12 48:6,7 59:13 64:17 88:13 118:10 distances (1) 88:10 distinction (1) 14:7 distinguish (1) 84:7 distinguishes (1) 67:20 distribution (37) 4:22,25 5:2,4 8:23 9:2,3,11,22,22 10:9,13,19 12:13 13:17,22 15:9,21 26:3 65:24 66:12 70:22 74:2 77:18 96:6 106:20 111:12 114:6 115:10,11,18,21,25 118:3 123:16 127:21 129:8 district (6) 93:21 94:1,5 95:6,9 112:4 dml18631 (2) 102:22 112:1 doctor (1) 122:24 doctoral (1) 4:4 document (9) 7:1 48:16 80:10 84:25 130:24 131:15 132:2 133:1,13 documents (5) 24:24 27:9 92:7 131:23,24 does (15) 12:23 27:22,25	50:3 53:19 55:8 75:1 79:18 97:5 107:8 118:13,16 121:25 124:4 132:12 doest (5) 1:25 55:13 132:7 133:1,14 doing (5) 78:12 87:2,4 105:3 119:6 done (19) 9:19 35:5 47:24 48:1 50:11 54:10 57:21 79:5 82:21 84:2 88:25 89:1 109:5 112:21 114:2 118:1 121:18 124:8 136:19 dont (32) 35:13 38:9 43:1 46:1 51:22 53:5 55:22 56:16 59:15 61:23 67:4 71:16 72:22 75:15 79:20 80:9 84:25 85:2,3 101:11,17 106:6 108:2 113:4,19 119:16 120:4 121:3 124:15 127:7,22 132:15 dot (1) 11:7 double (1) 75:13 doubt (2) 8:2 55:8 doubtful (1) 81:14 down (6) 1:12 5:17 33:13 50:22 63:11 134:17 downside (1) 63:20 downwards (1) 59:17 dr (28) 1:8,10,21 8:19 28:8 31:4 41:10 48:21 58:2 60:9 61:23 66:2 67:4 73:21 94:13 105:20 111:24 119:20 120:1,16,22 122:18 135:2,11 136:7,11,18 138:2 drains (1) 96:19 draw (6) 7:12 57:25 79:2 119:21 127:22 132:20 drawn (1) 127:8 draws (1) 7:10 dribbles (1) 64:16 driving (1) 132:14 dry (5) 11:14 21:25 34:21 35:4 100:1 discharging (1) 18:17 disclosure (1) 27:10 discrepancies (1) 79:11 discuss (6) 8:22 11:23 37:1 56:24 60:13 102:11 discussed (5) 62:17 96:7 103:25 110:18 112:4 discussing (5) 15:23 103:23 107:23 121:8 123:8 discussion (3) 16:8 61:17 102:1 discussions (2) 100:14 101:8 discussions (1) 127:13 dispersed (2) 59:18,22 disruption (1) 127:3 distance (13) 22:8 45:25 46:19,20,20 47:10,12 48:6,7 59:13 64:17 88:13 118:10 distances (1) 88:10 distinction (1) 14:7 distinguish (1) 84:7 distinguishes (1) 67:20 distribution (37) 4:22,25 5:2,4 8:23 9:2,3,11,22,22 10:9,13,19 12:13 13:17,22 15:9,21 26:3 65:24 66:12 70:22 74:2 77:18 96:6 106:20 111:12 114:6 115:10,11,18,21,25 118:3 123:16 127:21 129:8 district (6) 93:21 94:1,5 95:6,9 112:4 dml18631 (2) 102:22 112:1 doctor (1) 122:24 doctoral (1) 4:4 document (9) 7:1 48:16 80:10 84:25 130:24 131:15 132:2 133:1,13 documents (5) 24:24 27:9 92:7 131:23,24 does (15) 12:23 27:22,25	50:3 53:19 55:8 75:1 79:18 97:5 107:8 118:13,16 121:25 124:4 132:12 doest (5) 1:25 55:13 132:7 133:1,14 doing (5) 78:12 87:2,4 105:3 119:6 done (19) 9:19 35:5 47:24 48:1 50:11 54:10 57:21 79:5 82:21 84:2 88:25 89:1 109:5 112:21 114:2 118:1 121:18 124:8 136:19 dont (32) 35:13 38:9 43:1 46:1 51:22 53:5 55:22 56:16 59:15 61:23 67:4 71:16 72:22 75:15 79:20 80:9 84:25 85:2,3 101:11,17 106:6 108:2 113:4,19 119:16 120:4 121:3 124:15 127:7,22 132:15 dot (1) 11:7 double (1) 75:13 doubt (2) 8:2 55:8 doubtful (1) 81:14 down (6) 1:12 5:17 33:13 50:22 63:11 134:17 downside (1) 63:20 downwards (1) 59:17 dr (28) 1:8,10,21 8:19 28:8 31:4 41:10 48:21 58:2 60:9 61:23 66:2 67:4 73:21 94:13 105:20 111:24 119:20 120:1,16,22 122:18 135:2,11 136:7,11,18 138:2 drains (1) 96:19 draw (6) 7:12 57:25 79:2 119:21 127:22 132:20 drawn (1) 127:8 draws (1) 7:10 dribbles (1) 64:16 driving (1) 132:14 dry (5) 11:14 21:25 34:21 35:4 100:1 discharging (1) 18:17 disclosure (1) 27:10 discrepancies (1) 79:11 discuss (6) 8:22 11:23 37:1 56:24 60:13 102:11 discussed (5) 62:17 96:7 103:25 110:18 112:4 discussing (5) 15:23 103:23 107:23 121:8 123:8 discussion (3) 16:8 61:17 102:1 discussions (2) 100:14 101:8 discussions (1) 127:13 dispersed (2) 59:18,22 disruption (1) 127:3 distance (13) 22:8 45:25 46:19,20,20 47:10,12 48:6,7 59:13 64:17 88:13 118:10 distances (1) 88:10 distinction (1) 14:7 distinguish (1) 84:7 distinguishes (1) 67:20 distribution (37) 4:22,25 5:2,4 8:23 9:2,3,11,22,22 10:9,13,19 12:13 13:17,22 15:9,21 26:3 65:24 66:12 70:22 74:2 77:18 96:6 106:20 111:12 114:6 115:10,11,18,21,25 118:3 123:16 127:21 129:8 district (6) 93:21 94:1,5 95:6,9 112:4 dml18631 (2) 102:22 112:1 doctor (1) 122:24 doctoral (1) 4:4 document (9) 7:1 48:16 80:10 84:25 130:24 131:15 132:2 133:1,13 documents (5) 24:24 27:9 92:7 131:23,24 does (15) 12:23 27:22,25	elevated (1) 15:8 else (2) 60:14 135:8 elsewhere (2) 130:14 135:17 emboldened (2) 49:9 108:12 emergency (1) 5:15 emphasis (2) 9:9 35:3 emphasise (4) 8:6 37:12 40:15 67:22 empirical (1) 89:4 employees (2) 7:25 92:1 empty (2) 21:6 62:23 en (1) 72:3 enable (1) 83:25 enabled (1) 75:24 enabling (1) 31:5 encountered (2) 6:3 26:1 encourage (1) 102:5 end (14) 14:15 22:2 23:16 60:5 61:20 62:6 73:19 83:8 98:7 106:10 107:15 115:5 130:22 133:19 energy (5) 20:9 22:11,12 59:19 94:18 engine (1) 11:11 engineer (1) 75:7 engineering (17) 3:15,15,17,22 4:1,14,15,16 24:22 71:22,22 98:6 110:22 114:18,21 124:10 125:18 engines (1) 30:17 england (1) 100:25 enough (3) 16:4 21:5 133:24 ensure (3) 39:24 46:5 63:21 entire (1) 111:18 entirely (4) 10:1 70:19,23 126:5 entitled (3) 2:15 48:14 70:2 enumerated (1) 126:11 environment (1) 48:23 environmental (4) 3:21 4:1 44:8,11 environments (1) 68:13 equal (2) 21:17 69:24 equally (18) 14:10 15:17 22:14,18 25:21 40:22 44:23 47:22,24 48:6 57:21,25 59:12 67:3 104:22 114:16 118:13 126:10 equation (2) 66:25 67:1 equipment (50) 6:1,2 7:3 12:11 21:7 22:2,7 23:8,13,24 24:2,5,15,17 25:1,2,9,14 27:11 40:4 41:18 48:20,24 49:14 50:2,13,13,16,17,24 51:5 52:1 54:2 56:5 58:19,23 59:1 62:22 63:12 64:6 96:2 100:3 104:18 107:4 113:21 114:13 115:19 116:9 123:21 132:15 equivalent (2) 65:4 134:11 essence (10) 14:3 19:20 40:5 62:25 64:5,20 72:21 73:8,14 133:4 essential (4) 53:11 67:10 71:1 102:7 essentially (7) 14:6 15:10 62:18 66:15 94:7 109:4 131:17 essentials (1) 24:3 establish (2) 8:21 39:13 establishing (1) 32:8 estate (1) 46:18 estimate (4) 38:8 40:3 44:13 107:12 estimated (5) 23:10 123:13 129:17 131:10 134:10 estimates (8) 41:2 49:2 52:14 56:23,25 57:2,3 121:21 et (11) 15:17,18 18:19 44:2 68:20 97:11 107:1,5 114:14,17,20 even (19) 19:19 20:21 44:3,5
---	--	---	---	---	--	--	---

48:3 50:6 54:4 55:10,13
60:2 69:13,17 77:13 87:3,9
106:23 110:10 111:5 113:1
event (3) 60:10 111:17
130:13
events (1) 112:22
every (1) 81:5
everyone (2) 1:3 5:22
everything (4) 2:7,8 8:12
100:15
evidence (28) 1:5,22 2:4
6:13,15 7:7 8:7,16 11:24
26:22 27:13 29:17,19
57:17 60:2,13 64:7 72:10
86:22 89:5 92:6 96:7 107:8
120:5 131:7 136:15,24
137:11
exacerbated (1) 88:9
exact (3) 48:2 50:17 79:2
exactly (4) 50:12 84:11
100:20 114:19
examination (1) 22:22
examine (1) 73:4
example (23) 10:3 11:21,22
18:6 20:11,20,20 25:12,19
28:17 45:4 54:5 59:9,12
67:2 73:2 81:4 89:10 90:20
100:17 124:21,25 126:21
examples (4) 61:13 82:23
98:4 101:7
excavation (1) 68:18
exceed (3) 51:7 134:13,21
exceeded (3) 129:24,24
131:14
exceeds (2) 52:14 77:19
excluded (1) 52:15
exercise (1) 126:22
exercised (1) 97:11
exist (1) 74:25
existing (1) 105:10
expanded (4) 35:25 76:6
119:13 121:1
expect (6) 53:20 77:15 79:9
98:1 113:23,24
expectantly (1) 85:2
expectations (1) 125:7
expected (4) 58:18 77:24
84:3,18
expects (1) 82:1
experience (2) 78:10 101:18
experienced (1) 110:9
experimental (4) 9:9 5:4
40:20 44:24 53:25,25 54:5
61:11 86:19
experiments (3) 5:5 61:14,15
expert (4) 1:4 3:5 124:9
137:10
expertise (10) 3:12 4:20
5:7,14 7:14 14:21 57:9
101:19 123:23 124:24
experts (2) 57:21 113:16
explain (6) 18:6 21:2 23:6
66:9 67:24 115:6
explained (3) 16:21 74:2
83:23
explains (3) 13:12 49:10
116:2
explanation (4) 64:19 75:18
83:19 112:22
explicitly (6) 35:6 50:3
69:15,18 107:7 130:18
express (1) 17:18
expressed (1) 19:13
extended (2) 30:18 95:17
extensive (1) 4:9
extensively (1) 86:10
extent (5) 45:22 58:10 88:13
114:22 133:8
exterior (2) 28:22 35:1
external (2) 28:3 34:15
externally (1) 5:25
extinguishing (1) 32:24
extra (2) 37:11 104:24
extract (4) 92:15 114:5
118:9 123:6
extracted (5) 65:14 91:8,17

106:19 126:17
extrapolate (1) 79:4
extremely (6) 8:3 54:1 68:21
81:1 86:9 88:21
eye (1) 45:7
eyeballing (1) 94:23

F

f (1) 32:23
faced (1) 125:20
facilities (1) 15:16
factor (8) 15:5 16:23 21:22
58:8 59:2,7 91:16 101:23
factored (1) 125:10
factors (16) 14:13,17,21
15:2 24:14,17 55:5 57:7,13
58:13 73:16 80:2 82:20
85:24 123:25 124:13
factory (4) 58:10 69:10 73:9
74:21
faculty (1) 3:16
failed (1) 55:22
failures (2) 110:4,23
fair (26) 5:7 9:14 12:11 21:9
26:6 27:3 35:18 43:16
57:5,6,11 64:25 71:25
72:13 91:12,14 92:4,20
93:1 105:5,7 107:13 117:7
127:15 130:1 131:15
fairly (5) 109:6,13,15
127:17,18
fall (1) 101:18
falling (2) 33:3 59:10
falls (1) 45:6
far (8) 16:17 44:10 74:8
116:2 117:21 123:22
126:19 127:6
feasible (2) 100:13 124:17
february (1) 85:12
fed (2) 12:2 13:22
feed (1) 14:9
feedback (1) 98:4
feel (1) 133:12
feels (1) 28:23
fell (3) 59:17 76:21 77:2
fellowship (1) 4:15
few (2) 28:25 114:10
fh (2) 85:13,20
fh1 (1) 121:9
field (1) 5:5
fighting (4) 2:16 95:18
130:25 134:21
figure (17) 10:17 13:12 25:3
29:3,5,13 31:13,16 37:4
38:7 39:13 42:20 119:13
121:1,12 130:18 133:3
figures (15) 24:7,14,19,21
39:20 51:11 76:21 78:1,8
80:3 103:9 104:19 123:13
124:19 129:23
final (5) 20:5 25:6 49:7
113:9 133:16
finally (8) 9:21 11:17 26:3
34:5 37:4 72:19 93:5
133:10
find (20) 5:18 29:13 42:20
51:19 58:21 70:3 75:18
78:6 83:18,18 84:15 85:7
89:11 101:25 117:24 118:6
119:20 129:11 131:23
134:4
finding (1) 58:5
fine (2) 39:15 67:12
finish (1) 137:9
fire (127) 2:16 5:23,24 6:8
10:19,19 11:8,11 12:7
14:22 16:25 18:11,19
23:20 27:18 28:22 30:17
34:16 36:10,14,17 37:5
39:24 40:2 42:11 44:9
46:17 48:15,25 49:17
50:14,16 56:11 57:24
64:23 65:20 68:7,12,15
70:2,10 74:13,16
78:5,14,17,19
79:8,16,18,18,19 80:21

81:4,9 82:2 83:14,21,23
84:3,6,9,10,11 85:13,21,23
86:4,8,11,23,24 87:3,6,7
88:15
89:20,21,21,23,23,25 90:2
95:19 100:1,15 101:6
104:2 105:13 106:12
107:3,18,19 110:15 111:18
112:23 114:13 115:16,22
116:7,19,23 117:22 118:24
119:4 123:22 124:3,3,6,8
125:5,22 126:10,20
129:18,19,20
130:9,10,13,18,25 131:10
132:9 133:9 134:22
firefighter (5) 11:18 59:20
78:18 79:5 82:1
firefighters (10) 7:24 27:13
29:8 31:7 63:2,9 64:22
85:15,22 96:21
firefighting (5) 1:5 5:15 6:9
7:13,18 11:15,18 12:10
14:14,18 16:5,19 21:7,23
22:2 25:1,14 26:2 27:11
28:15 31:8 40:4 59:6,9,21
62:22 63:12 65:21 76:2
77:6 83:16 84:4,5 90:18
96:2 102:9,24 104:18
113:11,17,21 114:2 115:19
116:9 122:10 127:14
129:17 134:13,15,24
first (51) 3:14 6:25 8:22
10:22 12:23 15:5 17:10
23:2,7 26:9 28:5,11,12
29:18 30:5 32:9 35:21
36:10 37:18 38:13
39:13,21 41:12,21 57:2,18
60:6 66:4 71:21 85:25
90:16,25 91:7 92:12
93:3,15,20 99:15 100:18
103:2,12 105:20,21 121:12
122:2,15 128:20 131:23
132:3,14 133:6
fitted (1) 70:9
ittings (1) 23:20
five (3) 13:2 79:2 81:5
fiveyear (1) 4:15
flooding (1) 96:20
floor (3) 42:9,9,10
floors (3) 104:5 105:13 131:3
flow (256) 6:1,4,9,15 13:24
16:25 17:2,8,13,20,23,25
18:4,9,10,25
19:4,5,6,7,11,14,16,17,18,21,23
20:3,4,14 21:3,3,5,23
22:1,6,14,18
23:14,17,18,25
24:1,7,19,21
25:1,3,7,14,15,18 30:2,21
31:18 37:19,21
38:3,7,7,14,17,20,22,23,25
39:4,7,20,25 40:3,22,25
41:1,2,5,8,15,18,23 42:17
43:6 44:20 48:14,18 51:3
52:4,17,24 53:8,12,14
55:25 56:6,11,13 60:6
62:2,8,13,14,15,18
63:12,17 64:2,4,9 65:14,16
66:5,10,11,14,16,20,24
67:2,15,17,20,23 68:1,5,25
69:3,4,4,9 70:13,20,24,25
71:5,14 72:5,16 74:24
75:21,25 76:7,10,12,15,19
77:4,14,17,24
78:4,12,13,19,23
79:15,19,22 80:4,7,22,22
81:1,3,8 82:5,7,17 83:4,12
84:2,3,17 87:9,12,25
89:7,19,20,24,25
90:3,5,10,21
91:2,8,8,17,17 95:11,15,21
97:1,2,2,3,15,21
99:5,10,12,20,22
100:4,7,19 104:17 105:2,9
106:18 113:13 114:20
115:3,9,11,17,20,23

116:8,15,20 117:2,9
118:3,6,7,8,9 119:5
121:22,23 122:13,25
123:13,14,17 124:2,3,19
125:11,20 126:16
127:20,23 128:18
130:4,18,25
131:5,10,13,14 132:4
133:25 134:12,14
flowing (2) 48:11 95:2
flows (1) 77:12
flush (1) 83:25
flushing (1) 84:2
flux (2) 25:23 60:3
focus (2) 14:25 34:25
focused (3) 4:6 114:24 123:2
focuses (1) 5:11
follow (4) 54:4 67:14
107:8,25
followed (1) 103:14
following (10) 51:2 74:14
99:17 102:14 103:3 115:7
123:24 125:5,12 135:17
follows (2) 37:24 71:21
foot (3) 8:10 77:11 129:14
footage (2) 26:24,25
force (3) 9:6 17:15,16
forgive (1) 98:22
forms (3) 22:15 69:13 101:7
formulated (1) 115:19
formulating (1) 126:7
formulation (3) 115:15
118:5,10
forthcoming (1) 100:7
forward (2) 86:15 137:11
found (9) 2:17,21 13:4 98:20
103:7 108:20 109:3 120:24
134:7
founded (1) 5:10
four (13) 4:20 35:21 36:5,6
71:14,19 76:20 95:17,22
96:19 102:13,25 104:17
fourth (2) 73:5 91:9
frame (1) 31:5
frames (1) 70:3
france (1) 81:4
free (1) 137:3
frequently (1) 62:9
friction (3) 20:11 55:23 88:5
front (2) 84:25 119:16
full (3) 1:20 42:16 80:22
fully (11) 24:14 59:12 87:7,8
96:23 97:8,12 102:21
103:9 118:15 122:14
function (2) 22:12 84:19
functions (1) 9:2
fundamental (3) 4:23 16:3
19:11
fundamentally (2) 17:14
18:2
further (14) 12:10 38:4
41:25 46:10 50:6 87:25
96:16 101:12 123:24
130:16 134:17
136:10,11,14
furthermore (1) 100:5
furthest (1) 46:14

G

g (1) 33:11
g272 (5) 89:22,24,24 90:2,3
gain (2) 105:12 107:1
gaining (1) 96:21
gains (6) 25:5 103:23,24
104:13 105:4 106:22
gap (1) 75:3
garden (4) 18:5 64:15 65:3
73:2
gate (1) 93:19
gather (1) 6:13
gathered (2) 26:23 56:18
gauges (1) 56:7
gcse (2) 66:23 67:6
gear (1) 132:14
general (2) 24:22 69:12

generally (6) 10:9 16:13
17:17 24:9 50:6 84:2
generic (1) 57:11
geodesy (1) 3:17
geographic (1) 12:21
geometry (1) 58:20
get (13) 18:9 21:11,12 39:16
45:22 55:13 105:2 107:7
112:21 114:17 118:16
119:5 135:11
gis (1) 86:24
gist (1) 114:15
give (11) 1:22 55:20 59:9
89:9 118:25 119:13
133:13,16 136:14,25
137:11
given (17) 19:8 27:13 53:3
54:8 66:17 74:7 97:17
100:15 107:6 116:6 117:24
118:6,8 119:19 123:18
127:18 134:1
gives (4) 20:2 50:9 91:24
132:4
giving (3) 2:3 25:12 108:8
goal (2) 77:5 82:3
goals (2) 8:14 21:18
going (22) 1:4 17:20,25 22:7
32:9 33:13 34:19 37:11
62:21 80:13 82:9 86:14
87:22 96:11 100:15 106:10
118:15 132:8,20,23 133:24
135:20
golf (2) 35:16,17
gone (2) 50:8 79:5
good (13) 1:3,21 19:19
40:23 60:10 61:2 63:1
66:16 100:18 106:1 109:25
119:2 137:15
governed (2) 18:13 20:15
governing (1) 73:10
gradually (1) 21:6
granularity (2) 27:6 34:13
graph (9) 42:21,21 43:1,3,5
45:1,5 46:11,23
grateful (2) 116:13 136:24
gravity (4) 9:6 13:8,22 55:24
great (3) 19:7 98:2 136:20
greater (5) 12:22 21:17
116:2,8 126:19
greatly (1) 136:23
green (3) 29:6 36:2 45:5
grenfell (42) 2:16 5:24
12:13,17 15:21 23:2
30:6,25 34:15 35:4,9
36:2,11,15 37:7 38:1 42:5
43:15,19 48:15,25 49:17
50:14,16 51:6 65:15 75:21
77:25 78:17 89:2,13 93:1
96:20 99:24 106:12 108:20
121:14,15 124:4 131:3,13
134:22
ground (32) 11:23 30:24
31:4,6,11,15 33:3,7,16,22
35:10 37:21,25 38:6 39:3,6
41:9 49:23 52:10,12,20
55:10,12,12 89:12 90:5
93:1 99:22,25 100:15
104:4 122:8
group (1) 5:9
gss (1) 128:25
gt (1) 36:3
guarantees (1) 91:2
guarded (1) 131:20
guess (1) 127:25
guidance (10) 98:5 101:5,5
107:20 124:10 130:20,24
131:15 133:1,13
guideline (1) 132:2

H

h (1) 33:14
h1 (4) 36:10 37:13 76:7
129:19
h3 (8) 36:14 76:10
89:2,22,23 90:1,2 129:20

h5 (15) 65:19 76:12 83:14,22
84:15 85:11,13,19,22
86:17 95:8,11,16 96:24
129:20
h8 (4) 36:17 76:15 124:8
129:18
half (2) 92:17 96:25
halfopen (1) 97:6
hammersmith (15) 13:5,14
14:3,9 15:24 102:16
103:3,4,21 104:16 107:23
108:13,17 110:7 111:4
hand (1) 100:24
handheld (14) 11:18 25:17
28:11,14,15,17 29:7,15
32:23 33:11,14,25 34:6
35:10
happen (1) 82:15
happened (2) 82:19 118:21
happening (1) 79:7
hasnt (1) 108:8
havent (1) 110:16
having (9) 25:17 59:10 65:8
77:6 85:20 100:10 110:22
118:17 124:1
head (13) 2:12 20:16,23
53:17 88:20 90:23 96:15
105:8 129:1,7,18,19,21
heading (4) 5:19 49:9 50:21
123:10
headline (1) 108:12
heads (1) 129:15
hear (2) 1:4 136:22
hearing (2) 1:4 137:21
heat (3) 25:8,22 60:3
height (11) 42:1,16
43:7,8,22 44:19 45:6 50:23
53:1 59:17,23
held (1) 29:7
help (6) 4:4 17:12 33:19
53:10 103:20 119:9
helped (1) 112:9
helpful (5) 48:8 78:7 82:24
94:8 119:14
helpfully (1) 29:23
here (45) 3:11,23 14:7,25
15:13 16:11 23:6,15 27:9
29:14 30:20,23 31:14
33:1,19 36:20 37:1,11 39:9
44:14,18 45:18,25 52:12
53:13 58:9,13 62:18 65:11
66:23 67:11 70:6,12
71:2,11 77:5 88:4 100:11
103:23 107:14 108:24
112:8 118:1 127:10 133:21
hes (1) 135:12
hierarchical (1) 10:1
high (10) 18:3 21:5 27:5
34:11,12 40:5,9,20 43:19
45:19
highdensity (1) 109:18
higher (18) 13:9 18:24,25
22:6,7 42:7 44:6 55:14
64:11 66:20 67:1 77:25
91:2 112:24 115:3,8
122:24
highest (1) 59:16
highlight (3) 12:1 17:7
118:22
highlighted (4) 15:3 20:20
36:5 54:6
highly (2) 40:10 102:1
highpressure (1) 30:10
highrise (1) 122:4
hill (11) 12:17 13:3,4,6 14:4
15:23,25 103:5 134:7,9,19
hold (3) 3:14 4:14 31:7
holding (2) 11:18 31:8
hole (1) 18:8
holland (3) 13:6 14:4 15:24
home (1) 17:22
honest (1) 119:11
horizontal (3) 46:11,19,20
horizontally (1) 47:3
horrendous (1) 82:23
128:10,17
horticultural (1) 64:14

hose (13) 18:5 28:15 30:11
34:22 64:15,17,23 65:3,4
73:2 88:10,20 90:8
hoses (13) 12:8,10
20:11,21,21 23:20
53:18,19,20 88:5,10
89:21,23
hotel (1) 35:17
hour (1) 135:6
hours (14) 28:13 30:1,1
31:2,2 90:14 93:4,6,24
103:17,17,18 126:3 134:15
housing (1) 131:2
however (5) 59:25 74:7
76:24 85:17 101:20
hrs (17) 32:2,2,3,3,4,16
33:15,17,18 34:2,2,8,8
90:2 94:4 96:18,18
huge (2) 81:12 110:19
hugely (1) 132:18
human (2) 82:20 101:22
hydrant (136) 11:8 12:7,8
17:3,4,8,11 18:11,19,25,25
19:4,8,18 20:6,9 21:4
36:10,14,17,20
37:12,13,14 56:11
65:19,20,20
66:10,11,15,16,17,20
67:21,23
68:2,3,4,5,7,7,9,12,15,20
69:2,5,6,10,16,16,23
70:10,21 71:1,13 72:12,17
73:1,9,11 74:1,16
76:7,12,15 77:1,7,15,17
82:2,17
83:5,14,15,15,20,21,22,23
84:9,10,11
85:13,14,14,16,19,19,23
86:7,8,11,11,17,22,24
87:1,3,7,7,8,11,14,19
88:6,24 89:2,20,22,23,25
90:2,9 91:4 95:8,11,16
96:24,24 97:6,10,16
113:12 115:22 118:16
121:10 124:8 126:1,22
129:16,18,19,20,20
hydrants (105) 6:8 9:6 15:9
16:25 19:6 23:12 35:21
36:6 37:5,6 40:23 41:1,3
65:15,17,25 66:4 67:16
68:18 69:13,20 70:2 72:6
73:11 74:6,13,20,24
75:21,25 76:19 77:2,16,25
78:13,13,20
79:2,8,16,18,19 80:13,23
81:1,4 83:24
84:3,4,6,6,9,17,21,21
85:21,21 86:4,21 88:1,14

identical (2) 84:6 85:21	55:17 58:25 95:6 133:22	investigates (1) 115:8	istrps0000000116 (2) 73:20	119:8,12,18,24	50:11 51:9,9,15,16,24	43:2 45:24 55:10,11
identified (21) 8:13 34:9	indications (1) 100:6	investigation (3) 7:21 60:1	77:10	120:10,11,20,21 131:19	52:2,5 53:3,20 54:4,12	56:21,22 62:6 63:15 65:11
42:4 57:17 61:10 62:2	individual (4) 10:8,10 71:23	75:22	istrps0000000121 (1) 51:20	132:20 135:2,6	55:11,16,22,25 56:4,5,18	68:5 70:17 71:7,11 73:20
64:5,7 65:8 78:2 83:11	124:7	inviting (1) 26:15	istrps0000000122 (1) 53:5	136:1,2,9,10 137:6,8,14,17	59:15 61:18 65:22 79:21	75:4,6,13,20 78:8 80:2
85:25 86:5 91:7 111:22,24	individuals (2) 7:23 8:2	involvement (1) 87:23	istrps000000016 (1) 71:10	kinners (2) 46:9 78:8	87:2 90:14 92:3,8,9,12,18	84:6,15 120:1,25 127:9,11
112:16 119:16 124:18,21	industrial (1) 46:17	iordanov (1) 1:20	its (83) 1:22 7:3,6 9:2,15	knew (1) 100:20	95:15,18,22 96:21,24	96:9,14 98:21 103:13
132:3	industry (3) 40:12 101:25	irrespective (1) 18:9	11:7 13:19,19 15:15,18,20	know (30) 11:11 14:8 20:14	97:10 98:14,19,25	105:5,15 108:4,11,15
identifies (1) 23:7	129:9	isnt (5) 63:21 64:16 91:12	18:11,12,12 21:14,15 22:9	34:19 44:8 52:9 57:12	99:3,16,18,23 100:6,8	115:6 120:1,25 127:9,11
identify (16) 10:22 15:5	inevitable (2) 69:22 88:9	114:25 137:12	24:3,6,11 25:2,7,7,18	68:14 77:6 78:7 79:1,15,20	102:5 103:22 115:16	130:6,7 133:20 134:5
16:23 19:3 21:22 24:12,24	inevitably (1) 7:8	isolated (1) 71:23	30:2,21 33:23 36:23	80:9,13,16 81:3,6 87:6	116:18,23 117:17 121:18	137:11
26:1 31:23 35:15 41:9	infinitely (1) 16:18	isolation (1) 68:3	38:13,16,20 39:4,7,17	88:4 97:24 98:2 100:16	122:3 123:21	looked (2) 83:9 109:14
56:24 78:12 85:22 93:20	influence (1) 80:12	issues (3) 56:22 87:13 132:25	50:10 55:3 58:23 61:20	106:23 118:7,23 122:3	124:1,6,7,10,17 126:25	looking (14) 16:11 23:15
130:20	information (6) 24:8,9 44:10	istrp000000001 (1) 2:17	63:13 64:11,14 66:23	124:15 127:8 131:22	127:1,5,23 129:16 134:12	31:3 45:1 49:11 56:7 75:10
ie (2) 10:24 71:22	79:17 85:18 100:22	istrp0000000015 (1) 5:17	69:21 71:8 73:5,21 75:4	knowledge (14) 3:1 14:21	ifb00123672 (1) 48:12	84:24 99:15 107:13 114:11
ignited (2) 25:23 33:2	infrasense (1) 5:10	istrp0000000016 (2) 3:11	78:12 79:14,19 80:23	55:4 75:8 98:7,10,11	ifb0012367216 (1) 50:20	117:22 127:15 131:5
ignore (1) 75:13	infrastructure (2) 68:16,17	4:19	83:3,5,20 84:18 88:21	113:20,24,25 118:18	ifb001236722 (1) 48:16	looks (3) 45:13 68:1 119:1
ill (5) 2:1 5:21 28:8,8 47:14	initially (1) 33:15	istrp0000000017 (1) 5:3	90:17 91:4,25 94:20 95:2	124:1,24 126:9	ifb001236723 (1) 49:20	loss (7) 20:16,17,23 77:20
illustrates (1) 10:18	inlet (18) 18:19 52:3	istrp0000000025 (1) 7:19	97:9 98:15,23 100:24	knowledgeable (1) 82:14	ifbs (6) 49:5 51:18 52:10,21	88:8,14 111:13
illustration (2) 31:11 89:16	53:14,16,22,23	istrp00000000256 (1) 8:15	106:7 108:3 112:19 113:3	known (5) 4:7 5:22 11:19	55:7 96:2	losses (16) 20:9,10 53:17
illustrative (2) 123:15 124:25	54:7,16,18,19 55:14,19	istrp00000000317 (3) 14:15	114:8 118:8 119:14 127:2	49:23 85:15	lid (1) 85:14	55:23 65:25 69:22
im (16) 18:17,21 26:11 39:11	62:12 63:19 94:20 104:20	16:24 21:21	132:18 133:24	kv (9) 70:10,12,18 72:6,11	lie (1) 57:8	88:1,5,20 89:22 90:14,23
44:23 47:8 83:1 96:11	112:3,9	istrp00000000320 (1) 21:1	136:15,17,21	74:15,16 77:14,17	lift (1) 49:21	91:9,15 94:18,21
100:23 103:10 104:6	inlets (3) 102:22 112:1	istrp0000000035 (1) 8:25	itself (7) 8:23 36:2 44:21	L	like (22) 8:22 37:19 39:19	lost (1) 81:21
117:24 118:15 125:20	115:25	istrp0000000038 (1) 10:16	58:9 91:23 110:20 127:3	lab (1) 68:21	43:2 49:25 56:24 57:12	lot (19) 20:17,18,22 40:20
126:10 127:9	inoperable (2) 78:21 86:5	istrp00000000511 (1) 130:14	ivan (4) 1:8,10,20 138:2	labelled (9) 28:4 36:3 37:14	64:14,18 66:2 67:21	53:24 54:9 72:15 80:21
images (2) 28:21 29:14	input (1) 54:24	istrp00000000514 (1) 132:24	ive (10) 46:8 54:20 68:11	65:19 83:14 85:13	78:16,22 83:6 88:22 91:21	82:20 90:7 100:17
image (3) 68:2 86:10	inquiry (6) 1:17 2:14 3:9	istrp00000000519 (1) 70:16	71:18 82:22 84:20 87:18	86:8,24,25	97:6 128:10,17 131:20	110:22,23 113:2
122:11	27:14 92:8 138:3	istrp00000000548 (3) 128:14	109:5 127:18 132:3	labelling (1) 87:11	133:16 135:8	131:16,21,23 132:1 136:19
immediately (4) 36:1 49:8	inside (1) 34:24	130:5 133:20	J	laboratory (1) 5:5	liked (1) 50:15	lottery (1) 79:19
85:4 121:9	inspected (1) 97:10	istrp0000000006 (1) 22:25	j (3) 28:4 34:6,14	labs (1) 5:10	likely (6) 69:21 79:12 96:24	low (29) 13:17 18:4 19:18,20
impact (24) 25:20,22 44:12	install (2) 68:8,14	istrp0000000061011 (1)	jammed (1) 97:13	lack (2) 55:4 65:22	97:11,19 127:1	37:19 41:5,7,15,18,23 44:9
56:3 57:22 63:18 87:1	installation (6) 74:5 77:16,20	35:14	jet (50) 11:18 22:4,10,12,19	lacked (1) 99:2	likewise (1) 67:9	60:6 62:1 64:4 65:14,16
89:4,6 90:23 95:7,10,21	79:14 80:24 84:21	89:11	25:6,21 28:11 29:10,24	ladder (15) 29:25 30:13,17	limitations (4) 56:25 123:12	66:4 82:22 85:3,11 87:9,25
97:17 98:10,12 104:1,6,25	installations (2) 82:21,23	istrp00000000622 (1) 89:15	30:24 31:24 32:14,17	47:19 48:2 49:9,19,21	127:17 132:4	89:19 91:7,8,17,17 97:16
106:24,24,25 107:21	installed (14) 21:19 69:5	istrp000000006236 (2) 37:24	33:11,14,14,16,20,21,24,25	132:12	limited (5) 27:16	106:18
118:16	70:21 71:13 72:12	62:4	34:1,6,6,7 42:2 44:7,21	language (1) 24:22	41:12,22,23 63:12	lower (6) 52:6 54:20 64:23
impacts (2) 68:24 88:20	73:11,12 74:1,14 77:18,25	istrp000000006236238 (1)	45:3,4,6,11,22	large (7) 12:20 13:16 15:19	4:19 5:18 7:19	69:21 79:3 84:3
impeding (1) 105:13	82:18 84:5 85:12	65:10 83:8	46:2,15,22,24 47:18 50:23	21:14 64:15 78:22 114:5	12:16 17:9 19:3 20:8 21:22	lowest (2) 84:16 129:17
imperial (5) 3:22 4:1,14 5:9	instance (1) 26:10	istrp0000000063 (2) 23:6	52:1 53:1 58:1 59:17 62:14	largely (1) 101:16	23:16 25:25 28:2 29:24	ls (11) 90:4,5,6 99:13
68:4	instances (1) 27:16	25:25	63:5,7,23 64:11,24	larger (5) 16:18 20:21 36:5	31:23 32:22 33:13,24	116:16,21 131:1,1,11
implement (1) 112:25	instead (3) 11:21 56:6 129:7	istrp00000000637 (1) 29:5	63:5,7,23 64:11,24	94:21 126:16	45:2,5,14,18 46:9 49:12	134:11,14
implemented (1) 109:23	institution (1) 81:14	istrp00000000638 (1) 29:13	jets (30) 6:5 23:1,9 26:9	late (1) 89:3	62:6 70:17 83:19 85:10	ltd (1) 12:19
implication (2) 78:3 81:11	instructions (5) 5:19 6:22	istrp0000000064 (1) 26:19	28:3,4,9 29:23 32:23	later (12) 11:23 16:8 19:5	89:11,15 95:4 106:10,10	luke (1) 57:22
implicitly (1) 50:11	7:6,15,21	istrp00000000652 (1) 42:20	33:6,23 34:9,14,15	30:22 33:15 37:1 39:16	108:15 111:25 115:6	lunch (2) 120:2 121:8
implied (1) 107:6	insufficient (2) 62:8 64:10	istrp0000000066 (2) 35:25	35:1,9,16 38:1	44:24 87:22 93:5 95:13	116:14 128:21 130:22	M
importance (2) 37:1 118:17	integral (1) 71:21	119:12	41:13,16,17,24 42:7,16	97:13	133:21	m (6) 128:25
important (11) 19:17 21:4	intended (3) 1:24 8:1 41:19	istrp0000000067 (3) 28:2	52:5 56:23 62:3,15,23 63:4	latter (1) 73:5	lines (4) 11:4 66:9 78:19	129:4,7,18,21,21
36:25 50:5,10 68:13 81:2	interactions (3) 61:18 92:2	29:22 31:22	jointly (1) 61:14	lay (7) 21:3 43:20 45:6 52:23	92:16	main (10) 7:1 11:14 14:6,10
88:21 118:8 123:12 124:14	101:23	istrp0000000068 (2) 32:21	judge (1) 98:11	67:23 96:2 97:5	linked (1) 98:15	21:25 34:21 35:5 100:1
imprecise (1) 99:2	interchangeable (2) 9:24	34:22	judgement (4) 59:20 73:24	laymans (7) 17:2 19:5 23:24	35:7	129:4,8
improvement (1) 96:1	67:18	istrp00000000810 (1) 13:1	110:22 125:19	25:12 66:14 95:24 103:20	listed (3) 27:9,21 124:14	mains (6) 11:4 13:16,17,25
improvisation (2) 98:8,10	interconnections (1) 20:22	istrp000000008100 (2) 76:5	july (2) 2:17 75:23	lead (3) 5:9 74:4 108:2	lists (1) 134:6	14:11 109:16
improvise (2) 63:10 64:22	interested (1) 119:10	84:15	jumping (2) 39:9 111:24	leak (1) 18:12	literally (1) 114:10	maintain (1) 21:5
inadequate (1) 102:1	interesting (1) 136:21	istrp000000008216 (1) 115:5	june (28) 1:1 2:16 6:17 7:9	leakage (2) 9:14,17	literature (1) 74:17	maintenance (3) 58:15,16
inaudible (2) 18:5 85:1	intermittently (5) 31:1 32:25	istrp000000008218 (2)	8:4 22:23 28:5 37:22 38:2	leaks (2) 106:4,6	littres (2) 17:23 21:15	83:24
incident (21) 5:15 40:11 51:6	33:17 34:1,8	117:14 123:5	49:17 85:17 86:23 95:25	learned (1) 132:11	25:15,16 30:3,2 43:6	making (5) 14:2 25:19 94:24
59:9 89:3 92:1 93:1 95:13	internally (1) 5:24	istrp000000008219 (1)	102:13 103:14,14	least (5) 40:17 45:6 67:18	56:12,13 78:24 82:2 89:7	102:2 119:4
96:17 97:21 99:22 101:1	interpretation (17) 66:6	120:25	116:17,22 117:10 125:17	72:21 114:1	104:4 105:11 117:3,5,10	management (10) 40:11
104:8,11 106:14 107:9	71:20 72:8 73:18,25	istrp000000008226 (2)	126:3 129:13,17,24 131:11	leave (2) 28:24 98:13	122:6,7,9,10,15 132:5	98:3,5 99:6,19 101:1
109:24 126:2,24 127:2,12	74:4,9,9,11,25 75:11,12,14	116:12 117:16	134:4,13 137:22	leaves (1) 136:12	44:5,12 48:3 78:9 97:14	102:2 119:4
incidentbased (1) 102:2	76:18,24 77:23 87:10	istrp000000008229 (1) 134:5	justification (1) 104:9	led (1) 111:13	117:23 121:19	manager (1) 100:17
incidents (1) 101:6	interpreted (2) 72:24 123:19	istrp000000008231 (2) 106:9	justified (1) 54:20	left (2) 10:23 117:16	live (1) 28:24	managing (1) 62:12
include (10) 10:2 14:19	interrupt (1) 26:11	131:8	K	legal (2) 74:5 75:5	lmin (18) 90:4,4,6 97:1,3,3	manual (1) 56:7
15:13,21 27:9 65:15 69:17	interruption (1) 62:3	istrp000000008234 (1)	k (3) 34:22,23 35:2	legitimade (3) 58:11 59:2,23	99:12,23,25 100:1,2	manually (3) 93:19
79:18 101:1 102:14	interruptions (2) 41:15 63:10	129:11	keep (3) 58:5 103:9 119:6	leisure (2) 36:21,23	116:16,21 131:1,1,11	126:11,15
included (5) 57:8 65:23	intersection (1) 36:14	istrp00000000872 (1) 66:8	kensington (2) 36:21,23	lend (1) 74:11	134:11,14	manufacturer (9) 24:11
99:9,16,21	intervention (5) 93:16,25	istrp00000000879 (2) 83:18	key (10) 9:19 14:13,17 15:5	length (6) 20:21 71:15 88:19	loading (2) 114:8 122:1	42:22 43:24 49:15 50:7,8
includes (7) 12:21 69:14 72:6	95:14,19	85:9	16:23 20:4 21:22 90:8	89:21,23 90:8	located (5) 12:17	74:18 82:6,6
99:23 115:14 122:4,12	interventions (5) 93:8,14,20	istrp0000000088 (1) 12:15	102:2 112:5	less (11) 32:1 56:12 62:21	36:10,14,17,21	27:10 74:17
including (8) 5:25 7:23 26:23	into (52) 5:21 10:7 13:22	istrp00000000881 (1) 86:16	kind (26) 10:4 17:24 19:22	63:4,11 69:24 70:10 71:22	location (2) 23:11 95:8	manufacturing (7) 74:3,20
69:5 76:1 92:1,7 124:10	18:7,8 20:23 21:11,16	istrp000000009101 (1) 108:3	20:16 22:11 24:23 30:12	76:20 78:23 109:19	locations (6) 6:8 40:2 84:1	many (2) 82:22 100:25
105:6 107:10,14 108:1	22:7,11 24:17,24 32:9	istrp000000009102 (3)	50:8 54:20 68:10 69:2 79:4	let (3) 18:6 47:15 78:11	100:3 115:22 124:22	map (3) 35:25 36:1 117:25
110:3 114:17	34:12 35:7 39:16 40:9 46:8	102:11 105:16 111:22	81:8,19,20 86:20 87:16	lets (12) 17:23 35:21	logbook (1) 112:23	maps (1) 85:17
increased (9) 20:11 90:3	50:4,18 51:23 53:21 58:8	istrp000000009106 (1)	98:2 100:22,23 101:21	46:15,24 57:16,23 61:13	logistically (1) 124:16	march (1) 2:21
97:1 103:22 105:9 109:10	59:7 62:8,13,21 63:13 67:4	108:10	110:14 114:18 118:17	82:1 119:5 122:7 126:6	london (20) 3:23 5:23	marginal (7) 103:23 104:13
110:5,8 111:3	69:15 75:9,22 82:13 88:21	istrp00000000985 (1) 93:11	125:25 132:16	136:7	12:18,22 14:10,12 68:18	105:4,12 106:22 107:1,14
increases (1) 107:14	89:3,7,24 91:1,2 95:11,22	istrp00000000986 (1) 96:14	kinetic (2) 22:11,12	letters (1) 36:25	78:4,14,18,20 79:7,18 82:3	marked (1) 84:7
increasing (8) 95:8,11,21	101:5,11,22,24 103:24,25	istrp0000000099 (1) 92:16	kinked (2) 20:11,21	level (7) 40:5 82:22 102:1	86:22 87:6 107:18,19	marker (1) 30:23
97:21 102:15,19 103:24	104:3 107:16 110:20	istrp00000000993 (1				

67:9 78:6 79:10,23 80:7,9,17 81:10,13 82:4,11,24 117:15,21 118:1,2 119:7,10,23,25 120:8,12,16,19 131:20 132:19 135:5,10,16,24 136:3,7,17 137:3,6,9,15,18 mass (2) 16:15 22:13 match (2) 63:12 132:8 material (6) 27:5 33:3 95:7,10,21 96:1 materials (4) 8:10,13 27:3 133:8 mathematical (13) 4:8 19:25 39:21 40:8 96:6 115:10 116:5 118:2 125:4,10 126:1,18,22 mathematically (1) 129:15 maths (2) 66:23 67:6 matter (3) 113:6 133:16 136:20 matters (13) 2:25 3:8,13 6:25 7:13 14:2 37:16 56:21 58:2 91:22 101:16 105:5 133:5 maximise (2) 107:4 113:13 maximising (1) 22:18 maximum (28) 23:18 24:1,1,5 25:7,7 42:1,8 43:7,8,13,21 44:15,17,19 45:5 49:2 50:23 51:4,10,25 52:6,25 54:24 59:3,17 118:9 134:12 maybe (2) 85:6 119:21 mean (25) 2:10 15:15 19:21 20:13 21:10 22:10 33:19 61:8 66:22 74:19 75:1 81:17 82:20 85:24 86:19 88:19 89:4 97:5,22 100:16,24 109:15 114:5 131:23 132:13 meaning (5) 6:25 9:24 81:21 109:8 132:18 meaningful (1) 72:19 means (8) 7:17 19:24 21:6 22:1 25:9 93:18 105:12 127:10 meant (1) 41:18 measure (6) 19:7 45:16 54:7 66:10,15 129:7 measurement (2) 54:2,3 measurements (1) 61:20 measures (2) 66:16 130:11 measuring (1) 129:5 mechanical (3) 56:7 87:3,13 medicine (1) 3:23 meet (1) 134:20 megalitres (1) 134:10 members (2) 27:18 136:19 memory (2) 78:23 85:1 mentioned (4) 15:12 19:10 35:7 61:22 mercury (3) 31:18 49:22 55:13 message (1) 114:16 met (1) 128:12 metal (1) 85:14 meteorological (1) 57:20 metersic (1) 51:7 methods (1) 4:25 metres (24) 21:14 42:8,9,9 43:8,9,11,14,19,20 44:13 46:24 47:2,12,18,20 50:25 52:13,14 90:10 105:8 106:13 107:11 121:15 metropolitan (1) 27:1 middle (2) 49:12 126:23 midst (1) 126:2 midway (2) 5:17 127:2 might (22) 6:11 11:21 20:19 24:14 26:4 28:14 39:8 46:9 58:19 68:10,18,23 70:15 81:10 82:15 90:19 97:12 103:25 119:18 126:8,17 135:4 mind (17) 16:21 38:22,25	47:22 58:12 59:2,24 70:17 74:22 85:4 86:18 98:23 104:12 105:4 110:5,15 111:2 mindful (1) 77:22 minds (1) 39:14 mindset (1) 119:2 minimal (8) 9:14 57:25 95:7,10,20 97:17 108:16 110:24 minimise (1) 9:18 minimising (1) 77:19 minimum (13) 6:18 9:16,20 38:22,23 39:1 74:23 81:15 118:9 128:25 129:23 130:17 134:15 minute (23) 17:24 25:15,16 30:3 32:1 43:6 56:12,13 63:5 78:24 82:2 89:7 104:4 105:11 117:3,6,10 122:6,7,9,10,15 132:5 minutes (1) 114:10 mishaps (1) 87:11 mislabelled (1) 85:20 mismatch (1) 118:23 missed (1) 135:7 mistakenly (1) 85:13 mitigate (1) 90:14 mm (1) 94:3 mm (1) 94:3 mobile (1) 86:1 mobilisation (1) 99:19 mobilised (1) 100:3 model (14) 39:21 40:18,21,21 49:16 96:6 97:24 114:7 115:12 118:2 124:11 125:4 126:12,15 modeller (2) 101:2,2 modelling (10) 4:8,24 40:13 101:8 115:11 116:5 117:2 125:10 126:1,22 models (4) 40:8,8,9 50:17 modest (3) 105:6,8 107:15 moment (4) 31:4 60:7 63:16 80:1 moments (1) 28:25 monitor (31) 11:23 21:24 23:21 30:9,24 31:4,11,15 33:16 32:23 35:10 38:22 39:3,6 44:5 46:16 49:9,23,23 52:10,12,20 54:15 55:10,12,12 56:6 89:13 99:25 104:4 122:8 monitored (1) 55:25 monitornozzle (1) 23:19 monitors (7) 37:22 38:1,7 41:9 50:4 53:15 90:5 monitorsnozzles (2) 52:3,7 months (4) 109:23 110:3,14,25 moorebick (68) 1:3,9,11,15 16:10,20 18:3,20 45:9,13,19,22 46:4,8,13,23 47:2,6,15,21 48:8 54:11,23 55:1,6 60:8,16,20,25 61:2 67:9 78:6 79:10,23 80:7,9,17 81:10,13 82:4,11,24 117:15,21 118:4,12 119:7,10,23,25 120:8,12,16,19 131:20 132:19 135:5,10,16,24 136:3,7,17 137:3,6,9,15,18 139:3 140:13 141:13 142:13 more (35) 8:21 13:11 43:19 47:16 48:3 58:2 59:18 64:18 66:23 71:24 73:4 81:13 83:7,19 94:21,25 97:15 107:2,2 110:11 111:6 113:12 114:25 118:13,25 119:3,5,14 121:19 123:2 131:2 133:2 134:25 135:21 136:8 morning (8) 1:3,21,22 60:10 128:8 137:16,19 most (9) 37:14 47:25 53:13 73:24 79:7 96:24 97:11,19 98:20 move (3) 85:6 91:21 128:2	msc (2) 3:15,21 much (45) 1:11,21,22 2:9 4:6 5:23 16:22 17:3 18:10 19:10 29:18 44:25 47:10 48:9 51:16 55:14 60:16,20 61:2 63:22,24 66:24 68:25 79:3 82:12,25 104:23 105:1 107:21 109:20 114:19 120:7,8,19 121:18 122:11 133:25 135:24 136:1,12,15,23,25 137:1,18 multi (1) 131:2 multiple (9) 32:23 90:19 102:23 107:20 113:10 114:3 116:18,23 124:6 multiplied (1) 19:23 must (1) 130:10 <div>N</div> name (2) 1:19,20 namely (2) 95:13,19 narrower (1) 65:6 national (5) 26:24 130:24 131:14 132:2 133:13 nature (1) 59:22 near (5) 63:21 118:19 124:11 125:11 126:13 nearby (1) 86:4 neat (1) 65:12 necessarily (3) 59:15 65:5 66:5 necessary (4) 6:4 7:18 39:17 131:12 need (26) 8:20 16:15,16 22:10 24:16 30:7 31:7 35:13 38:9 43:1 47:17 51:22 53:5 58:8 67:4,11 81:22,23 82:3,17,18 104:2 108:2 118:13 122:13 125:20 needed (3) 6:2 29:1 90:9 needs (12) 9:19 21:17 25:9 53:15 72:23 81:25 82:13 94:24 99:5 100:7 102:8 122:9 negate (1) 90:23 negative (1) 75:14 neighbouring (1) 93:23 network (62) 6:16 7:24 8:23 9:2,4,22 10:6 12:13 15:9 26:3 40:1 41:1 61:16 66:13,18 68:8 69:6,23 70:22 74:2 77:18 84:11 85:18 87:8 92:25 94:6,19 95:1 96:6,10 97:14,24 98:3,5,9 99:6,19 101:4 103:6,25 106:3 109:15 110:6,9,11 111:15 112:7 113:14,23,24 114:6 115:10,12,18,21,25 117:5 119:2 123:16,18 127:21 128:4 networks (9) 4:7,25 5:2,5,6,12 9:11 10:6 13:23 never (1) 30:9 nevertheless (2) 97:15 104:2 next (12) 30:24 33:10,24 36:21 38:10 39:19 41:4 71:16 85:9 93:8 109:4 128:10 nhs4n (1) 93:4 night (24) 6:17 25:2 36:6 37:8 38:8 39:24 42:11 44:9 63:2,14 65:1 76:2 86:6 88:14 93:14 104:6 111:18 112:23 116:6 118:21 123:21 126:9,19 127:24 nighttime (1) 13:20 nmc (1) 99:5 nod (1) 2:11 nominal (1) 24:20 none (3) 7:25 38:2 123:19 nor (1) 8:1 normal (2) 31:8 103:13	normally (4) 31:20 44:16 105:23 121:22 north (1) 35:3 northwest (4) 33:16,23 39:6 89:1 note (10) 30:25 43:5,14 52:12 72:10 90:13 123:12 128:2 130:7,15 noted (2) 30:20 59:16 nothing (1) 114:25 noticed (5) 86:20,21,23 97:7,13 noticing (1) 96:25 notified (1) 87:18 notify (1) 87:17 notion (5) 13:24 20:16 24:4 25:4 82:10 november (1) 48:14 nozzle (31) 18:19 21:24 22:15,18,19 31:5,18,20 42:18 43:8,9 46:25 53:14,16,22,23 54:7,15,16,18,19,23,25 55:13,14,19 56:1 58:20,21 63:19 64:11 nozzles (8) 31:16,17 50:4,18 53:15 54:13,14 55:16 nst (1) 97:7 nst1l (1) 93:3 nst2d (1) 93:3 nst3a (1) 93:4 nst4n (2) 96:23 97:19 nst5m (1) 93:5 nst6r (1) 93:5 nsts (7) 92:25 96:11,16,19 98:25 100:5,8 number (14) 6:5 7:23 16:9 20:2 26:10 40:11 68:19 74:18 85:24 101:13 109:7 115:16 132:2,4 numbers (7) 50:3,7,15,17 132:1,17,18 nutshell (2) 62:19 64:12 <div>O</div> object (1) 47:13 objective (2) 20:5 46:17 obligation (2) 24:11 79:15 observation (1) 57:11 observations (3) 7:16,17 101:13 observe (2) 84:22 101:22 observed (2) 52:5 107:24 observing (1) 127:10 obstacle (1) 46:2 obvious (1) 33:2 obviously (2) 101:12,18 occupied (1) 131:2 occurred (2) 55:24 99:1 occurring (3) 20:19 25:23 111:17 oclock (7) 23:3 28:6 120:3,10 128:8 137:16,19 offer (1) 112:18 office (1) 57:20 officers (1) 7:24 offset (1) 25:8 ofwat (2) 129:2,6 okay (16) 26:18 28:10 30:15 55:21 58:4 67:5,8 85:5 88:19 94:15 103:11 122:19 123:4 132:22 135:15,23 older (1) 110:11 oloughlin (1) 127:12 onboard (5) 62:8,10,13 95:12,22 once (2) 79:16 82:17 ones (1) 57:16 online (1) 27:19 onto (3) 33:22 38:1 41:13 onwards (3) 28:3 85:10 89:11 open (2) 17:22 118:15 opened (6) 87:8 96:23,25 97:8,14 112:6	opening (16) 65:4 87:7 93:18,21 94:1,16 95:6,9,20 97:18 102:21,22 112:1,2,3,9 operate (1) 97:12 operated (6) 12:19 23:21 25:10 93:19 103:15 109:24 operates (1) 13:13 operating (3) 81:16 109:9,21 operation (11) 4:21 6:2 22:18 24:6 62:10 80:18 90:24 95:1 106:12 110:17 112:25 operational (18) 6:17 7:13 14:22 22:16,16 39:1 48:19 58:23 59:6 68:8,22 80:11 82:7 83:24 101:16 113:17 124:2 127:6 operationally (3) 100:13 124:16,22 operations (2) 59:22 127:14 operator (1) 114:16 opinions (1) 3:8 opportunity (2) 100:22 137:1 opposite (1) 73:17 optimal (7) 6:2 22:15 24:20 44:21 48:20 126:17,17 112:25 optimisation (10) 4:24 5:11 115:15,20 118:5,11,14 126:1,8,23 optimised (2) 48:23 51:4 optimum (4) 115:16 116:7 124:17 127:21 option (5) 103:2 105:15 111:21 113:9 118:21 options (1) 45:23 107:22,25 opus (1) 29:4 ord (1) 37:14 order (7) 46:24 47:18 63:21 68:16 115:17 124:19 133:2 ordinarily (1) 11:11 organisational (1) 101:17 organisations (1) 102:8 orifice (11) 18:14,15,16 19:12,13,15,22 20:3 44:2 66:25 106:7 otherwise (3) 28:24 49:23 85:21 ought (5) 131:22 133:6,13 135:12,18 outcome (2) 25:6 68:25 outlet (2) 62:14 70:9 outreach (4) 46:15,17,19 107:5 outside (4) 7:14,14 14:21 57:8 oval (1) 29:6 over (19) 5:3 8:14 17:21,25,25 26:19 29:12 32:21 49:19 71:15 73:19 78:22 80:12,24 89:14 90:9 96:13 99:14 101:25 overall (3) 49:5 81:21 114:15 overarching (1) 10:11 overlooked (1) 135:14 overseeing (1) 87:18 overview (1) 128:15 own (5) 56:23,25 94:20 101:18 112:19 owned (1) 85:11 <div>P</div> pace (1) 2:9 pages (5) 35:13 38:4,10 53:6 71:16 panel (3) 53:10 113:6 136:19 panels (1) 60:4 paper (1) 78:16 paragraph (45) 23:7,9,11,13,15 26:1,3 32:12 42:13 48:17 49:7,12 51:1,20 52:8 62:6 65:11 70:5,7 71:11 73:22 75:10 77:10 83:9 85:10 90:13 92:23 96:15 98:21 102:14	103:13 105:16 109:4 113:9 128:21 129:11,13 130:6,7,21 131:9 133:21 134:5,8,18 paragraphs (1) 73:20 parallel (1) 90:20 parameters (1) 48:21 park (3) 13:6 14:4 15:24 part (19) 4:10 9:17 12:18 13:1 15:19 20:4,15 22:21 49:14 54:15,18 71:24 75:22 81:24 94:19 109:16 123:20 127:10 128:14 partial (1) 63:9 particular (55) 6:24 13:13 16:13 17:7,25,25 20:5,23 24:18 25:8,13,23 30:11,23 31:6 35:3 37:20 39:2 43:2,12 44:4,5 46:3 47:11 50:18 54:8 63:20 65:11 68:12 72:16,16 82:16 87:14 89:6 90:22,25 92:16 93:11,17 96:10 99:11 101:3,6 102:14 104:10,24 105:3 107:17 119:19 123:3 130:6 133:12,19 134:1 135:8 particularly (2) 8:6 107:3 parts (2) 110:11 111:6 pass (1) 73:3 pause (8) 1:14 29:2 32:3 60:19 120:9 121:2,5 135:25 paused (2) 21:8 63:6 paying (1) 105:14 payton (1) 97:4 pbarht07 (1) 93:23 pbarht08 (4) 93:22 94:3 102:15,17 pda (2) 122:2,12 peak (5) 59:16 117:9 128:3,8 131:10 peaked (1) 134:15 people (8) 11:10 28:20 29:1 31:12 36:25 52:9 55:20 135:16 peoples (1) 39:14 per (22) 17:24 25:15,16 30:2 43:6 56:12,13 78:24 82:2 89:7 104:4 105:11 117:3,5,10 122:6,7,9,10,15 132:5 134:10 perceive (1) 112:24 percentage (2) 38:24 78:22 perfection (1) 100:11 perform (2) 53:22 78:5 performance (20) 48:20 49:15 51:22 52:2,6,9,15 55:14,15 58:9,17,25 68:23 71:23,25 73:11 77:20 80:12 82:10,12 performed (3) 58:23 68:20 118:20 performing (1) 54:4 perhaps (3) 58:25 75:1 135:18 period (2) 17:21 80:24 periodic (3) 80:22 81:1 99:18 periods (1) 13:17 person (2) 82:13 136:22 personal (1) 8:1 personnel (1) 92:9 perspective (9) 7:12 14:17,20,23 55:3 56:22 75:5,7 123:16 persuaded (1) 56:18 phase (1) 27:14 phd (1) 3:25 phenomena (4) 4:6,9 18:13 110:16 photograph (4) 29:7 84:20,24 85:7 photographs (2) 27:17 86:16 phrase (2) 19:17 42:6 physical (7) 4:16 14:25 16:13,14 18:13 20:15	125:5 physically (1) 56:7 pick (2) 118:15 126:15 picking (1) 44:18 picks (1) 128:6 picture (1) 103:10 pictures (1) 68:17 piece (6) 6:2 22:2,7 23:24 25:13 50:24 pieces (1) 40:3 pinching (1) 65:4 pipe (20) 17:10,16 18:19,24 20:18 55:4 68:4,19 93:24 94:3 106:4 108:2,12,16,24,24 110:4,23 112:24 129:2 pipeline (1) 68:9 pipes (17) 9:4 10:7,10 11:4 12:7 69:5,22 109:6,12,18,19,24 110:9,12,13,21 111:13 pipework (12) 68:23 69:11,15,18 71:13 72:7,13 74:1 77:21 79:13 80:19 84:22 pipng (2) 68:9,11 pitched (1) 45:4 pitfalls (2) 72:25 82:15 place (13) 16:17 30:22 53:3,21 54:3 55:5 60:7 104:23 105:18 109:6 110:2,25 113:1 placed (3) 31:5 35:6 114:12 placement (1) 59:7 plain (2) 16:3 31:19 plane (1) 97:4 planning (1) 5:15 plate (1) 87:21 platform (7) 31:25 32:5,14 42:15,15 49:21,22 platforms (2) 30:14 132:12 play (2) 1:25 44:18 please (19) 1:11,19 2:14,6,10 60:11,17,20 61:23 109:5 111:23 112:12 117:1,14 120:3,4,10 135:21 plural (1) 32:23 pm (5) 120:13,15 136:4,6 137:20 pointed (1) 81:2 pointing (1) 73:17 points (12) 42:24 71:17 80:20 98:15 102:4,7 123:1,6 127:18 132:20 133:12 135:8 police (3) 26:24 27:1 35:17 policies (1) 56:3 polyethylene (1) 109:19 poorly (1) 73:12 position (3) 109:5 125:23 130:1 positioned (4) 43:9 46:1 47:23,23 possible (13) 25:10 43:13 44:19 45:20 51:7 77:19,20 79:10 116:15,20 123:17 124:16 125:25 possibly (7) 67:6 79:24 82:6 98:20,23 113:6 131:21 postgrenfell (1) 112:20 potential (2) 24:16 87:13 potentially (2) 46:16 102:12 powerful (1) 63:25 practical (12) 25:12,18 39:23 47:16 51:4 57:4 59:9 86:12,13 89:9,16 129:5 practically (1) 125:24
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premises (1) 129:2 prepared (1) 48:13 prescribe (1) 81:15 presence (1) 133:9 present (3) 19:1 51:23 104:20 presented (1) 26:22 presents (1) 100:22 preserve (1) 81:25 press (2) 27:18 132:11 pressure (156) 4:7,24 5:1 6:15,18,18 9:13 17:10,13,15,17,18 18:4,7,17,18,24 19:8,14,19,24,24 20:1,9,10,16,16 21:24 22:2,6 23:14,17,18,25 24:1,7,19,21 39:25 40:25 42:18 52:4,17,24 53:8,12,14,16,17,17,22,23 54:7,17,18,19,24 55:14,19,23,25 56:6 58:14 63:18,19 64:2 65:23,25 66:12,17 69:22 72:16 88:1,5,8,14,20,23 89:22 90:17,21,22,23 91:3,10 92:19 93:22,23 94:3,17,21 95:8 102:15,16,19,20,21 103:24 104:8,10,20,22,24,25 105:8,17 106:4,11,13,19,25 107:9,11,15,24 108:2,14,18 109:9,10,20,21 110:2,6,8,19,24 111:3,4 112:8,10,17 114:17 115:11,21,24 116:17,22 117:4,6 118:3,25 119:2 128:18,20,25 129:1,4,6,7,12,15,18,19,21,23 pressuremanaged (5) 104:21 105:22 106:2 108:19 109:22 pressurereduction (1) 109:7 pressurised (1) 13:20 presumably (4) 15:13 18:3 84:18 113:17 pretty (2) 41:2 119:2 prevent (1) 63:10 preventing (1) 96:20 previous (1) 97:9 price (1) 105:14 primary (1) 91:4 principal (3) 12:14 56:17 91:16 principle (1) 71:21 principles (1) 19:11 private (3) 37:12,13 121:10 proactively (1) 100:8 probably (18) 8:20 14:8 16:8 24:13 30:13 39:8 44:15 46:18 47:12 59:25 60:6 73:21 82:21 86:6 89:5,6 113:22 126:7 problem (10) 2:5 62:25 64:20 115:15,20 118:5,11,14 126:8,10 problems (4) 64:8 87:6 124:23 128:6 procedure (2) 122:2,3 procedures (2) 61:19 101:1 proceedings (1) 135:17 process (2) 72:4 125:1 processes (1) 61:19 produce (2) 64:24 65:5 produced (1) 49:15 producing (1) 8:11 professional (2) 59:20 72:24 professor (2) 57:22 137:12 programme (1) 109:16 progressed (1) 99:21 project (11) 22:8 23:8 25:6 43:7 46:2,24 47:7,9,14,18 64:10 projected (14) 22:19 28:12	33:17,21 34:1,7 38:1 41:13 42:2 44:21 51:25 52:5 62:14 64:17 projecting (1) 42:16 projection (7) 46:21 47:24 48:1,4,7 58:1 59:8 projects (1) 22:3 prompt (1) 114:18 prompted (1) 128:4 proper (1) 125:23 proposition (3) 59:24 126:4 127:4 propositions (1) 105:19 protect (1) 28:25 protection (1) 133:10 protocol (1) 61:15 provide (19) 9:12 19:8,20 38:24 44:4 53:21 55:18 65:12 66:11 81:8 95:18 98:6 101:4 102:8,23 113:11 128:15 131:24 133:2 provided (22) 2:14,20 3:4,5 19:19 26:24 27:1 29:23 34:13 39:22 42:21 43:5 44:25 48:21 53:8,12,15 54:21 86:25 92:7 96:1 115:9 provides (5) 27:5 43:24 50:9 94:2 130:16 providing (4) 116:18,23 124:9 136:13 provision (11) 1:5 2:15 9:19 14:14,18 21:23 48:22 114:1 128:16 130:24 132:3 proximity (2) 37:13 86:2 prvs (1) 115:24 public (1) 27:18 publications (1) 79:4 published (2) 27:19 78:16 pulled (1) 48:3 pump (61) 12:3 16:25 17:4,8 20:10 21:4,13,18,19 23:12,20 35:11,15,20 42:18 53:16 55:24 58:14 62:9,11,13,21 63:5,11,15,18,25 64:1 65:25 85:16 86:1 88:2,6 89:7,22,24,24 90:1,2,3,9,15,16,19,25 91:1,2,3,4,10,15 95:12,13,13,23 113:12,14,20 121:17,17 124:8 pumped (5) 12:10 13:14,19 62:22 63:11 pumping (18) 11:1,10 12:9 13:5,10,14 14:3,5,9,11 15:14,18,24 88:22 90:25 103:4 108:17 110:17 pumps (26) 9:7 13:21 21:6 35:16 58:15,17,18 62:10 63:25 64:1 88:25 90:19,24 102:16 103:3,15,21 104:16 107:1,23 108:13,17 110:7,17 111:4 112:16 puncture (1) 18:4 purchased (1) 132:11 purchasing (1) 132:13 pure (1) 98:8 purely (1) 132:14 purpose (12) 9:11,15 11:25 12:15 15:6 34:10 54:22 65:9 84:8 101:3 128:13 130:5 purposes (9) 1:6 8:11 19:1 27:24 31:3 51:23 83:25 94:14 123:15 pushing (1) 101:12 puts (1) 82:13 puzzling (1) 55:3	5:9,14,17 6:24 7:6,19 8:9,19,25 9:9,11,21 10:14,22 11:1,4,7,10,13,17,21 12:4,13,25 14:2,13,25 15:4,12,20 16:2 17:7 18:24 19:3,16 20:7,24 21:20 22:6,20 23:6,24 24:7,19,25 25:12,24 26:11,13,15,18 27:8,13,16,21 28:1,8,11,17 29:10,12,21 30:15,20 31:11,21 32:12,21 33:6,10,24 34:5,14,19 35:8,13,20,24 36:5,9,14,17,20,25 37:4,10,16 38:16,19 39:3,6,11,13,16,19 40:13,15 41:4,7,15,18,21 42:4,12 43:1,5,19 44:18 45:1 49:7 50:1,5,19 51:18 52:15,19 53:4 55:20,22 56:5,10,16,21 57:2,7,14,16 58:2,5,8,25 59:5,15 61:23 62:1,21 63:4,9,20 64:4,14,20,22 65:3,8 66:20 67:4,6,13,15,20 69:4,8,20,25 70:15 71:4,7 72:3,10,19 73:4,16 75:10,19 76:4,10,12,15,18,24 77:9 84:14,24 85:2,6 86:12,14 87:15,22,25 88:8,13,17 89:9 90:13 91:4,7,12,14,20 92:6,12,15,22 93:3,8,20 94:11,13,16 95:2 96:5,9,13 97:17 98:13 99:9 101:12 102:4,10 103:11,20 104:12,15 105:4,15,24 106:1,8,17 107:6,13,22 108:7,22 109:3 110:5 111:2,9,12,17,21 112:12 113:6,9,16,19 114:4,11,24 115:2 116:11 117:9 121:6 122:18,20,22 123:5 124:21 125:3,10,16,22 126:6,21 127:15 128:1,9 130:3 131:17 132:23 133:16 134:3 qualification (1) 14:19 qualified (1) 82:14 qualify (1) 55:8 qualitative (1) 99:2 quality (2) 9:13 98:18 quantify (4) 99:4 104:23 111:8 114:21 quantitative (3) 99:9 100:6,14 quantity (9) 9:12 15:6 16:2,10 133:17,22,23 134:3,24 quarter (1) 135:6 query (1) 71:1 question (16) 16:16 46:10 47:13,15 61:5 66:6 78:8,25 107:7 108:7,8 111:2,7 122:18 131:4,13 questionable (1) 132:18 questioning (3) 46:9 48:11 112:14 questions (17) 1:17,24 5:20 6:14 60:5 114:19,21,25 123:22 132:23 135:2,12,18,22 136:8,11 138:3 quick (1) 49:22 quickly (2) 17:3 101:4 quite (4) 45:7 98:23 110:21 125:23 quote (3) 4:20 49:13 90:8	rate (106) 6:1,4,10 16:25 17:2,8,13,20,23 18:4,9,25 19:7,20 20:3 21:3,24 22:1,6,14,19 23:14,17,18 24:1,25 25:1,7,9,16 38:3,22,23 39:1,20 43:6 44:20 52:4,17,24 53:14 56:1,11,13 60:6 62:13 63:17 64:2,5,10 65:14 66:11,16 72:16 78:4 80:4,7 82:5,7 83:5 87:9,12,25 89:7,19,25 90:3,6,10,21 91:2 95:11,16 97:1,2,2,3,21 99:5,10,12,22 100:4 105:2,9 106:19 113:13 114:20 115:9 116:15,20 117:3,9 118:9 122:13 128:19 130:4,18,25 131:5,13,14 132:4 133:25 134:12,14 rated (26) 23:14,17,17 24:7,19 25:2,10,14,18 30:2,21 38:2,7,14,16,20 39:4,7 42:17 44:20 52:3 53:23 54:18 80:4 90:5 109:11 rates (33) 37:19,21 38:7 40:3 41:3,5,8,15,18,23 62:2,8 78:23 79:22 81:8 83:12 84:2,3 91:8,8,17,17 95:21 104:17 115:3,17 116:8 122:25 123:14,18 126:16 127:20,23 rather (6) 2:11 16:20 45:2 54:12 108:7 131:20 rating (3) 23:25,25 109:21 rationale (1) 94:16 reach (38) 20:4 22:19 23:10 25:7,21,21 41:12 22,24,25 42:7,8 43:13,21,25,25 44:5,15,16,16,17 45:22 46:11,14,22 48:4 49:3 51:10,25 52:5,7,13 56:24 57:10 59:3 62:16 64:24 104:5 reached (4) 38:23 42:1 45:6 55:9 reaching (3) 8:16 20:5 51:12 read (4) 5:21 73:17,21 75:2 reader (1) 4:13 reading (1) 98:22 reads (2) 73:22 81:11 ready (2) 60:25 120:16 reaffirms (1) 55:18 real (5) 68:21 118:19 124:11 126:2,23 reality (1) 94:23 realife (1) 57:4 really (17) 16:11 26:15 50:10 55:3 56:24 61:22 85:24 94:8,12 95:2 97:22 100:22 107:4 113:4 114:24 132:7,24 realtime (1) 126:13 realworld (1) 74:6 reason (11) 55:7 61:11 72:1,7,14 83:4,11 87:25 104:6 110:1 118:19 reasonable (5) 60:7 75:15,18 122:11 130:11 reasoning (2) 73:4 109:3 reasons (11) 56:17 59:6 65:14 71:15,15,19 73:23 91:7 106:18 109:13 125:23 reassurance (1) 50:9 received (14) 25:2,15,18 30:20 38:8,13,16,19 39:3,7 64:10 98:4 112:14,18 receives (2) 19:9 66:18 receiving (1) 64:15 recently (1) 132:11 recognise (3) 75:8 81:24 82:15 recommendation (1) 54:17 recommendations (2) 53:3	131:25 recommended (2) 109:11 131:14 recommends (1) 130:25 record (3) 1:19 5:21 109:9 recording (1) 56:8 records (3) 58:15,16 86:24 red (4) 11:7,10 37:4,5 reduce (5) 94:18 106:3,4,6,6 reduced (8) 59:19,21 89:24 93:22,23 94:3 97:6 104:8 reducing (5) 63:17,17 90:10 102:21 115:24 reduction (24) 65:23 102:17,20 104:10,23 105:17 106:11,13,20,25 107:9,24 108:14,18 109:10 110:8 111:5 112:8,10,17 116:17,22 117:4,6 reemphasised (1) 61:24 refer (18) 10:8 27:8,13 29:10 31:19 32:18 34:22 72:3,16,17,19 78:16 93:3 97:9 103:2 105:15 112:8 113:9 reference (8) 29:4 70:12 85:2,3 104:12 105:4 117:25 129:3 referenced (1) 27:2 references (2) 74:18,19 referred (4) 7:1 24:20 99:7 131:6 referring (9) 17:3 31:14 44:14 80:1 88:4 97:23 110:13 119:21 120:24 refers (14) 9:21 33:2 42:1 67:15 70:20 71:4,12 72:12 73:9 76:25 82:5 105:12 113:11 129:3 refill (1) 21:8 refilled (2) 62:12 63:7 refilling (1) 62:24 refined (1) 125:4 reflection (1) 61:8 regard (1) 133:18 regardless (1) 77:22 regards (2) 61:5 104:25 region (1) 12:21 regular (3) 79:17 121:23 125:9 regulations (3) 128:24,25 133:9 regulator (1) 129:3 regulatory (5) 128:11,16 129:25 131:24 133:17 relate (1) 91:8 related (1) 72:4 relates (5) 70:24 74:1 77:14 79:24 91:9 relating (6) 27:10 60:13 74:5,24 120:5 128:11 relation (8) 5:14 15:20 23:14 52:1,22 66:11 107:22 129:12 relationship (1) 64:1 relatively (2) 106:23 109:12 relay (6) 90:1,15,16,19 121:17,18 relays (1) 124:8 release (1) 25:9 relevant (9) 3:9 7:21 14:22 39:17 66:6 72:10 73:13 123:7 128:15 reliable (3) 40:16,17 133:3 relied (4) 8:11 27:4,17 56:6 relies (1) 123:24 relieved (1) 18:21 rely (3) 71:19 72:8,14 remain (1) 12:23 remains (2) 77:18 97:16 remember (1) 2:6 remind (2) 31:11 103:3 remotely (1) 92:19 renovation (1) 109:16 reorganise (1) 127:1 reorientate (1) 83:10	repeatability (1) 54:9 repeatedly (1) 62:23 rephrase (1) 2:1 replaced (2) 33:15 87:20 replicated (1) 57:4 reply (2) 131:21 134:6 report (65) 2:15,18,20,23 3:5 5:21 6:24 7:2,2,7,10 8:12,17 9:21 10:15 12:14 22:25 23:7 24:25 26:20 27:2 28:17 34:10 41:7 48:13,17,18,21 49:1 50:3 51:1,15,19 53:4 59:16,19 62:2,5 67:15,20 70:15 71:9,10 73:6,16 77:9 83:11,17 89:10,17 91:24 93:12 96:14 107:25 119:16 123:6,23 127:16 128:14 130:21 134:3,6 136:13,14,21 reported (2) 97:2,3 reports (4) 2:14 3:1,4,8 represent (3) 11:4 24:15 27:22 representative (4) 51:24 79:1,6 118:24 represented (1) 64:3 request (6) 86:14 92:18 112:18,21 114:5,17 requested (2) 100:6,8 requests (3) 95:15 99:9,16 require (2) 2:4 128:25 required (10) 13:10 16:19 53:22 56:13 79:22 99:10,22 127:1,5 133:11 requirement (9) 70:20,24 71:12 72:12 73:8,10,25 74:15 76:25 requirements (7) 6:19 15:1 74:5 81:15 99:20 100:19 102:2 requires (2) 99:12,23 requiring (1) 63:5 rescue (7) 80:22 81:9 114:13 119:5 130:9,10,19 research (7) 4:5,16,23 5:4,9 53:25,25 researcher (1) 101:24 reservoir (5) 10:24 13:4,5,18 91:1 reservoirs (10) 9:5 10:3,5 13:7,22 15:8,12,16,17,23 resources (2) 12:18 107:4 respect (2) 82:23 131:25 respectively (2) 42:10 50:25 respond (1) 114:23 response (7) 5:15 6:20 51:14 54:7 69:12 81:18 95:15 responses (1) 112:20 responsible (1) 83:1 rest (4) 69:6,23 116:2 128:19 restarted (1) 63:7 result (3) 21:10 56:19 110:20 resulted (6) 62:9,15 95:25 106:12 107:10 110:6 resulting (1) 108:1 results (13) 40:16 44:24,25 50:21 51:24 55:11 56:18 61:21 76:4 79:3 81:2 116:11 127:19 resume (3) 60:11 120:3 135:20 return (3) 19:4 119:21 122:23 reversals (1) 13:24 review (1) 92:6 reviewed (1) 27:23 revisit (1) 61:4 rig (1) 68:4 rightfully (1) 61:10 rigorous (1) 94:25 rigour (1) 99:3 ring (2) 14:6,10 riser (1) 35:4 rising (3) 11:14 21:25 34:21 risk (11) 106:4,6 108:12,16	110:3,10,24 111:5,18 112:24 113:4 road (3) 36:17 89:2,3 roads (1) 36:15 robust (1) 40:19 roe (1) 127:12 role (2) 91:22 127:13 roles (1) 98:2 rolls (2) 132:13,14 room (4) 28:20,24 60:13 120:4 root (2) 19:23 20:1 roughly (2) 21:14 50:22 round (2) 70:9 111:24 royce (2) 132:13,14 run (6) 61:15 98:5 118:13 125:20 126:14 133:25 running (4) 61:19 109:17 114:7 126:7 runs (1) 121:25 runup (2) 131:4,12						
						S						
						s13a1 (4) 32:14 42:15 65:18 83:13 s13p1 (1) 95:13 safe (7) 22:17 24:6 46:18 96:21 102:8 127:23 134:23 safely (3) 23:21 24:2 100:12 safety (4) 22:17 24:13,17 44:1 sake (2) 32:8 42:6 same (15) 3:5 9:25 13:22 18:13 21:11 49:15,16 50:13 57:25 84:10,11 95:17 109:1 118:25 132:7 sample (2) 79:1,6 satisfactory (1) 133:2 satisfy (1) 16:13 save (3) 51:22 52:9 67:6 saw (2) 69:12 103:4 saying (4) 32:7 47:8 73:14 107:13 scenario (1) 128:7 scenarios (2) 98:6 123:13 schematic (1) 11:25 schematics (1) 94:9 scheme (5) 106:11 109:22 110:25 116:17,22 science (1) 3:22 sciences (1) 4:16 scientific (1) 64:18 scientifically (1) 88:17 scope (6) 7:15 60:1 74:12 101:18 123:23 126:9 screen (3) 25:24 48:13 130:22 scroll (2) 66:22,24 scrutinise (1) 75:4 searching (1) 120:22 second (19) 16:16,23 19:3 22:21 23:16 29:14 30:8 32:6 49:12 62:1 72:7 83:11 91:1,2 93:25 105:15 112:22 121:25 122:17 secondly (13) 2:3 7:2 9:11 23:9 41:15 56:5 57:7 72:3 86:2 98:11 106:2 109:10 133:7 seconds (1) 63:6 section (15) 3:12 5:18 8:9,13 14:16 17:21 21:2 69:14 74:12 89:12 93:11 108:11 116:2 128:10 130:9 secure (1) 102:8 securing (1) 130:11 sediments (1) 83:25 see (63) 3:11 5:17 7:19 8:9 10:16 11:10,13,17 13:1 14:16 16:7 17:9 20:8 21:22 25:25 28:2,17,21 29:5,14,23 31:11 34:21 38:11 45						

70:6 71:17 76:4 77:10 81:17 84:15 85:9 89:9 92:15,23 101:7 106:9 108:11 111:25 116:13 118:19 119:10,19 121:9 129:13 130:22 131:8 133:4 135:6,7,21 136:7 seeing (2) 81:20 137:12 seek (1) 7:12 seeks (1) 49:1 seem (1) 132:8 seems (8) 60:1 78:25 79:6,23 87:20 112:19 113:2 116:25 seen (4) 29:19 36:20 82:22 98:3 selects (1) 115:15 separate (4) 75:20 98:13 115:2 128:1 september (2) 49:11 75:24 serial (4) 50:3,7,15,16 series (4) 86:16 90:20,24 125:13 serious (1) 128:5 service (20) 7:24 10:4 14:22 15:16 26:25 27:1 48:24 81:9 85:18 87:8 92:25 96:11 97:14,25 98:9 113:23 114:13 119:5 128:24 129:3 services (4) 80:22 128:23 130:9,19 serving (1) 18:24 set (22) 2:25 3:8,12 8:17 13:16 14:11 22:25 29:14 38:10 53:7,20 68:15 71:11 73:5 88:22 100:10 102:13 116:11 127:16 128:20 129:11 132:12 sets (5) 50:21,23 62:4 123:6,10 setting (4) 81:15 90:15,24 124:7 settings (5) 63:11 69:10 115:24 116:17,21 setup (7) 13:11,13 23:19 77:20 90:1 113:20 127:2 several (1) 58:13 sewerage (1) 128:23 shadowing (1) 87:18 shaft (4) 13:6,6 14:4,5 shafts (1) 15:25 shake (1) 2:11 shall (7) 57:14 67:14 70:10 74:16 136:8 137:9,11 shallower (1) 45:4 sharply (1) 59:17 short (7) 1:24 60:23 76:21 77:2 120:14 135:13 136:5 shorthand (1) 70:12 shortly (1) 87:20 should (21) 8:1 28:19,23 38:21,25 54:21 58:23 61:10 75:2 76:19 84:6 87:19 108:22 119:12 121:22 123:19,21 125:8 127:24 133:1 136:17 show (4) 28:22 36:5 79:3 117:1 showed (2) 117:2 120:23 shower (1) 17:23 shown (2) 46:11 68:17 shows (7) 37:4 43:5 45:3 46:14 84:20 121:7,12 side (16) 28:12 31:25 32:15,25 33:12 34:1,7 35:5 48:4 52:21 89:1,1 99:12,24,25 129:4 sides (2) 35:3 39:3 sierra (3) 35:17 38:19,21 significant (6) 89:4 91:16 99:20 104:5,15 128:6 significantly (7) 45:7 54:20 59:18,21 68:10 84:2 134:21 similar (4) 50:13,13 55:16 112:3	simple (8) 1:25 12:5 14:3 19:1,25 22:1 49:1 54:5 simplest (1) 15:20 simplistic (2) 12:6 17:22 simplistically (1) 56:16 simulate (1) 101:3 simulated (1) 129:15 simulates (1) 118:2 simulations (1) 6:14 since (2) 46:8 58:10 single (4) 56:10 113:12 121:17 122:4 sir (82) 1:3,8,9,11,15,18 16:10,20 18:3,20 45:9,13,19,22 46:4,8,13,23 47:2,6,15,21 48:8 54:11,23 55:1,6 60:5,8,16,20,21,25 61:2 67:9 78:6 79:10,23 80:7,9,17 81:10,13 82:4,11,24 83:3 117:15,21 118:4,12 119:7,9,10,19,23,25 120:8,11,12,16,19,21 131:20 132:19 135:4,5,10,16,24 136:2,3,7,10,17 137:3,6,8,9,15,17,18 sit (1) 1:12 site (2) 87:17 117:22 sits (1) 31:5 situated (2) 37:6 105:21 situation (3) 46:16 86:9 107:3 situations (1) 57:4 six (2) 35:15 92:24 size (1) 133:7 slight (2) 9:16 14:7 slightly (9) 43:19 47:16 56:21 75:13 76:5 83:9 101:12 114:11 134:17 slowly (1) 58:3 sm (1) 97:4 small (13) 14:8 44:3 60:2 64:15 69:14 104:1 106:24,24,25 110:10 111:6,9 113:4 smaller (1) 37:4 smooth (1) 31:20 sofia (1) 3:17 solution (2) 63:9 119:14 somehow (1) 58:19 someone (2) 85:3 101:23 something (5) 73:5 78:19 84:18 88:3 98:1 sometimes (6) 1:25 13:19 24:20 49:21 67:15 121:3 sophisticated (1) 118:14 sort (19) 14:7 19:16 25:4 30:22 31:16 44:14 47:11 55:17 69:1,2 83:10,19 86:20 87:5 90:17 106:23 122:23 125:8,21 sorts (1) 82:19 sounded (1) 131:20 source (7) 10:24 11:1 12:6 24:8,9 56:11 88:24 sources (13) 6:11 13:2 15:22 26:4,23 27:2,8,9,21,23 94:20 103:5 134:6 south (5) 30:25 33:12 35:5 39:3 99:25 southeast (1) 36:11 southwest (2) 78:18,20 space (1) 113:5 speak (1) 80:5 specific (11) 33:22 38:6 44:1 50:7 54:3 60:4 68:5 84:1 114:8 124:17,18 specifically (4) 55:12 58:14 93:18 119:15 specification (4) 22:17 37:15 58:24 70:2 specifications (5) 22:16 24:10 58:18 81:23,25 specified (3) 25:10 54:17 74:17	specify (1) 50:3 spectrum (1) 107:15 speed (2) 63:25 64:1 spread (3) 57:24 105:13 111:14 spreading (1) 94:20 sprinklers (1) 133:10 square (2) 19:23 20:1 squeeze (2) 18:7,10 staff (2) 113:16,19 stage (6) 2:3 94:13,13 95:3,3 135:11 stages (2) 105:24 126:6 stagnant (1) 84:1 stakeholders (2) 72:11,15 standalone (17) 67:21,22 69:2,8,21 70:21,24 73:9 74:3,8,20,25 75:11,14 76:25 77:15 79:11 standard (26) 66:7 69:14 70:1,4,9 71:7,12,20 72:4,20,25 73:10,18 74:13,19,23 75:2,12 76:21 77:3,14,23 79:25 81:11 82:4 122:2 standards (13) 7:1 54:4 69:17 73:13,13 81:14,21 128:11,16,17,24 129:25 133:18 standardsetting (1) 80:10 standby (1) 101:2 standpipe (1) 86:4 stands (1) 37:2 start (6) 34:15 41:10 62:24 63:17 81:20 88:3 starting (5) 8:6 17:9 28:2 107:20 116:14 starts (2) 8:14 128:21 stated (3) 20:13 57:19 82:5 statement (4) 30:12 50:12 99:10 101:20 statements (11) 7:23 26:23 63:3 85:25 86:3 92:7 100:18 108:6 112:15,15 127:11 stateoftheheart (1) 56:5 states (3) 26:20 74:12 130:10 static (1) 129:1 stating (2) 30:7 127:7 station (9) 11:1 13:5,14 14:4,9,11 15:24 103:4 108:17 stations (4) 15:14,18 44:10 57:21 status (2) 23:11 124:2 statute (1) 130:16 statutory (2) 12:20 128:15 stay (14) 8:9 10:15 12:25 17:7 20:25 28:1 35:24 53:4 65:9 86:14 92:22 93:10 95:3 133:19 stem (2) 87:14 97:12 stenographer (2) 2:7 58:5 step (2) 78:11 116:25 steps (1) 28:23 still (3) 28:21 73:2 109:11 stipulated (1) 130:18 stipulates (1) 70:8 stoianov (29) 1:8,10,20,21 8:19 28:8 31:4 41:10 48:21 58:2 60:9 61:23 66:2 67:4 73:21 94:13 105:20 111:24 119:20 120:1,16,22 122:18 135:2,11 136:7,11,18 138:2 stop (5) 25:22 60:7,11 120:2 129:4 stopped (1) 62:24 stopping (1) 62:9 storage (7) 9:5 15:16 16:18,19 21:13,15 134:19 store (1) 13:8 stored (1) 15:8 strapping (1) 64:23 strategies (1) 127:6	strategy (1) 7:13 stream (3) 28:24 64:15 65:6 street (1) 68:14 streets (1) 10:7 stress (3) 110:9,14,22 strictly (1) 14:25 strongly (1) 25:4 structurally (1) 84:9 structure (3) 10:2 26:6,16 struggle (1) 97:22 stuck (1) 30:11 studies (1) 5:6 stumbled (1) 86:7 subcontractors (1) 82:21 subheading (2) 70:7 133:22 subheadings (1) 133:5 subject (3) 4:4 22:24 114:7 subjected (2) 110:14,21 subparagraph (1) 93:13 substance (1) 98:18 substantial (1) 111:13 substantiate (1) 44:25 successfully (1) 109:9 sudden (1) 110:19 suddenly (4) 68:20 107:1 110:1,3 sufficient (3) 75:8 122:13 126:14 suggest (2) 60:2 135:18 suggested (1) 117:17 suggestion (1) 123:20 suggestions (1) 100:11 suggests (3) 72:11 80:3 129:6 suitable (1) 124:22 summarise (4) 8:10 38:10 71:17 109:4 summarised (4) 48:18 71:18 72:21 109:13 summary (31) 5:7 6:22 8:15 9:3,15 10:20 12:11,23 21:9 26:6 27:3,23 35:18 38:11 40:6 43:16 44:13 55:20 64:25 65:12 72:1,13 91:12,14 92:4,20 93:1 96:2 98:19 117:2 130:1 supervision (1) 82:22 supplemental (7) 2:23 59:1 71:9 73:6,16 77:9 136:14 supplementary (3) 2:20 6:24 51:19 supplied (7) 6:9 15:17 35:11,20 38:2 42:17 52:24 supplies (2) 13:15 17:11 supply (53) 4:7 5:12 6:16 9:23 10:10,11 12:8 13:3,7,10,18 14:1,5 15:1 17:4 21:7 23:12,19 26:4 34:21,23,23 35:2,4,16 36:6 52:2,17 54:16 63:22 65:21 66:17 74:14 75:22 76:1 83:16 84:5 96:1 99:4 100:1,7 102:8 103:22 111:19 113:12 123:17 124:6 127:2 128:11,23 129:16 130:12,17 supplying (4) 26:2 44:20 62:11 129:2 support (3) 74:11 109:3 124:10 supporting (1) 112:23 suppose (1) 54:12 supposed (1) 61:12 sure (7) 18:23 41:6 44:23 45:9 54:2 57:1 87:24 surface (2) 25:23 70:3 surprising (2) 53:2 74:4 surrey (2) 32:14,18 surrogate (1) 129:7 surrounding (3) 33:7 36:1 111:15 switching (3) 102:15 103:2 105:17 sworn (2) 1:10 138:2 symbol (3) 10:23 11:7 29:6 synonymous (1) 108:25	system (33) 9:3,8,10,22,23 10:11,19 12:7 13:13 15:15,19,21 16:12,18 20:23 65:24 71:24,25 74:14 81:7,25 82:13 88:21 90:18 98:1 101:10 104:7,23 106:20 110:20 114:22 126:14 133:24 systematic (1) 54:1 systematically (1) 26:8 systems (7) 4:14,15,22 10:2,2 71:21 133:10 T table (4) 76:5 78:9 84:14 92:17 taken (15) 7:8 8:1 27:17 40:18 69:15 72:20 74:11,19 91:25 96:9,10,16 97:24 101:5,10 takes (1) 22:17 taking (3) 27:21 101:22 116:25 talk (2) 17:2 120:4 talking (2) 16:10 88:4 tallest (1) 45:1 tandem (1) 88:22 tangible (1) 107:2 tank (14) 10:23 21:6,8,11,12,13,16,18 62:13 63:5,6,13 89:24 90:3 tanks (8) 15:8,12 62:8,11,21,23 95:12,22 tap (3) 17:22 97:6 129:5 target (2) 94:18 115:17 technical (6) 14:8 90:7 91:22 99:3 112:2 118:18 technically (2) 75:17 82:14 technician (3) 92:18 98:9 119:1 technicians (8) 7:24 85:18 87:8 92:25 96:11 97:14,25 113:23 technology (1) 3:23 telemetry (3) 101:10 124:12 126:13 telephone (1) 92:13 telling (3) 46:13,23 47:4 ten (4) 34:14 109:19 117:17 124:18 term (4) 10:11 17:22 93:17 112:2 terminal (1) 86:1 terms (41) 7:3 9:1,24 10:17,20 12:5 13:15 16:3 17:2,18 19:6,25 21:3 22:1 23:24 25:12 27:6 40:18 43:21 45:25 46:19 48:6 49:1 51:2 52:23 61:18 62:3,19 66:14 67:16,23 93:15 95:24 97:5,21 103:20 108:23,25 115:7 116:4 126:18 test (20) 49:1 51:22,24 52:15,16,20 55:15 61:19 68:5 69:17 77:3 79:5,15 80:15,17,22,23 81:1 82:17 86:10 tested (10) 49:19 50:24 52:3,7 56:2 68:11 69:10 84:17 123:15 testing (20) 7:3 24:12 39:23 40:22 49:10 50:8 51:18 55:8,22 56:10,19 69:13,16 72:5 75:23 77:2 79:17,19 121:23 125:5 tests (26) 48:14,18 49:5,15 50:4,11,18,21 51:3 52:2,6,10 53:23 54:5,10,22 56:4 78:13,13,19,21 86:19 87:2,4 124:3 125:13 text (1) 85:6 thames (51) 4:10 6:16 12:19 14:5 39:22 61:14 85:11 86:25 87:17,23 91:23,25 92:3,8,9,12,19,24 93:9,13	95:25 96:9 97:20 98:15,19 100:14 101:10 102:5,13 106:21 107:20,25 109:17 112:6,13,14,16,19 113:1,16,19 114:12 118:20 119:1 124:9 125:25 126:9,12,21 127:24 128:5 thank (72) 1:9,11,13,18,21 4:12 10:14 12:4 15:4 16:21 18:20,21 20:7,24 21:20 22:20 29:21 31:13,21 35:8 37:16 39:18 48:8 50:19 55:6 58:7 60:15,16,18,20,21 61:1,2,25 70:16 75:19 82:24 83:3 87:15,22 91:20 106:8 120:7,8,10,11,12,18,19,21 121:6 122:22 128:9 130:3 132:19 135:23,24 136:1,2,3,10,12,16,18,22,25 137:1,2,3,17,18,19 thats (126) 2:4,19,23 3:20 5:13 7:5 8:5,8 11:3,6,12,16 12:24 15:2,11,15 16:1,6,20 18:23 21:11 22:5,14 23:5,23 24:22 26:8 28:7,16 31:13 33:5,21 35:6,19 36:16,19,23 37:3,9 38:18 39:15 40:5 44:2,23 45:24 46:21 47:7 48:8 51:16 52:12 53:2 54:14 56:20 62:25 63:13,15,20 64:20,21 65:2,4 67:12,19 69:1,18 71:6 72:5,15,22 76:23 77:5 80:20,25 82:3,9,12,16,24 84:17 86:13 88:7 91:6,12,19 92:14,21 93:7 94:22 96:8 12 98:1,2 99:6 103:8 104:6 105:7,7,23,25 107:12,16 108:19,21,22 109:15,17 112:11 113:6 114:6 115:1 116:10 117:8,12,20 118:7 121:10,23 122:14 125:18 130:22 131:4 132:16,16 137:6,8 themselves (4) 28:25 81:16 88:11 100:9 theoretical (2) 49:2 51:10 theoretically (2) 117:3 127:20 thereabouts (2) 43:14,22 thereby (1) 94:20 therefore (3) 73:12 88:21 134:23 theres (3) 53:21 82:19 132:1 theyre (5) 18:13 57:2 100:20 102:7 108:25 theyve (2) 80:18 132:11 thing (9) 9:25 37:11 39:8 44:7 49:25 53:24 109:1,22 110:15 thinks (1) 135:12 third (9) 20:8 21:22 29:19 48:17 50:22 51:21 64:4 72:14 111:21 thirdly (7) 2:6 23:11 38:19 41:18 56:10 72:10 133:9 though (5) 34:25 37:18 45:13 55:13 128:20 thread (1) 70:9 three (17) 14:13,17 17:7 29:14 30:5,7 32:6,7 37:25 38:10 41:7 42:4 56:17 81:5 91:7 104:5 136:19 threshold (1) 39:1 through (44) 3:13 8:12 11:14 12:6,10 14:10 15:9 18:11,12,12,14,15 19:11 21:18 24:12 28:4,8 34:14 35:5,14 38:9 40:19,22 43:1 50:8 53:6,6 57:14,16 66:2 71:15,16 85:25 86:20 93:23 94:3 101:10 102:25	103:11 106:10 123:2 127:2 128:17 132:25 throughout (4) 7:7 92:1 104:8 106:14 throw (2) 51:5,8 thrust (1) 78:7 thumb (1) 65:5 thursdays (1) 137:22 thus (4) 31:24 51:21 73:22 134:18 time (25) 4:1 6:16 16:17 17:21,25 27:6 47:25 48:24 51:6 60:10 80:24 103:21 105:18 118:19,25 119:19 121:3 122:18 124:11 125:22 126:2,23 132:7 134:1 136:10 timeliness (1) 39:9 times (1) 40:1 timing (1) 23:9 tiny (1) 18:8 tip (1) 31:19 title (1) 69:9 tl (1) 89:19 today (5) 1:4 8:23 22:22 136:15 137:7 todays (1) 1:4 together (2) 27:21 115:23 tolerably (2) 40:17 133:3 tomorrow (4) 137:10,15,16,19 too (4) 12:5 14:2 19:1 56:16 took (1) 40:6 topic (10) 37:20 41:4 65:9 71:8 75:20 83:6 98:13 115:2 123:3 128:1 topics (1) 37:19 total (7) 16:11 35:21 43:10,22 92:24 97:15 117:2 totally (1) 114:15 touch (1) 44:23 touched (4) 69:25,25 83:6 106:17 touches (1) 7:8 touching (1) 123:9 towards (1) 40:19 tower (60) 2:16 5:24 12:17 13:3 23:2 27:17 28:12,22 31:1 32:1,15 33:3,6,7,22 34:24 35:1,4 36:2,2,11,20 37:7 38:1 41:13 42:5,17 43:15,19,22 48:15,25 49:17 50:14,16 51:6,13 64:25 65:15 75:21,23 76:1 78:17 88:14 96:20 99:24 103:6 105:21 106:12 108:20 111:19 112:7 121:14,15 124:5 125:12 131:3,6 134:7,22 towers (1) 9:5 track (2) 81:18 109:8 tradeoff (1) 22:17 tradeoffs (1) 24:13 training (1) 114:18 trajectory (1) 46:22 transcript (1) 92:15 transcripts (1) 92:8 transform (1) 22:11 transients (3) 4:7 5:1 110:20 transmission (7) 10:3,5,6,12 13:16,25 14:11 transport (2) 9:4 88:6 travels (1) 12:6 treatment (2) 10:4 15:18 triangle (1) 47:9 tried (3) 26:8 81:18 86:3 trigger (1) 28:20 trigonometry (2) 45:25 47:8 true (2) 3:1 72:22 try (1) 16:13 trying (7) 2:7 9:18 39:11 103:10 104:6 107:4 117:24 turbulence (1) 20:19 turn (37) 8:20,21 14:13 22:21 29:12 32:21 35:20
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