

<p>1 Thursday, 16 June 2016 2 (10.00 am) 3 PROFESSOR INGE SCHMITZ FEUERHAKE (continued) 4 (Assisted by interpreter) 5 Cross-examination by MR HEPPINSTALL (continued) 6 MR HEPPINSTALL: Just before we continue with the 7 cross-examination, Dr Busby has informed me this morning 8 that Professor Howard has to be away for 4.30 because he 9 has a flight at six o'clock, whereas Professor Hooper is 10 not flying off today. So he asked that Professor Howard 11 goes before Professor Hooper, which is fine. 12 MR JUSTICE BLAKE: Good. Right. 13 MR HEPPINSTALL: Could you take out volume SB7, tab 123, 14 please. Sorry, Professor, do you want to -- 15 A. Am I allowed, my Lord, to make some very short 16 corrections to my speech yesterday? 17 MR JUSTICE BLAKE: It was a speech, was it? Well, it was 18 meant to be an answer to a question, but, yes, if 19 something has arisen that you have reflected upon, tell 20 us what it is if you would like to qualify. 21 A. Yes. The main approach of Dr Heppinstall is that -- 22 MR JUSTICE BLAKE: He is asking questions, so -- 23 A. Yes -- is that we do not consider the arguments of the 24 other side. And this is not generally true in my work. 25 It is true that we should have mentioned, commented this</p> <p style="text-align: center;">Page 1</p>	<p>1 proceedings of ECRR in the 1980s where I referred to 2 their calculation. At that time they talked about 3 5 millisieverts. But what we did not admit yesterday, 4 what is also in the papers of Professor Sawada, is that 5 we have another parameter to show that this estimation 6 is too low. Because the geneticist, Japanese geneticist 7 Abe and others, published by the RERF, ABCC at that 8 time, his study on chromosome aberrations in the A bomb 9 survivors. 10 This was not done not in city group, you know 11 they -- 12 MR JUSTICE BLAKE: Well, is this coming to the end of your 13 clarification? Because I don't want to go off into 14 a whole new tangent at this stage in the proceedings 15 bearing in mind in particular I want you to complete 16 your evidence so you can get your flight. So -- 17 A. Yes, I -- five minutes. 18 MR JUSTICE BLAKE: No, I'm afraid not five minutes. 19 A minute, please. 20 A. The last remark: the chromosome studies showed that the 21 so-called zero group, which is 2.5 kilometres away from 22 the hypocentre, they calculated zero dose but the Abe 23 group measured a significant elevation, an increase of 24 chromosome aberrations in those people and we derived 25 a dose of about 20 millisieverts. 20 millisieverts is</p> <p style="text-align: center;">Page 3</p>
<p>1 paper, this genetic paper of -- which was new yesterday. 2 MR HEPPINSTALL: The Mark Little paper. 3 A. Mark Little and others. 4 MR JUSTICE BLAKE: Yes. 5 A. Because they indeed support the present opinion of the 6 ICRP, not fully but to a high degree. But we did not 7 know about this work, unfortunately, and our peer 8 reviewers of our paper didn't evidently know it. 9 MR JUSTICE BLAKE: So you didn't know about the paper. 10 A. Yes. 11 MR JUSTICE BLAKE: When you say "we", who is "we"? 12 A. The other author, as you know, is Dr Busby and a German 13 author Pflugbeil. 14 MR JUSTICE BLAKE: Yes. 15 A. Then the point of the Hiroshima dosimetry, the fallout 16 dosimetry. 17 I was not prepared to discuss the theme, although I 18 have worked by myself and cited myself in the 1980s upon 19 it. 20 MR JUSTICE BLAKE: Yes. 21 A. I know, of course, the calculations of the RERF. I have 22 a thick book. Okajima is the editor of the things. 23 I did not know this report of Okajima and Halle, which 24 is a newer one, I think. 25 I made a great publication in the conference</p> <p style="text-align: center;">Page 2</p>	<p>1 not negligible. We know that from the British study on 2 Muirhead and so. In the workers, their mean dose there 3 was 20 millisieverts and they found increased cancer 4 rates. 5 MR JUSTICE BLAKE: Right. 6 A. Thank you. 7 MR JUSTICE BLAKE: Thank you. 8 MR HEPPINSTALL: Turn now to SB7, tab 123. This the Rowland 9 study that you mention at page 9, section 8, of your 10 report. 11 A. Yes. 12 Q. It's actually published -- there are two documents in 13 this tab. The first is the published summary of the 14 work which appears under the first named author, Wahab, 15 and then if you turn five pages you get to the report 16 that was actually presented to the New Zealand Nuclear 17 Test Veterans Association where the first named author 18 is Rowland and of course we know that Rowland was the 19 leader of the project. 20 Then we get the rest of that report. 21 A. But what is the question? 22 Q. I am just -- 23 MR JUSTICE BLAKE: We are getting there. Just pause. 24 MR HEPPINSTALL: You mention these papers in your report. 25 So I presume you are familiar with them, Professor?</p> <p style="text-align: center;">Page 4</p>

<p>1 A. Yes. This elevation of chromosome aberrations, yet you 2 must know this, that the translocation method is not 3 very sensitive. It represents -- if you find 4 a significant increase you find a huge internal dose. 5 MR JUSTICE BLAKE: Well, hang on, let's wait for the 6 question otherwise we're not going to be able to proceed 7 in an orderly fashion. 8 MR HEPPINSTALL: So you're aware that this chromosomal 9 analysis was carried out on New Zealand test veterans 10 who were on two boats which were sailing around the 11 South Pacific seas during the British test. You are 12 aware of that context? 13 A. Yes. 14 Q. So you are further aware that one would imagine that by 15 and large they would have a shared collective experience 16 in that sense, because they are on two boats. 17 A. Yes. I'm aware of this. 18 Q. So can we just look at the dosimetry that Rowland came 19 up with at page 34 of the Rowland paper rather than the 20 published paper. 21 THE INTERPRETER: Sorry, which page? 22 MR HEPPINSTALL: Page 34. This is not of the published 23 paper but of the report. The numbers are at the bottom. 24 MR JUSTICE BLAKE: This is -- 25 A. Page 34?</p> <p style="text-align: center;">Page 5</p>	<p>1 dicentric work because, as you can see, not much work 2 was actually done and therefore a lot of the results are 3 nil. But if we look at the mFISH chromosomal analysis 4 we see that that's translated into a range of doses, 5 don't we? If we look down that column -- 6 MR JUSTICE BLAKE: You are looking at dose -- 7 MR HEPPINSTALL: It's the fourth column from the left. 8 MR JUSTICE BLAKE: Yes, yes. Called "Dose in grays". 9 MR HEPPINSTALL: Yes. So if we look down that column we see 10 we have a lot of zeros, but then we have a great range 11 between 0.1 grays and all the way up to 1.15 -- 12 A. Yes. 13 Q. -- gray. Now, don't you find that analysis very 14 surprising, Professor, when these sailors all had the 15 same shared experience on two boats? 16 A. That's not surprising, I think. Because they breathe 17 otherwise, they behave otherwise, these -- these studies 18 were made years after that. 19 Q. So you think that some of the chromosomal aberrations 20 were not biomarkers for exposures at Christmas Island 21 but biomarkers for other exposures? 22 A. No, no, that's not my point but that you have that is 23 a problem of internal dosimetry, that you have 24 individual differences, great differences in the 25 metabolism of the fallout you breathe.</p> <p style="text-align: center;">Page 7</p>
<p>1 MR HEPPINSTALL: So there are two documents behind the tab. 2 The first is the published paper, then you move into the 3 report which is presented -- 4 MR JUSTICE BLAKE: 34 is the table you wanted to take us to? 5 MR HEPPINSTALL: Yes. 6 MR JUSTICE BLAKE: Right. 7 MR HEPPINSTALL: So have you looked at this table before, 8 Professor? 9 A. No. 10 Q. No? 11 A. I read the paper, but this is a report. 12 Q. Well, if we just see how far we get. If we look at the 13 dosimetry we see that the coded veteran is given on the 14 left-hand side. Then we get the results of the 15 chromosomal analysis, the scoring. Then we see that 16 that has been translated into dose in grays. 17 A. Yes. 18 Q. We then get the 95 per cent confidence intervals for the 19 dose. I think we then get some information about the 20 dicentric rings that were noticed. Then we get a dose 21 based on that dicentric analysis which is a different 22 dose. Then we get the confidence intervals for the 23 dicentric analysis. Do you see that? 24 A. Yes. 25 Q. Now, if we look at the -- well, let's just ignore the</p> <p style="text-align: center;">Page 6</p>	<p>1 Q. But can it really be credible, Professor, that 2 a veteran -- 3 A. I must not -- 4 MR JUSTICE BLAKE: Hang on for the question. Wait, don't 5 get in there too quickly. 6 MR HEPPINSTALL: Can it really be credible that the spread 7 of dose is quite so wide as what we are looking at here? 8 A. Yes, unfortunately. 9 Q. But you understand that 1.4 gray, or 1.4, I think, 10 NZTVO26 -- 11 MR JUSTICE BLAKE: Yes. 12 MR HEPPINSTALL: -- that's 1,400 millisieverts, Professor. 13 A. Yes. 14 Q. How can it be that a New Zealand sailor several hundred 15 miles from the detonation could have been exposed to 16 a dose of 1,400 millisieverts? 17 A. That is because of the system. Internal dosimetry with 18 chromosome aberrations quantitatively is only possible 19 if you know where the locations are, which tissues were 20 irradiated and only in the case of homogenous 21 irradiation, you can make a quantitative -- you can go 22 through this curve. That is unfortunately the problem. 23 If you -- we know the lymphocytes are investigated. 24 The lymphocytes circle in the whole body and the heavy 25 metal things, uranium, plutonium, thorium, they</p> <p style="text-align: center;">Page 8</p>

<p>1 concentrate in the lymph nodes. So it is possible that</p> <p>2 you get a very high rate of exposed lymphocytes in the</p> <p>3 nodes. Huh? You don't know where the location is,</p> <p>4 where the irradiation occurred.</p> <p>5 Q. Is it right that translocations can be caused by</p> <p>6 a number of things not just including radiation?</p> <p>7 A. No, that's not right. You normally can decide by the</p> <p>8 pattern, you see if it is caused by the pattern of the</p> <p>9 distribution in a cell. You must look at single cells</p> <p>10 as a distribution of the types of chromosomes of</p> <p>11 aberration. You have certain types of aberrations, not</p> <p>12 only translocations.</p> <p>13 This will give you an information if chemical -- how</p> <p>14 is it called? -- mutagenes are -- mutagenic substances</p> <p>15 are involved or if ionising radiation is involved.</p> <p>16 Q. It -- sorry, go on.</p> <p>17 A. It is a qualitative method to find this out.</p> <p>18 And the chromosomes produced by ionising radiation</p> <p>19 are such types which are originated by a double strength</p> <p>20 break in the DNA, and this --</p> <p>21 THE INTERPRETER: Frequency.</p> <p>22 A. -- frequency, this frequency is relevant in order to</p> <p>23 decide to differentiate against other agents.</p> <p>24 MR HEPPINSTALL: Professor, the authors of this work are far</p> <p>25 more reticent and uncertain about their conclusions than</p> <p style="text-align: center;">Page 9</p>	<p>1 radiation. Do you agree?</p> <p>2 A. You mean that these people could have been exposed by</p> <p>3 other things --</p> <p>4 Q. Yes, in the intervening 40 or 50 years.</p> <p>5 A. You must know that perhaps a CT, which is a very heavy</p> <p>6 X-ray, produces a very tiny effect. It produces, one CT</p> <p>7 produces, it is on the --</p> <p>8 THE INTERPRETER: Upper body.</p> <p>9 MR HEPPINSTALL: Upper body.</p> <p>10 A. A significant elevation in dicentric chromosomes but not</p> <p>11 in translocation. The translocation method is less</p> <p>12 sensitive.</p> <p>13 And if you propose that these high rates can be</p> <p>14 produced by other agents, other X-rays also, that is</p> <p>15 nearly impossible but because they represent other</p> <p>16 methods what should it be? A normal x-ray could it not</p> <p>17 be. A heavy, heavy burden by what? It's not very</p> <p>18 probable, I think.</p> <p>19 Q. If we just go on in that paragraph:</p> <p>20 "The introduction of fish has proved invaluable to</p> <p>21 ...(Reading to the words)... in humans.</p> <p>22 "An attempt was made in the current study to</p> <p>23 reconstruct possible radiation dosage in the Operation</p> <p>24 Grapple veterans. Possible exposure estimates are</p> <p>25 listed in table 1. We acknowledge that there are many</p> <p style="text-align: center;">Page 11</p>
<p>1 you are. Let's look at page 42, the bottom of page 42,</p> <p>2 where it says:</p> <p>3 "Chromosome analysis of ...(Reading to the words)...</p> <p>4 exposure is a well-established technique. The dose</p> <p>5 estimates in cases of accidental overexposure ..."</p> <p>6 Now, you're aware, aren't you, that in those</p> <p>7 circumstances of accidental overexposure the mFISH takes</p> <p>8 place very quickly after the accidental exposure?</p> <p>9 A. When was it? I forgot.</p> <p>10 Q. Well, these New Zealanders were there at the time of the</p> <p>11 test in 1956/57. This mFISH is taking place over</p> <p>12 50 years later. What I am putting to you is what they</p> <p>13 are talking about here, where mFISH is used, for example</p> <p>14 if a nuclear worker is accidentally overexposed and it's</p> <p>15 done within weeks of that overexposure.</p> <p>16 A. Yes, it's possible, yes.</p> <p>17 Q. The reason for that, Professor, is because if because</p> <p>18 there are other things that could have this effect, for</p> <p>19 example other radiation exposures that you might have in</p> <p>20 an X-ray or a CT scan, if you leave it 50 years some</p> <p>21 account has got to be taken of all the events in one's</p> <p>22 life where you might have been exposed to ionising</p> <p>23 radiation.</p> <p>24 A. Yes.</p> <p>25 Q. Including living on Planet Earth and receiving the sun's</p> <p style="text-align: center;">Page 10</p>	<p>1 uncertainties surrounding this estimate, which should be</p> <p>2 used only as a guide."</p> <p>3 Now, isn't that the true position, Professor, that</p> <p>4 this is only a very tentative attempt at reverse</p> <p>5 dosimetry?</p> <p>6 A. This attempt is very, very relevant to show that there</p> <p>7 was an exposure and that there was a rather high</p> <p>8 exposure. But I repeat, it's not possible in</p> <p>9 an in-homogenous distribution of the isotopes in the</p> <p>10 body to make a quantitative approach. But it is</p> <p>11 important to know if they have been irradiated. If you</p> <p>12 find no significant elevation you do not know if they</p> <p>13 have been irradiated to some degree.</p> <p>14 Q. Now, if we just go back to the published paper where</p> <p>15 that dose information was not published and if we look</p> <p>16 at page 84 within the published paper.</p> <p>17 MR JUSTICE BLAKE: Internal page 84.</p> <p>18 MR HEPPINSTALL: Yes. They are on the bottom-left. If you</p> <p>19 go back to the front of the tab.</p> <p>20 MR JUSTICE BLAKE: The first document at the front of the</p> <p>21 tab, you should get to this page.</p> <p>22 MR HEPPINSTALL: Page 84.</p> <p>23 MR JUSTICE BLAKE: You are in the right territory.</p> <p>24 A. Ah yes, I see.</p> <p>25 MR JUSTICE BLAKE: Yes.</p> <p style="text-align: center;">Page 12</p>

3 (Pages 9 to 12)

<p>1 MR HEPPINSTALL: At the bottom of page 84 in the first 2 column there's a passage that starts: 3 "The significantly higher translocation frequencies 4 in the group of veterans compared to the controls 5 suggest that this may be a consequence of their 6 participation in Operation Grapple." 7 You agree that the right verb to use is "may"?</p> <p>8 A. What is it in English? 9 THE INTERPRETER: Careful. Prudent.</p> <p>10 A. This is a very careful comment on their own results. 11 I repeat: the method is radiation-specific to a high 12 degree. You can decide what source was the origin.</p> <p>13 Q. They say: 14 "However, since a statistical association is not 15 necessarily proof of a causal relation possible 16 confounders need to be considered."</p> <p>17 A. Yes, that's a common comment.</p> <p>18 Q. Then in the next paragraph they deal with the way that 19 they try to deal with smoking.</p> <p>20 A. Yes.</p> <p>21 Q. Then in the next paragraph they note that there might 22 have been a confounding factor specific to service on 23 naval vessels. Do you see that? 24 "Although one might consider chemicals from fresh 25 paint or similar agents, it is difficult to conceive of</p> <p style="text-align: center;">Page 13</p>	<p>1 of potential confounding factors leads us to the view 2 that this highly elevated frequency is most likely 3 attributable to radiation exposure."</p> <p>4 A. That's it.</p> <p>5 Q. Well, they are carefully not saying "radiation exposure 6 in Operation Grapple," are they, Professor?</p> <p>7 A. They are very careful because they know that they will 8 be criticised if they say they are very sure that it is 9 radiation.</p> <p>10 Q. Indeed, and they go on to say: 11 "Further clarification might be attained by a 12 similar study on British or Fijian participants in 13 Operation Grapple." 14 Don't they?</p> <p>15 MR JUSTICE BLAKE: I think what is being put to you is they 16 seem to be saying here that it is radiation but not 17 necessarily radiation arising from this particular 18 Operation Grapple.</p> <p>19 A. I declare that that's nearly impossible to have such 20 an elevation in a normal life with accidents of --</p> <p>21 MR HEPPINSTALL: So you have no such reservations and indeed 22 you express no such reservations in your report?</p> <p>23 A. I report, I refer on works of other researchers and 24 I draw a conclusion looking over the whole field of 25 information.</p> <p style="text-align: center;">Page 15</p>
<p>1 such factors causing the highly significant and lasting 2 increase in translocation of frequencies." 3 So contrary to what you were saying earlier, 4 Professor, there are other agents that could create the 5 same effect. That's what the authors are saying.</p> <p>6 A. Not the same effect but not the same pattern in the 7 cell.</p> <p>8 Q. Then the authors say: 9 "Whether radiation exposure during Operation Grapple 10 or contaminations incurred by the naval personnel can 11 have been the causative factor is not easily answered." 12 That is the case, isn't it, Professor? This a very 13 difficult area where the conclusions are very difficult 14 to draw and it's very important to be tentative and 15 provisional, isn't it?</p> <p>16 A. The conclusions are not very different to draw because 17 you have not a single work on this topic. You have 18 a variety of researchers who did such studies, and they 19 come to a result. And we look at the whole story. All 20 findings compilation is important.</p> <p>21 Q. If we look at the conclusion at page 86 it said: 22 "In summary, a sample group of New Zealand naval 23 personnel who participated in Operation Grapple shows 24 three times the frequency of total chromosome 25 translocations ...(Reading to the words)... Our analysis</p> <p style="text-align: center;">Page 14</p>	<p>1 Q. I just want to show you the New Zealand test veteran 2 epidemiology at B14/235, and we've extracted it. 3 I think it may already be on your desk.</p> <p>4 MR JUSTICE BLAKE: Yes.</p> <p>5 MR HEPPINSTALL: This is commonly known as the Pearce 6 Report. This is the New Zealand-sponsored 7 epidemiological study into 528 New Zealand veterans.</p> <p>8 A. What report is it you mentioned?</p> <p>9 Q. Have you considered the epidemiology of the New Zealand 10 test veterans, Professor?</p> <p>11 MR JUSTICE BLAKE: Well, the Pearce Report I think we were 12 told.</p> <p>13 MR HEPPINSTALL: Yes.</p> <p>14 A. No, I'm not an epidemiologist.</p> <p>15 MR JUSTICE BLAKE: So you are not familiar with this --</p> <p>16 A. I did not follow up the statistics they did.</p> <p>17 MR HEPPINSTALL: All right, well, we'll leave that there 18 then if you are not familiar and you are not 19 an epidemiologist. 20 I just want to touch on some additional new --</p> <p>21 MR JUSTICE BLAKE: Where do we slot this in? Just into the 22 also ran bundle?</p> <p>23 MR HEPPINSTALL: Yes, SB22. I think the SB22s are on their 24 way to you.</p> <p>25 MR JUSTICE BLAKE: Yes, well, I started mine.</p> <p style="text-align: center;">Page 16</p>

1 MR HEPPINSTALL: I'm very grateful.
 2 MR JUSTICE BLAKE: Yes, sorry, carry on. I'm conscious of
 3 the time. When have you actually got to physically
 4 leave this building? At 11 o'clock or before?
 5 MS BUSBY: 11 o'clock.
 6 MR JUSTICE BLAKE: Do you think we are going to finish in
 7 time?
 8 MR HEPPINSTALL: I hope so, yes.
 9 MR JUSTICE BLAKE: We all share the hope.
 10 MR HEPPINSTALL: We do.
 11 You touched upon the radiogenicity of pancreatic
 12 cancer and CLL yesterday which is not something you put
 13 in your report so I just need to very quickly deal with
 14 that. You should have another loose document which is
 15 taken from E3/12 which is the UNSCEAR annex on
 16 pancreatic cancer. Could you just turn that up, please.
 17 **A. Yes, that is 2000.**
 18 Q. It is 2006, you are right.
 19 Panel C, this is extracted from, as I say, E3/12.
 20 There is an interesting introduction which includes
 21 criteria for good quality --
 22 MR TER HAAR: Sorry to interrupt. Could I just tell the
 23 Tribunal this is to be found also in supplementary
 24 bundle SB21, tab 30.
 25 MR JUSTICE BLAKE: Jolly good. We have it here.

Page 17

1 MR TER HAAR: The only reason I mention it --
 2 MR JUSTICE BLAKE: We have to get on, Mr ter Haar.
 3 MR TER HAAR: I am anticipating saving time later. I will
 4 be cross-examining on this. It might be helpful if the
 5 Tribunal were to have that copied because it's fuller
 6 and it means you will have all your notes in the same
 7 place. But it's a matter for the Tribunal.
 8 MR JUSTICE BLAKE: Yes.
 9 MR HEPPINSTALL: It has "Criteria for good quality
 10 epidemiological studies" at the beginning. That's why
 11 I left that section in as it may be of interest. If we
 12 turn forward we get to internal page 68, pancreatic
 13 cancer.
 14 THE INTERPRETER: We have 67 and 69. 68 is blank.
 15 MR HEPPINSTALL: Oh. I have a 68. We may have to revert
 16 to -- anyway, it's not crucial because all I want to put
 17 to you is -- well, on another page, page 70, do you have
 18 page 70?
 19 THE INTERPRETER: No.
 20 MR JUSTICE BLAKE: Perhaps Mr ter Haar's suggestion is
 21 looking stronger by the moment.
 22 MR HEPPINSTALL: It is looking quite a good one.
 23 MR JUSTICE BLAKE: It's just am very anxious, I am trying to
 24 manage the process --
 25 MR TER HAAR: It's SB21, tab 30.

Page 18

1 MR HEPPINSTALL: Tab 30, thank you very much.
 2 **A. I can refer shortly on pancreatic cancer.**
 3 MR JUSTICE BLAKE: Hang on, we are having difficulty getting
 4 the information for you to comment on upon.
 5 MR HEPPINSTALL: It's the double-sided copying trick.
 6 THE INTERPRETER: SB21?
 7 MR HEPPINSTALL: SB21. Is SB21 up there yet? Tab 30 and
 8 turn to page 68.
 9 We see that UNSCEAR 2006 starts its examination of
 10 pancreatic cancer at page 68. It reviews the
 11 epidemiology as we talked about yesterday. And then its
 12 summary is at paragraph 226, page 70, and the conclusion
 13 is:
 14 "There is little, if any, evidence for associations
 15 between pancreatic cancer and radiation dose whether in
 16 relation to external or internal low LET radiation or to
 17 internal high LET radiation."
 18 Do you agree, Professor?
 19 **A. No, I don't agree. I told you already that there are**
 20 **data which refutes this conclusion. Because the main**
 21 **reference you know for this board is the A bomb**
 22 **survivor, and what we must learn or consider about**
 23 **pancreas cancer is the following.**
 24 **Pancreas cancer is a rare event. In former times --**
 25 **I know that because I have worked in the nuclear**

Page 19

1 **medicine for some years -- when nuclear medicine was**
 2 **a new discipline, and I knew from that that in former**
 3 **times, until the 1970s, was rather to diagnose. The**
 4 **pancreas is very small and it is hidden in the organs of**
 5 **the body, and you couldn't really detect it by**
 6 **conventional X-ray diagnosis. And the nuclear medicine**
 7 **people they were very proud that they were able to have**
 8 **a kind of imaging now with radioisotopes. So -- and but**
 9 **if one has -- if the cancer develops, people die very**
 10 **soon. This is the case up to now.**
 11 **And so you may have -- you may have -- probably you**
 12 **may have missed the cases in the A bomb survivors.**
 13 MR JUSTICE BLAKE: So your comment is that you don't agree
 14 with UNSCEAR because they may have missed pancreatic
 15 cancer in the A bomb survivors? Yes?
 16 **A. They -- no, they take references which are not complete**
 17 **because we have other findings --**
 18 MR JUSTICE BLAKE: Well, that's another point --
 19 **A. Now in --**
 20 MR JUSTICE BLAKE: I am just trying to get in summary form
 21 what your answer is, and I am just trying to make sure
 22 I have an accurate record.
 23 In respect of the A bomb survivors which UNSCEAR
 24 have used for comparative data I think your answer is
 25 that there may have been pancreatic cancers that were

Page 20

<p>1 missed. You were then going on to say there were other 2 studies which they didn't refer to?</p> <p>3 A. Yes.</p> <p>4 MR JUSTICE BLAKE: Right, we are going to have to keep it 5 that tight, I'm afraid, otherwise we are not going to 6 get anywhere.</p> <p>7 MR HEPPINSTALL: Now quickly, please, chronic lymphatic 8 leukaemia, SB2, tab --</p> <p>9 A. Let me correct this.</p> <p>10 MR JUSTICE BLAKE: I'm afraid --</p> <p>11 A. It is true that UNSCEAR -- that the A bomb survivor 12 studies, the first one did not see any case, but later 13 on, Preston 2007, it's one year after the UNSCEAR 14 report, they saw not significant but they saw 15 an increase.</p> <p>16 This is -- I wrote about that.</p> <p>17 MR JUSTICE BLAKE: Right, okay. We are going to have to 18 move on to CLL.</p> <p>19 MR HEPPINSTALL: SB2, tab 2.21, the report of Dr Haylock in 20 these proceedings which presumably you considered. 21 I want to look at his conclusion, please, on chronic 22 lymphatic leukaemia. 23 If you turn three pages you get to his section on 24 chronic lymphatic leukaemia. And his conclusion is, he 25 runs through LSS, INWORKS, Zabolstaska, the Chernobyl</p> <p style="text-align: center;">Page 21</p>	<p>1 A. Yes, but it is not correct. Because --</p> <p>2 MR JUSTICE BLAKE: Sorry, are you telling us that there's 3 some information subsequent to January 2016 or are you 4 making a different point?</p> <p>5 A. I make a point that this is accepted, perhaps for 6 example in Germany as a radiogenic cancer because of the 7 US studies, and it is accepted by what is the -- the 8 NIOSH compensation board. They accepted as a radiogenic 9 cancer and they made a paper upon that --</p> <p>10 MR HEPPINSTALL: Professor I --</p> <p>11 A. -- and Mr Haylock evidently doesn't know that.</p> <p>12 Q. Professor, I've deliberately not gone to the US 13 information because I think that's a question of legal 14 submission --</p> <p>15 A. It is in the international literature.</p> <p>16 MR JUSTICE BLAKE: Try to keep your answers -- you are 17 running out of time.</p> <p>18 MR HEPPINSTALL: Last question. SB6, please, tab 89. This 19 is your paper that you published with Dr Busby and 20 Sebastian Pflugbeil.</p> <p>21 A. Yes.</p> <p>22 Q. Now, yesterday, early in the morning, there were 23 submitted some articles which are listed in table 1 at 24 page 3 of 13.</p> <p>25 DR BUSBY: They haven't yet been submitted.</p> <p style="text-align: center;">Page 23</p>
<p>1 clean-up workers, and then his conclusion is: 2 "Thus the overwhelming weight of epidemiological 3 data from the LSS and other large scale epidemiological 4 studies of low dose exposures provide no evidence that 5 CLL is likely to be inducible by radiation exposure." 6 Do you agree?</p> <p>7 A. What -- likely?</p> <p>8 Q. "... no evidence that CLL is likely to be inducible by 9 radiation exposure."</p> <p>10 A. This is not right. From when is it, this? 16? Oh, he 11 is not updated. He is not on the stage of knowledge. 12 Because this was a point which I talked about. The 13 common paper with Richardson and people, they fought in 14 the United States for years to show that CLL is 15 radiogenic, and they -- in this paper is explained why 16 the A bomb survivor study didn't find it. Because CLL 17 is a very rare disease in Japanese people. It's not 18 quite as rare as in Europeans --</p> <p>19 MR JUSTICE BLAKE: I think you told us that yesterday.</p> <p>20 A. Yes.</p> <p>21 MR JUSTICE BLAKE: So are you telling us that -- just pause.</p> <p>22 A. Yes.</p> <p>23 MR JUSTICE BLAKE: Are you telling us that since this 24 statement was written in January 2016 there has been 25 some important new information upon this topic?</p> <p style="text-align: center;">Page 22</p>	<p>1 MR HEPPINSTALL: I'm not going to go them. But you listed, 2 table 1 --</p> <p>3 MR JUSTICE BLAKE: Just listen to the question.</p> <p>4 MR HEPPINSTALL: -- you have submitted -- well I've received 5 copies in any event of Hoffmann, Lasjuk, Feschenko, 6 Kulakov, Petrova, Wertelecki and Akar. You've handed 7 those in, as I understand it, to the Tribunal.</p> <p>8 A. Yes.</p> <p>9 Q. The table 1 is entitled "Increase of congenital 10 malformations after exposure by the Chernobyl accident".</p> <p>11 A. Yes.</p> <p>12 Q. It's true, isn't it, Professor, on a reading of those 13 papers they are far more tentative than you are being. 14 They are suggesting further investigations into those 15 congenital malformations and they are nowhere near as 16 certain as you are in this table?</p> <p>17 A. This is a common comment of those preliminary studies. 18 This is not the main subject of our report here because 19 this was published by us already in 2009 in a paper 20 Busby/Schmitz Feuerhake, and these observations were 21 done shortly after the accident. And they were 22 exceptional because people in several countries very far 23 away observed a step that had data before the accident, 24 they had data after the accident. And this was our 25 concern that this should be known. Also Hoffmann has</p> <p style="text-align: center;">Page 24</p>

6 (Pages 21 to 24)

<p>1 made a compilation and he questioned, was Chernobyl the 2 origin of this, the cause -- 3 Q. Just pause there because I want to ask you: none of the 4 confounding factors, like lack of folic acid, alcohol 5 abuse, or other health factors in these regions which 6 are mentioned in these papers, they are not mentioned in 7 your review at all, are they? 8 MR JUSTICE BLAKE: Listen to the question first. 9 MR HEPPINSTALL: You haven't mentioned any of those 10 confounding factors which the authors of these papers 11 mention, have you? 12 A. They have looked in a different way. Somebody has 13 doubt, some clearly not. What I said yesterday, we look 14 at the whole story, we compile the information and if 15 you there and there and there find the same known effect 16 of radiation you will not find a common -- other -- you 17 know that they have been exposed, you will not find 18 another common confounder, certainly, yes. 19 MR HEPPINSTALL: No further questions, my Lord. 20 MR JUSTICE BLAKE: Thank you. Dr Busby. 21 Re-examination by DR BUSBY 22 DR BUSBY: I'm conscious of the time also and I really won't 23 be asking many questions. 24 MR JUSTICE BLAKE: Well, you can't because we are now 25 17 minutes to 11 o'clock.</p> <p style="text-align: center;">Page 25</p>	<p>1 MR JUSTICE BLAKE: We have that already, yes. 2 DR BUSBY: Well, that was the question, my Lord. There we 3 are. 4 So the second question is that you were taken to the 5 HPA paper yesterday which was presented, and it doesn't 6 have a tab because it just came in yesterday. This was 7 the HPA paper which is by Mobbs, Muirhead and Harrison, 8 HPA/RPD066. 9 MR JUSTICE BLAKE: Yes. 10 DR BUSBY: That was the one that was to provide a summary of 11 our current understanding of radiation risks at low 12 doses. 13 A. Yes, yes. 14 DR BUSBY: That one. 15 A. I'm afraid I don't know what it is. 16 Q. No, we'll get you one. Just so that you know what we 17 are talking about. (Handed) 18 MR JUSTICE BLAKE: Yes. 19 A. Yes. 20 DR BUSBY: So this is -- I wanted to ask you if you had any 21 caveats, if you had any concerns about this paper, about 22 the conclusions? I mean there's a lot in here about 23 fallout studies and Chernobyl studies, and so on, risks 24 from internal measures and so forth. If you had any 25 warnings about --</p> <p style="text-align: center;">Page 27</p>
<p>1 DR BUSBY: Well, yes. 2 MR JUSTICE BLAKE: Sorry, that's where we are at. 3 DR BUSBY: I only have really one main question and that has 4 to do with these papers. 5 MR JUSTICE BLAKE: Which papers? 6 DR BUSBY: The ones that Mr Heppinstall was just talking 7 about. 8 MR JUSTICE BLAKE: We don't have them. 9 MS BUSBY: They are just there. 10 DR BUSBY: They are there. We just want to ensure that this 11 is an opportunity to let your Lordship know that they 12 are there. (Handed) 13 MR JUSTICE BLAKE: We haven't obviously read them. But put 14 the question. 15 DR BUSBY: But in fact if your Lordship -- if the Tribunal 16 is prepared to go to the paper that Professor Schmitz 17 Feuerhake mentioned, which is the SB -- 18 MR JUSTICE BLAKE: Can you just put the question, Dr Busby? 19 DR BUSBY: I was talking to you, my Lord. 20 MR JUSTICE BLAKE: Yes. 21 DR BUSBY: Well, the question is that the papers that you 22 have in front of you that Mr Heppinstall has just 23 mentioned, these are all papers on which you rely in the 24 recent genetic radiation risks paper, you rely on those, 25 so they are papers that you rely on?</p> <p style="text-align: center;">Page 26</p>	<p>1 MR JUSTICE BLAKE: "Do you have any comments or reservations 2 about this paper?" is the question. 3 DR BUSBY: Yes, any reservations about it. 4 A. I'm afraid I -- I cannot go in any details. 5 MR JUSTICE BLAKE: No. 6 DR BUSBY: I quite understand. Okay. 7 A. You mean the critics to the uranium findings -- I think 8 it's not possible. Well, the argument is I was asked if 9 the ICRP risk figures are correct, are they a severe 10 underestimation, and I see not in this paper that this 11 thesis of mine is -- [German word]. 12 MR JUSTICE BLAKE: Contradicted? 13 THE INTERPRETER: Represented. 14 DR BUSBY: Addressed? 15 A. Regressed. I don't find any argument why it is 16 regressed. 17 MR JUSTICE BLAKE: Are you familiar with the paper before 18 yesterday? 19 A. No. 20 MR JUSTICE BLAKE: You are unfamiliar with it. 21 A. No. 22 DR BUSBY: I think that's as far as it can go, my Lord. I'm 23 happy to leave it at that. Thank you very much. Thank 24 you. 25 MR JUSTICE BLAKE: Well, we've just achieved the conclusion</p> <p style="text-align: center;">Page 28</p>

7 (Pages 25 to 28)

<p>1 of your evidence, a few minutes later than I planned but 2 we've done so. Thank you very much for coming. That 3 completes your evidence. I hope you get a safe flight 4 back. 5 THE WITNESS: Thank you very much. 6 MR JUSTICE BLAKE: Thank you. Thank you for your help as 7 well [to the interpreter]. It was worthwhile having you 8 there. 9 (The witness withdrew) 10 MR JUSTICE BLAKE: Are we ready to move on to the next 11 witness now? 12 DR BUSBY: Yes, my Lord. 13 MR TER HAAR: While that witness is coming forward, can 14 I just mention that on Monday you asked about whether my 15 clients' claims were being pursued by the widows or 16 other people. There should be a table now before you 17 which shows you, I hope -- I handed it to your clerk -- 18 MR JUSTICE BLAKE: It is constructively before us. 19 MR TER HAAR: If not, we will make sure you get it. That 20 tells you which of my clients are dead, and where their 21 widows are also dead. I think that is the information 22 you asked for. 23 MR JUSTICE BLAKE: Dr Rayner, I think, has it. 24 DR RAYNER: Yes. 25 PROFESSOR CHARLES VYVYAN HOWARD (affirmed)</p> <p style="text-align: center;">Page 29</p>	<p>1 University of Ulster as I understand it, Professor? 2 A. That's correct. 3 Q. Is it right that Dr Busby has also held a visiting 4 professorial office or role within that university? 5 A. That is correct. 6 Q. Were you involved or did you procure Dr Busby holding 7 that office? 8 A. I proposed him as a visiting professor, yes. 9 Q. Did you work with him at the University of Ulster? 10 A. We -- he helped -- I had a PhD student called Andreas 11 Alsaesser whose work is part of my report and Dr Busby 12 did give some assistance in co-supervising Dr Alsaesser. 13 Q. Given that Dr Busby is representing the appellants in 14 these proceedings why is this information not contained 15 in your report, Professor? 16 A. I wasn't sure that it was relevant. It didn't occur to 17 me to mention it. 18 Q. If you arranged for Dr Busby to have a position at your 19 university, you had a prior relationship or professional 20 friendship with Dr Busby? 21 A. I've known Dr Busby over a period of some 20 years, 22 I think. I was trying to recall the other day when we 23 first met. I think it was in the bar at a scientific 24 meeting and we discovered that we both came from 25 a military background. His father I think got the</p> <p style="text-align: center;">Page 31</p>
<p>1 MR JUSTICE BLAKE: Thank you. Now, are you content to stand 2 during your evidence or would you prefer to sit down? 3 A. Well, I prefer to stand. 4 MR JUSTICE BLAKE: Right. If you need to sit, please do so, 5 as long as we can hear you and you are able to keep your 6 voice up. 7 A. Yes, thank you, my Lord. 8 Examination-in-chief by DR BUSBY 9 DR BUSBY: Professor Howard, you have a copy of your report 10 there? 11 A. Yes, I do. 12 Q. This is your report, and you stand by it. Is that 13 right? 14 A. That's correct. 15 Q. Is there anything that you wish to add or correct in 16 your report? 17 A. I did consider -- there's something that's not in my CV, 18 my Lord, which is possibly relevant. I did serve as 19 a medical officer in the Royal Naval Reserve for 20 15 years and during that time we did cover nuclear, 21 biological and chemical warfare. 22 MR JUSTICE BLAKE: Thank you. 23 DR BUSBY: Thank you. 24 Cross-examination by MR HEPPINSTALL 25 MR HEPPINSTALL: You are an emeritus Professor in the</p> <p style="text-align: center;">Page 30</p>	<p>1 Military Cross and was actually in a Hiroshima prisoner 2 of war camp and my father got the Distinguished Service 3 Cross at Suez. He was a pilot. That's how we got to 4 know each other and then we discussed science and that 5 has gone on over a number of years. 6 Q. Did you not think it appropriate to disclose that 7 relationship and prior involvement with the 8 representative of the appellants whom you are here to 9 give evidence on behalf of by way of a potential if not 10 actual conflict of interest, Professor? 11 A. I didn't -- it's public knowledge. These positions are 12 public knowledge, and I didn't consider that that was 13 necessary -- I didn't even think of that. 14 Q. Is it public knowledge that you procured Dr Busby's 15 appointment to the University of Ulster? 16 A. Well, that would be available if it was asked for. 17 Q. Don't you think you have a duty to be honest about it 18 and to tell this Tribunal rather than having to have the 19 Tribunal enquire into that matter? 20 A. I don't think it has any effect on my report, my Lord, 21 and if I should have done that then I would've been 22 happy to do so but maybe I'm naive in these matters. 23 I didn't consider it material to my report. 24 Q. The bottom of page 3 of your report, please. 25 You discuss Professor Catovsky's report to this</p> <p style="text-align: center;">Page 32</p>

<p>1 Tribunal in respect of Mr Battersby case and chronic 2 lymphatic leukaemia, and as we go over the page you make 3 a criticism or you say: 4 "It is strange that Professor Catovsky did not refer 5 to the key Zablotska paper in his report." 6 Do you see that? 7 A. Yes. 8 Q. Do you know the date of Professor Catovsky's expert 9 report? 10 A. Well, I -- that was 2011, I think. 11 Q. What's the date of the Zablotska paper, Professor? 12 A. It's 2013, yes. 13 Q. So do you withdraw your comment that it is strange that 14 Professor Catovsky did not refer to the paper in his 15 report? 16 A. In the supplementary report, I think that was the same 17 year. 18 Q. What's the date of the supplementary report? 19 A. 2013. 20 Q. 7 January 2013. When did the Zablotska paper come out? 21 A. I don't recall in detail. 22 Q. Do you withdraw your statement that it's strange that 23 Professor Catovsky did not refer to the Zablotska paper? 24 A. Yes, under those circumstances I do. 25 Q. Did you check any of the facts that we've just gone</p> <p style="text-align: center;">Page 33</p>	<p>1 Zablotska paper, and she starts the sentence at the 2 bottom of page 10: 3 "It should be noted that in both the recent study 4 ..." 5 Which I think is Gudzenko. Are you aware of that 6 one, the more recent update on Zablotska? 7 A. I'm not sure that I have read that. 8 Q. Do you just want to look at reference 20? 9 A. Reference 20 in? 10 Q. In this paper. 11 MR JUSTICE BLAKE: The page -- 12 A. Ah yes. 13 MR JUSTICE BLAKE: Page 13, reference 20. 14 A. Yes. 15 MR HEPPINSTALL: So you've not considered the update on 16 Zablotska? 17 A. No, I haven't. 18 Q. Well: 19 "... and in the previous study reported by 20 Zablotska, the numbers of cases of CLL diagnosed are 21 small. In the 2013 study of over 110,000 Chernobyl 22 liquidator workers over the period 1986 to 2006 there 23 were 137 leukaemia cases a total of which 79 were CLL 24 and with dose estimates." 25 So it's right, isn't it, that the Zablotska paper is</p> <p style="text-align: center;">Page 35</p>
<p>1 through before making that statement? 2 A. Can you qualify that? 3 Q. Did you look at the dates of Professor Catovsky's 4 reports and the -- 5 A. Yes, I did. I'm -- I must have made an error. 6 I apologise for that. 7 Q. That allegation was made by Dr Busby before the 8 Upper Tribunal. Did Dr Busby pass to you that 9 information when you were writing your report? 10 A. Dr Busby outlined the areas where he wanted me to 11 cover -- 12 MR JUSTICE BLAKE: I think it's being put to you: did 13 Dr Busby -- the question is: did Dr Busby point out that 14 there was a failure by Professor Catovsky to mention the 15 key Zablotska paper? I think that's the question. 16 A. No, I don't think so. 17 MR HEPPINSTALL: Can we look at what Professor Thomas says 18 about the Zablotska paper, please. SB2, tab 2.18. 19 A. Is that in this thing here? 20 Q. You probably have SB1 open at the moment. You need SB2. 21 (Pause) 22 A. Sorry, what was the number? 23 Q. It's 2.18. She turns to Mr Battersby's case at page 10. 24 A. Yes. 25 Q. In the second paragraph there, 2.12.2, she mentions the</p> <p style="text-align: center;">Page 34</p>	<p>1 very tentative in its conclusion because of the low 2 statistical power of the study, because of the very low 3 numbers of CLL cases actually within the study? 4 A. Yes. 5 Q. Now, I think you also rely in terms of chronic lymphatic 6 leukaemia on the conclusions of the US Government body 7 NIOSH; is that correct? 8 A. That's correct. 9 Q. Perhaps we could look at those, please. Again this in 10 the original bundle as D3/10 but we've extracted it. 11 (Handed) 12 A. Thank you very much. 13 Q. I have temporarily lost my copy, Professor. (Pause). 14 We'll try and do it from memory. So if we look at 15 these -- I find these federal registers of the 16 United States Government quite difficult to follow, but 17 we have here at the first page the Department of Health 18 and Human Services setting out its guidelines for 19 determining the probability of causation under the 20 Energy Employees Occupational Illness Compensation 21 Program Act of 2000. 22 So as I understand this, Professor, this is the 23 discussion of the US Government's decision to admit CLL 24 into its Occupational Illness Compensation Program. You 25 understand that to be the context?</p> <p style="text-align: center;">Page 36</p>

1 **A. Yes.**
 2 Q. And NIOSH, which I think is the expert body, sets out
 3 its reconsideration of CLL from page 15269 onwards.
 4 **A. Yes.**
 5 Q. And we see that it set up a panel of experts for the
 6 purpose of deciding whether or not it should be treated
 7 as being admitted into that program. And if you look at
 8 the third column on page 15269 you see about a third to
 9 halfway down, and I think because this has been used in
 10 previous hearings it was highlighted:
 11 "The consensus among the panellists ...(Reading to
 12 the words)... with respect to CLL's association with
 13 ionising radiation and additional research was required
 14 to definitively answer this question."
 15 Do you agree that that was the conclusion of the
 16 expert panel?
 17 **A. Yes, that's what's written there. But again I mean**
 18 **you've already pointed out the fact that this is**
 19 **statistically quite a problematic area because of the**
 20 **rareness of the illness and --**
 21 Q. Well, let's try and take this a little quicker. So are
 22 you aware that in order to qualify under this scheme
 23 there has to be a non-zero risk of radiogenicity?
 24 **A. That's as I understand it, yes.**
 25 Q. So anything, anything above zero will count for the

Page 37

1 purposes of this statutory compensation scheme. And
 2 it's that basis that, notwithstanding the conclusion of
 3 the experts, it's that basis that the US Government
 4 decided to admit CLL to the scheme?
 5 **A. I think we have to add to that, my Lord, that we**
 6 **shouldn't be surprised if radiation caused CLL. I mean,**
 7 **it's a malignant disease and radiation is a known cause**
 8 **of malignant disease.**
 9 **So the logical basis for including it is there.**
 10 **And I think everybody admits how difficult it is to**
 11 **actually measure these things because of the**
 12 **multifactorial nature of the disease. But the fact that**
 13 **the United States and other countries have decided to**
 14 **compensate sufferers is in my -- therefore, to me means**
 15 **that the weight of scientific evidence is moving in the**
 16 **direction of accepting it as a radiogenic disease, which**
 17 **is a logical conclusion.**
 18 Q. Well, Professor, are you sure about your answer that the
 19 United States Government has decided to compensate for
 20 chronic lymphatic leukaemia in all cases?
 21 **A. Not in all cases but it's on a list of things to**
 22 **compensate.**
 23 Q. It's on a list but let's look at the criteria you have
 24 to satisfy, 15272, please, second column.
 25 You're aware, are you, that to get on the list

Page 38

1 there's got to be something above zero risk but to get
 2 compensation the probability of causation has to be
 3 50 per cent or more?
 4 **A. Yes.**
 5 Q. The same as the British occupational exposure scheme.
 6 You're aware of that?
 7 **A. There's a balance of probabilities.**
 8 Q. Yes. So we see that a CLL risk model was developed in
 9 that second column about halfway down. It starts:
 10 "The CLL risk model was quantitatively tested by
 11 calculating the probability of causation results for
 12 males between 20 and 40 years of age, hypothetically
 13 exposed to 1 sievert of high energy gamma ...(Reading to
 14 the words)... because of the same risk coefficient ...
 15 "The results of these ...(Reading to the words)...
 16 exceeds 50 per cent only at the 99 percentile and then
 17 only for times and exposure greater than 15 years for
 18 men initially exposed at age 20."
 19 So you can only cross that boundary, if we're
 20 looking at a high dose of 1000 millisieverts --
 21 1 sievert -- where you were exposed at age 20 and the
 22 onset is 15 years thereafter. So it's a very limited
 23 window in which compensation is actually awarded, isn't
 24 it?
 25 **A. Yes, it is a boundary that has been crossed, though, and**

Page 39

1 **I think also in this particular case we're not dealing**
 2 **with external radiation, we're considering internal**
 3 **radiation and the previous witness has been presenting**
 4 **data which shows that you can get malignant disease and**
 5 **other conditions at lower doses than 1 sievert.**
 6 Q. Mr Battersby's latency period is well over 15 years,
 7 isn't it?
 8 **A. It is.**
 9 Q. Now, are you able to help us with whether or not uranium
 10 binds to DNA? Is that within your field of expertise?
 11 **A. Well, I'm -- like most pathologists, I'm a microscopist,**
 12 **and in fact my chair was in bio-emitting. I've done**
 13 **a lot of high resolution electron microscopy and indeed**
 14 **I was the President of the Royal Microscopical Society**
 15 **--**
 16 Q. Forgive me, is that a "yes"?
 17 **A. It's entirely relevant because when you put tissue into**
 18 **an electron microscope, a beam of electrons is focused**
 19 **at it but you won't see anything unless you have some**
 20 **contrast. And the way we contrast that tissue is by**
 21 **staining it with heavy metals. One of the heavy metals**
 22 **is uranium, it's delivered in the form of uranyl**
 23 **acetate, and it's been shown by many people that this**
 24 **then binds to tissues and that includes DNA. What**
 25 **happens then is that the electrons are defracted by**

Page 40

<p>1 heavy metal atoms and so you see the structure in 2 negative relief. 3 So if that didn't happen then the whole field of 4 electron microscopy would have probably failed to 5 progress. 6 MR JUSTICE BLAKE: Right, so your experience as 7 a pathologist with expertise in microscopy -- I was just 8 trying to read my own writing; both of which are 9 challenging tasks at this stage -- leads you to the 10 conclusion that the uranyl acetate has this function of 11 binding, but I think the question was more generally: do 12 you have expertise about the properties of uranium 13 outside its transformation into a uranyl acetate and 14 biology? 15 A. I don't have any direct research experience in that 16 field, no. But I mean we know that uranium ions or 17 uranium oxide will bind to phosphates and there are 18 plenty of phosphates around in the body, including -- 19 I mean DNA is a highly phosphorised molecule. So it's 20 not surprising that it does. 21 MR HEPPINSTALL: Let me put this to you directly, Professor. 22 The Secretary of State's position is that whilst uranyl 23 acetate may bind to DNA, uranium does not. There's no 24 evidence that it does. 25 A. Well, I mean there will be some ionisation, whether it's</p> <p style="text-align: center;">Page 41</p>	<p>1 MR JUSTICE BLAKE: So in your view there's no significant 2 difference on the topic of the binding properties 3 between uranium and uranyl acetate? 4 A. Yes. 5 MR HEPPINSTALL: Professor, what evidence is there that any 6 of these veterans were exposed to uranyl acetate? 7 A. We don't know what they were exposed to exactly because 8 I haven't -- that information is not available. But 9 a major component of hydrogen bombs is uranium and they 10 will have been exposed to nanoparticles containing 11 uranium, various isotopes. 12 One of the things I've done in the last 15 years, 13 my Lord, is to study what happens to nanoparticles. 14 I've had two large grants from the EU to look into the 15 fate of nanoparticles within the body. 16 So we have now demonstrated that if you inhale 17 particles in the range 1 to 100 nanometres, that's 18 nanoparticles, then they are delivered preferentially to 19 the alveolus at the bottom of the lung and then they 20 travel around the body by the same mechanism that 21 viruses do. They travel -- on cells' surfaces there is 22 a continuous process going on called endocytosis, where 23 a little pocket is formed, it grabs anything around it 24 and transports it across the membrane. It's been 25 demonstrated that particles inhaled in this way will be</p> <p style="text-align: center;">Page 43</p>
<p>1 from uranium particles or whether it's as an acetate. 2 And there's also a chemi-absorption of proteins on to 3 the surface of particles. There's another process 4 that's possible. 5 Q. Hang on, Professor, your words are: "There is 6 unequivocal evidence also that uranium has a strong 7 chemical affinity for DNA." 8 Then we get reference 4. Reference 4 is the Huxley 9 paper, which is in the bundle, "Preferential staining of 10 nucleic acid containing structures for electron 11 microscopy", which I think you agree is only about 12 uranyl acetate staining? 13 A. That's a salt of uranium. The thing that's producing -- 14 Q. Just pause, Professor. How can you say "There is 15 unequivocal evidence that uranium has a strong chemical 16 affinity for DNA" by citing a paper about something 17 else? 18 A. Well, it's not about something else. It's about the 19 fact that we can see things down the electron microscope 20 because uranium, the atom uranium has bound to 21 structures and is causing a negative image because of 22 absorption of electrons. If that didn't happen we would 23 not see it and we do, so we know that it's there. 24 That's the whole basis of being able to image biological 25 structures down the electron microscope.</p> <p style="text-align: center;">Page 42</p>	<p>1 delivered to the brain, the heart, the lungs, the liver, 2 the kidneys and the reticuloendothelial systems, being 3 bone marrow, where they are also preferentially taken 4 up. 5 So given exposure, particularly by inhalation, we 6 know there will be distribution throughout the body. 7 Now when a particle lodges in some part of the body 8 we don't know exactly what the chemistry is, but in 9 a small particle with a very, very high surface area 10 there will be a tendency for myo interaction and it's 11 very low solubility but that's not to say there is none 12 and solubilisation could occur. 13 So I think that exposure, given the fallout to which 14 the vets were exposed, will inevitably lead to body-wide 15 contamination of small particles. 16 Q. What do you do to uranium to turn it into uranyl 17 acetate? 18 A. Uranyl acetate? Well, you have to react it with acids. 19 Q. React it with acids. Did that take place at Christmas 20 Island or Maralinga? 21 A. The body contains acids. There's a thing called 22 a metabolism going on and biotransformation of 23 internalised materials usually occurs. They don't just 24 stay as they are when you breathe them in. 25 Q. Professor, please try not to make up things as you go</p> <p style="text-align: center;">Page 44</p>

<p>1 along. Your statement says this is unequivocal evidence 2 also of uranium's strong chemical affinity for DNA. You 3 cite the Huxley paper. You do not say that somehow 4 uranium fallout, assuming it's there -- and the 5 Secretary of State doesn't necessarily accept it's 6 there, but accepting it's there -- went through some 7 sort of process, outside or inside the body, to turn it 8 into a chemical form whereby it might be able to bind 9 with DNA. None of that is in your report, Professor.</p> <p>10 A. Well, the answer is it's never been studied so we don't 11 actually know the answer to that question. However, the 12 experience is with internalised metals that they will 13 undergo some form of biotransformation and become more 14 bio-available. I think that's a general statement I can 15 make there but you're right, nobody's ever done the 16 research to really know exactly what exactly happens to 17 internalised uranium particles.</p> <p>18 However, we should on the current basis of all our 19 knowledge about these things assume that some form of 20 biotransformation will occur.</p> <p>21 MR JUSTICE BLAKE: Does that qualify for the term 22 "unequivocal evidence", that state of affairs in your 23 view?</p> <p>24 A. Well, the unequivocal evidence is what we see down the 25 microscope.</p> <p style="text-align: center;">Page 45</p>	<p>1 Q. Professor, did you read the protocol for the instruction 2 of expert witnesses?</p> <p>3 A. Yes, I did.</p> <p>4 Q. Do you not understand that you have a duty to make clear 5 to this Tribunal that things are quite not as 6 unequivocal or as emphatic as you are making them sound?</p> <p>7 A. Well, what I said with respect to uranium I stand by 8 because I look at that sort of information every day 9 down the microscope. We know that uranium binds to DNA, 10 because we see it.</p> <p>11 Now, whether one can extrapolate in full knowledge 12 from internalised uranium particles to a form where that 13 would happen, I agree, there is -- that is something 14 that's not fully known.</p> <p>15 Q. But Professor, you know that this Tribunal is interested 16 in things coming out of the fallout, entering the body 17 and causing illness. You know that that's what this 18 case is about?</p> <p>19 A. Absolutely, yes.</p> <p>20 Q. So are you not under a duty to point out that the 21 crucial process, the process by which uranium might turn 22 into the acetate which might bind to the DNA has no 23 foundation in research or evidence at all? Are you not 24 under a duty to put that in your report?</p> <p>25 A. I think what I've said is reasonable in the current</p> <p style="text-align: center;">Page 47</p>
<p>1 MR HEPINSTALL: Professor --</p> <p>2 A. We're going round and round in circles, I know.</p> <p>3 Q. Let's see what you do say. You say:</p> <p>4 "The ICRP risk model does not incorporate either of 5 these facts into its calculations of the effects of 6 exposure to uranium and that the existence of such 7 effects could plausibly explain many anomalous genotoxic 8 effects found in those exposed to uranium."</p> <p>9 Is the reason why it isn't incorporated because 10 you've just told us there's no evidence for uranium 11 coming out of fallout and turning into a chemical 12 compound that could bind with DNA?</p> <p>13 A. We -- I don't -- to my knowledge nobody studied the 14 internal -- I mean, there are two questions that you 15 have to ask. One is: where does it get to? Well, 16 I think we have a very good idea of where these things 17 get to now.</p> <p>18 The second questions is: does it matter? That's 19 always much more difficult to answer and the basic 20 research into the fate of internalised nanoparticles of 21 uranium has not been fully investigated. Therefore we 22 have to rely on what we know in general about what 23 happens to things that are internalised and some form of 24 biotransformation probably at quite a low level would be 25 expected.</p> <p style="text-align: center;">Page 46</p>	<p>1 state of knowledge. I have no doubt that uranium does 2 bind and I have -- again, I would expect internalised 3 metal particles to undergo biotransformation and lead to 4 more bio-available -- that's the way the body deals with 5 external compounds, my Lord. It tries to make them more 6 bio-available so that it can then excrete them so that 7 the whole of the detoxification process involves trying 8 to solubilise internalised metals, particles, other 9 compounds, organic compounds, latch on another compound 10 to make them more water soluble so that they can undergo 11 excretion. That's a general tenet of detoxification of 12 any geno chemical.</p> <p>13 Q. Professor --</p> <p>14 A. Therefore I would expect that to be the case.</p> <p>15 Q. You go on to say in this paragraph:</p> <p>16 "These effects are also shown in studies of test 17 veterans."</p> <p>18 And you give us reference 8 and reference 9, do you 19 see that, which is Rabbitt Roff and then 9 is Busby and 20 de Messieres? Do you see that?</p> <p>21 A. Yes.</p> <p>22 Q. By "these effects" do you mean that uranium must be 23 binding to DNA, causing congenital malformations in the 24 offspring and progeny of test veterans?</p> <p>25 A. No, uranium does not have to bind to DNA, although that</p> <p style="text-align: center;">Page 48</p>

1 **would make the process more efficient. It does not have**
 2 **to bind to DNA to cause these effects. It just has to**
 3 **be present in the body as nanoparticles.**
 4 Q. Well, you told the Tribunal in your report that these
 5 effects are also shown. So the "effects" that you are
 6 talking about in paragraph 3.5 is uranium's interaction
 7 with DNA; is that right?
 8 **A. Well, I actually -- I mean I address that there but**
 9 **I didn't say that that was absolutely essential for**
 10 **these effects to be observed. That's not true.**
 11 MR JUSTICE BLAKE: What do you mean by "these effects"?
 12 **A. Well, radiation is recognised as a carcinogen, so**
 13 **cancer, my Lord, and it's also recognised as**
 14 **a teratogenic, a causation of congenital malformations.**
 15 **So it is a teratogen and those are the two principal**
 16 **areas that I am concerned with.**
 17 MR HEPPINSTALL: Over the page, page 8, you deal with the
 18 paper again, 4.1, and in your second paragraph you say:
 19 "Taken together, these provide persuasive evidence
 20 that the test veterans as a group shared some prior
 21 exposure to genotoxic stress which caused transmissible
 22 genetic or genomic damage."
 23 **A. Yes, I think that's the case.**
 24 Q. And then further on at the end your last sentence is:
 25 "One of the veterans in this case, Mr Battersby,

Page 49

1 very probably suffered from this effect as his wife gave
 2 birth to twins which were badly deformed and did not
 3 survive."
 4 **A. That's what I understand to be the case, and that would**
 5 **seem to me to be a logical corollary.**
 6 Q. That statement is based on the Busby and de Messieres
 7 study and the Rabbitt Roff study; yes?
 8 **A. And then of course subsequently the second report that**
 9 **I put in. Yes, there's a raised incidence and I can't**
 10 **think of any other -- I mean there were 12,000 vets**
 11 **originally. I can't think of any other shared**
 12 **experience that they might have had where a teratogenic**
 13 **agent would have been administered, which they would**
 14 **have been exposed to.**
 15 Q. Before you convey or make such a statement to this
 16 Tribunal, or perhaps more importantly to the Battersby
 17 family, do you think you have to have a sound evidential
 18 basis before doing so?
 19 **A. I think we have an evidential basis.**
 20 Q. A sound evidential basis?
 21 **A. Yes, okay, well, I think that the evidence that we have**
 22 **is adequate to come to that conclusion.**
 23 Q. Let's look at SB6/84, please. This is the paper you
 24 refer to, Professor.
 25 **A. Yes.**

Page 50

1 Q. Are you experienced in looking at epidemiological
 2 studies and assessing their quality?
 3 **A. Right. Well, I'm an expert on survey sampling, which is**
 4 **the basis of epidemiology. I have published a book on**
 5 **three-dimensional survey sampling in microscopy and**
 6 **that's sold 10,000 copies. I ran a course on**
 7 **biostatistics when I was at Liverpool University for**
 8 **medical students. And I was appointed by Sir Cyril**
 9 **Clarke, who was the Professor of Medicine at Liverpool,**
 10 **as the chairman of the Liverpool pregnancy and diabetes**
 11 **study which ran for 15 years, and we published a major**
 12 **paper in the BMJ, an epidemiological paper.**
 13 **I've also published other papers in the field of**
 14 **epidemiology. So I'm used to reading them. I don't**
 15 **describe myself as an epidemiologist but I do understand**
 16 **the topic.**
 17 Q. The second page of the paper, the first column under the
 18 table, this is the methodology:
 19 "1,000 questionnaires were posted to the last known
 20 address of members. The questionnaire asked details of
 21 the veteran's service number, branch and occupation in
 22 the services. It asked for details of participation in
 23 the A bomb tests."
 24 First of all, do you think it's right that the
 25 subjects of the study themselves should be asked to give

Page 51

1 details of their participation in the A bomb tests?
 2 **A. I accept that these studies -- this sort of study is**
 3 **less than ideal. An ideal study would be to do a**
 4 **respective consecutive of all cases, looking at the**
 5 **clinical notes and then recording the outcome that way.**
 6 **However, the fact that this approach is not ideal**
 7 **doesn't mean to say that it's not useful. It can be**
 8 **used as a pointer. Of course one can always argue about**
 9 **the pros and cons of selection bias, self-reporting.**
 10 **But these are things that even after a long period of**
 11 **time patients or parents are not likely to forget. And**
 12 **so I think it's useful information, while acknowledging**
 13 **that it's not ideal.**
 14 Q. They gave details of any miscarriages and birth
 15 outcomes, their children and children's early health and
 16 late health and also the same details for the
 17 grandchildren.
 18 It can't be appropriate, can it, that a subject of
 19 an epidemiological survey would provide details as to
 20 their own health, the health of their children and the
 21 health of their grandchildren? It's not appropriate, is
 22 it?
 23 **A. What do you mean by "not appropriate"?**
 24 Q. Well, it is a very unsafe way of carrying out
 25 an epidemiological study?

Page 52

<p>1 A. What, for self-reporting? 2 Q. Yes. 3 A. It's not ideal, I accept that. But when there is 4 a dearth of information in an area which one can 5 consider to be important then it is -- I wouldn't say 6 it's inappropriate, it's a way of getting at some 7 information and then seeing what it says to you. But 8 obviously with caveats as to the shortcomings of the 9 approach. It's -- I mean clearly I just outlined before 10 what the ideal approach would be and it would be very 11 I think illuminating to be able to go down that route 12 but that takes a lot of time and money and setting up 13 a research project. 14 Q. The subjects of this study were members of the British 15 Nuclear Test Veterans Association, weren't they? 16 A. As I understand it, yes. 17 Q. Do you think it's important to take into account the 18 bias that might be inherent in selecting a group of 19 subjects from a campaigning body? 20 A. I assume that they have reported what -- you mean the 21 veterans themselves? 22 Q. Yes. These are veterans who are members of a body who 23 have historically campaigned about the effects of the 24 tests on their health. Is that the right pool of people 25 to use for an epidemiological study?</p> <p style="text-align: center;">Page 53</p>	<p>1 "Each veteran was asked to recruit a control of 2 approximately the same age to fill out questionnaire 3 which gave the same details." 4 A. Yes. 5 Q. It is epidemiological bad practice to ask the subjects 6 of the study to recruit their own controls, isn't it? 7 A. Normally I would tend to try and take control data from 8 the whole of the background population. 9 Q. Then we go on -- 10 A. But if they are trying to match here ... 11 Q. It gets worse, doesn't it, Professor? 12 "To avoid the element of choice of a control whose 13 children were known to be healthy or to avoid the 14 reverse of choosing a control whose children who were 15 not, we listed a sequence of choice of control as 16 follows: friend, work colleague, neighbour, in-law, 17 other. This introduced an element of randomness to the 18 choice of control." 19 That really does take the control group outside of 20 any possible good practice in epidemiology, doesn't it, 21 Professor? 22 A. It's not ideal. 23 Q. "We permitted questionnaires to be filled in by spouses 24 or children of veterans who had died." 25 So people who may not have known about the health</p> <p style="text-align: center;">Page 55</p>
<p>1 A. Well, they are the people that are of the interest for 2 this study, so there aren't any others. I mean you can 3 only get the information from them. 4 Q. Professor, are you aware of the NRPB studies into the 5 nuclear test veterans? 6 A. Yes, I'm aware of them. 7 Q. There's a national registry of nuclear test veterans 8 over 20,000 strong. 9 A. Yes. 10 Q. That data is available, isn't it, Professor? 11 A. I haven't availed myself of it. 12 Q. No, but if you are going to choose a pool for 13 an epidemiological study isn't the worse possible pool 14 you can choose members of a group who consider -- not 15 all of them I accept, but a group that has as one of its 16 aims the obtaining of compensation for nuclear test 17 veterans by reason of their participation in the tests? 18 Isn't that the worse possible pool to go fishing in, 19 Professor? 20 A. There is a potential source of bias there, yes. 21 Q. A potential source of bias or an obvious and dangerous 22 source of bias Professor? 23 A. Well, that's an assumption but, yes, there's a potential 24 source of bias. 25 Q. We go on:</p> <p style="text-align: center;">Page 54</p>	<p>1 situation of people who had died. 2 A. Erm -- I hear what you are saying, yes. 3 Q. Well, a child of a veteran may not know the health 4 situation of their father, may they? 5 A. May not. 6 Q. No. Professor, if you take all of these flaws in this 7 epidemiological study together, aren't we in a position 8 where you really cannot rely on its results? 9 A. Well, I note its results and I note the results of -- 10 it's like the previous witness was saying. You look at 11 the whole of the information that's available and not 12 just one paper. 13 Q. Are you aware that the Rabbitt Roff questionnaires were 14 framed in very similar terms? 15 A. Yes. 16 Q. Professor, you do not just note these studies; these 17 studies are the basis of your conclusions, both in 3.5 18 and in section 4. They are the basis of your statement 19 that: 20 "One of the veterans, Mr Battersby, very probably 21 suffered from this effect as his wife gave birth to 22 twins which were very badly deformed and did not 23 survive." 24 Do you think that these studies are a proper basis 25 for making that statement?</p> <p style="text-align: center;">Page 56</p>

<p>1 A. I think if you take a Bayesian approach to this, the 2 studies point in the same direction. And that's why 3 looking at the whole of the available literature on that 4 is important. 5 Q. Professor, let's forget the Bayesian approach, let's 6 think of an ethical approach. Don't you think you have 7 a duty, before making a statement which could affect not 8 just the Battersby family but many other families of 9 veterans and the way they think about their health and 10 its causation, that you can only make those statements 11 on a sound scientific basis? 12 A. Yes, well, let me comment on that. 13 What we're dealing with here, my Lord, is 14 a situation where people -- I think it is 15 acknowledged -- have been exposed to dusts of uranium, 16 containing uranium, and these have lodged in their body 17 and from what we know they will be distributed 18 throughout the body. 19 Now, the basis on which the exposure is estimated is 20 illogical in my opinion. That is that for a teratogenic 21 effect to occur -- and we are dealing with teratogenesis 22 here -- the foetus will pass through windows of 23 vulnerability when the DNA in various organs in sequence 24 will be unwound while the cells are dividing. That's 25 when they are very susceptible to damage from radiation.</p> <p style="text-align: center;">Page 57</p>	<p>1 A. The reason I am saying that, sir, is because we 2 shouldn't be surprised if we find a rise in congenital 3 malformations. That would be what I would expect from 4 what I know about the biology. 5 MR JUSTICE BLAKE: Isn't that about as much as you could say 6 then, unless there is reliable independent evidence to 7 support that conclusion? I think that's the discussion 8 that is being put to you. It's a question of whether 9 you've pitched your conclusions at a higher level of 10 certainty than was scientifically available to you. 11 MR HEPPINSTALL: Well, let's look at some independent 12 science, shall we? You should have on your table the 13 Mark Little paper, "Evidence relevant to untargeted and 14 transgenerational effects in the offspring of irradiated 15 parents". It's hopefully still loose on your desk, 16 my Lord. 17 A. Was that given out this morning? 18 Q. No, it was given out yesterday. 19 A. Appendix A, was it? 20 Q. No, it's an NIH public access -- we can provide you with 21 another one (Handed). 22 If you just flick through the last pages you will 23 see from page 26 onwards, this is a huge compendium 24 of -- a review of a compendium of studies -- well over, 25 I think, 200 studies -- looking at untargeted and</p> <p style="text-align: center;">Page 59</p>
<p>1 Now, with a single flash of gamma radiation that 2 will cause some damage but what we're dealing with here 3 is radiation that's present in the body continuously, 4 24 hours a day, 365 days a week, and therefore it's 5 going to be there as foetuses pass through various 6 windows of vulnerability and therefore the likelihood of 7 exposure is very high. 8 That really is not, in my opinion, addressed by the 9 ICRP model. I mean if you think that -- I mean the 10 CERRIE committee itself said that, you know, 1 alpha 11 decay gives rise to a dose of 500 microsieverts. Now, 12 if you dilute that into the whole body, which is what 13 the ICRP model does, then you get a negligible dose. 14 But if you think about it in the terms of where that 15 particle is sitting, it is going to deliver an extremely 16 high dose to the region of the particle, and the range 17 of the alpha particle will be maybe four or five cells. 18 MR JUSTICE BLAKE: I think you are being asked about the 19 positive basis for the conclusions that you reached in 20 your report, and you've just told us about the 21 disagreement you have with the ICRP model. 22 A. Yes. 23 MR JUSTICE BLAKE: I am conscious from what I've already 24 read and heard that there are lots of disagreements in 25 this earlier which makes it --</p> <p style="text-align: center;">Page 58</p>	<p>1 transgenerational effects. 2 Can we pass you another? 3 MR JUSTICE BLAKE: No, no. I know exactly where it is. 4 I was just doing some tidying up. 5 MR HEPPINSTALL: I beg your pardon. 6 If we look at the abstract of this paper, as I say 7 it's a review of many other papers, we can see in the 8 second paragraph that the conclusion is that studies of 9 disease in offspring of irradiated humans have not 10 identified any effects on health? 11 A. These are based on external radiation? 12 Q. Well, you can see they say: 13 "We reviewed the health effects in offspring of 14 human populations exposed as a result of radiotherapy 15 and some groups exposed to chemotherapy. We also 16 assessed risks in offspring of other radiation-exposed 17 groups...(Reading to the words)... Experimental 18 findings are also briefly surveyed." 19 Then if you want to see more detail, if you turn to 20 page 14, please, you might want to read section 3.2 to 21 yourself. 22 MR JUSTICE BLAKE: Just read that bit to yourself. (Pause). 23 A. That was precisely what I've just been saying. We're 24 dealing -- these are dealing with external radiation or 25 short-lived isotopes and we're dealing here with chronic</p> <p style="text-align: center;">Page 60</p>

<p>1 lifelong exposure to internal radiation and therefore 2 the likelihood of damage is very much higher and that's 3 a major problem. 4 MR HEPPINSTALL: First of all, that may well be your 5 position, Professor, but don't you think you have a duty 6 to this Tribunal to say, "Well, there is this paper by 7 Busby and de Messieres and there's Rabbitt Roff, but 8 also there is a wealth of other evidence about 9 congenital malformations relating to, I accept, mainly 10 external radiation, that I also need to draw to the 11 attention of the Tribunal that goes the other way?" 12 Don't you think you have a duty to do that? 13 A. Well, in fairness, my Lord, the time available to 14 prepare these reports is very short -- 15 MR JUSTICE BLAKE: Were you aware of this paper when you 16 prepared your report? 17 A. I'm aware of much of the literature on external 18 radiation, my Lord. 19 MR JUSTICE BLAKE: I think this is a literature review 20 paper, isn't it? 21 MR HEPPINSTALL: Yes. 22 A. Yes. 23 Q. If you look at the back there's a huge number -- well, 24 there's three tables of papers that were reviewed by 25 these authors to come to their conclusions.</p> <p style="text-align: center;">Page 61</p>	<p>1 literature the previous witness put forward where the 2 levels of radiation exposure are much lower than would 3 be predicted as being necessary by the ICRP model. 4 Q. So your entire thesis is based on the assumption that 5 Mr Battersby and Mr Smith received an internal dose? 6 A. Well, I mean, I think Mr Smith was estimated by -- 7 I can't remember the name of the author, but it began 8 with an H -- 1 microsievert, Mr Battersby 40 9 microsieverts. 10 Q. Millisieverts. 11 A. Sorry, millisieverts. 12 Q. There's an order of magnitude difference. 13 A. Absolutely. Millisieverts. But we've heard of evidence 14 that actually levels of external radiation much lower 15 than that are still being associated with effects and 16 that's because of the biology. It changes completely 17 when you have hot particle emitters internalised in the 18 body, and again it's this fact that it's a localised 19 intense radiation where the particle is lodged that 20 makes it more biologically effective than you would 21 expect from the ICRP model. You know, this dilution of 22 the total effects into the total organ volume or the 23 total body volume actually doesn't bear any resemblance 24 to what's going on in the body biologically. 25 Q. Professor, I have to tell you that one conclusion that</p> <p style="text-align: center;">Page 63</p>
<p>1 A. I mean, there are a lot of question marks over papers 2 where the choice of the control group is not ideal. For 3 instance in Hiroshima they were chosen within the area 4 where exposure to internal -- 5 Q. We are talking about your duty to mention any of this, 6 Professor. Have you mentioned anywhere in your reports 7 evidence that goes the other way which is contrary to 8 your conclusions? 9 A. I did not address the literature which is based on 10 external radiation because I think that what is before 11 the Tribunal is a case which involves internal 12 radiation. I mean, if I'd had a few months to write my 13 report I think I would have definitely tried to do that 14 but I didn't have time and I've addressed myself to what 15 I think is relevant, which is internal radiation. 16 Q. Professor, you didn't have time to put a sentence in 17 your report that said, "Of course there are papers that 18 go the other way" and cite, say, the Little paper? You 19 didn't have time to do that at all? 20 A. Well, I could have done but I've based my opinion on 21 addressing internal radiation and I have therefore not 22 really taken into account cases based on external 23 radiation because the biology for congenital 24 malformations and for cancer is different if you are 25 being exposed -- you know, we've heard of a lot of the</p> <p style="text-align: center;">Page 62</p>	<p>1 can be drawn from reading your report is that what you 2 have been asked to do and what you have done is solely 3 to provide supporting evidence to Dr Busby and the 4 ECRR's theories about risks from exposure to radiation 5 and you have not explored any alternative theories or 6 any evidence to the contrary. 7 A. Well, I'm not a member of the ECRR. I think that's the 8 first thing to say. That is my report, those are my 9 opinions, and I think we have to recall that the CERRIE 10 committee, which in the end turned out to be pretty 11 conservative, had to admit that the ICRP model was out 12 by a factor of 10 probably in trying to assess the 13 effect of internal radiation. So then Mr Battersby's 40 14 millisieverts would come to 400 millisieverts and, you 15 know, I don't think there's anybody in this room who 16 wouldn't accept that that was something which was going 17 to have an effect. 18 Q. Professor, the ICRP, UNSCEAR, BEIR VII, IRSN, CERRIE, 19 COMARE and latterly the HPA have all been highly 20 critical of ECRR methods, epidemiology, the basis of 21 their science and their conclusions, because they rely 22 on studies such as the ones we've looked at, Busby and 23 de Messieres. 24 Do you not accept that you have a duty to this 25 Tribunal, and moreover to the public, to make sure that</p> <p style="text-align: center;">Page 64</p>

<p>1 those criticisms are set out and explored?</p> <p>2 A. What I am bringing to this Tribunal, my Lord, is</p> <p>3 experience in the fate of particles in the body. I'm</p> <p>4 recognised as an international expert on that and</p> <p>5 an expert in teratology, knowing what the mechanisms are</p> <p>6 for the likelihood of damage to the foetus in windows of</p> <p>7 vulnerability.</p> <p>8 So I've come to my conclusions not because of the</p> <p>9 ECRR. I've come to my conclusions because of my</p> <p>10 experience as a pathologist and nanopathology as well.</p> <p>11 And to me the current methods of assessing this are</p> <p>12 not based on the known logical conclusions to known</p> <p>13 scientific facts. That's why I have come to give</p> <p>14 evidence.</p> <p>15 MR HEPPINSTALL: No further questions, my Lord.</p> <p>16 MR TER HAAR: Let me just raise one matter. I didn't want</p> <p>17 to interrupt my learned friend's flow, but it is</p> <p>18 a matter of some concern. It was put to this witness</p> <p>19 that the evidence that he gave that Professor Catovsky</p> <p>20 should have had regard to the Zablotska paper could not</p> <p>21 be a fair point because of the date of the publication.</p> <p>22 It's very unfortunate my learned friend should put this</p> <p>23 when in the bundle under SB4, tab 39, is the Zablotska</p> <p>24 paper showing it was published online on</p> <p>25 8 November 2012. It would therefore have been available</p> <p style="text-align: center;">Page 65</p>	<p>1 congenital conditions significantly greater than that of</p> <p>2 the controls and also that of the general population of</p> <p>3 England.</p> <p>4 "The effect remains highly statistically significant</p> <p>5 even assuming a high selection of bias in the responses</p> <p>6 and credibility is strengthened by the high rates of</p> <p>7 miscarriage reported by the veterans compared with the</p> <p>8 controls, a result which could hardly have been due to</p> <p>9 selection effects."</p> <p>10 Q. So my question to you then is first of all do you agree</p> <p>11 that there were not just controls that were selective</p> <p>12 but there were also controls that represented the</p> <p>13 general population of England?</p> <p>14 A. Yes, if it's compared with the general population of</p> <p>15 England that would be a normal control.</p> <p>16 Q. And those controls were in fact later on, if we go to</p> <p>17 the "subjects and methods" section on the second page --</p> <p>18 no, sorry, just below table 2 on the third page where it</p> <p>19 says:</p> <p>20 "We made two approaches to analysing these data."</p> <p>21 A. Yes.</p> <p>22 Q. So what were the two approaches? Could you just briefly</p> <p>23 tell us whether you think those two approaches were</p> <p>24 reasonable given the constraints there were on the type</p> <p>25 of study? There was a case control study and also</p> <p style="text-align: center;">Page 67</p>
<p>1 to a standard online search carried out by any expert --</p> <p>2 MR JUSTICE BLAKE: Not in 2011, I don't think.</p> <p>3 MR TER HAAR: But Professor Catovsky's second report --</p> <p>4 A. The subsequent report was in 2013, my Lord.</p> <p>5 MR TER HAAR: So the point made was inaccurate factually and</p> <p>6 unfair.</p> <p>7 MR JUSTICE BLAKE: Thank you.</p> <p>8 Re-examination by DR BUSBY</p> <p>9 MR JUSTICE BLAKE: Yes.</p> <p>10 DR BUSBY: If I might take you back to this contentious</p> <p>11 Busby and de Messieres paper, where much was said about</p> <p>12 the choice of controls and all the other possible</p> <p>13 biases. If we can go to the first page of that paper,</p> <p>14 which is at --</p> <p>15 A. I've got it here.</p> <p>16 Q. You've got it. SB/84. Right. Now there's a box at the</p> <p>17 head of this paper which was peer reviewed, I have to</p> <p>18 say, nobody's mentioned this, and at the bottom of this</p> <p>19 box in the abstract would you mind reading or could you</p> <p>20 just go to the caveat?</p> <p>21 A. The one starting "Whilst caution ..."?</p> <p>22 Q. "Whilst caution ...", yes.</p> <p>23 A. "... must be exercised due to structural problems</p> <p>24 inherent in the study, we conclude that the veterans'</p> <p>25 offspring qualitatively exhibit a prevalence of</p> <p style="text-align: center;">Page 66</p>	<p>1 a comparison with EUROCAT.</p> <p>2 A. Yes.</p> <p>3 Q. Can you tell us what EUROCAT is?</p> <p>4 A. EUROCAT is a database of congenital malformations run</p> <p>5 across the whole of Europe. It used to be run by my</p> <p>6 colleague Professor Helen Dolk in the University of</p> <p>7 Ulster but she has now after many years relinquished</p> <p>8 that so --</p> <p>9 Q. So would you say that EUROCAT is an authoritative source</p> <p>10 of control data for such a study?</p> <p>11 A. Absolutely, yes.</p> <p>12 Q. So therefore, by comparing with the EUROCAT national</p> <p>13 data in a sense it's a backup for the comparison with</p> <p>14 the selected controls process that Mr Heppinstall was so</p> <p>15 upset about?</p> <p>16 A. That's right. It's a way of checking its validity.</p> <p>17 Q. In fact, the paper shows that the results for the</p> <p>18 controls process and the EUROCAT process were</p> <p>19 substantially the same?</p> <p>20 A. Correct, yes.</p> <p>21 Q. Thank you.</p> <p>22 Yes, earlier on you mentioned -- you were talking</p> <p>23 about the dose from a track of an alpha particle to a</p> <p>24 cell and you said 500 microsievets, I thought?</p> <p>25 A. Did I?</p> <p style="text-align: center;">Page 68</p>

<p>1 Q. Later on, Mr Heppinstall corrected you.</p> <p>2 A. It's millisieverts.</p> <p>3 Q. You meant millisieverts.</p> <p>4 A. I apologise.</p> <p>5 Q. I am sure that you corrected that, that it was</p> <p>6 500 millisieverts was the dose to a cell --</p> <p>7 A. Yes.</p> <p>8 DR BUSBY: -- from a single alpha particle track.</p> <p>9 No further questions.</p> <p>10 MR JUSTICE BLAKE: Thank you.</p> <p>11 Questions from the Tribunal</p> <p>12 DR RAYNER: Can I just clarify what you were saying about</p> <p>13 the foetus being exposed, the various windows of</p> <p>14 vulnerability?</p> <p>15 A. Yes.</p> <p>16 DR RAYNER: Because as far as I'm concerned "foetus" is</p> <p>17 a very specific term used in embryological development.</p> <p>18 A. Okay, the conceptus.</p> <p>19 DR RAYNER: Okay. Thank you.</p> <p>20 MR JUSTICE BLAKE: Thank you, Professor. That completes</p> <p>21 your evidence. Thank you for coming. You can go.</p> <p>22 THE WITNESS: Thank you, my Lord.</p> <p>23 (The witness withdrew)</p> <p>24 MR JUSTICE BLAKE: We'll take a break now for the</p> <p>25 stenographers to have a rest. 10 past 12.</p> <p style="text-align: center;">Page 69</p>	<p>1 MR TER HAAR: I was concerned about the amount of time</p> <p>2 available with Professor Thomas just tomorrow, so having</p> <p>3 a bit of today will be helpful and also a bit extra</p> <p>4 tomorrow will also be helpful.</p> <p>5 MR JUSTICE BLAKE: Provisionally, we can always review it,</p> <p>6 and see where we get to at the end of today. If we</p> <p>7 start at 9.45 tomorrow and if we finish a little earlier</p> <p>8 than 4 o'clock I don't think there will be too many</p> <p>9 tears shed over that.</p> <p>10 MR TER HAAR: That is probably right.</p> <p>11 DR BUSBY: We would be content with 9.45, my Lord.</p> <p>12 If I call Professor Hooper.</p> <p>13 MR JUSTICE BLAKE: Yes.</p> <p>14 PROFESSOR MALCOLM HOOPER (sworn)</p> <p>15 Examination-in-chief by MR BUSBY</p> <p>16 MR JUSTICE BLAKE: Now, do you want to give your evidence</p> <p>17 standing up or sitting down?</p> <p>18 A. I think I'm okay standing, thank you very much.</p> <p>19 MR JUSTICE BLAKE: Right. If you ever want to change that</p> <p>20 position please do so just as long as audibility is not</p> <p>21 lost.</p> <p>22 A. Right, thank you.</p> <p>23 DR BUSBY: Right. Professor Hooper, you have a copy of your</p> <p>24 report there, don't you?</p> <p>25 A. Yes.</p> <p style="text-align: center;">Page 71</p>
<p>1 (12.55 am)</p> <p>2 (A short break)</p> <p>3 (12.10 pm)</p> <p>4 MR JUSTICE BLAKE: Yes. Just before you call your next</p> <p>5 witness I thought it would be appropriate just to have</p> <p>6 a check on how we are doing in time. I think that,</p> <p>7 despite our various problems earlier in the week, we've</p> <p>8 now caught up and we are about 50 minutes ahead of time,</p> <p>9 but we will deal with the next witness today. Tomorrow</p> <p>10 I was proposing to sit at 9.45.</p> <p>11 MR HEPPINSTALL: We might be able to do better than that,</p> <p>12 my Lord, because Professor Thomas is here and ready to</p> <p>13 start.</p> <p>14 MR JUSTICE BLAKE: I see.</p> <p>15 MR HEPPINSTALL: I don't think I'm going to be that long</p> <p>16 with Professor Hooper.</p> <p>17 MR JUSTICE BLAKE: Okay.</p> <p>18 MR HEPPINSTALL: Subject to his answers.</p> <p>19 MR JUSTICE BLAKE: Then I'll keep quiet and review. I have</p> <p>20 to do a hand down at 9.45 --</p> <p>21 MR HEPPINSTALL: We can take stock at 4 o'clock.</p> <p>22 MR JUSTICE BLAKE: Would 9.45 be inconvenient?</p> <p>23 MR HEPPINSTALL: Not to this side, my Lord.</p> <p>24 MR JUSTICE BLAKE: I appreciate you may have to absorb</p> <p>25 information and papers are floating --</p> <p style="text-align: center;">Page 70</p>	<p>1 Q. Do you have anything to add to it or any changes you</p> <p>2 might wish to make?</p> <p>3 A. There's one small omission which was the date of the</p> <p>4 Depleted Uranium Oversight Board, which was 2001 to</p> <p>5 2006, which should follow after the assessment panel on</p> <p>6 the third line from the bottom of the first paragraph.</p> <p>7 It's just the dates really.</p> <p>8 MR JUSTICE BLAKE: The board was 2001 to --</p> <p>9 A. 2006. That was the DUOB which followed -- well, it was</p> <p>10 also in tandem with the other committee, yes.</p> <p>11 MR JUSTICE BLAKE: Thank you.</p> <p>12 Cross-examination by MR HEPPINSTALL</p> <p>13 MR HEPPINSTALL: Do you remain the President of the National</p> <p>14 Gulf War Veterans and Families Association?</p> <p>15 A. Yes.</p> <p>16 Q. What's the aims and objectives of that association,</p> <p>17 please?</p> <p>18 A. We represent the interests of the veterans and their</p> <p>19 families from the first Gulf War.</p> <p>20 Q. Does it campaign on the issues of the alleged ill-health</p> <p>21 effects of depleted uranium?</p> <p>22 A. It campaigns on the care of the sick Gulf veterans and</p> <p>23 it's not just to do with depleted uranium.</p> <p>24 Q. But it includes depleted uranium?</p> <p>25 A. It includes depleted uranium and other exposures.</p> <p style="text-align: center;">Page 72</p>

<p>1 Q. Does that association provide representation at War 2 Pension and Armed Forces Compensation Appeals relating 3 to depleted uranium? 4 A. They have an officer who does that, yes. 5 Q. Have you represented veterans or provided expert 6 evidence in such appeals? 7 A. Yes, I have. 8 Q. Has that always been on the side of the veteran and has 9 the source of your instructions for that come through 10 the association? 11 A. No, it's always been on the side of veterans that I've 12 been asked to be their scientific adviser. 13 Q. So you are also the scientific adviser? 14 A. Yes, indeed. 15 Q. And has Dr Busby also undertaken that work, provided 16 expert evidence -- 17 A. Not to my knowledge. The expert evidence that Dr Busby 18 has been involved in has been the work with the Depleted 19 Uranium Oversight Board which was a Government 20 committee. 21 Q. How long have you known Dr Busby? 22 A. By reputation for some time but I first got involved 23 with him on the Depleted Uranium Oversight Board 24 especially. 25 Q. And since then? Since 2002?</p> <p style="text-align: center;">Page 73</p>	<p>1 Q. You don't think they might also have a claim on being 2 leading national and international experts on 3 radioactivity and its effects on people and the 4 environment? 5 A. They may very well be but in my experience my contacts 6 have been mainly through the work that I've done for the 7 DUOB. 8 Q. You mention at paragraph 6 the ECRR. 9 A. Yes. 10 Q. Are you aware of the serious criticisms made of that 11 body and its work by several international and national 12 regulatory and advisory bodies? 13 A. I'm aware that it is debatable, yes. 14 Q. Well, are you aware of the criticisms? 15 A. I'm aware of the criticism that came through the DUOB 16 which is echoing the criticisms of the ECRR. 17 Q. You say in the last sentence of that paragraph: 18 "I was one of those who argued this in the DUOB in 19 2002 and 2006 and scientific developments since have 20 strengthened this position." 21 Can you assist us with the "this", please? 22 A. Yes, it has, because the chemical affinity for DNA as 23 a target for radiation and genotoxicity is something 24 that is very important with regard to the concerns of 25 the veterans from the first -- from the atomic veterans</p> <p style="text-align: center;">Page 75</p>
<p>1 A. Since 2006, yes, I have been intermittently involved 2 with him with questions for the Gulf War veterans and 3 I have followed his work in Iraq with some considerable 4 interest. 5 Q. And you describe in the bottom at page 1 of your report: 6 "Dr Busby is the leading national and international 7 expert on radioactivity and its effects on people and 8 the environment." 9 A. Yes. 10 Q. That's a little bit of an exaggeration to say he's the 11 leading national and international expert, Professor. 12 A. Well, in my reading of the literature he is. I have 13 found him to be reliable and a very good witness and 14 doing some very good science. 15 Q. Do you only read literature produced by Dr Busby, the 16 ECRR and members thereof? 17 A. No. My references show that. 18 Q. So you also read literature by others, do you? 19 A. Yes, I do. 20 Q. Mark Little? 21 A. I haven't seen his particular paper, no. 22 Q. Professor Brenner of Columbia University? 23 A. Go on. No. 24 Q. No? 25 A. No.</p> <p style="text-align: center;">Page 74</p>	<p>1 and from the veterans of Gulf War 1. 2 Q. Do you accept that there's evidence that uranyl acetate 3 has a high chemical affinity for DNA but not uranium? 4 A. Could you just repeat that question, please, very 5 slowly? 6 Q. Well, I'll maybe make it simpler. Is it uranyl acetate 7 that has a high chemical affinity for DNA or uranium? 8 A. My Lord, I'm astonished at such a question. This is 9 third year chemistry in a grammar school. 10 MR JUSTICE BLAKE: Can we have the answer? 11 A. The answer is uranium is a metal, uranium acetyl is the 12 ion formed from the metal interacting with acetic acid. 13 The ion is a soluble form of uranium. Uranium the metal 14 is not soluble except in acids and strong acids. We are 15 dealing with two different things. It's the ion that 16 associates with DNA, not the metal, and I would have 17 thought that would have been aware -- some of you should 18 have been aware of that fact. 19 The metal does not associate with DNA. It's 20 actually quite dangerous stuff to handle. The ions 21 themselves bind at the phosphate groups on the backbone 22 of the DNA of cells and as Professor Howard is telling 23 you this is a fact that is used to visualise DNA in 24 cells in electron microscopy. 25 Q. Doesn't it have to be in its acetate form in order to</p> <p style="text-align: center;">Page 76</p>

<p>1 see that effect?</p> <p>2 A. No, it doesn't. It can be any salt. The simple</p> <p>3 chemistry is acid plus base equals salt plus water and</p> <p>4 if you get uranium with acetic acid you get uranyl</p> <p>5 acetate, which is the ion. If you do it with nitric</p> <p>6 acid you get uranyl nitrate and it is the ion that</p> <p>7 associates with the DNA.</p> <p>8 The choice of the pairing -- an ion is in fact</p> <p>9 a matter of choice for the nature of the experiment and</p> <p>10 acetate is a very good choice because it's not going to</p> <p>11 interfere with the medium very much.</p> <p>12 Q. Let's forget about the pairing and the salts and the</p> <p>13 acetates and the nitrates and so forth. Let's just deal</p> <p>14 with -- well, let's just deal with uranium coming out of</p> <p>15 fallout.</p> <p>16 A. Yes.</p> <p>17 Q. Without that metal going through a process to turn it</p> <p>18 into a salt, let's call it, for that metal there is no</p> <p>19 evidence that that alone binds the DNA, is there?</p> <p>20 A. Yes, but that metal alone does not come out from the</p> <p>21 fallout. The fallout is generated at a very high</p> <p>22 temperature in the fireball at something in the region</p> <p>23 of 5,000 degrees centigrade, I believe, and that</p> <p>24 generates uranium oxides, mixed oxides. U308 is the</p> <p>25 atomic composition that is generally agreed, and that is</p> <p style="text-align: center;">Page 77</p>	<p>1 Q. In that you say:</p> <p>2 "New Zealand nuclear test veterans ..."</p> <p>3 Then you say "Wahab et al 2008".</p> <p>4 A. Mm.</p> <p>5 Q. So you remember considering that paper?</p> <p>6 A. Yes.</p> <p>7 Q. So we can now look at that paper, SB7/123.</p> <p>8 A. Yes.</p> <p>9 Q. You recognise that as the Wahab paper?</p> <p>10 A. Yes, indeed.</p> <p>11 Q. And if you turn back a few pages you'll see that you</p> <p>12 then find the formal report which was presented to the</p> <p>13 NZNTVA, the New Zealand nuclear test veterans. Do you</p> <p>14 see that, 2007?</p> <p>15 A. Which tab are we at?</p> <p>16 MR JUSTICE BLAKE: You are in the same tab, but if you go on</p> <p>17 through the article which is --</p> <p>18 A. Not before it.</p> <p>19 MR JUSTICE BLAKE: -- and you go to the page after 87, then</p> <p>20 it starts again, I think, at the bottom.</p> <p>21 A. (Pause)</p> <p>22 MR JUSTICE BLAKE: Is it "Elevated Chromosome</p> <p>23 Translocation"?</p> <p>24 A. That's the title.</p> <p>25 MR JUSTICE BLAKE: Page 87, bottom-right.</p> <p style="text-align: center;">Page 79</p>
<p>1 a composition of two atoms or three atoms, actually, of</p> <p>2 uranium. Two are in the high valence and hexavalent state</p> <p>3 and one is in the tetravalent state. So you have</p> <p>4 uranium oxides that come down in the fallout, not</p> <p>5 uranium, and they will interact with acids and form</p> <p>6 uranyl acetate and water.</p> <p>7 It's really very, very basic chemistry.</p> <p>8 Q. These additional stages to get from the fallout to DNA</p> <p>9 are not described in your report, are they, Professor?</p> <p>10 A. Well, they're not because it is a simple matter of the</p> <p>11 environment. If you have an acid there present, and you</p> <p>12 have plenty of acids present in blood and in saliva and</p> <p>13 juices and in the gastrointestinal tract, the generation</p> <p>14 will take place very straightforwardly. It's just</p> <p>15 a very simple basic process.</p> <p>16 Q. Have you considered carefully the Wahab paper studying</p> <p>17 the nuclear test veterans and the associated report by</p> <p>18 Professor Rowland?</p> <p>19 A. I have looked at that paper. I do not have it with me</p> <p>20 at the moment.</p> <p>21 Q. We can supply you with a copy. If you look at page 4 of</p> <p>22 your report.</p> <p>23 A. Yes.</p> <p>24 Q. Second paragraph.</p> <p>25 A. Right.</p> <p style="text-align: center;">Page 78</p>	<p>1 A. Right. Thank you.</p> <p>2 MR HEPPINSTALL: So did you also consider the Rowland paper</p> <p>3 as well as the Wahab paper?</p> <p>4 A. No, I haven't seen this one.</p> <p>5 Q. You've not seen this one before. Right.</p> <p>6 Well, if you turn to page 34.</p> <p>7 A. Yes.</p> <p>8 Q. Where you have a table that sets out the doses.</p> <p>9 A. Yes.</p> <p>10 Q. That have been worked out from the chromosomal</p> <p>11 aberrations.</p> <p>12 A. Mm.</p> <p>13 Q. So you have the blinded participants with their codes on</p> <p>14 the left, we then get the cells scored.</p> <p>15 A. Mm-hm.</p> <p>16 Q. We know which ring it's in, and the next column, and</p> <p>17 then we get the dose; do you see that?</p> <p>18 A. Yes.</p> <p>19 Q. You then get the confidence intervals. Then there's</p> <p>20 another three columns which deal with the dicentric</p> <p>21 testing.</p> <p>22 A. Yes.</p> <p>23 Q. But those results, as you can see, were sparse.</p> <p>24 So if we just look at the main conclusions of the</p> <p>25 main results, can you see that the dose range is all the</p> <p style="text-align: center;">Page 80</p>

<p>1 way from quite a few nils, through the low 0 point, the 2 low decimals, all the way to 1.4, NZTV-026. You can see 3 that? 4 A. I can't see the 1.24. 5 Q. Take a moment to study it, if you wish. 6 MR JUSTICE BLAKE: The 124, I can tell you, 13 lines down 7 from the top. The participation of the veteran is 026. 8 A. The veteran is 026. I've got 0s in there, the dose. 9 MR JUSTICE BLAKE: Take that line. 026, 201, 8, 1.4. Do 10 you have that? 11 A. No, I haven't. Where is it? 12 MR JUSTICE BLAKE: Do you have "NZTV-026"? 13 A. Yes, I have. 14 MR JUSTICE BLAKE: Right. What is the next entry in the 15 next column along? 16 A. 203, yes. 17 MR JUSTICE BLAKE: That is jumping down. That's 33. 201 is 18 26. 19 A. 201. 20 MR JUSTICE BLAKE: Yes. 21 A. Sorry, yes, you are in the cell scores, I was reading 22 the -- 23 MR JUSTICE BLAKE: Well, I am trying to draw your attention. 24 So if you are sticking on that line, 026, 201, 8, and 25 then I think in the column dose you are being shown 1.4.</p> <p style="text-align: center;">Page 81</p>	<p>1 problems that came out of the DUOB was how do we get 2 such a differential distribution of illnesses amongst 3 people who are, essentially, very much in the same 4 environment? Because there's a big problem of 5 randomness about this, where, exactly what is, who and 6 when and where. 7 So I'm not surprised by this, I'd expect to see 8 something like this in a highly random -- 9 Q. They are on two vessels. 10 A. Yes. 11 Q. I think it's problematic because we don't know who these 12 participants are and the two vessels do different 13 things. 14 A. Yes. 15 Q. But we would expect to see, wouldn't we, if you are on 16 a vessel -- and I think the allegation is that they came 17 across fallout whilst steaming through the South 18 Pacific -- 19 A. Mm. 20 Q. -- if the veterans came across that patch of fallout why 21 would we expect to see different doses? 22 A. It depends where they were in the ship. If they're 23 inside the ship, down in the bottom of the ship, and not 24 on the surface, on the top, I'd expect them to get very 25 different doses.</p> <p style="text-align: center;">Page 83</p>
<p>1 Do you have that? 2 A. Yes. 3 MR JUSTICE BLAKE: I am just trying to navigate you. 4 A. Thank you very much, that's very helpful. 5 MR HEPINSTALL: Then you can actually see the confidence 6 interval on that 1.4 stretches from 0.5 to 2.1. Do you 7 see that? 8 A. Yes. Grays, yes. 9 Q. Now, you're aware that these New Zealand test veterans 10 were on two ships in the south Pacific at the time of 11 the tests? 12 A. Yes, yes. 13 Q. So would one not expect them all to have similar doses 14 within a short to medium range? 15 A. Not necessarily. 16 Q. Would you really expect the range to be so many at nil 17 and then all the way up to as high as 1,400 18 millisieverts? 19 A. The question -- the problem really is how do you handle 20 the randomness of the fallout and the way in which these 21 things have happened in quite discrete areas. And, 22 also, this is the external dosing in grays, the sieverts 23 would be the absorbed dose, we don't know -- it's the 24 same number, almost, as the absorbed dose -- but 25 that's -- one of the questions and one of the big</p> <p style="text-align: center;">Page 82</p>	<p>1 Q. I accept there would be a range, but don't you think 2 this range is so extreme that it points to some serious 3 unreliability in the result? 4 A. Well, the results are the results, unless there's been 5 some very serious mismeasurement. These are the results 6 they've got to live with, and they are difficult results 7 to live with, but there are explanations for them, 8 particularly in the location of the personnel on the 9 ship. 10 Q. Are you aware of the Pearce epidemiology into the 11 New Zealand nuclear test veterans? 12 A. I've just received that this morning, I haven't really 13 looked at it, and I'm not an epidemiologist so I'm not 14 really qualified to make any serious comment on that. 15 Q. You also rely on the Busby and de Messieres paper, we 16 see that from the next paragraph. 17 A. Yes. 18 Q. You also rely, we see within those square brackets, on 19 the Rabbitt Roff paper as well? 20 A. Yes. 21 Q. You've just told us that you don't have expertise in 22 epidemiology. 23 A. That is true. 24 Q. Did you look at those papers before making the statement 25 that chromosome damage in germ cells will have effects</p> <p style="text-align: center;">Page 84</p>

1 on offspring?
 2 **A. Well, the chromosome damage is mentioned in the paper we**
 3 **just looked at.**
 4 Q. Well no, let's talk about Busby and de Messieres and
 5 Rabbitt Roff.
 6 **A. It's not something that's specific to those papers, it's**
 7 **mentioned in several papers.**
 8 Q. I agree you also cite Doyle, Areneta, Kang, Alaani, but
 9 I want to talk about Busby and de Messieres.
 10 **A. Yes.**
 11 Q. Have you read that paper?
 12 **A. Yes.**
 13 Q. You don't have any epidemiological expertise, but on
 14 reading that paper did anything cause you any concern?
 15 **A. No, I don't think it caused me any special concern.**
 16 **There's lots of questions to be answered, but it's**
 17 **answered some of them.**
 18 Q. Were you in court when Professor Howard was
 19 cross-examined?
 20 **A. Yes, I was.**
 21 Q. So you saw me put to him the concerns about the way in
 22 which the controls were chosen, selected, the way in
 23 which there's self-report, the pool.
 24 Let me ask you this: you're the president of
 25 a campaigning group for veterans. Do you think it would

Page 85

1 be appropriate to use them as an appropriate pool for an
 2 epidemiological study?
 3 **A. Yes, it's been done, actually, and -- it's not been done**
 4 **in any depth because the Government wouldn't allow it --**
 5 **but the paper that I quote from Schroeder is the one on**
 6 **the chromosomal aberrations found in Gulf War veterans.**
 7 **Now, I don't know where those controls came from because**
 8 **Schroeder did that.**
 9 Q. Well, all Gulf War veterans, or was the subjects just
 10 drawn from the membership of your association?
 11 **A. Gulf War veterans who were available through the**
 12 **association, not necessarily members.**
 13 Q. Do you think there is an inherent bias in asking those
 14 who believe they were damaged by an agent to report
 15 about their health?
 16 **A. I'm not quite sure I understand the question because the**
 17 **answer is obviously it is important for them to report**
 18 **about their health.**
 19 Q. If you are going to collect data from which you are
 20 going to do a scientific study do you think it's
 21 appropriate to ask people who have a belief, who are
 22 campaigning, on the ground that depleted uranium caused
 23 their ill-health, is it appropriate to them to report on
 24 their own ill-health for a purpose of a scientific
 25 study?

Page 86

1 **A. Well, that was what they believed. What they thought**
 2 **and what they were concerned about was the depleted**
 3 **uranium was widely used in the battlefield, many of them**
 4 **were exposed and it was a potential agent for causing**
 5 **them ill-health. That's why they were looking at it and**
 6 **that's why Schroeder looked at it. It was a German**
 7 **study done in the German laboratories because the**
 8 **English laboratories would not do it. We asked the to**
 9 **repeat it and they would not do it.**
 10 **So funding was refused to follow up that lead. It**
 11 **seems to me entirely appropriate, when people are ill,**
 12 **to enquire about the environmental concerns of the**
 13 **battlefield. In Iraq they were awful. You can see from**
 14 **the death rates and the damage from radiation and**
 15 **radiation-related effects in the whole of the Iraqi**
 16 **population.**
 17 **I've got one paper here where there were a**
 18 **250,000-fold increase in damage to eyes. You know, so**
 19 **if that's gonna happen to their eyes, what about my**
 20 **eyes?**
 21 MR JUSTICE BLAKE: We've got quite enough on our plate to
 22 deal with.
 23 **A. Right, sorry.**
 24 MR JUSTICE BLAKE: Fascinating as it would be to extend our
 25 activity to look at Gulf War depleted uranium, that's

Page 87

1 not what we are doing.
 2 I think let's just drive back to where my
 3 understanding of the question is, but if I've got my
 4 understanding wrong I'm sure I'll be corrected.
 5 You know very well, that the issue here is about
 6 causal link and doubt about causal link between the
 7 experiences of the servicemen in 56 to 60, a wide
 8 bracket.
 9 **A. Yes.**
 10 MR JUSTICE BLAKE: One way, it seems, we've been told, and
 11 we understand, that evidence can support or undermine
 12 a particular claim, is epidemiological studies.
 13 **A. Yes.**
 14 MR JUSTICE BLAKE: But can you have an epidemiological study
 15 which can either support or shed different light, or
 16 undermine a claim, if it's based upon the very group of
 17 claimants or campaigners for claimants that the whole
 18 issue of causation is about?
 19 **A. Well, you've got to look at the claimants because that's**
 20 **people you're interested in.**
 21 MR JUSTICE BLAKE: I'm sure you've got to look at the
 22 claimants, but one does that by looking at their medical
 23 reports, doesn't one, and experiences. Is it a form of
 24 epidemiological study independent of that narrative?
 25 **A. Well, the epidemiology is concerning people who are**

Page 88

<p>1 showing certain signs and symptoms, clinical signs and 2 symptoms, and if those are present then the answer is 3 yes. 4 MR JUSTICE BLAKE: But you're not an epidemiologist? 5 A. That's quite right, but if I was asking an epidemiologist 6 to look at it that's what I would be asking him to do, 7 "These people are ill, please will you look at it", and 8 we've got some reasons for thinking what might cause 9 that illness, then we can proceed from that position. 10 MR JUSTICE BLAKE: Right. 11 A. Which is what we did -- 12 MR JUSTICE BLAKE: I have your answer. 13 MR HEPPINSTALL: You mention a lot of epidemiology, don't 14 you, in your evidence to this Tribunal? 15 A. Well, it depends what you mean "a lot", I don't think 16 I did mention a lot, I just mentioned enough to show 17 that I was aware of certain epidemiological data and 18 that it was indicative of my concerns about the 19 veterans -- the atomic veterans -- who received 20 a massive assault from depleted -- from uranium, and 21 depleted uranium, as it came down in the black rain, and 22 from these massive bombs that were detonated. 23 Q. Sorry, Professor, you are making massive assumptions 24 there, aren't you? 25 A. Well --</p> <p style="text-align: center;">Page 89</p>	<p>1 then, Professor? 2 A. Because there is expertise that will show it, and my 3 informed judgment, from the release of depleted uranium 4 from rockets and shells, is that there is a whole amount 5 of fallout that comes from them; but it's not going 6 anything like as high or anything like as extensive as 7 the cloud over Christmas Island, which you can look at 8 in photographs. 9 Q. Professor, do you think it's appropriate to compare 10 apples and oranges? Compare your extensive experience, 11 as president of a campaigning organisation, and draw on 12 that information in these appeals, which are about 13 something else entirely? Do you think it's appropriate? 14 A. I think it's appropriate because I'm interested in the 15 truth of these matters; I'm not interested in 16 campaigning at the expense of everybody else. My 17 concern is for truth and justice for these people, and 18 it's not for spinning a tale that will somehow persuade 19 other people to take my point of view without evidence. 20 That's my concern: it's truth and justice. 21 Q. Do you think your position as president of a campaigning 22 organisation for veterans, especially when it's linked 23 to depleted uranium, means you can't give independent 24 evidence to this Tribunal? 25 A. Only if I lack integrity, and I do not lack integrity.</p> <p style="text-align: center;">Page 91</p>
<p>1 Q. Where on earth are you getting your evidence about 2 a massive insult and black rain? Who has told you about 3 that? 4 A. Well, the black rain was reported over Hiroshima. It 5 was reported over the atomic bomb sites in Christmas 6 Island. So that -- 7 Q. What's your source for massive amounts of black rain in 8 Christmas Island? What have you read? 9 A. Well, I've read reports from the -- Hiroshima itself. 10 MR JUSTICE BLAKE: No, black rain, Christmas Island. 11 MR HEPPINSTALL: What's your source? 12 A. My source is the evidence from people who were there. 13 Q. You've read witness statements to that effect? 14 A. No, I've got a witness statement with me, actually, 15 which I've not had time to read this morning; but that's 16 what I am hoping to find in there. 17 Q. Haven't you just been told this, Professor? 18 A. No, I haven't. It's logical, when you send all this 19 stuff up into the air, that it will come down again, and 20 if it's raining it will be washed down in rain. 21 Q. Do you have any expertise about the physical properties 22 of a nuclear cloud going into the sky, Professor? Do 23 you have any expertise relevant to that question? 24 A. I don't have any expertise in that field, no. 25 Q. Why on earth are you telling this Tribunal about it</p> <p style="text-align: center;">Page 90</p>	<p>1 Q. For example, do you think it would have been a good idea 2 to have carefully thought about whether you should be 3 putting epidemiology in your report when you have no 4 expertise in that area? 5 A. It wasn't put in there to show I had expertise, it was 6 put in her to show that I have awareness. 7 Q. But you don't put any awareness of epidemiology that 8 goes the other way in this report, do you? 9 A. Well, in actual fact I do. One of my references is 10 a DoReMi low dose research towards multi-disciplinary 11 integration, which is a reference there. 12 Q. Where do you reference that in your actual text? 13 A. Well, it's in the index. 14 Q. But it's not in the text. 15 A. Page 8 of my submission. 16 Q. That's the references, but where is it in the text? 17 A. The reason it's in there is because I am part of 18 a multidisciplinary team. You need multidisciplinary 19 teams to look at these sort of big issues, and I'm one 20 part of a team. I don't expect myself to be expert in 21 all aspects. And what they are planning here at 22 a European level is the development of a new project, 23 which will be very expensive to carry out, looking at 24 biology, dosimetry and epidemiology. That's why I am 25 aware of these things. I'm not claiming to be</p> <p style="text-align: center;">Page 92</p>

<p>1 an expert, but I'm aware of these things.</p> <p>2 Q. The DoReMi, to be fair to you, Professor, you do cite it</p> <p>3 on page 5. You say:</p> <p>4 "There does at least seem to be some measure of</p> <p>5 concern involving in this area DoReMi 2015."</p> <p>6 It's then you get into the discussion about MELODI.</p> <p>7 A. Well yes, MELODI is part of what lies behind the DoReMi</p> <p>8 study, yes.</p> <p>9 Q. Can you turn to page 6 of your report.</p> <p>10 A. Yes.</p> <p>11 Q. I just need -- tried to understand what you are saying</p> <p>12 in this last paragraph on page 6:</p> <p>13 "It's my understanding that the law, as related to</p> <p>14 the pensions appeals, is that the appellant only has to</p> <p>15 show that there's some reasonable doubt based on</p> <p>16 evidence which is not fanciful and that their condition</p> <p>17 could have been caused by their exposures. It seems to</p> <p>18 me that if the EU could have enough doubt about the</p> <p>19 radiogenicity of uranium to give several million Euros</p> <p>20 to a major scientific project to investigate the issue,</p> <p>21 that must be good enough for the Tribunal to find that</p> <p>22 there is sufficient doubt about the MoD's assertion that</p> <p>23 the cancers developed by the test veterans..."</p> <p>24 Then you add in the Gulf War veterans:</p> <p>25 "... were not caused by their exposures."</p> <p style="text-align: center;">Page 93</p>	<p>1 genomes, all there forming a whole range of</p> <p>2 possibilities for various cancers being developed. And</p> <p>3 other conditions.</p> <p>4 Q. Professor, you are an emeritus Professor of medicinal</p> <p>5 chemistry at Sunderland University.</p> <p>6 A. That's right.</p> <p>7 Q. Have you done any research on any of the matters that</p> <p>8 you've just talked about?</p> <p>9 A. I've not published any. But that's because I have</p> <p>10 been -- well, I've been busy trying to get the</p> <p>11 information together --</p> <p>12 Q. So what you have --</p> <p>13 A. -- except in the DUOB report.</p> <p>14 Q. Is what you have just set out information you have</p> <p>15 learnt in the capacity as president or member of the</p> <p>16 National Gulf War Veterans and Families Association?</p> <p>17 A. No, it's not just in that. I was involved with the</p> <p>18 Government war veterans since 1997. So before that</p> <p>19 I was interested and I was concerned, I was seeing</p> <p>20 veterans, they came to the university to undertake</p> <p>21 a test which was for a different kind of test altogether</p> <p>22 from the ones we're talking about, but it was a test</p> <p>23 that we had at the university which looked at potential</p> <p>24 damage to the nervous system and to the gut. That's</p> <p>25 when I first met them.</p> <p style="text-align: center;">Page 95</p>
<p>1 You are here, Professor, to give scientific evidence</p> <p>2 to this Tribunal.</p> <p>3 A. Yes.</p> <p>4 Q. Where is the science in saying that an EU funding</p> <p>5 decision supports the raising of a reasonable doubt of</p> <p>6 causation? Where is the science?</p> <p>7 A. Well, do they want to throw money away on something that</p> <p>8 is specious or fanciful? I don't think so. I think</p> <p>9 this is a well designed thing, it came out of the CURE</p> <p>10 study, so that this is a deliberate development from the</p> <p>11 CURE study which led to the formation of the DoReMi</p> <p>12 proposals. I don't think it's fanciful, and I don't</p> <p>13 think it's fanciful and I think the evidence is, from my</p> <p>14 point of view, as an expert, is in the biology of these</p> <p>15 systems.</p> <p>16 There are lots of things happening from inhaled</p> <p>17 depleted uranium, especially, which leads to damage to</p> <p>18 people by effects which are not directly radiation or</p> <p>19 reduced. So this is how, for example -- to go back to</p> <p>20 your DNA story -- the DNA story, the DNA opens up and is</p> <p>21 chemically broken by the addition of a binding of</p> <p>22 uranium to the DNA backbone, and then that will cause</p> <p>23 the backbone to open up and fragment the genome, really,</p> <p>24 so that you've got a broken genome, we've got fragmented</p> <p>25 genomes, you've got repaired genomes, half-repaired</p> <p style="text-align: center;">Page 94</p>	<p>1 Q. Are you aware, Professor, that Mr Justice Charles ruled</p> <p>2 that Dr Busby could not been an expert in proceedings</p> <p>3 because of his campaigning activities on behalf of</p> <p>4 veterans and others?</p> <p>5 A. Yes, I am.</p> <p>6 Q. Is it not also the case, Professor Hooper, that the</p> <p>7 reason you are here today is to give evidence on behalf</p> <p>8 of the veterans because you support their cause?</p> <p>9 A. I do support their cause, but it's to give evidence</p> <p>10 about the truth of the case, not their cause.</p> <p>11 MR HEPPINSTALL: No further questions, my Lord.</p> <p>12 Re-examination by DR BUSBY</p> <p>13 DR BUSBY: Professor Hooper, is the source of your expertise</p> <p>14 on uranium effects partly the research and discussions</p> <p>15 of the Depleted Uranium Oversight Board which took place</p> <p>16 over five years?</p> <p>17 A. Yes. That's correct, yes.</p> <p>18 Q. In that five years were there an enormous or at least</p> <p>19 certainly a significant number of scientific papers</p> <p>20 drawing attention to anomalous effects of uranium</p> <p>21 presented and discussed by the board?</p> <p>22 A. That's correct, yes.</p> <p>23 Q. So, therefore, your understanding, and what you've been</p> <p>24 telling the Tribunal about the anomalous effects of</p> <p>25 uranium, are supported by your discussions and the -- is</p> <p style="text-align: center;">Page 96</p>

<p>1 that not a fair question, my Lord?</p> <p>2 MR HEPPINSTALL: Ever so slightly leading.</p> <p>3 DR BUSBY: I'm not very good at this sort of thing. Don't</p> <p>4 answer it, in that case.</p> <p>5 A. I think I already have.</p> <p>6 Q. Yes, I think you already have.</p> <p>7 MR JUSTICE BLAKE: We may not attach much weight to</p> <p>8 a leading question, at least in re-examination.</p> <p>9 DR BUSBY: Yes, one other question I wanted to ask you</p> <p>10 about, which perhaps you may have already partly</p> <p>11 covered. It has to do with these numbers in the</p> <p>12 chromosome aberration fish testing that was carried out</p> <p>13 by Rowlands and his team which I wanted to ask you</p> <p>14 about.</p> <p>15 What is your understanding of the range of</p> <p>16 possibilities for exposure of people who are on ships</p> <p>17 which have all sorts of compartments in them, as</p> <p>18 I understand it, there are different things that people</p> <p>19 do on the ships, you have the captain. What would be</p> <p>20 your understanding of the range of exposure that might</p> <p>21 be just a consequence of where they were at the time?</p> <p>22 A. My experience of that is the detonation cloud from --</p> <p>23 again from the Gulf War, I'm afraid -- where it released</p> <p>24 chemical agents over the whole battlefield area. Ships</p> <p>25 offshore were picking up the sign from their NAIAD</p> <p style="text-align: center;">Page 97</p>	<p>1 DR BUSBY: Sorry, my Lord.</p> <p>2 MR JUSTICE BLAKE: Does that mean we've reached the end of</p> <p>3 your evidence?</p> <p>4 DR BUSBY: Yes, that's end of our evidence, my Lord.</p> <p>5 MR JUSTICE BLAKE: Thank you very much. Shall we resume</p> <p>6 at --</p> <p>7 MR HEPPINSTALL: Two o'clock.</p> <p>8 MR JUSTICE BLAKE: -- two o'clock.</p> <p>9 Someone is having the happy task of preparing the</p> <p>10 contents of divider 22.</p> <p>11 MR HEPPINSTALL: My learned friend Ms Cohen has a list in</p> <p>12 the papers and we will sort it out, my Lord.</p> <p>13 MR JUSTICE BLAKE: I look forward to seeing that in due</p> <p>14 course.</p> <p>15 (12.50 pm)</p> <p>16 (The short adjournment)</p> <p>17 (2.00 pm)</p> <p>18 MR JUSTICE BLAKE:</p> <p>19</p> <p>20</p> <p>21 MR JUSTICE BLAKE: Yes.</p> <p>22 MR HEPPINSTALL: I call Professor Thomas, please.</p> <p>23 MR JUSTICE BLAKE: Thank you.</p> <p>24 PROFESSOR GERALDINE ANNE THOMAS (affirmed)</p> <p>25 MR JUSTICE BLAKE: Are you happy standing up?</p> <p style="text-align: center;">Page 99</p>
<p>1 detectors of nerve agents. Again, it was people on the</p> <p>2 deck who were the ones who reported this and were</p> <p>3 exposed; the people in the bottom, the bowels of the</p> <p>4 ship, didn't hear it at all, they just didn't know what</p> <p>5 was going on. But somebody came dashing round and said</p> <p>6 "Get your NBC suits on because the alarm has gone off".</p> <p>7 So that's -- really my experience is drawn from</p> <p>8 that.</p> <p>9 Q. So just to be clear on what you are telling us. There</p> <p>10 could be people who were not exposed because, for</p> <p>11 example, they were not in any part of the ship where any</p> <p>12 exposure could take place?</p> <p>13 A. Yes, I think that's -- yes, I would agree with that,</p> <p>14 yes.</p> <p>15 Q. So, therefore, the range that we're talking about, from</p> <p>16 zero exposure to large exposure, could be explained?</p> <p>17 A. Yes, indeed.</p> <p>18 DR BUSBY: Thank you. Well, I have no further questions,</p> <p>19 my Lord.</p> <p>20 MR JUSTICE BLAKE: Thank you, that completes your evidence.</p> <p>21 THE WITNESS: Thank you very much.</p> <p>22 MR JUSTICE BLAKE: And you may go.</p> <p>23 (The witness withdrew)</p> <p>24 MR JUSTICE BLAKE: Does that mean we've reached the end of</p> <p>25 the evidence you wish to call, Dr Busby? Hello?</p> <p style="text-align: center;">Page 98</p>	<p>1 A. Yes, for the moment. I may sit down a bit later.</p> <p>2 MR JUSTICE BLAKE: As you wish.</p> <p>3 Examination-in-chief by MR HEPPINSTALL</p> <p>4 MR HEPPINSTALL: Professor Thomas, could you turn up bundle</p> <p>5 SB2, tab 2.18, please.</p> <p>6 A. Yes.</p> <p>7 Q. Hopefully there you should find your report to this</p> <p>8 Tribunal dated 17 December 2015.</p> <p>9 A. Yes.</p> <p>10 Q. Do you remain Professor of Molecular Pathology at</p> <p>11 Imperial College, London?</p> <p>12 A. I do.</p> <p>13 Q. And director of the --</p> <p>14 MR JUSTICE BLAKE: West London Genomic Medicine Centre?</p> <p>15 A. Yes, I do.</p> <p>16 MR HEPPINSTALL: Thank you very much.</p> <p>17 At the end of this statement at page 11, you gave</p> <p>18 a statement of truth; is that still the position today?</p> <p>19 A. It is.</p> <p>20 Q. I think you want to make some minor corrections to your</p> <p>21 report.</p> <p>22 A. Yes.</p> <p>23 Q. Could you just take us to those, please?</p> <p>24 A. Yes, I noticed -- I haven't got my report here so it</p> <p>25 might take me a while to find it -- one spelling</p> <p style="text-align: center;">Page 100</p>

<p>1 mistake. It should be Techa River in 2.12.2, the second 2 to last line, just after the 21 in brackets, the K 3 should be removed. 4 I can't remember what the other one was now. 5 MR JUSTICE BLAKE: The spelling of -- 6 A. It's Techa, not "Techka". So just take the K out. 7 Then I missed out "carcinoma" after the word 8 "pancreatic" and I need to find out where that was. 9 MR HEPPINSTALL: There is at 2.11.1 the last line is: 10 "... when the incidence of pancreatic cancer ..." 11 A. Yes. 12 Q. Where do you want to add "carcinoma"? 13 A. "... the incidence of pancreatic ...", I missed the word 14 "cancer" or "carcinoma". Either will do. 15 MR JUSTICE BLAKE: Which page are we on? 16 A. We are on page 10. 17 MR HEPPINSTALL: 2.11.1. 18 MR JUSTICE BLAKE: Right. 19 A. Third line from the end of the paragraph: 20 "The incidence of pancreatic ..." 21 MR JUSTICE BLAKE: Okay, got it. 22 MR HEPPINSTALL: At the time when you wrote this report 23 I understand that you had considered Mr Hallard's first 24 report; is that right? 25 A. I had, yes.</p> <p style="text-align: center;">Page 101</p>	<p>1 Q. Have you prepared reports for that purpose before? 2 A. Not for the court, no. I have prepared another report 3 but it wasn't included, I don't think, in the court 4 papers. I prepared a report for the previous Tribunal. 5 Q. To do with this? 6 A. Yes. 7 Q. The nuclear veterans? 8 A. Yes. 9 Q. I imagine, because it's an unfamiliar process, obviously 10 you had to take your guidance as to what to do with your 11 report very much from the instructing lawyers. 12 A. Absolutely. 13 Q. So don't take what I'm about to ask you critically but 14 I just want to explore a little what your understanding 15 was and how you went about it. 16 A. Well, I was asked to do a very specific job, which was 17 to consider whether there was reasonable doubt raised on 18 reliable evidence that exposure to ionising radiation at 19 certain British nuclear tests was the cause of the 20 appellants' claimed condition and I was asked very 21 specifically to only do that and based on the dose, 22 which was assessed by Rick Hallard, who is our expert on 23 that. 24 Q. It was actually a slightly more general level of 25 questioning at the moment about the process of writing</p> <p style="text-align: center;">Page 103</p>
<p>1 Q. Have you had an opportunity to consider his two 2 subsequent reports? 3 A. Yes, I have. 4 Q. Do they cause you to change any of your opinions as 5 expressed in this report? 6 A. No, not at all. 7 MR HEPPINSTALL: My Lord, if the report could stand in the 8 evidence as evidence-in-chief, I have no further 9 questions. 10 MR JUSTICE BLAKE: Thank you. 11 Cross-examination by MR TER HAAR 12 MR TER HAAR: Professor Thomas, good afternoon. 13 A. Good afternoon. 14 Q. As you may know, I represent one of the two groups of 15 appellants. 16 A. (Nodded assent) 17 Q. The larger group. 18 MR JUSTICE BLAKE: Everyone apart from Mr Battersby and 19 Mr Smith. 20 MR TER HAAR: That's a simpler way of putting it, yes. 21 MR JUSTICE BLAKE: She might then know who you represent. 22 MR TER HAAR: Yes, my Lord. 23 First of all, have you given expert evidence in the 24 witness box either in court or at a Tribunal before? 25 A. No, I have not.</p> <p style="text-align: center;">Page 102</p>	<p>1 a report -- 2 A. Yes. 3 Q. -- in this case. 4 Very often an expert witness preparing a report, who 5 may have had the misfortune to come to court more often 6 than you have, will set out a list of the information 7 that was made available to the expert. 8 A. Mm-hm. 9 Q. It's quite customary to say, "I was instructed to look 10 at this question and I was given the following material 11 upon which to form my assessment." 12 Now it's not a criticism of you; you haven't 13 actually done that here. 14 A. I wasn't aware I was supposed to list that because 15 I thought you were informed of what we were provided 16 with. 17 Q. It's not a criticism, it's just a fact, it just 18 happened. But those who instruct me, the solicitors who 19 instruct me, wrote a letter to the Government's lawyers 20 this week and asked what you had relied upon. That 21 clearly was a question which was referred to you, 22 I think. 23 A. Mm-hm. 24 Q. And you listed out or they listed out in a letter which 25 must have come from you --</p> <p style="text-align: center;">Page 104</p>

<p>1 A. Which I saw sight of yesterday, yes.</p> <p>2 Q. -- that you had had the possibility to look at really</p> <p>3 all the other experts' reports that had been filed in</p> <p>4 the previous First Tier Tribunal?</p> <p>5 A. Yes.</p> <p>6 Q. I take it that you looked at them and took them into</p> <p>7 account?</p> <p>8 A. Yes, I had looked at many of them previous to that for</p> <p>9 the report that I provided for the previous Tribunal as</p> <p>10 well.</p> <p>11 Q. I quite understand.</p> <p>12 One document that does not appear to have been</p> <p>13 provided to you is the judgment of Mr Justice Charles</p> <p>14 who was the judge who presided over the Upper Tier</p> <p>15 Tribunal. Are you aware that there was an appeal?</p> <p>16 A. Yes, yes.</p> <p>17 Q. It was said by the Upper Tier Tribunal that the legal</p> <p>18 basis upon which the original Tribunal had reached its</p> <p>19 conclusion was either wrong or was wrongly reasoned?</p> <p>20 A. Yes.</p> <p>21 Q. May I take it that you have looked at that judgment as</p> <p>22 well as the other matters which were listed out?</p> <p>23 A. I'm aware of that judgment. I haven't looked at it in</p> <p>24 detail. It's written in legal language and I understood</p> <p>25 there had been a query raised about the procedure.</p> <p style="text-align: center;">Page 105</p>	<p>1 own opinions are, and possibly you will also say that</p> <p>2 what you set out are the mainstream opinions?</p> <p>3 A. Mm-hm.</p> <p>4 Q. But what I think you haven't done is to set out what</p> <p>5 alternative views there might be, and if you like say</p> <p>6 whether they are credible, incredible, should be taken</p> <p>7 into account, should not be taken into account from</p> <p>8 a scientific point of view. Do you understand the point</p> <p>9 I'm asking you about?</p> <p>10 A. I think I understand the point you're making. I'm not</p> <p>11 entirely sure I agree with what you're saying but</p> <p>12 I think I understand the point you're making. I've</p> <p>13 considered only the point I was asked to address.</p> <p>14 I could have waxed lyrical about loads of other things</p> <p>15 but I stuck exactly to what I was asked to do.</p> <p>16 Q. But your understanding of what you were asked to do</p> <p>17 appears not to have included setting out whether there's</p> <p>18 an alternative school of thought which might lead to</p> <p>19 a different conclusion. Am I right about that?</p> <p>20 A. If you mean have I considered some of the papers that</p> <p>21 have been discussed earlier in these proceedings, that</p> <p>22 set out different opinions about how dose should be</p> <p>23 estimated, I don't think that was within the scope that</p> <p>24 I was asked to do.</p> <p>25 Q. And I'll come in the course of some of the questions to</p> <p style="text-align: center;">Page 107</p>
<p>1 Q. There's a lot else on your plate, I imagine. Not only</p> <p>2 this but elsewhere.</p> <p>3 I want to just try and fix in mind what we say is</p> <p>4 the correct legal approach -- the Tribunal may disagree</p> <p>5 with it -- just so you can see where I am coming from.</p> <p>6 What we say is that when you are looking to see</p> <p>7 whether there's a reasonable doubt as to causation --</p> <p>8 that is to say in this context -- once you've</p> <p>9 established that for example somebody has bladder</p> <p>10 cancer, the question of causation is: was that bladder</p> <p>11 cancer caused by service on Christmas Island?</p> <p>12 A. Yes.</p> <p>13 Q. Now in many scientific contexts, and many legal</p> <p>14 contexts, that is a question answered on the balance of</p> <p>15 probabilities?</p> <p>16 A. Mm-hm.</p> <p>17 Q. But here the Tribunal has to deal with a rather</p> <p>18 different test which is: is there a reasonable doubt</p> <p>19 based upon reliable evidence as to whether there's that</p> <p>20 causal link? You understand first of all that's the</p> <p>21 language of the pension legislation?</p> <p>22 A. Yes.</p> <p>23 Q. Now what I want to explore with you a bit as I go</p> <p>24 through the questions is this. My impression is that</p> <p>25 what you have done is quite clearly set out what your</p> <p style="text-align: center;">Page 106</p>	<p>1 some statistical material relating to the effects of low</p> <p>2 doses.</p> <p>3 A. Mm-hm.</p> <p>4 Q. You refer briefly to the problems of low doses but you</p> <p>5 don't set out what appears to be at least a credible</p> <p>6 alternative view to yours that the LNT, the "no</p> <p>7 threshold", really means no threshold and at low doses</p> <p>8 you cannot apply a linear --</p> <p>9 A. On the contrary. I think I actually state that in this</p> <p>10 that it is very difficult below 100 millisieverts to be</p> <p>11 absolutely certain --</p> <p>12 Q. You do.</p> <p>13 A. -- what that looks like.</p> <p>14 Q. You certainly do say that but I don't think you set out</p> <p>15 the -- there appears to be a contradiction, and I'll</p> <p>16 come to it in a moment, where you say "but the</p> <p>17 relationship is linear"?</p> <p>18 A. That is assumed for risk purposes as being linear.</p> <p>19 Perhaps I didn't make that clear.</p> <p>20 Q. That's really helpful because that leads me into what</p> <p>21 may be an important point to keep in mind when looking</p> <p>22 at the scientific evidence.</p> <p>23 First of all, if we look at the evidence there is</p> <p>24 for whether radiation causes effects we can look at</p> <p>25 a number of different groups of people who have been</p> <p style="text-align: center;">Page 108</p>

<p>1 researched, if I can put it that way, a number of 2 cohorts. 3 A. Yes. 4 Q. Obviously, right at the forefront on everybody's 5 analysis are the survivors of the two atomic bombs in 6 Japan? 7 A. Yes. 8 Q. Which is the LSS study? 9 A. Yes. 10 Q. Every bit of literature places that research right at 11 the forefront -- 12 A. Yes. 13 Q. -- of all the work that's done and you make that point? 14 A. Yes. 15 Q. There was I think also -- well, I'll start again. 16 A second area for research is in respect of those -- 17 I was going to say Western soldiers and sailors who were 18 involved in nuclear testing? 19 A. Mm-hm. 20 Q. So that would clearly include the Christmas Island 21 veterans? 22 A. Yes. 23 Q. But also those who are involved at Maralinga in 24 Australia? 25 A. Mm.</p> <p style="text-align: center;">Page 109</p>	<p>1 Q. Three Mile Island I had particularly in mind. 2 A. Yes. 3 Q. We can also look at -- there is research about the 4 effects of living near nuclear power stations? 5 A. Mm-hm. 6 Q. There's also research in relation to occupational 7 hazards, so people working in power stations, people in 8 nuclear submarines? 9 A. Yes. 10 Q. I think I may have missed some others, but a final big 11 group relates to the ongoing research in relation to 12 people who are irradiated, if that's the right 13 expression, as a result of medical procedures? 14 A. Yes. 15 Q. So whether they are receiving a radioactive dose as part 16 of radiotherapy -- 17 A. For radiodiagnostics. 18 Q. CT scans, X-rays, if you need a filling in your teeth, 19 all those sorts of things? 20 A. Yes. 21 Q. So there is a considerable body of material. 22 A. Mm-hm. 23 Q. There also of course are a very large number of people 24 carrying out research? 25 A. Mm-hm.</p> <p style="text-align: center;">Page 111</p>
<p>1 Q. And also I assume there are similar studies in relation 2 to Americans. 3 A. Yes, there are, and Australia and New Zealand as well. 4 Q. I'm not sure whether the French have divulged any -- 5 A. I'm not sure. 6 Q. Although they did going for nuclear testing as well. 7 A. Absolutely they did. 8 Q. Similarly, perhaps for understandable reasons, the 9 Chinese haven't been entirely forthcoming with any 10 similar research. 11 A. Yes. 12 Q. But curiously enough there is actually some research 13 from the former Soviet Union because there is some 14 evidence about testing in Kazakhstan. 15 A. Yes, I know that literature pretty well. 16 Q. So that's a second group of cohorts? 17 A. Yes. 18 Q. A third group of cohorts -- the third group, whether it 19 is a cohort or not, is research done following the 20 Chernobyl disaster? 21 A. Yes. 22 Q. And I imagine there may also be similar research looking 23 at the results of, for example, the nuclear accident in 24 America? 25 A. Hanford and Three Mile Island.</p> <p style="text-align: center;">Page 110</p>	<p>1 Q. I don't know if you know the expression "quot homines 2 tot sententiae", but it is Latin for meaning "as many 3 men as there are, there are that many opinions". 4 A. Yes. 5 Q. But one of the difficulties we have is this: that we 6 need to assess principally what lessons we learn from 7 the LSS cohort? 8 A. Mm-hm. 9 Q. That's the primary information we have, isn't it? 10 A. I mean, that's the largest source of information of 11 a constantly followed population -- whether studies have 12 been designed appropriately although I admit your side 13 of the room may say that's not true. 14 Q. I will come to some of the perhaps methodological 15 problems with the LSS study but sometimes we have to 16 just do what we can with the material we have? 17 A. Absolutely. 18 Q. One of the areas again as to your role which I don't 19 entirely follow is how it interplays with other experts. 20 A. Yes. 21 Q. Can I just put it this way. You are not by profession 22 or by specialisation an epidemiologist? 23 A. No, I'm not but I have worked with many epidemiologists 24 and what I do for a living supports the epidemiologists 25 when they are looking for biological markers.</p> <p style="text-align: center;">Page 112</p>

1 Q. Of course it does and one of the things that's become
 2 apparent during this week is that the interplay between
 3 professions in this area of cancer protection, cancer
 4 causation, is very much a multidisciplinary area.
 5 **A. Absolutely.**
 6 Q. But Mr Haylock -- or Dr Haylock, I'm not sure -- who is
 7 going to be coming to give evidence next week, he is an
 8 epidemiologist?
 9 **A. He is a biostatistician.**
 10 Q. His report starts by talking about his
 11 epidemiological --
 12 **A. Biostatisticians are involved in epidemiological studies**
 13 **so whatever he says he is, he is.**
 14 Q. This Tribunal also has in front of it, and it's agreed
 15 it's part of the material for consideration,
 16 epidemiological reports from Professor Parker.
 17 **A. Mm-hm.**
 18 Q. Who is I think a very well known and distinguished
 19 Canadian epidemiologist?
 20 **A. Yes.**
 21 Q. And Professor Kaldor, who is a very well known and very
 22 distinguished UK-based epidemiologist.
 23 **A. Yes.**
 24 Q. I think that you would accept that both of those
 25 epidemiologists are distinguished in their views and

Page 113

1 carry weight?
 2 **A. Yes, they are well known in their field but there are**
 3 **other epidemiologists who might have a slightly**
 4 **different version on some of the evidence that they**
 5 **might put forward. They are one opinion of different**
 6 **epidemiologists and as you said, there are many and**
 7 **there are many ideas and many, many different responses**
 8 **to things.**
 9 Q. Absolutely. At the moment I am trying to establish that
 10 sometimes, even with all the respect which one scientist
 11 gives to another, a scientist will say "I'm afraid that
 12 particular scientist is so far" -- to use the American
 13 expression -- "left field that I treat their evidence
 14 with enormous caution".
 15 **A. Absolutely. There are certain epidemiologists I will**
 16 **put a heavier weight on their opinions because I trust**
 17 **their studies, they have been well defined and the**
 18 **evidence is given in their papers of how they developed**
 19 **their studies.**
 20 Q. As I understand it, both Professors Parker and Kaldor
 21 are within that group of reliable --
 22 **A. Yes, they are within that group. I'm not going to say**
 23 **any more than that because I don't think that's fair.**
 24 Q. I understand you may disagree with some of their
 25 evidence, but both of them represent views which can

Page 114

1 credibly be held by experienced epidemiologists?
 2 **A. Yes.**
 3 Q. Can I go back to what we started to talk about, the
 4 different purposes for which one needs to carry out this
 5 research with these cohorts we discussed.
 6 At one level, perhaps the most unpleasant level,
 7 a military nation will want to know what the effect of
 8 a nuclear explosion is in case it's used in anger?
 9 **A. Sure.**
 10 Q. For that purpose, what the military are most interested
 11 in is immediate effects, the acute effects, both to
 12 property and to human beings?
 13 **A. Yes.**
 14 Q. It's suggested -- I'm not going to go there, but it's
 15 suggested that that might be one of the purposes for
 16 which the LLS study was started. Leave that aside.
 17 The second concern will be occupational?
 18 **A. Mm.**
 19 Q. So that you need to try to establish a benchmark below
 20 which you can feel: well, there might be some residual
 21 risk but the risk is acceptable; I can put this man into
 22 a power station, I can put this sailor into a nuclear
 23 submarine?
 24 **A. Mm.**
 25 Q. For that purpose you are looking for a threshold, aren't

Page 115

1 you?
 2 **A. You are taking all risks into account, so if you want to**
 3 **argue that's a threshold then you can use that term.**
 4 **I think what you are doing is doing a risk/benefit**
 5 **analysis.**
 6 Q. Of course you are. You are recognising a certain
 7 situation as you cannot eliminate all risks --
 8 **A. There is no such thing as no risk to anything. We might**
 9 **as well get that out of the way now. That is absolutely**
 10 **certain. When I walk out of here tonight I could be run**
 11 **over by traffic on the road. You take that risk because**
 12 **you want to get to the other side of the road so I think**
 13 **we have to accept there's a risk to absolutely**
 14 **everything.**
 15 Q. It may not be the major purpose but at least one of the
 16 major purposes of the ICRP work ongoing is to try to
 17 establish the "safe" levels of exposure in
 18 an occupational context?
 19 **A. Very conservative safe levels. That I think should be**
 20 **acknowledged as well.**
 21 Q. But as you rightly pointed out a moment ago, taking into
 22 account a risk/benefit ratio?
 23 **A. Yes.**
 24 Q. A similar exercise, a perhaps sometimes more acute
 25 exercise of balancing risk and benefit operates in the

Page 116

1 medical field?
 2 **A. Mm-hm.**
 3 Q. It is one thing what the appropriate risk is if I go to
 4 my dentist and have an X-ray of my teeth done. It's
 5 altogether another if I'm already suffering from cancer
 6 and I need to go through radiotherapy?
 7 **A. Absolutely.**
 8 Q. Again, what research is trying to do is to try to
 9 establish not what an absolutely safe level is but what
 10 a reasonable practicable level is?
 11 **A. Yes.**
 12 Q. For the purpose of, in that case medical treatment?
 13 **A. Mm-hm.**
 14 Q. Or diagnosis?
 15 **A. Mm-hm.**
 16 Q. We can then distinguish another area where what you are
 17 doing is getting involved in either the pension
 18 compensation scheme for example in America --
 19 **A. Mm-hm.**
 20 Q. -- which is based seemingly on a balance of
 21 probabilities -- the NIOSH scheme as it used to be
 22 called -- or in civil litigation where the standard is
 23 the balance of probabilities?
 24 **A. Mm-hm.**
 25 Q. In that context somebody who is coming along to give

Page 117

1 evidence is being asked: is it more likely than not that
 2 causation is established?
 3 **A. Yes.**
 4 Q. But I think what you are being asked to do in this case
 5 is unique, isn't it, in relation to the role of somebody
 6 in your position? Because there's no other context in
 7 which you are asked about reasonable doubt about
 8 causation.
 9 **A. It is an unusual phrase that -- you know, I'm not expert**
 10 **in this. You will know whether that's an unusual**
 11 **situation to be in or not from the law's perspective.**
 12 Q. From the law's perspective you are quite right --
 13 my Lord knows more than I do -- but so far as from
 14 a medical perspective is concerned it's an extremely
 15 unusual test to be asked to apply?
 16 **A. For a start off I'm not a medic, so I'm never in that**
 17 **position.**
 18 Q. From the point of view of dealing with the probability
 19 of cause of cancer, reasonable doubt is never a test
 20 applied scientifically, is it?
 21 **A. You always question whether the agent -- if you are**
 22 **setting up an experiment to decide whether something is**
 23 **carcinogenic, you question whether the agent you are**
 24 **using and the system you have designed to test whether**
 25 **that agent is using is carcinogenic and then you should**

Page 118

1 **also bear in mind all the other things you are doing in**
 2 **that experiment which may have an influence on that.**
 3 **I would agree you are always looking for doubt. If**
 4 **you are a good scientist you are always looking for**
 5 **doubt, you are always looking for the alternative**
 6 **hypothesis, and finding a way to test that so that you**
 7 **can take a hypothesis way. Like with medicine as you**
 8 **diagnose people you end up subtracting the things you**
 9 **know and are left with something you say: "I can't get**
 10 **any further than that, therefore I can assume it's**
 11 **likely to be the cause".**
 12 Q. I entirely follow that. One of the things about the
 13 scientific process -- Copernicus and look at Galileo --
 14 somebody can start with a proposition which appears to
 15 be sort of received wisdom improbable but it proves to
 16 be correct.
 17 **A. Yes.**
 18 Q. One of the problems with diagnosis of causes of cancers
 19 is that it is so immensely multifactorial?
 20 **A. Absolutely.**
 21 Q. And that is, particularly when we are dealing with low
 22 dose radiation --
 23 **A. Yes.**
 24 Q. -- that is a fantastically difficult problem
 25 statistically, isn't it?

Page 119

1 **A. Yes, because when you get to a point where actually more**
 2 **cancers are going to be caused by other agents that**
 3 **we're all exposed to -- some of you will smoke,**
 4 **I certainly eat too much and my diet will have a role in**
 5 **my cancer risk, your genetics have a role in your cancer**
 6 **risk -- yes, everything else can come to bear and you**
 7 **might end up with, if you take the BEIR VII criteria,**
 8 **for example, 100 Americans given 100 millisieverts each,**
 9 **one will get cancer likely from the causes of radiation,**
 10 **whereas 42 others will get cancer from other causes. So**
 11 **you're looking for the needle in the haystack.**
 12 Q. That's very interesting, let's take that. You have
 13 established that out of a cohort of 100 people 43 are
 14 going to be adversely affected by the same disease?
 15 **A. Yes.**
 16 Q. As a statistician, epidemiologist, whatever profession
 17 you want to call it, you say "I know of those 43 it is
 18 probable that one is radiologically affected"?
 19 **A. If you believe the LNT, yes. It's all based on the LNT.**
 20 Q. 42 probably aren't?
 21 **A. Mm-hm.**
 22 Q. That causes a problem that faced with an individual
 23 human being --
 24 **A. How do you decide --**
 25 Q. -- John Smith comes into your surgery -- not yours but

Page 120

<p>1 a medic's surgery --</p> <p>2 A. Yes.</p> <p>3 Q. -- how do you decide whether he is the one out of the</p> <p>4 43?</p> <p>5 A. Yes.</p> <p>6 Q. But what you might say, though, is: "I can't tell.</p> <p>7 I know one of 43 is going to be affected in that way --</p> <p>8 or probably -- and it might be this one"?</p> <p>9 A. Mm-hm.</p> <p>10 Q. That would be a fair conclusion on that particular</p> <p>11 example, wouldn't it?</p> <p>12 A. Mm-hm.</p> <p>13 Q. So you may say: "I just can't tell if he is the 43rd".</p> <p>14 A. Given the probability is weighted like that you would</p> <p>15 say: the off-chance it is unlikely I have picked the one</p> <p>16 out of the 43.</p> <p>17 So it depends on how you look at things.</p> <p>18 Q. Yes. Equally, if you turn it the other way round you</p> <p>19 can say: "I don't know but it's quite possible he's the</p> <p>20 43rd"?</p> <p>21 A. You can't prove and you can't disprove so you're stuck.</p> <p>22 Q. That's the problem the Tribunal may have in this case.</p> <p>23 A. There's the question of the word "reasonable" I think is</p> <p>24 the nub here.</p> <p>25 Q. Yes. Let's move on a little then to this question of</p> <p style="text-align: center;">Page 121</p>	<p>1 appropriate person to ask questions about the</p> <p>2 methodology of the LSS.</p> <p>3 A. No, I think I'm an incorrect person to ask about the</p> <p>4 methodology of the LSS.</p> <p>5 Q. Because if we turn to your report --</p> <p>6 MR JUSTICE BLAKE: From what you've seen, is Dr Haylock more</p> <p>7 likely to be an appropriate person for that topic?</p> <p>8 A. Yes, I think Dr Haylock would be able to answer</p> <p>9 questions on that.</p> <p>10 MR JUSTICE BLAKE: So you are passing the buck down the</p> <p>11 line?</p> <p>12 A. I am passing the buck to somebody who I consider is more</p> <p>13 expert than me. That's my job here.</p> <p>14 MR JUSTICE BLAKE: I'm just checking.</p> <p>15 A. I don't want to mislead anybody.</p> <p>16 MR JUSTICE BLAKE: No, no.</p> <p>17 MR TER HAAR: I have to say I thought you might say that.</p> <p>18 As you are here and if you were able to --</p> <p>19 A. Yes.</p> <p>20 Q. I don't --</p> <p>21 A. Epidemiological methodology is not my expert area so</p> <p>22 I think it would be more appropriate for you to address</p> <p>23 those comments to Dr Haylock.</p> <p>24 Q. That's tremendous, but just to check that I am, so to</p> <p>25 speak, going to address my questions to the right</p> <p style="text-align: center;">Page 123</p>
<p>1 the LSS study.</p> <p>2 A. Mm-hm.</p> <p>3 Q. Now, first of all, in terms of pure epidemiology can</p> <p>4 I take it, for the reasons I asked you earlier, that you</p> <p>5 would defer to the specialist epidemiologists such as</p> <p>6 Professor Parker and Professor Kaldor?</p> <p>7 A. I would actually choose somebody else. I would choose</p> <p>8 Elisabeth Cardis, somebody who I know very well and I'm</p> <p>9 aware of all of her work. So yes, I would defer to</p> <p>10 somebody like Elisabeth Cardis rather than the two you</p> <p>11 cited.</p> <p>12 Q. Unfortunately I haven't got her here.</p> <p>13 A. No.</p> <p>14 Q. The Tribunal needs to assess the evidence. Would you</p> <p>15 agree with me that compared to your speciality, each of</p> <p>16 them is more expert in epidemiology than you are?</p> <p>17 A. I would have to look at their CVs and read their reports</p> <p>18 again to tell you whether I felt it was an accurate</p> <p>19 portrayal of what we now consider to be the consensus of</p> <p>20 scientific opinion. I'm happy to do that if you wish me</p> <p>21 to.</p> <p>22 Q. I may do --</p> <p>23 A. It is quite a while since I read them so I can't recall</p> <p>24 immediately to mind what they say.</p> <p>25 Q. What I really want to ask is whether you are the</p> <p style="text-align: center;">Page 122</p>	<p>1 person, could you go, please, to page 4 of your report.</p> <p>2 A. Yes.</p> <p>3 Q. At paragraphs 1.11 first of all 1.11 to 1.13?</p> <p>4 A. Mm-hm.</p> <p>5 Q. Reading those paragraphs, it seemed to me as</p> <p>6 a non-scientist that they were really your summary, your</p> <p>7 understanding of the epidemiology --</p> <p>8 A. No, actually they are quotations taken from the paper by</p> <p>9 Komiya et al which is why the reference is there because</p> <p>10 if you look at that paper you'll find I quoted directly</p> <p>11 from that paper which is the most recent review of that.</p> <p>12 Q. So as to whether there are any methodological problems</p> <p>13 with the LSS which might affect that paper, Dr Haylock</p> <p>14 is the man to ask and not you?</p> <p>15 A. Yes, absolutely.</p> <p>16 Q. Good. Okay, that's good because this feeds in, doesn't</p> <p>17 it, to some parts at any rate of the comments you give</p> <p>18 on individual appellants?</p> <p>19 If we go on to page 6, looking for example at</p> <p>20 Mr Beeton who you deal with in paragraph 2.2, there at</p> <p>21 the end of that paragraph, the last sentence you say:</p> <p>22 "The most recent data from the LSS study indicates</p> <p>23 that no risk for cardiovascular disease can be</p> <p>24 determined in those that received doses of less than</p> <p>25 500 milligram."</p> <p style="text-align: center;">Page 124</p>

<p>1 I was about to say "microgrey" but milligray. 2 Now that appears to me -- correct me if I'm wrong -- 3 to be your reading of an epidemiological conclusion? 4 A. Yes, I mean the dose that is given in the LSS below 5 which they are not happy at giving any risk associated 6 with cardiovascular disease is 500 milligray. It is 7 direct quotation from the studies. 8 Q. I follow that. Again it's the same line of questions. 9 If I want to explore whether or not there are any 10 methodological reasons to challenge that, Dr Haylock -- 11 it's his territory? 12 A. He will certainly know the literature on that. You 13 know, I have taken the best scientific opinion, which is 14 a consensus opinion which is the LSS study is the right 15 model to use. 16 Q. Professor Thomas, don't get me wrong. It's not 17 critical. 18 A. No, no, it's fine. 19 Q. I am just trying to make sure I don't waste the 20 Tribunal's time and ask the person most suited to answer 21 questions. 22 A. All of that information is based on what is considered 23 to be the scientific consensus of the relationship 24 between dose and effect. 25 Q. Yes.</p> <p style="text-align: center;">Page 125</p>	<p>1 gone outside your territory when you're looking at these 2 particular individuals. 3 A. Mm-hm. 4 Q. But first of all, when it comes to reliance upon 5 epidemiology you defer to those who are more specialised 6 in that field? 7 A. Yes. 8 Q. When it comes to specific cancers and other conditions, 9 of which is PRV one example, you defer to those -- I'm 10 not sure if the right word is "clinicians" but those 11 researchers who have more knowledge of those particular 12 conditions? 13 A. Yes. 14 Q. If we were dealing with thyroid cancers we would be 15 plumb in your area and there would probably be no one 16 more expert than you in the country? 17 A. I think others have to argue that but thank you for the 18 compliment, yes. 19 Q. When it comes to other matters we do have already 20 specialist opinions in the papers which we can refer to? 21 A. Yes. 22 Q. Good. Thank you. 23 The other point, though, on which you haven't given 24 opinions -- again it's a question of what you were asked 25 to do, so again no criticism, but next week we will be</p> <p style="text-align: center;">Page 127</p>
<p>1 A. That doesn't mean there aren't other opinions. It's 2 just that the scientific consensus does not consider 3 them to be valid and there are people better qualified 4 than I am to tell you what those reasons may be. 5 Q. And to test whether it's a credible alternative view -- 6 A. Yes. 7 Q. -- over to Dr Haylock? 8 A. Yes. 9 Q. Good, thank you very much. 10 Is the same true in relation for example to the next 11 page, paragraph 2.4, Mr Hatton? It looks as though it 12 is. Where you say in relation to PRV, here you are 13 relying on Professor Catovsky? 14 A. Yes, I am because I don't think that is covered in the 15 LSS. 16 Q. There you are deferring to Professor Catovsky's opinion? 17 A. Yes. 18 Q. You say you share it but -- 19 A. Based on what I read of his report I shared his 20 conclusions with -- or the references here given. I'm 21 not an expert on haematological problems so I would 22 defer to his opinion because he is an expert. 23 Q. So when the Tribunal comes to read your report would 24 this be a fair way of looking at it: you obviously have 25 considerable expertise and I'm not suggesting you've</p> <p style="text-align: center;">Page 126</p>	<p>1 hearing evidence from Mr Hallard. 2 A. Yes. 3 Q. You were asked to take his figures and say: assuming 4 those figures are right, what's the consequence? 5 A. Yes. 6 Q. We will be suggesting to him next week that actually 7 there are various matters he hasn't taken sufficiently 8 into account and that if you take them into account his 9 figures are too low. That's a matter for him to deal 10 with. We may be successful in persuading him, we may 11 not. 12 But what you haven't done is to set out for the 13 benefit of the Tribunal what your alternative view would 14 be in relation to a number of these. I think Dr Beeton, 15 for example, you'd say: well, I'd have to get the figure 16 up above 500 milligray? 17 A. Yes, absolutely. 18 Q. But you haven't set out for example what would be the 19 consequence if for Mr Abdale it should be 4 millisievert 20 or 10 millisievert or 20 millisievert. 21 A. I wasn't provided any evidence -- certainly I didn't see 22 from the reports you provided from your side of the 23 argument doses that were individually tailorised for me 24 to make any comments on. The only ones I was provided 25 with were from Mr Hallard and in fact I would not have</p> <p style="text-align: center;">Page 128</p>

1 written this without dosimetric information because that
 2 would have been very stupid.
 3 Q. Why?
 4 A. Because you cannot assign a cause and effect unless you
 5 know the dose. The dose is absolutely critical.
 6 I think you know that as well as I do.
 7 Q. I wouldn't want to bet on that!
 8 MR JUSTICE BLAKE: Can I ask just ask a question to clarify.
 9 You've just been asked about Mr Abdale and the received
 10 dosage you got from Dr Hallard.
 11 A. Yes.
 12 MR JUSTICE BLAKE: I think I'm right that you, following
 13 him, add up at 2.1, 2 millisieverts with, 2.2, 146
 14 millisieverts, making a total of -- does one combine
 15 them to make a --
 16 A. No, what I'm doing is trying to give you some context to
 17 say that if you've lived for this number of years on the
 18 planet you have an average radiation dose which I've
 19 been quite conservative with. 2 is quite low. It's 6,
 20 for example, in Cornwall. Don't tell the Cornish
 21 authorities that because they'll be really upset about
 22 that. But it's just to give you some context that in
 23 his lifespan he would have received radiation from
 24 natural background sources of 146 which you can't avoid.
 25 We all get exposed to that. But the extra that he

Page 129

1 received from being involved in those tests was about
 2 2 millisieverts.
 3 MR JUSTICE BLAKE: 2 millisieverts.
 4 A. So if you wanted add his total dose up you could say
 5 148. But then I would urge caution because you don't
 6 know what his medical records say about how much
 7 diagnostic radiology or if he had a treatment of
 8 anything. That is not included in the information we
 9 were provided. So you can't give a sum total of dose
 10 because you don't have all the information. All I can
 11 do is to set a background dose which we can't avoid
 12 against an extra dose that was received as a result of
 13 being where he was at the time of the explosions.
 14 MR JUSTICE BLAKE: But the entry dose is internal exposure
 15 at 2 millisieverts, 2.2, is it? I just want to
 16 understand --
 17 A. That's the internal exposure cited on Mr Hallard's
 18 report and that's the one I used for the extra exposure
 19 he would have had because of him being present at the
 20 tests.
 21 MR JUSTICE BLAKE: The question I have, and it may be a very
 22 stupid one, is that in 2.1 is any external exposure by
 23 reason of presence in Christmas Island accounted for?
 24 You dealt with the background exposure that we all have
 25 but is there any --

Page 130

1 A. No, where it was an internal tissue we are talking about
 2 I have used the internal dose because I think that may
 3 be of more concern and the internal doses are actually
 4 quite low. They are a lot lower than people would
 5 expect them to be. If you want I can elaborate on that
 6 but I don't want to waste the court's time.
 7 MR JUSTICE BLAKE: I may be wasting yours but I was
 8 exploring this.
 9 MR TER HAAR: First of all, my Lord, next week we will be
 10 looking with Mr Hallard at how he gets to this.
 11 MR JUSTICE BLAKE: Yes.
 12 MR TER HAAR: But Professor Thomas, can I just on that issue
 13 of how low or how high the internal dose is deal with
 14 this with you. Because I think this is within very much
 15 your speciality.
 16 As I understand it, the way in which this is treated
 17 is that you assume that whatever is taken into the body
 18 is so speak spread through the whole body mass?
 19 A. No, it depends on the isotopes so you have to understand
 20 the isotopes that are present. So, for example, iodine
 21 and thyroid is a very good example. We know that the
 22 thyroid naturally concentrates iodine because iodine is
 23 a very rare element normally. We need iodine to make
 24 our metabolism work, so over generations our bodies have
 25 developed mechanisms to basically suck up and store

Page 131

1 iodine to make those hormones. If you give a dose of
 2 radio-iodine most of it will end up in the thyroid
 3 because of the biological mechanisms that allow you to
 4 concentrate it.
 5 Other things do get spread throughout the body
 6 because they don't have a biological mechanism that
 7 binds them chemically to structures within individual
 8 tissues. So the dose is very different on the isotopes.
 9 You also have to take into account the physical half
 10 life of an isotope. So something that does not emit its
 11 radiation very often has a long physical half life and
 12 you also have to take into account the biological half
 13 life of the chemistry of your body and that varies.
 14 Iodine, for example, has a half life of about 100 days
 15 in terms of its biology. So if you take a dose in it
 16 will stay there for about 100 days and then it will get
 17 replaced. But the physical half life of iodine-131 is
 18 only eight days, whereas caesium has a 30-year half life
 19 so most of the time the caesium will sit there and will
 20 not emit much radiation while it is in your body and it
 21 is lost from the body in about 80 to 100 days.
 22 So the actual dose to the tissue is the combination
 23 of the type of radiation, which is the weighting factors
 24 used in the ICRP model, so an alpha particle is a lot
 25 bigger than a beta electron that has a small energy

Page 132

<p>1 ratio.</p> <p>2 So it takes into account that. And it also takes</p> <p>3 into account the biological and physical half life of</p> <p>4 those isotopes.</p> <p>5 It's not as easy is taking a dose of medicine. It's</p> <p>6 a lot more complicated and you have to bear in mind all</p> <p>7 of those to really understand the effects of radiation.</p> <p>8 That's why people find it so difficult.</p> <p>9 Q. Some of the evidence which the Tribunal has been hearing</p> <p>10 this week, I think you have been here whilst it's been</p> <p>11 going on, is where the significance is of, for example,</p> <p>12 Professor Howard's evidence -- whether you accept it or</p> <p>13 not, just so we can set the context of the importance of</p> <p>14 it --</p> <p>15 A. Yes.</p> <p>16 Q. -- that if it be right that uranium -- I'm not asking</p> <p>17 for the answer to the question -- if it be right that</p> <p>18 uranium bonds with DNA in cells that in itself could be</p> <p>19 extremely important in some forms of cancer --</p> <p>20 A. Can I comment on that? He's quite right, it does bind</p> <p>21 when you have a thin section --</p> <p>22 Q. I will let you have an opportunity to deal with that but</p> <p>23 first of all, that is the context of the significance of</p> <p>24 the evidence that was being given. Am I right about</p> <p>25 that?</p> <p style="text-align: center;">Page 133</p>	<p>1 hypothesis and then there's the question as to whether</p> <p>2 you as a scientist agree with that hypothesis?</p> <p>3 A. Yes.</p> <p>4 Q. I think you go so far as to say that that is not</p> <p>5 a credible scientific view.</p> <p>6 A. No, I don't say it's not a credible scientific view.</p> <p>7 There's evidence that uranium binds to the phosphate of</p> <p>8 DNA, because we do use it as a stain for electron</p> <p>9 microscopy. We could substitute lead instead but</p> <p>10 actually we do use uranium because it's very good. So</p> <p>11 I don't have a problem with that. What I have a problem</p> <p>12 with is then jumping from that to say it's causing</p> <p>13 defects in people. That's where I take issue. He's</p> <p>14 quite right that we do use uranium acetate as a dye for</p> <p>15 electron microscopy.</p> <p>16 Q. Would you quarrel with the proposition if it was put in</p> <p>17 a slightly less firm way, not that it "will cause" but</p> <p>18 that it "might cause" that transformation?</p> <p>19 A. There are several caveats that you have to be aware of</p> <p>20 from the biology before you can jump to that.</p> <p>21 First of all, if you intake uranium you are going to</p> <p>22 take it into your body in one of two ways. You are</p> <p>23 going to ingest it. All of us have some uranium in us</p> <p>24 because it is a constituent part of the earth. It's</p> <p>25 a very small amount, usually, but you either eat it in</p> <p style="text-align: center;">Page 135</p>
<p>1 A. Yes, but the uranium has to get to your DNA in your</p> <p>2 body.</p> <p>3 Q. I'm sorry, at the moment I'm taking it by stages. The</p> <p>4 theory which was being put forward by Professor Howard,</p> <p>5 which I understand you are about to tell me you disagree</p> <p>6 with, but the reason why it's important is this. If it</p> <p>7 be right that uranium once it gets into your body in</p> <p>8 some form can bond with the DNA in cells, it is at least</p> <p>9 the view of some people that that in itself can be</p> <p>10 a cause of sometimes quite aggressive cancers, for</p> <p>11 example pancreatic cancer?</p> <p>12 A. Actually there is no evidence for uranium being</p> <p>13 carcinogenic -- and it's been looked at -- in man,</p> <p>14 absolutely no evidence. Genotoxic, but not because of</p> <p>15 its physical properties but because of its chemical</p> <p>16 properties because it's a heavy metal ion.</p> <p>17 Q. As I say, I understand you to disagree with this and it</p> <p>18 would be impossible for me to stop you expressing your</p> <p>19 view but I am going to give you the opportunity in</p> <p>20 a moment. Do I understand first of all rightly the</p> <p>21 hypothesis which other people are putting forward with</p> <p>22 which you disagree?</p> <p>23 A. You understand the hypothesis being put forward, it's</p> <p>24 just that I think that hypothesis is not correct.</p> <p>25 Q. I'm taking it by stages to make sure we agree with the</p> <p style="text-align: center;">Page 134</p>	<p>1 your food or you'll breathe it in in the atmosphere.</p> <p>2 Q. Shall we take it as being -- to limit the number of</p> <p>3 options, can we for the moment assume that it's</p> <p>4 inhalation?</p> <p>5 A. Okay. So first of all it will get into your lungs.</p> <p>6 Then it has to get out of your lungs into the blood</p> <p>7 system to be distributed around the body. There is good</p> <p>8 evidence looking at uranium millers, people who crush</p> <p>9 uranium in mills, that very small amounts of uranium</p> <p>10 actually stay within the lungs. Most of it you cough up</p> <p>11 with the mucus. That's why we produce mucus in our</p> <p>12 lungs is to transfer particles and things we don't want</p> <p>13 in our lungs out. So most of it comes straight back out</p> <p>14 again and does not get deposited. A small amount might</p> <p>15 get into the lungs. Very little of that will get into</p> <p>16 the bloodstream because most uranium compounds are</p> <p>17 insoluble and if they are not soluble in water they</p> <p>18 can't go through.</p> <p>19 I was originally a pharmacologist and spent a lot of</p> <p>20 time doing toxicology.</p> <p>21 Q. I come back to my question. Subject to caveats as to</p> <p>22 how probable it is, would you at least accept it is</p> <p>23 a possibility which --</p> <p>24 A. But again the dose is critical. The amount that</p> <p>25 actually gets into the body and stays in the various</p> <p style="text-align: center;">Page 136</p>

1 **tissues is absolutely critical. In fact, what you find**
 2 **with uranium it is so toxic that if you take in too much**
 3 **you have kidney problems as you are trying to excrete it**
 4 **from your kidneys.**
 5 Q. Isn't one of the problems --
 6 **A. 70 per cent of it gets excreted in the kidneys.**
 7 Q. -- that we face in this particular regard that the
 8 number of situations in which people inhale uranium
 9 happily are very few indeed?
 10 **A. I take it you are talking about inhaling radioactive**
 11 **uranium? Because we're all exposed to stable uranium.**
 12 Q. I'm talking about the sort of situation that this
 13 Tribunal is considering, where you have uranium in the
 14 air and possibly resurgent, resuspended from the ground
 15 as a result of a nuclear bomb.
 16 **A. In certain areas around the nuclear bomb, yes. I think**
 17 **we still have to decide what the distance is over that**
 18 **where it would be deposited because it is quite a heavy**
 19 **atom.**
 20 Q. That again we'll be going through to see how Mr Hallard
 21 can help us about that and whether he has the expertise
 22 to say what he says about that. That's next week's
 23 journey. But the point I was putting to you is that one
 24 of the problems of deciding what the effect of inhaling
 25 uranium in that situation is is that in practical terms

Page 137

1 we have a tiny statistical sample?
 2 **A. No, we actually have quite a lot. There are uranium**
 3 **miners who when things were less well controlled in the**
 4 **industry would have taken in quite a bit of dust and**
 5 **some of that would have contained small amounts of**
 6 **radioactive uranium. We know certainly they inhaled**
 7 **radon and we know that is a significant health issue**
 8 **with them.**
 9 **Radon is a much shorter lived isotope and we're all**
 10 **inhaling radon whether we like it or not, that's part of**
 11 **our background dose. There is actually quite**
 12 **a substantial amount of information. If you look at the**
 13 **miners' cohorts that would give you some information**
 14 **about that.**
 15 Q. That would give you some information, I'm not denying
 16 that, but in terms of a significant statistical survey
 17 it's very difficult because --
 18 **A. More people were exposed in that situation than have**
 19 **been exposed in this situation so actually I would have**
 20 **thought they were statistically better studies.**
 21 Q. They might be better but they are still limited --
 22 **A. Every study has its limits.**
 23 Q. -- not least because -- I'm putting it bluntly -- many
 24 of the countries in which uranium has been mined not
 25 being entirely careful about their employees, some have

Page 138

1 never divulged their statistics, some you are dealing
 2 with matters many, many years later --
 3 **A. But there are good cohorts. The Wismet miners' cohort**
 4 **in Germany is a very good one to look at and that has**
 5 **had extensive investigation.**
 6 Q. But again -- remind me what's the cohort in that case?
 7 **A. Wismet miners. W-I-S-M-E-T.**
 8 Q. How many people were involved?
 9 **A. I would have to look up the papers to tell you but they**
 10 **may be in bundle.**
 11 MR JUSTICE BLAKE: It's not one that is referenced in your
 12 materials?
 13 **A. It isn't one that is referenced because I wasn't**
 14 **concerned with that.**
 15 MR JUSTICE BLAKE: I am just trying --
 16 **A. No, no, it might well be in the bundle. We can probably**
 17 **find it.**
 18 MR JUSTICE BLAKE: -- to track down the limits of my
 19 education.
 20 **A. I can certainly find the reference for you overnight if**
 21 **that's what you would like.**
 22 MR TER HAAR: Professor, the reason we got into this is you
 23 have taken -- I totally understand what you were asked
 24 to do -- you have taken the dose levels from
 25 Mr Hallard's report?

Page 139

1 **A. Mm-hm.**
 2 Q. So you haven't been involved with, if you like, any
 3 input from your point of view into whether those doses
 4 are rightly calculated or not?
 5 **A. Yes, it wouldn't have been appropriate. I don't have**
 6 **the expertise to do that.**
 7 Q. I understand. At the moment we don't even know what
 8 levels of uranium there would have been because the
 9 Government hasn't even disclosed whether uranium was
 10 used at all?
 11 **A. Yes, and whether the uranium was deposited in the areas**
 12 **in which the veterans were --**
 13 MR JUSTICE BLAKE: I'm not quite sure that's right.
 14 MR TER HAAR: Sorry, I think it would be more accurate to
 15 say the levels of uranium --
 16 **A. I think you might find that was a bit difficult to get**
 17 **out of the Government as I'm sure that would be**
 18 **a secret.**
 19 MR TER HAAR: We haven't tried, but Professor Busby has
 20 tried.
 21 **A. I'm sure that would not be regarded as something that**
 22 **could be disclosed widely.**
 23 Q. For obvious reasons.
 24 It seems to me at the end of the day most of the
 25 questions I thought I had for you are either going to be

Page 140

<p>1 for Mr Hallard or Dr Haylock, so thank you very much for 2 your time. 3 A. Thank you. 4 MR JUSTICE BLAKE: Do you have some questions? 5 DR BUSBY: I think probably I do. I'm a little bit wrong 6 footed, my Lord. 7 MR JUSTICE BLAKE: Shall we take a break now? 8 DR BUSBY: I had hoped to have tonight to get ready to 9 cross-examine Professor Thomas. A break would be 10 beneficial. Yes, thank you. 11 MR JUSTICE BLAKE: Well, let's have a break. I was going to 12 have until ten past three. I will have to rise tonight 13 at 10 past 4. I would hope, however, that if -- 14 DR BUSBY: Yes, yes, my Lord, that would be very helpful. 15 We could get in the first half of our -- I do have 16 rather a lot of questions for Professor Thomas. 17 MR JUSTICE BLAKE: Yes. 18 DR BUSBY: Or I will have, I should say. 19 MR JUSTICE BLAKE: Well, yes, except I seem to remember that 20 I saw that you didn't actually have any questions to 21 pose on the report and bearing in mind the -- yes, the 22 document at the back of tab 2.22. You need to make 23 quite sure that the questions you do want to pursue you 24 are fruitfully pursuing with the right witness. 25 DR BUSBY: I think we flagged up our questions -- is this</p> <p style="text-align: center;">Page 141</p>	<p>1 Q. I think you did say that, didn't you? 2 A. I said that in my statement. 3 Q. You also told Mr ter Haar that you had read all of the 4 reports that were in the case. That is at least four 5 reports from the Battersby/Smith appellants. 6 A. I have read them but it was some time ago so I would 7 need to look at them to refresh my mind. 8 Q. My concern is this. Perhaps you can explain why, since 9 as an expert you are required to, as I understand it, 10 discuss alternative hypotheses or evidence which goes 11 against what it is that you are putting into your 12 report, why your report doesn't appear to contain any 13 discussion whatever of the very large body of 14 information and the papers that were cited and the 15 general presentation of the arguments which we will go 16 through this afternoon and probably tomorrow, relating 17 to this issue. Why did you not -- 18 A. Because I did not regard that as the evidence on which 19 I should be basing my information. I was asked to look 20 at the dose which was to be provided by me and to assess 21 whether it was likely or unlikely that the dose that 22 these appellants were exposed to would have caused the 23 illnesses that they report. That is what I was asked to 24 do from my letter of appointment to this particular 25 Tribunal.</p> <p style="text-align: center;">Page 143</p>
<p>1 the one you are talking about? 2 MR JUSTICE BLAKE: Anyway, I will rise until 10 past 3. 3 Please just think through what you want to explore you 4 are exploring with the right person. There we are. 5 You are in the middle of giving your evidence. If 6 you haven't given evidence before, please don't talk to 7 anyone about your evidence until it's all over. Thank 8 you. 9 (2.55 pm) 10 (A short break) 11 (3.10 pm) 12 Cross-examination by DR BUSBY 13 DR BUSBY: May I start? 14 MR JUSTICE BLAKE: Yes. 15 DR BUSBY: I do apologise. I was a minute late, I think my 16 watch -- 17 MR JUSTICE BLAKE: Don't worry. 18 DR BUSBY: It wasn't keeping the right time. 19 Professor Thomas, good afternoon. 20 A. Good afternoon. 21 DR BUSBY: What I want to start by asking you is if you 22 have -- and I think you've said you have -- considered 23 the CPR rules that outline what an expert report should 24 contain. 25 A. Yes.</p> <p style="text-align: center;">Page 142</p>	<p>1 Q. Of course it was, of course it was, but since, as you 2 say, you did read the CPR recommendations for experts -- 3 A. But I would have required the dose from those reports. 4 I did not see any evidence of an individual dose for 5 each of those appellants in these particular reports so 6 I would not be able to do that. 7 Q. Right, okay. So we've talked a lot about dose and it 8 would be very helpful to me anyway and to the Tribunal 9 if you could just tell us what that means. What is 10 dose? 11 A. Do you mean in terms of radiogenicity or do you mean in 12 terms of general dose? 13 Q. How would you calculate or it measure it? What does it 14 mean? 15 A. If you're talking about radiogenic isotopes, 16 radioisotopes, then it's slightly different from if you 17 are talking about a dose that you would administer to 18 a patient of a drug, okay? The dose is the amount of 19 a substance to which your tissues are exposed. That's 20 what the definition of "dose" is. 21 Q. The amount of substance to which your tissues are 22 exposed? 23 A. Yes, and different tissues may be exposed to different 24 doses from the same intake of a substance. 25 Q. I'm sorry, there seems to be a misunderstanding here.</p> <p style="text-align: center;">Page 144</p>

<p>1 I am talking about the concept of dose as we are 2 speaking about it in this Tribunal. That would be, to 3 be quite specific, the absorbed dose from a radioactive 4 exposure --</p> <p>5 A. Then it's exactly the same. It's the amount of 6 radiation which is the substance to which you are 7 exposed, which your individual tissues are exposed to. 8 So it could be a chemical agent or it can be radiation. 9 The substance that you are in exposed to in this case is 10 the radiation.</p> <p>11 Q. That's right. I agree that's a good general definition 12 of dose. I can say I had a dose of 300 milligrams of 13 aspirin. But that's not quite what I'm getting at. 14 What I'm talking about is what is meant scientifically, 15 since you I can see are an expert in this area of 16 radiation risk and cancer, and you would agree with me 17 I hope that where we start out in trying to estimate 18 whether or not the appellants received a sufficient dose 19 to cause a cancer we should start with some 20 understanding of what is meant by dose.</p> <p>21 A. That is my understanding of dose: the amount of 22 radiation to which your tissue is exposed. I don't -- 23 I am unaware of any other form of dose. I'm 24 a pharmacologist, I would be expected to understand it.</p> <p>25 MR JUSTICE BLAKE: We've got an answer on that question.</p> <p style="text-align: center;">Page 145</p>	<p>1 Q. Of course. Of course. But we need to get to some 2 idea -- I hope to get to some agreement with you or some 3 discussion with you where we can get to some point where 4 we can try to examine what is meant by "dose" when we 5 get down to the microscopic level. That's where we are 6 going along. So so far --</p> <p>7 A. It's the transfer of energy, yes, I would agree with you 8 on that.</p> <p>9 Q. So far we agree. Right. Of course, if the dose is from 10 an element or from a type of radiation exposure that 11 involves alpha particles you would agree that the doses 12 calculated are expressed in a quantity known as 13 sieverts?</p> <p>14 A. No, that's when you sum all the different types of 15 radiation together, so if you are exposed to both alpha 16 and gamma and beta, the sievert is the sum of the 17 individual components of dose which come from those 18 different types of radiation. That's the definition.</p> <p>19 Q. Let me put it differently. If you had an alpha exposure 20 of 1 gray, what would that represent in terms of 21 sieverts?</p> <p>22 A. I'm sorry, I can't calculate that. I'm not 23 a dosimetrist.</p> <p>24 Q. Well, if I were to suggest to you that all that you do 25 to get an alpha dose in sieverts, or a gamma dose or</p> <p style="text-align: center;">Page 147</p>
<p>1 Now where do you want to pursue the debate?</p> <p>2 DR BUSBY: I'm not really -- I can't really accept the 3 answer, my Lord, because it absolutely --</p> <p>4 MR JUSTICE BLAKE: Well, perhaps you had better put the 5 proposition that you think is the correct answer and ask 6 the witness to comment upon what you -- so make the 7 proposition you want her to comment upon.</p> <p>8 DR BUSBY: The generally scientifically accepted definition 9 of absorbed dose is energy per unit mass or joules per 10 kilogram. Would you agree with that?</p> <p>11 A. Yes.</p> <p>12 Q. That's really what I was going for.</p> <p>13 A. But radiation is a form of energy so I don't think that 14 we differ.</p> <p>15 Q. No, I'm sure we don't differ, it's just that we need 16 to -- because I want to follow this along in a logical 17 fashion to get to the point where I'm hoping to get to 18 with you.</p> <p>19 Well, if it's energy per unit mass, then the 20 quantity of dose that is 1 joule per kilogram would be 21 1 gray, would you agree with that, as a definition of 22 a gray, that's a definition of 1 gray?</p> <p>23 A. Yes, but I'm not an expert dosimetrist so when you come 24 into definitions like this that's not my expert field. 25 My expert is the effects of those doses.</p> <p style="text-align: center;">Page 146</p>	<p>1 a beta dose in grays is you multiply by a factor of 20?</p> <p>2 A. Which is the weighting factor that is used by ICRP, yes.</p> <p>3 Q. So you would agree with that?</p> <p>4 A. Yes.</p> <p>5 Q. Right. So do you know --</p> <p>6 A. That's more telling you about the effect --</p> <p>7 Q. Of course.</p> <p>8 A. -- that that dose is going to have.</p> <p>9 Q. We'll certainly go to the effects but in order to go to 10 the effects I'm afraid I'll have to sort of go slowly 11 through this rather boring scientific stuff and no doubt 12 I'll have to talk Mr Hallard about that on this level as 13 well. But at the moment, since your report is about the 14 effects of doses, I am hoping to start to try and 15 understand what you mean by "doses".</p> <p>16 A. Mm-hm.</p> <p>17 Q. Right. Now, if someone is exposed to external radiation 18 at Hiroshima, for example -- and this is the basis of 19 all the risk models that underpin the case of the 20 Secretary of State and the case that you are making in 21 your report here -- we would take all of the energy that 22 impinged on the unfortunate individual at Hiroshima from 23 the gamma radiation from the bomb and the neutrons and 24 all that stuff, the external stuff, and we would divide 25 it by the mass of the individual, so there would be</p> <p style="text-align: center;">Page 148</p>

<p>1 absorbed energy in joules divided by the mass of the 2 individual and that would give us the dosage rate? 3 A. Because there is no reason to suppose that you would not 4 be uniformly exposed. There is nothing that would be 5 targeted to a specific area of the body. Unless of 6 course you were shielded, in which case then you would 7 have a difference. 8 Q. Absolutely, quite so, so if half of you was behind 9 a building and you just happened to stick your arm out 10 then this arm would get a larger dose and that's because 11 it would get more joules per kilogram. So if you could 12 chop your arm off and weigh it and you took the number 13 of joules that were absorbed by that piece of you it 14 would give you the dose in grays? 15 A. Yes. 16 Q. The problem arises now -- it's quite important to the 17 discussions here -- what happens when you, for example, 18 inhale a particle of uranium from the bomb, because 19 these bombs were made of uranium -- the Hiroshima bomb 20 was made of uranium? 21 A. Yes. 22 Q. And it goes bang and all these particles come down. We 23 heard from Professor Sawada -- I think you were there at 24 the time -- 25 A. Yes, I was here.</p> <p style="text-align: center;">Page 149</p>	<p>1 Q. So this particle then goes right down through the gut, 2 in our thought experiment of course, and it lodges in 3 the colon, in the villi of the colon. You are a 4 pharmacologist, you understand -- 5 A. In the small intestine. 6 Q. That's right. Well -- 7 A. And the colon. 8 Q. We are going to go to the colon. We could do the small 9 intestine but we are talking about the -- this particle 10 lodges there, and we have this particle and it sits 11 there and it produces alpha particles for a long time 12 coming out of -- 13 A. In the case of uranium very rarely because of its long 14 physical half life. 15 Q. Of course. Not many of the particles but some. 16 Now my question is this, and I hope this is the key 17 issue here of what I want to get to: how would the ICRP 18 deal -- how would the conventional risk model that we 19 have now deal with the dose to the colon? 20 A. You are asking the wrong person because as I said before 21 I'm not a dosimetrist. But, you know, you have to have 22 the evidence of how much is left in the colon, how long 23 it stays there and all the rest of that. So you'd have 24 to build that into your model. But I'm not an expert on 25 the ICRP model and I think you should address that to</p> <p style="text-align: center;">Page 151</p>
<p>1 Q. -- about the problems with the black rain and then the 2 resuspension of the material and the inhalation and so 3 forth. 4 What would happen if one of those particles -- and 5 we're not saying at the moment it will but just for the 6 purposes of arguing on this concept of dose -- got 7 through the lung and it ended up in some piece of 8 tissue? How would you calculate the dose for that? 9 A. You'd have to know what the isotope was, so you would 10 have to know what its physical half life is, and then 11 you'd also have to know what biological half life of 12 that particular substance was in the body and whether it 13 dwelled for longer periods of time in one part of the 14 body than the other. 15 Q. Quite so. 16 MR JUSTICE BLAKE: Can I quickly get that answer down? 17 (Pause). Yes. Fire away. 18 DR BUSBY: Quite so. Now let's say that that particle -- 19 and I think you said that a lot of these particles get 20 into the lung but they don't go any further than that. 21 A. Yes, you cough them back up. 22 Q. But I think most people, and certainly there's a lot of 23 evidence and perhaps you can assume that having coughed 24 it up you then swallow it? 25 A. Yes, that is certainly one way of being exposed.</p> <p style="text-align: center;">Page 150</p>	<p>1 somebody who is. 2 Q. I will certainly go to another expert on it, but I don't 3 think that you need to be an expert on the ICRP model to 4 follow what it is I'm trying to get to. 5 The ICRP model, as we have just agreed, it dilutes 6 the energy in joules from any exposure into a mass of 7 tissue which I think I forgot we didn't agree this, but 8 I'm sure you will agree represents the organ? 9 A. Yes. 10 Q. So this would be the organ dose to the colon. 11 A. Yes, it's based on an average person. 12 Q. That's right. So the colon of an average person, and 13 this average person now has a single particle of uranium 14 that's got into his colon and it's just sitting there. 15 And so the ICRP model you would agree with me, I hope, 16 dilutes the decay of energy from that single particle 17 into the whole of the colon and that's the dose to the 18 colon from that single particle? 19 A. I'm not so sure that they go down to the granularity of 20 the single particle. 21 Q. That may be the problem, Professor Thomas. 22 A. So a single particle emitting an alpha is likely to 23 cause cancer in your way of thinking, yes? 24 Q. I'm not saying what my way of thinking is. I'm trying 25 to ask you what you think.</p> <p style="text-align: center;">Page 152</p>

<p>1 A. I think the dose you would be exposed to would be very, 2 very tiny from a single particle of uranium and the 3 chances of you getting cancer from that would be very 4 small. You are far more likely to get it from your 5 diet. 6 Q. That may well be, Professor Thomas, but that's not what 7 we're discussing at the minute. What I am trying to get 8 to at the minute is: what would the ICRP calculate that 9 dose to be, and your answer is it would be very small? 10 A. Yes, if you're talking about a single particle -- 11 Q. It would be vanishingly small, in fact. I think we can 12 agree vanishingly small, yes. 13 Now I am going to ask another question about this. 14 Do you know what the track length of an alpha emission 15 is? 16 A. Not offhand. I'd have to look it up. It's not the sort 17 of thing I keep in my mind. 18 Q. Sure, but I were to say it's about four cells? 19 A. It would depend where on the crypt villus it was lodged 20 because of course it has to get to the stem cells -- 21 Q. Of course it would, and in fact this is a thought 22 experiment, we can put it anywhere we like. I leave it 23 to you, you can put it wherever you want to. My concern 24 is what happens in the vicinity of this particle in 25 terms of dose.</p> <p style="text-align: center;">Page 153</p>	<p>1 mutations before you get cancer. 2 Si it isn't just as simple as one after(?) particle 3 hitting the DNA and then it gives you cancer, it's not 4 that simple a model. 5 Q. I am sure that's the case, Professor Thomas, and in fact 6 indeed there's an awful lot of evidence that there are 7 other aspects to cancer apart from the DNA damage 8 aspect. But that was not really the point of this line 9 of inquiry. 10 All I wanted you to agree with was that the dose to 11 the tissue local to the particle would be enormously 12 higher than that calculated as the dose to the colon by 13 the ICRP model. 14 A. No -- well, you average a dose across an organ to get an 15 effect, you don't take it as one particle hitting one 16 thing that happens to be a growth control gene. That 17 just doesn't work that way. 18 Q. Let me ask another question order that is sort of 19 related to this. 20 A. It's a bit like taking one paracetamol or a taking a box 21 of paracetamol, the effect is totally different. 22 Q. Well, in the case of one paracetamol and lots of 23 paracetamol you are diluting the paracetamol into the 24 whole body. 25 A. It depends on whether the tablet gets lodged and it</p> <p style="text-align: center;">Page 155</p>
<p>1 Now we've already agreed that dose is energy per 2 unit mass. Since we say that the energy released by 3 this particle is into a mass of cells that consist of 4 not many cells because the range is very small, it 5 doesn't go right the way into the whole colon, so the 6 question is: what is the dose to the cells where the 7 particle is? 8 A. Well, it would depend, you know, on when where it was 9 lodged but you have to ask a dosimetrist to tell you 10 that, I cannot tell you. 11 Q. I am just asking you -- 12 A. Presumably, if it's spread over four cells, the dose is 13 deposited at the end of the alpha track, so it would be 14 wherever the track ended which would end up probably in 15 one cell, I would guess, but it's a guess, I'm not 16 a dosimetrist. 17 Q. Right. 18 A. Of course the cell that has to be affected for colon 19 cancer -- which I am sure you are aware -- is the stem 20 cell. Stem cells divide very rarely, so actually their 21 DNA is protected most of the time because it's heavily 22 bound up and it's quite difficult to then chat about DNA 23 when it's bound up. And of course we also know about 24 the colon, that you also have to get a stem cell loss 25 from the leash in order to get to propagation of those</p> <p style="text-align: center;">Page 154</p>	<p>1 dissolves near your colon. There are reasons why you 2 get, for example, gastric problems after eating aspirin. 3 And that's because the local area where it dissolves has 4 a higher dose than the rest of the -- 5 Q. I think that's a helpful point of view, I think that 6 really rather supports what I'm saying, does it not? 7 A. No, because you're talking about a probability after 8 that of getting cancer and the model just isn't that 9 simple. 10 Q. But in this case you were talking about the probability 11 of getting gastric irritation at the point where -- 12 A. Well, you have quite a high density of material that is 13 being distributed. 14 Q. Exactly, a high density of material. 15 A. I'm sorry, I still don't follow where your argument goes 16 that one alpha track will necessarily make cancer. 17 MR JUSTICE BLAKE: We've got to be a little careful not to 18 have a purely a scientific debate about hypotheses. 19 You'd better just try to track it down to questions and 20 get the best out of this witness to develop the issue. 21 DR BUSBY: So there's only really one final key -- well not 22 "key" -- one final part to this line of examination. 23 That is does cancer start in an organ, Professor Thomas, 24 or does it start in a cell? 25 A. It starts in a cell, that is the conventional belief,</p> <p style="text-align: center;">Page 156</p>

<p>1 but it starts in a cell and then many other things have 2 to happen before you will get a cancer because a cancer 3 is an invasive element, it's not just a tumour. 4 Q. Okay, I think that's as far as we need to go with that. 5 A. But also remember your DNA repairs itself too. 6 Q. Of course, the DNA repairs itself, quite so. 7 Now, do you agree then that the target for 8 radiation-induced genotoxicity, which would include 9 cancer, is the DNA? 10 A. When you say that the radiation has a target, it has no 11 target, it happens to bump into DNA. So in that respect 12 it is the target. 13 Q. I think perhaps maybe I didn't use the right term, I was 14 using "target" in the scientific -- in a scientific 15 sense. I didn't mean -- 16 A. But the radiation does interact with other things in the 17 cell. But we're primarily talking about the interaction 18 with DNA -- 19 Q. But you would agree, would you not, that the scientific 20 consensus now is that cancer, as a consequence, at least 21 in part, or in large part, of lesions that have occurred 22 in the DNA? 23 A. Yes. 24 Q. Yes. 25 So I want to ask you, do you know what the</p> <p style="text-align: center;">Page 157</p>	<p>1 Q. No, I am thinking of something different. But anyway, I 2 mean that's your answer. Yes. In fact, calcium 3 hydroxylapatite is a phosphate, but maybe I'm not 4 allowed to say that. 5 A. Well, you're a chemist, you would understand far better 6 than I would, wouldn't you. 7 Q. Right. In your responses to Mr ter Haar this morning 8 you made a statement which I found rather confusing 9 which I would like you to explain to me. You mentioned 10 radioactive uranium and stable uranium when he was 11 talking about uranium inhalation from the environment. 12 You seemed to want to distinguish between radioactive 13 uranium, which would be something perhaps that the 14 people at Hiroshima might have inhaled, and stable 15 uranium. 16 A. I'm not sure I wanted to distinguish them, I wanted to 17 make it clear that uranium is all round us, it's the 18 isotopic amounts that vary in different places. 19 Q. Of course. But I wondered what you meant by "stable 20 uranium". 21 A. Stable uranium is the isotope that is not (inaudible 22 words). Don't ask me what its atomic number is. 23 Q. That's all right, so I understand. It's just that I've 24 not heard it called "stable uranium". 25 A. Well, every single chemical, entity, that has different</p> <p style="text-align: center;">Page 159</p>
<p>1 composition of DNA is? What sort of thing it is? 2 A. It's a double helix and it has four bases that form it, 3 it has a phosphate back chain. 4 Q. A phosphate back chain. What else in the body is 5 composed of phosphate? 6 A. There are lots of things. Many enzymes are 7 phosphorylated. Phosphorylation is an extremely 8 important part of biology, I'm not quite sure -- 9 MR JUSTICE BLAKE: Perhaps narrow it down. 10 DR BUSBY: Is the skeleton of the body composed of 11 phosphate? 12 A. It has some phosphate in it, it also has calcium 13 hydroxylapatite in it, which gives it its strength. 14 Q. And calcium hydroxylapatite is phosphate? 15 A. No, it's not, it's a different chemical compound. 16 Hydroxylapatite -- 17 Q. Let's get this right. Right. 18 A. Phosphate is everywhere in your body, you can't avoid 19 it. 20 Q. So you are saying that calcium hydroxylapatite is not 21 a phosphate? 22 A. No. 23 Q. You're not saying that? 24 A. No, I am saying it's -- I think you are thinking of 25 something slightly different.</p> <p style="text-align: center;">Page 158</p>	<p>1 isotopes usually has a stable form as well. So iodine, 2 for example, is 127, and iodine 131 is radioactive. 3 Q. Of course. But iodine 127 is not radioactive. 4 A. No. Iodine 129 is. 5 Q. So are you of the opinion that stable uranium is not 6 radioactive? 7 A. Stable uranium is not radioactive; it is the 8 non-radioactive isotope of uranium. 9 Q. I see, okay, okay. 10 A. Unless I didn't listen properly in my chemistry A level. 11 Q. Right. Well, the bomb casings -- I am not allowed to 12 ask you, you're not an expert on bomb casings. 13 A. No. 14 Q. Right. So can I ask you, as a pharmacologist you are 15 an expert on what happens to substances in the body, or 16 least to some extent, I mean it's your area of -- 17 A. It's my original area. 18 Q. -- it's your original area of expertise. Yes. So my 19 question is what happens in the body to metals that are 20 inhaled? For instance, uranium oxide particles that 21 might -- 22 A. It depends whether they're in a soluble form. Many of 23 them will, as I said before, will come out on the 24 mucociliary pathway, make it into the gut, but most of 25 them will be excreted by the faeces. A small amount may</p> <p style="text-align: center;">Page 160</p>

<p>1 get absorbed by the blood. The majority of that is then 2 excreted in the kidney. But it really does depend on 3 the solubility of the compound. 4 Uranium oxide, for example, is not soluble in water, 5 and things that aren't soluble in water don't get into 6 your body because most of your body is water. 7 Q. But if I were to eat some iron filings, for example, you 8 would say that none of the -- 9 A. A small amount might undergo some form of chemical 10 change and become a compound which is soluble, but the 11 majority of it will probably pass straight through you. 12 Q. Are there strong acids in the gut that might -- 13 A. There are strong acids, hydrochloric acid is one of the 14 components of your gut, yes. 15 Q. That might dissolve the -- 16 A. It would have to make something this it not insoluble, 17 if it made a chloride -- which you would expect it to do 18 because it's hydrogen chloride -- then that -- it would 19 depend on whether that was actually soluble in your gut 20 or a chlorate was soluble in your gut. 21 Q. So perhaps you might concede that if you were to inhale, 22 for example, a uranium particle, the one that we talked 23 about, and then it was coughed up because it was too 24 large and then it was on its way down to the colon, it 25 happened to go through the stomach where there was 5(?)</p> <p style="text-align: center;">Page 161</p>	<p>1 circulating in your body. About 1 to 2 per cent of that 2 may end up in your bones and that's it. So you're 3 looking at vanishingly small quantities of the uranium 4 you took in actually remaining in your body. Dose is 5 everything. The difference between pharmacology and 6 toxicology is dose. 7 Q. Yes, I think we've sort of dealt with dose because we 8 have sort of decided, or I thought you'd agreed with me, 9 that the dose to local tissue from particles, certainly, 10 could be significantly high compared to the dose -- 11 A. No, not to a tissue, to an individual cell. You wrapped 12 it right down to the cell. The individual cell, yes, 13 but not a tissue. 14 Q. I think we decided that an individual cell was the 15 origin of cancer, though? 16 A. Yes. It's not as simple as that, but we'll start there. 17 Q. Okay. So this very small amount of uranium that gets 18 into the body and has this affinity for the bone because 19 of the phosphate in the bone -- and this is where -- 20 A. But it stays there for one to two years, and then it's 21 excreted, so it isn't there permanently. 22 Q. I thought you said a few days. 23 A. No, sorry, the 70 per cent goes in the urine in 24 24 hours, and 1 to 2 per cent of the remainder will stay in 25 your bones, it stays there for about one to two years</p> <p style="text-align: center;">Page 163</p>
<p>1 normal hydrochloric acid, that some of it might 2 dissolve? 3 A. Well, it must be able to dissolve otherwise you wouldn't 4 be able to detect it in the blood. But it's only a very 5 small amount of what you take in, between 5 -- 0.5 and 6 5 per cent based on the data we have from the uranium 7 mill crushers. 8 So some of it does end up going into your blood, 9 yes, you are quite right. So it must have been 10 organified or made soluble in some respects in order to 11 get into your blood, otherwise it couldn't get there. 12 Q. So you are agreeing that inhaled uranium, or certainly 13 ingested uranium, a proportion of it will get into the 14 blood and then -- 15 A. A very small proportion of it. 16 Q. A small proportion of it will get into the blood. And 17 then what will happen? It's a -- 18 A. 70 per cent of that 0.5 to 5 per cent of an individual 19 dose that goes through your gut goes out in your urine 20 in 24 hours, which is why you get the renal toxicity 21 because that's the primary export route of heavy metals. 22 And if you look at most heavy metals you'll see the same 23 profile. 24 Q. Yes, right. 25 A. So you're left with a very tiny amount that may be</p> <p style="text-align: center;">Page 162</p>	<p>1 and then is turned over because your bodies are turning 2 over the whole time. 3 Q. Yes. Have you read the Royal Society report on depleted 4 uranium? 5 A. I can't recall it. I probably have at some point, but 6 I can't recall it right now. 7 Q. It's just that that says 13 years. But maybe you 8 disagree with that. 9 A. I was working off some data I had from the American 10 authorities, but you may be right. 11 Q. Okay. 12 A. And I'm sure it varies with different diets, et cetera. 13 Q. I think this was done from mice, actually. 14 A. Well, I would caution then. If it's done in mice 15 I would be cautious about transferring that straight to 16 humans because the metabolism is very different. 17 Q. I think it a paper by Anne Sabolla (?). Anyway, it's 18 not in the bundles, so we can't go to it, and it's not 19 that important. 20 Because you are saying that a proportion of it goes 21 to the bone. Well, it goes to the bone, I think we 22 agreed, because the bone contains calcium phosphate or, 23 also, calcium hydroxylapatite? 24 A. Mm. 25 Q. Right. But of course in the body you have already</p> <p style="text-align: center;">Page 164</p>

1 agreed that the DNA contains phosphate?
 2 **A. Mm-hm.**
 3 Q. So if it is in a form that can be stripped to the bone
 4 and measured there, then it could be in a form that
 5 binds to the DNA phosphate?
 6 **A. In theory, yes.**
 7 Q. Right. Well, that's all we need because nobody has
 8 actually measured it there yet.
 9 **A. No.**
 10 Q. All I am suggesting is the possibility that the DNA --
 11 the DNA --
 12 **A. But of course you have to remember if it's in the bone**
 13 **then the site of origin with the cancer would be**
 14 **an osseous carcinoma. We have absolutely no evidence**
 15 **whatsoever that exposure to uranium, genotoxic in terms**
 16 **of radiogenicity, or natural uranium, causes any**
 17 **problems in the bones.**
 18 Q. So you haven't read the papers --
 19 **A. In humans. I refuse to accept animal models that have**
 20 **not been validated in humans. In cancer we know that is**
 21 **a total waste of time.**
 22 Q. So you would agree then that in animals -- and there
 23 have been a lot of studies carried out with uranium,
 24 exposure of beagle dogs and mice and a whole range of
 25 animals at the Albuquerque -- at the New Mexico sites

Page 165

1 were experiments were done with uranium and radium and
 2 other things and they do show high levels of bone
 3 cancer.
 4 **A. I'm not aware of those studies, but I have to say that**
 5 **I would urge caution of taking something straight from**
 6 **an animal and applying it straight to a human. We gave**
 7 **up using animal models in cancer because they don't**
 8 **replicate the human situation.**
 9 Q. Absolutely, and I absolutely agree with you, but
 10 nevertheless it is some sort of evidence that you --
 11 **A. Yes, I mean you have to look at the doses and things**
 12 **like that and to see how it was administered and all the**
 13 **rest of it to make sure that it was applicable to the**
 14 **exposure that would you see in the humans and the doses**
 15 **that you would expect. Many of the toxicology studies**
 16 **really push the dose level right up.**
 17 Q. Right. Well, I think we've got to the point now where,
 18 although you say that a very very small amount of it is
 19 still possible for uranium to bind -- the soluble form
 20 of uranium that we eventually derived --
 21 **A. Once it's got into your cell and if it's in the right**
 22 **form it may, it may -- and there's no proof, as far as**
 23 **I know nobody has actually looked at the DNA to see if**
 24 **there's uranium bound to it after exposure -- it is**
 25 **possible that it sticks on the phosphate. How long it**

Page 166

1 **dwells there, I don't know.**
 2 Q. Yes.
 3 **A. That's very important when it comes to the dose in**
 4 **radiation, of course, because if it doesn't stay there**
 5 **very long it's highly unlikely to emit its alpha**
 6 **particle.**
 7 Q. But if it were on the DNA in this extremely unlikely
 8 possibility that you put forward it would have -- the
 9 dose to the DNA would be catastrophic, would it not?
 10 **A. Yes, and it may cause the death of that cell, because**
 11 **don't forget, of course, if you get too much DNA damage**
 12 **in the cells you get apoptosis occurring and then you**
 13 **won't get cancer.**
 14 Q. Of course. Indeed, I am told that in some people that
 15 is all you get is apoptosis and, about 1/5th of the
 16 population could never get cancer. I just thought I
 17 would say that --
 18 **A. Well, I would like to know where you got that one from**
 19 **because I don't think that's true.**
 20 Q. I got it from Eric Wright who is the world authority on
 21 this issue at Dundee.
 22 **A. Yes, I know who Eric Wright is.**
 23 Q. So I have come to -- I've almost finished with uranium.
 24 So we were talking about particles going into the lung,
 25 and then you cough up the particle because it's too big

Page 167

1 to get through the lung, as you were saying earlier.
 2 **A. Or literally because it happens to get stuck on the**
 3 **mucus that is coming up --**
 4 Q. But I want to talk about nanoparticles now. So these
 5 are particles that are not too big to get through the
 6 lung. Do you happen to know what size of particle can
 7 get through the lung?
 8 **A. No, that's not my sphere at all, and I'm not gonna**
 9 **answer questions on -- which I don't have the knowledge**
 10 **to answer.**
 11 Q. So if I were to say to you that any particle under 100
 12 nanometres can get through the lung, you wouldn't --
 13 **A. I wouldn't be able to give you an answer, it's the sort**
 14 **of thing I would have to look up because it's not the**
 15 **thing I'm interested in. So I don't carry those facts**
 16 **around in my head.**
 17 Q. Right. I just want you to look at a paper by
 18 Alexander Miller which is SB5/101.
 19 I am awfully sorry, my Lord, I did all this outside
 20 in a hurry. (Pause)
 21 MR JUSTICE BLAKE: McKeegan and Biggs. Are you in the right
 22 bundle?
 23 **A. Yes. Miller? The one I have is Miller. SB7? And**
 24 **I only have the abstract, I don't have the full paper.**
 25 **DR BUSBY: We only provided the abstract.**

Page 168

<p>1 A. I'm not happy to comment on papers where I only have 2 an abstract, I'm afraid. 3 Q. Right. 4 A. You can't read an abstract and be sure that that's 5 actually what the paper says. 6 Q. Yes. Well, we provided abstracts in order to -- 7 MR JUSTICE BLAKE: I thought -- 8 DR BUSBY: -- to reduce paper, because the 9 Secretary of State was complaining that we are giving 10 them too much paper. 11 MR HEPPINSTALL: If papers are to be relied upon they are to 12 be provided in full and not in abstract. 13 MR JUSTICE BLAKE: Wasn't that in my direction last Friday? 14 MR HEPPINSTALL: Yes. 15 MR JUSTICE BLAKE: Right. Do you have the full paper 16 somewhere, Dr Busby? 17 DR BUSBY: Well, not here, my Lord. 18 MR JUSTICE BLAKE: Are you going to have it for tomorrow 19 morning? 20 DR BUSBY: I could have it tomorrow morning. Would it be 21 possible to go ahead on the basis that this is what the 22 paper says -- 23 A. No, no, I'm sorry, I will not do that. An abstract can 24 be very misleading, because sometimes people will say 25 things in the abstract which, when you look through,</p> <p style="text-align: center;">Page 169</p>	<p>1 sure that we can have proper preparation. So can you 2 think ahead on that, or someone in your team, please, 3 and make sure all the things that you might or will rely 4 upon are provided. 5 Is there another topic you can move to? 6 DR BUSBY: Oh yes. I am sure we can find some other topics. 7 Yes. 8 I would now like to then move to the region in which 9 you are an expert, which is thyroid cancer. 10 A. Mm-hm. 11 Q. Perhaps at first I might ask you about the sensitivity 12 of the -- perhaps you could explain to us about the 13 sensitivity of, you know, roughly in quantitative terms, 14 about the sensitivity of the thyroid organ, what it is 15 and why it's sensitive to ionising radiation. 16 A. The thyroid is believed to be one of the two most 17 sensitive organs in the body, the other being the 18 breast, and it depends on the -- 19 THE COURT REPORTER: Could you slow down, please? 20 A. Breast and thyroid are believed to be two of the most 21 radiogenic tissues in the body. The thyroid, we know 22 that radioisotopes of iodine concentrate in the thyroid 23 gland, we use those clinically to actually cure people 24 of thyroid cancer, it's the best targeted treatment we 25 have for any cancer. We're not sure why it is more</p> <p style="text-align: center;">Page 171</p>
<p>1 that is not true in the paper. 30 per cent of my final 2 degree was on this sort of analysis. 3 MR JUSTICE BLAKE: If we are going to go to tomorrow 4 morning, as I think we are, then we may be able to get 5 the full paper, which will have a better quality of 6 debate. But I think from what I've just heard it's 7 probably important for the witness to have the full 8 paper before you ask her questions about it. So are you 9 going to be able to get to get to -- 10 DR BUSBY: Yes, I'm sure I can get that paper by tomorrow. 11 A. If somebody could e-mail it to me, I could pick it up at 12 home tonight. 13 MR JUSTICE BLAKE: I would have thought it's not beyond 14 human possibility. What do I know? But it requires you 15 team Dr Busby, to dig something out so that we can have 16 a useful debate. If we are going to do that for 17 tomorrow can we reserve this topic so we can do it in 18 one go with the full material rather than in two halves? 19 Generally speaking, if you have papers to put either 20 to this witness or anyone else who is coming tomorrow or 21 next week, can we have the full papers? That's what 22 I spotted that had been asked for. I think I directed 23 you to do that last Friday. I am told I did. 24 DR BUSBY: Yes, I think you did, my Lord. 25 MR JUSTICE BLAKE: Okay. That was with the purpose to make</p> <p style="text-align: center;">Page 170</p>	<p>1 sensitive to X-rays, but it is. 2 Q. Yes. Could you tell us how it is that you are an expert 3 in this particular area? What you have actually studied 4 in the area of the thyroid. 5 A. My PhD was on the clonal and neoplastic processes in the 6 thyroid, but mainly looking at chemical agents that 7 affect thyroid homogenesis --sorry. 8 MR JUSTICE BLAKE: Slow down. 9 A. My PhD was on the clonal and neoplastic proliferative 10 processes in the thyroid -- 11 MR JUSTICE BLAKE: Particularly when it comes to long words. 12 A. -- and that was mainly concerned with chemical agents 13 that affect thyroid hormone metabolism, which is a lot 14 of pesticides and things like that. 15 Subsequent to that, my boss at the time was one of 16 the foremost pathologists and expert in thyroid 17 pathology, and the Chernobyl accident happened, in 1992 18 he was asked to go to Belarus with a colleague from 19 Italy, who was a thyroid specialist -- in the clinical 20 sense rather than the pathology sense -- to investigate 21 whether the reports that we were hearing about, 22 an increase in thyroid cancer in children, were valid. 23 I was asked then to run the research after that 24 looking for -- well, everybody hoped they were going to 25 find a molecular fingerprint of radiation in thyroid</p> <p style="text-align: center;">Page 172</p>

<p>1 tissue that would tell us why these cancers were arising</p> <p>2 in this population. It hasn't been quite as simple as</p> <p>3 that as we're still looking for it now 30 years later</p> <p>4 after the explosion.</p> <p>5 MR JUSTICE BLAKE: Pause there.</p> <p>6 DR BUSBY: But at the time that there was the increase in</p> <p>7 thyroid cancer that Professor Williams was interested</p> <p>8 in, it was generally denied that there was a causal</p> <p>9 relationship -- in fact, it was denied there was</p> <p>10 an increase at first and it was Professor Williams that</p> <p>11 drew attention to it, wasn't it?</p> <p>12 A. It was the first two papers in nature in 1992, he was</p> <p>13 one of the authors of them.</p> <p>14 Q. Yes. So how is it that there was such an increase in</p> <p>15 thyroid cancer?</p> <p>16 A. Because there was a large amount of radioiodine</p> <p>17 released, and a large population of children were</p> <p>18 exposed. If it had been an adult population we may</p> <p>19 never have seen the increase.</p> <p>20 Q. So --</p> <p>21 A. Actually, it wasn't that surprising, if you've been</p> <p>22 working on the animal models you knew that giving</p> <p>23 radioiodine to juvenile animals is the only way you make</p> <p>24 thyroid cancers in animals. In fact, technically they</p> <p>25 are not cancers because they don't invade the thyroid</p> <p style="text-align: center;">Page 173</p>	<p>1 whether it's reasonable.</p> <p>2 Q. No, it doesn't seem reasonable, it seems crazy.</p> <p>3 A. I think you'd better talk to Professor Hallard about</p> <p>4 that.</p> <p>5 Q. What I meant was the statement, you know, is a statement</p> <p>6 that you would accept.</p> <p>7 MR JUSTICE BLAKE: Let's be sure that when you put</p> <p>8 a question you put a question. Just so we get the</p> <p>9 best --</p> <p>10 DR BUSBY: Yes. So do you know what the atomic number of</p> <p>11 iodine is, roughly?</p> <p>12 A. Talking about isotopes?</p> <p>13 Q. No, just --</p> <p>14 A. Again, I don't carry those. I mean, there are various</p> <p>15 isotopes. I know what the isotope numbers are, but I'd</p> <p>16 have to --</p> <p>17 Q. Well --</p> <p>18 A. -- check on that. I don't carry those things around in</p> <p>19 my head all the time.</p> <p>20 Q. No. Well, I was just going to suggest to you that the</p> <p>21 reason that iodine was -- that the thyroid was sensitive</p> <p>22 is because it has a very high atomic number.</p> <p>23 A. No, I think that's absolute rubbish. I think the</p> <p>24 concentration of the iodine tenfold against the blood is</p> <p>25 what gives you the highest dose and nobody disputes</p> <p style="text-align: center;">Page 175</p>
<p>1 lumps, thyroid nodules.</p> <p>2 MR JUSTICE BLAKE: Pause there.</p> <p>3 DR BUSBY: So just to step back slightly from this and to</p> <p>4 talk about the sensitivity of the thyroid. The thyroid,</p> <p>5 as you said, contains iodine?</p> <p>6 A. It takes up iodine from the bloodstream. It has</p> <p>7 an iodine pump mechanism and then it stores it.</p> <p>8 Q. So the concentration of iodine in the body is greatest</p> <p>9 in the thyroid organ?</p> <p>10 A. Yes.</p> <p>11 Q. Now, you have read the papers that were put in by</p> <p>12 Professor Howard in which he explains his research at</p> <p>13 the University of Ulster into the absorption of gamma</p> <p>14 radiation by different elements. Maybe you don't</p> <p>15 recall?</p> <p>16 A. Yes, I have read them. I would not say that</p> <p>17 I understood the physics of them, and I would be lying</p> <p>18 to you if I said that I completely understood --</p> <p>19 Q. So if I were to suggest to you that elements in the body</p> <p>20 absorb gamma radiation in proportion to the fourth power</p> <p>21 of the atomic number, which is what Professor Howard --</p> <p>22 A. Yes, I'm aware of that statement.</p> <p>23 Q. -- that would seem quite reasonable. You would accept</p> <p>24 --</p> <p>25 A. I didn't say it seems reasonable, because I don't know</p> <p style="text-align: center;">Page 174</p>	<p>1 that. That's the major effect.</p> <p>2 Q. Are you saying that the thyroid is not sensitive to</p> <p>3 x-rays?</p> <p>4 A. No, I didn't say that. If you remember I said earlier</p> <p>5 that, yes, we know it's sensitive to X-rays but we don't</p> <p>6 know why. And I don't know whether the mechanism you</p> <p>7 are suggesting is the right mechanism because I'm not</p> <p>8 qualified to answer that.</p> <p>9 Q. Very good.</p> <p>10 So what you are saying then is that after Chernobyl</p> <p>11 the dose -- the reason there was a huge increase in</p> <p>12 thyroid cancer after Chernobyl was exposure to</p> <p>13 radioactive iodine?</p> <p>14 A. Absolutely, irrefutably, because if you plot the graph</p> <p>15 against date of operation, against age of gestation, you</p> <p>16 see that all the points are above the line at which the</p> <p>17 child would have been three months in utero at the time</p> <p>18 of the exposure.</p> <p>19 If you go to -- as the population is ageing, as time</p> <p>20 is passing, there are fewer and fewer underneath that</p> <p>21 line, which tells you that it was a short-lived isotope,</p> <p>22 if it was iodine 131, concentrated in the thyroid, hence</p> <p>23 the number of thyroid cancers.</p> <p>24 Q. So what was the dose that produced that?</p> <p>25 A. It's a variable dose. It's not a single dose. The</p> <p style="text-align: center;">Page 176</p>

<p>1 doses varies from several -- grays in some people to, 2 you know, 50 -- 50 milligrays in others. 3 Q. So 50 milligrays can cause -- 4 A. You cannot say what caused it, you can say what doses 5 are associated with it, and there is a dose response and 6 it's believed to be linear, of course, because of the 7 LNT. But I can't tell you what dose causes a thyroid 8 cancer, that's impossible to say. There isn't 9 a threshold, we've agreed that. 10 Q. Well, I don't think I agreed that, and I don't think 11 that the ICRP agrees that either. 12 A. No, I disagree with that. The ICRP says there's 13 a threshold. There is an intervention level which is 14 different from a threshold -- 15 Q. So you are telling me that the ICRP says that there is a 16 threshold dose -- 17 A. No, I'm not telling you that at all. I am saying 18 there's an interventional level which is the doses to 19 the thyroid are estimated to be that, then you need to 20 take some action to minimise those doses. That's not 21 the same as saying there's a threshold level below which 22 there is no effect. 23 Q. I'm sorry, I thought that -- 24 A. No, I never said that. 25 Q. I thought you said that a minute ago.</p> <p style="text-align: center;">Page 177</p>	<p>1 DR BUSBY: Well not really, my Lord, because what I am 2 trying to do is in some way compare this accident at 3 Chernobyl and the exposure to these people, to radio 4 iodine, with the explosion at Hiroshima and the exposure 5 of people there to whatever they were exposed to. 6 In the case of Hiroshima we needed to know some idea 7 of the dose that caused a particular probability of 8 getting cancer. So all I am really going for, it's not 9 a big deal, it is just sort of approximate doses that 10 you think there was. If you like, a mean dose. 11 A. I can tell you what the mean dose of evacuees are, if 12 that helps. That was about 500 milligrays. Those were 13 the people who were closest to the reactor and they got 14 about 500 milligray. But the dose range is huge - some 15 people got several -- 16 MR JUSTICE BLAKE: Slow down, please. 500 milligrays. 17 A. Is the mean dose to the thyroid. 18 MR JUSTICE BLAKE: Of the evacuees. Mean dose to the 19 thyroid of the evacuees. But the dose range? 20 A. Is huge. It goes from several grays to the thyroid to 21 -- 22 MR JUSTICE BLAKE: Got that. 23 DR BUSBY: So, now, do you know how many people were exposed 24 to 500 milligrays? Is that some -- 25 A. Not huge -- no, it isn't -- I can't recall offhand, and</p> <p style="text-align: center;">Page 179</p>
<p>1 A. No, I did not say that. 2 Q. Fine, I must have misunderstood, I apologise. I'm not 3 trying to accuse you of anything or trick you or 4 anything like that. 5 MR JUSTICE BLAKE: I am just having a look at the time. If 6 you can find a point, a convenient breaking point in 7 this line of questions in the next five minutes, I would 8 be grateful. 9 DR BUSBY: I think I probably can do that, my Lord, yes. 10 Five minutes? 11 MR JUSTICE BLAKE: What I want to do is end by ten past, and 12 I may need to just raise some matters for a few moments 13 with each of you. So five minutes being a flexible 14 concept. 15 DR BUSBY: Right. So the increases in thyroid cancer at 16 Chernobyl were caused by exposure to radioactive iodine 17 from the accident? 18 A. Yes. 19 Q. And you can't tell us what the doses were, but -- 20 A. Well, I could tell you a dose range, but I can't tell 21 you individual doses. I don't have that -- 22 Q. No, I don't think I am trying to ask for individual 23 doses, I think I'm trying to get -- 24 MR JUSTICE BLAKE: Would a dose range be helpful to answer 25 your question?</p> <p style="text-align: center;">Page 178</p>	<p>1 it would be impossible to know that because not 2 everybody had accurate dosimetry done. 3 Q. Right. 4 A. But certainly those who were closest to the reactor. 5 I mean, again, it's not simple, because there's the 6 inhalation dose, there's also the dose of ingestion -- 7 sorry, I'm going too fast -- so there's the inhalation 8 dose and there's the dose of ingestion of contaminated 9 foodstuffs, which was largely milk from cows who were 10 grazing on the pasture. The rainfall was different in 11 different areas. The rain brings the iodine onto the 12 grass, the cows eat the grass, the milk has the iodine 13 in it, some of the children were drinking milk, some 14 weren't drinking milk, and some people had a backyard 15 cow and others didn't. So that's why the dose range is 16 huge. 17 DR BUSBY: I think, my Lord, at this point I have to say 18 that this line of questioning is going to continue for 19 more than five minutes, but this is a convenient place 20 to draw a line under it and we can pick it up again 21 tomorrow morning. 22 MR JUSTICE BLAKE: Thank you very much. We will continue, 23 if it's convenient to you, at 9.45 tomorrow morning. 24 THE WITNESS: I will do my utmost to get here, dependent on 25 the tube.</p> <p style="text-align: center;">Page 180</p>

1 MR JUSTICE BLAKE: Would you prefer ten o'clock?
 2 THE WITNESS: It is unlikely I will be late but I am stuck
 3 out on the Metropolitan Line.
 4 DR BUSBY: Ten o'clock?
 5 MR JUSTICE BLAKE: I have been making provisional
 6 contingency planning for everyone to have enough time to
 7 explore with this witness, but the sense I am getting is
 8 that we've moved quite far ahead.
 9 THE WITNESS: I will get here for 9.45.
 10 MR JUSTICE BLAKE: Whenever you can get here we'll start,
 11 because obviously the sooner we start --
 12 THE WITNESS: The sooner we finish.
 13 MR JUSTICE BLAKE: That is a scientific concept! To me, at
 14 least.
 15 Anyway, you are now in the middle of your evidence.
 16 The same warning applies. Thank you, I look forward to
 17 seeing you tomorrow morning.
 18 THE WITNESS: Thank you very much.
 19 DR BUSBY: Thank you, Professor.
 20 MR JUSTICE BLAKE: As the Professor is getting out of the
 21 witness box can we just have a quick look at what we
 22 might be doing tomorrow when at some point, I suspect
 23 tomorrow morning, we will complete her evidence.
 24 MR HEPPINSTALL: Indeed. Mr Hallard will be here tomorrow
 25 so we can move --

Page 181

1 MR JUSTICE BLAKE: So we move --
 2 MR HEPPINSTALL: -- seamlessly to Mr Hallard.
 3 MR JUSTICE BLAKE: Right.
 4 MR HEPPINSTALL: Because we are moving up the days, I think
 5 some effort has been made to warn Dr Haylock that it may
 6 be earlier than Thursday. It may not, but it may.
 7 MR JUSTICE BLAKE: Right, okay.
 8 MR HEPPINSTALL: Subject to anything that Mr ter Haar wishes
 9 to say about when he wants to start cross-examining
 10 Mr Hallard.
 11 MR JUSTICE BLAKE: Look, I think it's probably best, since
 12 you three will probably know which area do you want to
 13 pursue and what sequence you are going to do, but it
 14 looks like we are now getting more time, whereas
 15 48 hours ago we looked like we had a bit of a problem.
 16 MR TER HAAR: We've stolen time by passing the buck in some
 17 respects to Dr Haylock. So it would be probably helpful
 18 to start tomorrow with Mr Hallard because we may need to
 19 allow more time. I had anticipated I might well deal
 20 with Professor Thomas, but some of the matters I am now
 21 going to deal with Dr Haylock.
 22 MR JUSTICE BLAKE: It is just communication. So you can
 23 revise, delete, contract there and expand there, just so
 24 that everyone has time to know what's going on and it's
 25 absolutely helpful to know who is coming the next day.

Page 182

1 So one can focus thoughts upon the questions.
 2 MR TER HAAR: It looks as though we will at least start
 3 Mr Hallard's evidence at some point tomorrow.
 4 MR JUSTICE BLAKE: It does look like that, yes. I am rather
 5 hoping, however, that we do start at 9.45 or
 6 thereabouts, that we will complete by four o'clock
 7 tomorrow.
 8 MR TER HAAR: Oh, I think we take that as a given.
 9 MR JUSTICE BLAKE: Yes. Simply because there is more to
 10 life than ionising radiation.
 11 But I mean we are not going to -- if we start
 12 Mr Hallard tomorrow, at, say, 11.30 midday, we're not
 13 going to finish him tomorrow.
 14 MR TER HAAR: I would be surprised if we did.
 15 MR JUSTICE BLAKE: It would be a convenient moment towards
 16 the end of the afternoon, and so we don't have to burn
 17 the candle at both ends.
 18 MR TER HAAR: It's unlikely we complete his evidence
 19 tomorrow, and if we finish at 3.30 or four o'clock
 20 I don't think it will destroy the timetable for next
 21 week.
 22 MR JUSTICE BLAKE: Thank you very much. So I have to hand
 23 down judgment. So 9.45, or as soon as the witness is
 24 here. If we are all here then we can take advantage of
 25 that.

Page 183

1 (4.08 pm)
 2 (The court adjourned until
 3 Friday, 17 June 2016 at 9.45 am)
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 17
 18
 19
 20
 21
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Page 184

1	INDEX
2	
3	
4	PROFESSOR INGE SCHMITZ FEUERHAKE1
	(continued)
5	Cross-examination by MR HEPPINSTALL1
	(continued)
6	Re-examination by DR BUSBY25
7	PROFESSOR CHARLES VYVYAN HOWARD29
	(affirmed)
8	Examination-in-chief by DR BUSBY30
	Cross-examination by MR HEPPINSTALL30
9	Re-examination by DR BUSBY66
	Questions from the Tribunal69
10	PROFESSOR MALCOLM HOOPER (sworn)71
	Examination-in-chief by MR BUSBY71
11	Cross-examination by MR HEPPINSTALL72
	Re-examination by DR BUSBY96
12	PROFESSOR GERALDINE ANNE THOMAS99
	(affirmed)
13	Examination-in-chief by MR HEPPINSTALL100
14	Cross-examination by MR TER HAAR102
	Cross-examination by DR BUSBY142
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
	Page 185

A				
abberation 97:12	116:13 133:12	acknowledged	affirmed 29:25	171:2 181:8
ABCC 3:7	136:22 146:2	57:15 116:20	99:24 185:7,13	aims 54:16 72:16
Abdale 128:19	165:19 174:23	acknowledging	afraid 3:18 21:5,10	air 90:19 137:14
129:9	175:6	52:12	27:15 28:4 97:23	Akar 24:6
Abe 3:7,22	acceptable 115:21	Act 36:21	114:11 148:10	al 79:3 124:9
aberration 9:11	accepted 23:5,7,8	action 177:20	169:2	Alaani 85:8
aberrations 3:8,24	146:8	activities 96:3	afternoon 102:12	alarm 98:6
5:1 7:19 8:18	accepting 38:16	activity 87:25	102:13 142:19,20	Albuquerque
9:11 80:11 86:6	45:6	actual 32:10 92:9	143:16 183:16	165:25
able 5:6 20:7 30:5	access 59:20	92:12 132:22	age 39:12,18,21	alcohol 25:4
40:9 42:24 45:8	accident 24:10,21	acute 115:11	55:2 176:15	Alexander 168:18
53:11 70:11 123:8	24:23,24 110:23	116:24	ageing 176:19	allegation 34:7
123:18 144:6	172:17 178:17	add 30:15 38:5	agent 50:13 86:14	83:16
162:3,4 168:13	179:2	72:1 93:24 101:12	87:4 118:21,23,25	alleged 72:20
170:4,9	accidental 10:5,7,8	129:13 130:4	145:8	allow 86:4 132:3
absolute 175:23	accidentally 10:14	addition 94:21	agents 9:23 11:14	182:19
absolutely 47:19	accidents 15:20	additional 16:20	13:25 14:4 97:24	allowed 1:15 159:4
49:9 63:13 68:11	account 10:21	37:13 78:8	98:1 120:2 172:6	160:11
103:12 108:11	53:17 62:22 105:7	address 49:8 51:20	172:12	alpha 58:10,17
110:7 112:17	107:7,7 116:2,22	62:9 107:13	aggressive 134:10	68:23 69:8 132:24
113:5 114:9,15	128:8,8 132:9,12	123:22,25 151:25	ago 116:21 143:6	147:11,15,19,25
116:9,13 117:7,9	133:2,3	addressed 28:14	177:25 182:15	151:11 152:22
119:20 124:15	accounted 130:23	58:8 62:14	agree 11:1 13:7	153:14 154:13
128:17 129:5	accurate 20:22	addressing 62:21	19:18,19 20:13	156:16 167:5
134:14 137:1	122:18 140:14	adequate 50:22	22:6 37:15 42:11	Alsaesser 31:11,12
146:3 149:8	180:2	adjourned 184:2	47:13 67:10 85:8	alternative 64:5
165:14 166:9,9	accuse 178:3	adjournment 99:16	98:13 107:11	107:5,18 108:6
176:14 182:25	acetate 40:23 41:10	administer 144:17	119:3 122:15	119:5 126:5
absorb 70:24	41:13,23 42:1,12	administered 50:13	134:25 135:2	128:13 143:10
174:20	43:3,6 44:17,18	166:12	145:11,16 146:10	altogether 95:21
absorbed 82:23,24	47:22 76:2,6,25	admit 3:3 36:23	146:21 147:7,9,11	117:5
145:3 146:9 149:1	77:5,10 78:6	38:4 64:11 112:12	148:3 152:7,8,15	alveolus 43:19
149:13 161:1	135:14	admits 38:10	153:12 155:10	America 110:24
absorption 42:22	acetates 77:13	admitted 37:7	157:7,19 165:22	117:18
174:13	acetic 76:12 77:4	adult 173:18	166:9	American 114:12
abstract 60:6 66:19	acetyl 76:11	advantage 183:24	agreed 77:25	164:9
168:24,25 169:2,4	achieved 28:25	adversely 120:14	113:14 152:5	Americans 110:2
169:12,23,25	acid 25:4 42:10	adviser 73:12,13	154:1 163:8	120:8
abstracts 169:6	76:12 77:3,4,6	advisory 75:12	164:22 165:1	amount 71:1 91:4
abuse 25:5	78:11 161:13	affairs 45:22	177:9,10	135:25 136:14,24
accept 45:5 52:2	162:1	affect 57:7 124:13	agreeing 162:12	138:12 144:18,21
53:3 54:15 61:9	acids 44:18,19,21	172:7,13	agreement 147:2	145:5,21 160:25
64:16,24 76:2	76:14,14 78:5,12	affinity 42:7,16	agrees 177:11	161:9 162:5,25
84:1 113:24	161:12,13	45:2 75:22 76:3,7	Ah 12:24 35:12	163:17 166:18
	acknowledge 11:25	163:18	ahead 70:8 169:21	173:16

<p>amounts 90:7 136:9 138:5 159:18 analysing 67:20 analysis 5:9 6:15 6:21,23 7:3,13 10:3 14:25 109:5 116:5 170:2 Andreas 31:10 ands 172:14 anger 115:8 animal 165:19 166:6,7 173:22 animals 165:22,25 173:23,24 Anne 99:24 164:17 185:12 annex 17:15 anomalous 46:7 96:20,24 answer 1:18 20:21 20:24 37:14 38:18 45:10,11 46:19 76:10,11 86:17 89:2,12 97:4 123:8 125:20 133:17 145:25 146:3,5 150:16 153:9 159:2 168:9 168:10,13 176:8 178:24 answered 14:11 85:16,17 106:14 answers 23:16 70:18 anticipated 182:19 anticipating 18:3 anxious 18:23 anybody 64:15 123:15 anyway 18:16 142:2 144:8 159:1 164:17 181:15 apart 102:18 155:7 apologise 34:6 69:4</p>	<p>142:15 178:2 apoptosis 167:12 167:15 apparent 113:2 appeal 105:15 appeals 73:2,6 91:12 93:14 appear 105:12 143:12 appears 4:14 107:17 108:5,15 119:14 125:2 appellant 93:14 appellants 31:13 32:8 102:15 124:18 143:5,22 144:5 145:18 appellants' 103:20 Appendix 59:19 apples 91:10 applicable 166:13 applied 118:20 applies 181:16 apply 108:8 118:15 applying 166:6 appointed 51:8 appointment 32:15 143:24 appreciate 70:24 approach 1:21 12:10 52:6 53:9 53:10 57:1,5,6 106:4 approaches 67:20 67:22,23 appropriate 32:6 52:18,21,23 70:5 86:1,1,21,23 87:11 91:9,13,14 117:3 123:1,7,22 140:5 appropriately 112:12 approximate 179:9 approximately</p>	<p>55:2 area 14:13 37:19 44:9 53:4 62:3 92:4 93:5 97:24 109:16 113:3,4 117:16 123:21 127:15 145:15 149:5 156:3 160:16,17,18 172:3,4 182:12 areas 34:10 49:16 82:21 112:18 137:16 140:11 180:11 Areneta 85:8 argue 52:8 116:3 127:17 argued 75:18 arguing 150:6 argument 28:8,15 128:23 156:15 arguments 1:23 143:15 arisen 1:19 arises 149:16 arising 15:17 173:1 arm 149:9,10,12 Armed 73:2 arranged 31:18 article 79:17 articles 23:23 aside 115:16 asked 1:10 28:8 29:14,22 32:16 51:20,22,25 55:1 58:18 64:2 73:12 87:8 103:16,20 104:20 107:13,15 107:16,24 118:1,4 118:7,15 122:4 127:24 128:3 129:9 139:23 143:19,23 170:22 172:18,23 asking 1:22 25:23</p>	<p>86:13 89:5,6 107:9 133:16 142:21 151:20 154:11 aspect 155:8 aspects 92:21 155:7 aspirin 145:13 156:2 assault 89:20 assent 102:16 assertion 93:22 assess 64:12 112:6 122:14 143:20 assessed 60:16 103:22 assessing 51:2 65:11 assessment 72:5 104:11 assign 129:4 assist 75:21 assistance 31:12 Assisted 1:4 associate 76:19 associated 63:15 78:17 125:5 177:5 associates 76:16 77:7 association 4:17 13:14 37:12 53:15 72:14,16 73:1,10 86:10,12 95:16 associations 19:14 assume 45:19 53:20 110:1 119:10 131:17 136:3 150:23 assumed 108:18 assuming 45:4 67:5 128:3 assumption 54:23 63:4 assumptions 89:23 astonished 76:8 atmosphere 136:1</p>	<p>atom 42:20 137:19 atomic 75:25 77:25 89:19 90:5 109:5 159:22 174:21 175:10,22 atoms 41:1 78:1,1 attach 97:7 attained 15:11 attempt 11:22 12:4 12:6 attention 61:11 81:23 96:20 173:11 attributable 15:3 audibility 71:20 Australia 109:24 110:3 author 2:12,13 4:14,17 63:7 authoritative 68:9 authorities 129:21 164:10 authority 167:20 authors 9:24 14:5,8 25:10 61:25 173:13 available 32:16 43:8 54:10 56:11 57:3 59:10 61:13 65:25 71:2 86:11 104:7 availed 54:11 average 129:18 152:11,12,13 155:14 avoid 55:12,13 129:24 130:11 158:18 awarded 39:23 aware 5:8,12,14,17 10:6 35:5 37:22 38:25 39:6 54:4,6 56:13 61:15,17 75:10,13,14,15 76:17,18 82:9</p>
--	--	---	--	---

84:10 89:17 92:25 93:1 96:1 104:14 105:15,23 122:9 135:19 154:19 166:4 174:22 awareness 92:6,7 awful 87:13 155:6 awfully 168:19	45:18 50:18,19,20 51:4 56:17,18,24 57:11,19 58:19 64:20 105:18 148:18 169:21 Battersby 33:1 49:25 50:16 56:20 57:8 63:5,8 102:18 Battersby's 34:23 40:6 64:13 Battersby/Smith 143:5 battlefield 87:3,13 97:24 Bayesian 57:1,5 beadle 165:24 beam 40:18 bear 63:23 119:1 120:6 133:6 bearing 3:15 141:21 Beeton 124:20 128:14 beg 60:5 began 63:7 beginning 18:10 behalf 32:9 96:3,7 behave 7:17 beings 115:12 BEIR 64:18 120:7 Belarus 172:18 belief 86:21 156:25 believe 77:23 86:14 120:19 believed 87:1 171:16,20 177:6 benchmark 115:19 beneficial 141:10 benefit 116:25 128:13 best 125:13 156:20 171:24 175:9 182:11 bet 129:7	beta 132:25 147:16 148:1 better 70:11 126:3 138:20,21 146:4 156:19 159:5 170:5 175:3 beyond 170:13 bias 52:9 53:18 54:20,21,22,24 67:5 86:13 biases 66:13 big 82:25 83:4 92:19 111:10 167:25 168:5 179:9 bigger 132:25 Biggs 168:21 bind 41:17,23 45:8 46:12 47:22 48:2 48:25 49:2 76:21 133:20 166:19 binding 41:11 43:2 48:23 94:21 binds 40:10,24 47:9 77:19 132:7 135:7 165:5 bio-available 45:14 48:4,6 bio-emitting 40:12 biological 30:21 42:24 112:25 132:3,6,12 133:3 150:11 biologically 63:20 63:24 biology 41:14 59:4 62:23 63:16 92:24 94:14 132:15 135:20 158:8 biomarkers 7:20 7:21 biostatistician 113:9 Biostatisticians 113:12	biostatistics 51:7 biotransformation 44:22 45:13,20 46:24 48:3 birth 50:2 52:14 56:21 bit 60:22 71:3,3 74:10 100:1 106:23 109:10 138:4 140:16 141:5 155:20 182:15 black 89:21 90:2,4 90:7,10 150:1 bladder 106:9,10 BLAKE 1:12,17,22 2:4,9,11,14,20 3:12,18 4:5,7,23 5:5,24 6:4,6 7:6,8 8:4,11 12:17,20 12:23,25 15:15 16:4,11,15,21,25 17:2,6,9,25 18:2,8 18:20,23 19:3 20:13,18,20 21:4 21:10,17 22:19,21 22:23 23:2,16 24:3 25:8,20,24 26:2,5,8,13,18,20 27:1,9,18 28:1,5 28:12,17,20,25 29:6,10,18,23 30:1,4,22 34:12 35:11,13 41:6 43:1 45:21 49:11 58:18,23 59:5 60:3,22 61:15,19 66:2,7,9 69:10,20 69:24 70:4,14,17 70:19,22,24 71:5 71:13,16,19 72:8 72:11 76:10 79:16 79:19,22,25 81:6 81:9,12,14,17,20 81:23 82:3 87:21	87:24 88:10,14,21 89:4,10,12 90:10 97:7 98:20,22,24 99:2,5,8,13,18,21 99:23,25 100:2,14 101:5,15,18,21 102:10,18,21 123:6,10,14,16 129:8,12 130:3,14 130:21 131:7,11 139:11,15,18 140:13 141:4,7,11 141:17,19 142:2 142:14,17 145:25 146:4 150:16 156:17 158:9 168:21 169:7,13 169:15,18 170:3 170:13,25 172:8 172:11 173:5 174:2 175:7 178:5 178:11,24 179:16 179:18,22 180:22 181:1,5,10,13,20 182:1,3,7,11,22 183:4,9,15,22 blank 18:14 blinded 80:13 blood 78:12 136:6 161:1 162:4,8,11 162:14,16 175:24 bloodstream 136:16 174:6 bluntly 138:23 BMJ 51:12 board 19:21 23:8 72:4,8 73:19,23 96:15,21 boats 5:10,16 7:15 bodies 75:12 131:24 164:1 body 8:24 11:8,9 12:10 20:5 36:6 37:2 41:18 43:15 43:20 44:6,7,21
B				
B14/235 16:2 back 12:14,19 29:4 61:23 66:10 79:11 88:2 94:19 115:3 136:13,21 141:22 150:21 158:3,4 174:3 backbone 76:21 94:22,23 background 31:25 55:8 129:24 130:11,24 138:11 backup 68:13 backyard 180:14 bad 55:5 badly 50:2 56:22 balance 39:7 106:14 117:20,23 balancing 116:25 bang 149:22 bar 31:23 base 77:3 based 6:21 50:6 60:11 62:9,20,22 63:4 65:12 88:16 93:15 103:21 106:19 117:20 120:19 125:22 126:19 152:11 162:6 bases 158:2 basic 46:19 78:7,15 basically 131:25 basing 143:19 basis 38:2,3,9 42:24				

45:7 47:16 48:4 49:3 53:19,22 57:16,18 58:3,12 63:18,23,24 65:3 75:11 111:21 131:17,18 132:5 132:13,20,21 134:2,7 135:22 136:7,25 143:13 149:5 150:12,14 155:24 158:4,10 158:18 160:15,19 161:6,6 163:1,4 163:18 164:25 171:17,21 174:8 174:19	boundary 39:19,25 bowels 98:3 box 66:16,19 102:24 155:20 181:21 bracket 88:8 brackets 84:18 101:2 brain 44:1 branch 51:21 break 9:20 69:24 70:2 141:7,9,11 142:10 breaking 178:6 breast 171:18,20 breathe 7:16,25 44:24 136:1 Brenner 74:22 briefly 60:18 67:22 108:4 bringing 65:2 brings 180:11 British 4:1 5:11 15:12 39:5 53:14 103:19 broken 94:21,24 buck 123:10,12 182:16 build 151:24 building 17:4 149:9 bump 157:11 bundle 16:22 17:24 36:10 42:9 65:23 100:4 139:10,16 168:22 bundles 164:18 burden 11:17 burn 183:16 Busby 1:7 2:12 17:5 23:19,25 25:20,21,22 26:1 26:3,6,9,10,15,18 26:19,21 27:2,10 27:14,20 28:3,6 28:14,22 29:12	30:8,9,23 31:3,6 31:11,13,18,20,21 34:7,8,10,13,13 48:19 50:6 61:7 64:3,22 66:8,10 66:11 69:8 71:11 71:15,23 73:15,17 73:21 74:6,15 84:15 85:4,9 96:2 96:12,13 97:3,9 98:18,25 99:1,4 140:19 141:5,8,14 141:18,25 142:12 142:13,15,18,21 146:2,8 150:18 156:21 158:10 168:25 169:8,16 169:17,20 170:10 170:15,24 171:6 173:6 174:3 175:10 178:9,15 179:1,23 180:17 181:4,19 185:5,7 185:8,10,11,14 Busby's 32:14 Busby/Schmitz 24:20 busy 95:10	call 70:4 71:12 77:18 98:25 99:22 120:17 called 7:8 9:14 31:10 43:22 44:21 117:22 159:24 camp 32:2 campaign 72:20 campaigned 53:23 campaigners 88:17 campaigning 53:19 85:25 86:22 91:11 91:16,21 96:3 campaigns 72:22 Canadian 113:19 cancer 4:3 17:12,16 18:13 19:2,10,15 19:23,24 20:9,15 23:6,9 49:13 62:24 101:10,14 106:10,11 113:3,3 117:5 118:19 120:5,5,9,10 133:19 134:11 145:16,19 152:23 153:3 154:19 155:1,3,7 156:8 156:16,23 157:2,2 157:9,20 163:15 165:13,20 166:3,7 167:13,16 171:9 171:24,25 172:22 173:7,15 176:12 177:8 178:15 179:8 cancers 20:25 93:23 95:2 119:18 120:2 127:8,14 134:10 173:1,24 173:25 176:23 candle 183:17 capacity 95:15 captain 97:19 carcinogen 49:12 carcinogenic	118:23,25 134:13 carcinoma 101:7 101:12,14 165:14 cardiovascular 124:23 125:6 Cardis 122:8,10 care 72:22 careful 13:9,10 15:7 138:25 156:17 carefully 15:5 78:16 92:2 carried 5:9 66:1 97:12 165:23 carry 17:2 92:23 114:1 115:4 168:15 175:14,18 carrying 52:24 111:24 case 8:20 14:12 20:10 21:12 33:1 34:23 40:1 47:18 48:14 49:23,25 50:4 62:11 67:25 96:6,10 97:4 104:3 115:8 117:12 118:4 121:22 139:6 143:4 145:9 148:19,20 149:6 151:13 155:5,22 156:10 179:6 cases 10:5 20:12 35:20,23 36:3 38:20,21 52:4 62:22 casings 160:11,12 catastrophic 167:9 Catovsky 33:4,14 33:23 34:14 65:19 126:13 Catovsky's 32:25 33:8 34:3 66:3 126:16 caught 70:8
			C	
		C 17:19 caesium 132:18,19 calcium 158:12,14 158:20 159:2 164:22,23 calculate 144:13 147:22 150:8 153:8 calculated 3:22 140:4 147:12 155:12 calculating 39:11 calculation 3:2 calculations 2:21 46:5		

causal 13:15 88:6,6 106:20 173:8	58:17 76:22,24 80:14 84:25	42:2	chromosomal 5:8 6:15 7:3,19 80:10 86:6	clinically 171:23
causation 36:19 39:2,11 49:14 57:10 88:18 94:6 106:7,10 113:4 118:2,8	133:18 134:8 153:18,20 154:3,4 154:6,12,20 167:12	chemical 9:13 30:21 42:7,15 45:2,8 46:11 48:12 75:22 76:3 76:7 97:24 134:15 145:8 158:15 159:25 161:9 172:6,12	chromosome 3:8 3:20,24 5:1 8:18 10:3 14:24 79:22 84:25 85:2 97:12	clinicians 127:10
causative 14:11	cells' 43:21	chemically 94:21 132:7	chromosomes 9:10 9:18 11:10	CLL 17:12 21:18 22:5,8,14,16 35:20,23 36:3,23 37:3 38:4,6 39:8 39:10
cause 25:2 38:7 49:2 58:2 85:14 89:8 94:22 96:8,9 96:10 102:4 103:19 118:19 119:11 129:4 134:10 135:17,18 145:19 152:23 167:10 177:3	cent 6:18 39:3,16 137:6 162:6,18,18 163:1,23,24 170:1	chemicals 13:24	chronic 21:7,21,24 33:1 36:5 38:20 60:25	CLL's 37:12
caused 9:5,8 38:6 49:21 85:15 86:22 93:17,25 106:11 120:2 143:22 177:4 178:16 179:7	Centre 100:14	chemist 159:5	circle 8:24	clonal 172:5,9
causes 108:24 119:18 120:9,10 120:22 165:16 177:7	CERRIE 58:10 64:9,18	chemistry 44:8 76:9 77:3 78:7 95:5 132:13 160:10	circles 46:2	closest 179:13 180:4
causing 14:1 42:21 47:17 48:23 87:4 135:12	certain 9:11 24:16 89:1,17 103:19 108:11 114:15 116:6,10 137:16	chemotherapy 60:15	circulating 163:1 33:24	cloud 90:22 91:7 97:22
caution 66:21,22 114:14 130:5 164:14 166:5	certainly 25:18 96:19 108:14 120:4 125:12 128:21 138:6 139:20 148:9 150:22,25 152:2 162:12 163:9 180:4	Chernobyl 21:25 24:10 25:1 27:23 35:21 110:20 172:17 176:10,12 178:16 179:3	cite 45:3 62:18 85:8 93:2	co-supervising 31:12
cautious 164:15	cetera 164:12	child 56:3 176:17	cited 2:18 122:11 130:17 143:14	coded 6:13
caveat 66:20	chain 158:3,4	children 52:15,20 55:13,14,24 172:22 173:17 180:13	citing 42:16	codes 80:13
caveats 27:21 53:8 135:19 136:21	chair 40:12	children's 52:15	city 3:10	coefficient 39:14
cell 9:9 14:7 68:24 69:6 81:21 154:15 154:18,20,24 156:24,25 157:1 157:17 163:11,12 163:12,14 166:21 167:10	chairman 51:10	Chinese 110:9	civil 117:22	Cohen 99:11
cells 9:9 57:24	challenge 125:10	chlorate 161:20	claim 75:1 88:12,16	cohort 110:19 112:7 120:13 139:3,6
	challenging 41:9	chloride 161:17,18	claimants 88:17,17 88:19,22	cohorts 109:2 110:16,18 115:5 138:13 139:3
	chances 153:3	choice 55:12,15,18 62:2 66:12 77:8,9 77:10	claimed 103:20	colleague 55:16 68:6 172:18
	change 71:19 102:4 161:10	choose 54:12,14 122:7,7	claiming 92:25	collect 86:19
	changes 63:16 72:1	choosing 55:14	claims 29:15	collective 5:15
	Charles 29:25 96:1 105:13 185:6	chop 149:12	clarification 3:13 15:11	College 100:11
	chat 154:22	chosen 62:3 85:22	clarify 69:12 129:8	colon 151:3,3,7,8 151:19,22 152:10 152:12,14,17,18 154:5,18,24 155:12 156:1 161:24
	check 33:25 70:6 123:24 175:18	Christmas 7:20 44:19 90:5,8,10 91:7 106:11 109:20 130:23	Clarke 51:9	claimed 103:20
	checking 68:16 123:14		clean-up 22:1	claiming 92:25
	chemi-absorption		clear 47:4 98:9 108:19 159:17	claims 29:15
			clearly 25:13 53:9 104:21 106:25 109:20	clarification 3:13 15:11
			clerk 29:17	clarify 69:12 129:8
			clients 29:20	Clarke 51:9
			clients' 29:15	clean-up 22:1
			clinical 52:5 89:1 172:19	clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19
				clean-up 22:1
				clear 47:4 98:9 108:19 159:17
				clearly 25:13 53:9 104:21 106:25 109:20
				clerk 29:17
				clients 29:20
				clients' 29:15
				clinical 52:5 89:1 172:19

combine 129:14	comparison 68:1	174:8 175:24	confounding 13:22	contained 31:14
come 14:19 33:20	68:13	concept 145:1	15:1 25:4,10	138:5
50:22 61:25 64:14	compartments	150:6 178:14	confusing 159:8	containing 42:10
65:8,9,13 73:9	97:17	181:13	congenital 24:9,15	43:10 57:16
77:20 78:4 90:19	compendium 59:23	conceptus 69:18	48:23 49:14 59:2	contains 44:21
104:5,25 107:25	59:24	concern 24:25	61:9 62:23 67:1	164:22 165:1
108:16 112:14	compensate 38:14	65:18 85:14,15	68:4	174:5
120:6 136:21	38:19,22	91:17,20 93:5	cons 52:9	contaminated
146:23 147:17	compensation 23:8	115:17 131:3	conscious 17:2	180:8
149:22 160:23	36:20,24 38:1	143:8 153:23	25:22 58:23	contamination
167:23	39:2,23 54:16	concerned 49:16	consecutive 52:4	44:15
comes 91:5 120:25	73:2 117:18	69:16 71:1 87:2	consensus 37:11	contaminations
126:23 127:4,8,19	compilation 14:20	95:19 118:14	122:19 125:14,23	14:10
136:13 167:3	25:1	139:14 172:12	126:2 157:20	content 30:1 71:11
172:11	compile 25:14	concerning 88:25	consequence 13:5	contentious 66:10
coming 3:12 29:2	complaining 169:9	concerns 27:21	97:21 128:4,19	contents 99:10
29:13 46:11 47:16	complete 3:15	75:24 85:21 87:12	157:20	context 5:12 36:25
69:21 77:14 106:5	20:16 181:23	89:18	conservative 64:11	106:8 116:18
113:7 117:25	183:6,18	conclude 66:24	116:19 129:19	117:25 118:6
151:12 168:3	completely 63:16	conclusion 14:21	consider 1:23 13:24	129:16,22 133:13
170:20 182:25	174:18	15:24 19:12,20	19:22 30:17 32:12	133:23
comment 13:10,17	completes 29:3	21:21,24 22:1	32:23 53:5 54:14	contexts 106:13,14
19:4 20:13 24:17	69:20 98:20	28:25 36:1 37:15	80:2 102:1 103:17	contingency 181:6
33:13 57:12 84:14	complicated 133:6	38:2,17 41:10	122:19 123:12	continue 1:6
133:20 146:6,7	compliment 127:18	50:22 59:7 60:8	126:2	180:18,22
169:1	component 43:9	63:25 105:19	considerable 74:3	continued 1:3,5
commented 1:25	components 147:17	107:19 121:10	111:21 126:25	185:4,5
comments 28:1	161:14	125:3	consideration	continuous 43:22
123:23 124:17	composed 158:5,10	conclusions 9:25	113:15	continuously 58:3
128:24	composition 77:25	14:13,16 27:22	considered 13:16	contract 182:23
committee 58:10	78:1 158:1	36:6 56:17 58:19	16:9 21:20 35:15	Contradicted
64:10 72:10 73:20	compound 46:12	59:9 61:25 62:8	78:16 101:23	28:12
common 13:17	48:9 158:15 161:3	64:21 65:8,9,12	107:13,20 125:22	contradiction
22:13 24:17 25:16	161:10	80:24 126:20	142:22	108:15
25:18	compounds 48:5,9	condition 93:16	considering 40:2	contrary 14:3 62:7
commonly 16:5	48:9 136:16	103:20	79:5 137:13	64:6 108:9
communication	concede 161:21	conditions 40:5	consist 154:3	contrast 40:20,20
182:22	conceive 13:25	67:1 95:3 127:8	constantly 112:11	control 55:1,7,12
comparative 20:24	concentrate 9:1	127:12	constituent 135:24	55:14,15,18,19
compare 91:9,10	132:4 171:22	conference 2:25	constraints 67:24	62:2 67:15,25
179:2	concentrated	confidence 6:18,22	constructively	68:10 155:16
compared 13:4	176:22	80:19 82:5	29:18	controlled 138:3
67:7,14 122:15	concentrates	conflict 32:10	contacts 75:5	controls 13:4 55:6
163:10	131:22	confounder 25:18	contain 142:24	66:12 67:2,8,11
comparing 68:12	concentration	confounders 13:16	143:12	67:12,16 68:14,18

85:22 86:7 convenient 178:6 180:19,23 183:15 conventional 20:6 151:18 156:25 convey 50:15 Copernicus 119:13 copied 18:5 copies 24:5 51:6 copy 30:9 36:13 71:23 78:21 copying 19:5 Cornish 129:20 Cornwall 129:20 corollary 50:5 correct 21:9 23:1 28:9 30:14,15 31:2,5 36:7,8 68:20 96:17,22 106:4 119:16 125:2 134:24 146:5 corrected 69:1,5 88:4 corrections 1:16 100:20 cough 136:10 150:21 167:25 coughed 150:23 161:23 count 37:25 countries 24:22 38:13 138:24 country 127:16 course 2:21 4:18 50:8 51:6 52:8 62:17 99:14 107:25 111:23 113:1 116:6 144:1 144:1 147:1,1,9 148:7 149:6 151:2 151:15 153:20,21 154:18,23 157:6 159:19 160:3 164:25 165:12	167:4,11,14 177:6 court 85:18 102:24 103:2,3 104:5 171:19 184:2 court's 131:6 cover 30:20 34:11 covered 97:11 126:14 cow 180:15 cows 180:9,12 CPR 142:23 144:2 crazy 175:2 create 14:4 credibility 67:6 credible 8:1,6 107:6 108:5 126:5 135:5,6 credibly 115:1 criteria 17:21 18:9 38:23 120:7 critical 64:20 125:17 129:5 136:24 137:1 critically 103:13 criticised 15:8 criticism 33:3 75:15 104:12,17 127:25 criticisms 65:1 75:10,14,16 critics 28:7 cross 32:1,3 39:19 cross-examination 1:5,7 30:24 72:12 102:11 142:12 185:4,8,11,14,14 cross-examine 141:9 cross-examined 85:19 cross-examining 18:4 182:9 crossed 39:25 crucial 18:16 47:21 crush 136:8	crushers 162:7 crypt 153:19 CT 10:20 11:5,6 111:18 cure 94:9,11 171:23 curiously 110:12 current 11:22 27:11 45:18 47:25 65:11 curve 8:22 customary 104:9 CV 30:17 CVs 122:17 Cyril 51:8 <hr/> D D 185:1 D3/10 36:10 damage 49:22 57:25 58:2 61:2 65:6 84:25 85:2 87:14,18 94:17 95:24 155:7 167:11 damaged 86:14 dangerous 54:21 76:20 dashing 98:5 data 19:20 20:24 22:3 24:23,24 40:4 54:10 55:7 67:20 68:10,13 86:19 89:17 124:22 162:6 164:9 database 68:4 date 33:8,11,18 65:21 72:3 176:15 dated 100:8 dates 34:3 72:7 day 31:22 47:8 58:4 140:24 182:25 days 58:4 132:14 132:16,18,21	163:22 182:4 de 48:20 50:6 61:7 64:23 66:11 84:15 85:4,9 dead 29:20,21 deal 13:18,19 17:13 49:17 70:9 77:13 77:14 80:20 87:22 106:17 124:20 128:9 131:13 133:22 151:18,19 179:9 182:19,21 dealing 40:1 57:13 57:21 58:2 60:24 60:24,25 76:15 118:18 119:21 127:14 139:1 deals 48:4 dealt 130:24 163:7 dearth 53:4 death 87:14 167:10 debatable 75:13 debate 146:1 156:18 170:6,16 decay 58:11 152:16 December 100:8 decide 9:7,23 13:12 118:22 120:24 121:3 137:17 decided 38:4,13,19 163:8,14 deciding 37:6 137:24 decimals 81:2 decision 36:23 94:5 deck 98:2 declare 15:19 defects 135:13 defer 122:5,9 126:22 127:5,9 deferring 126:16 defined 114:17 definitely 62:13 definition 144:20 145:11 146:8,21	146:22 147:18 definitions 146:24 definitively 37:14 deformed 50:2 56:22 defracted 40:25 degree 2:6 12:13 13:12 170:2 degrees 77:23 delete 182:23 deliberate 94:10 deliberately 23:12 deliver 58:15 delivered 40:22 43:18 44:1 demonstrated 43:16,25 denied 173:8,9 density 156:12,14 dentist 117:4 denying 138:15 Department 36:17 depend 153:19 154:8 161:19 dependent 180:24 depends 83:22 89:15 121:17 131:19 155:25 160:22 161:2 171:18 depleted 72:4,21,23 72:24,25 73:3,18 73:23 86:22 87:2 87:25 89:20,21 91:3,23 94:17 96:15 164:3 deposited 136:14 137:18 140:11 154:13 depth 86:4 derived 3:24 166:20 describe 51:15 74:5 described 78:9 designed 94:9
---	--	--	---	---

112:12 118:24 desk 16:3 59:15 despite 70:7 destroy 183:20 detail 33:21 60:19 105:24 details 28:4 51:20 51:22 52:1,14,16 52:19 55:3 detect 20:5 162:4 detectors 98:1 determined 124:24 determining 36:19 detonated 89:22 detonation 8:15 97:22 detoxification 48:7 48:11 develop 156:20 developed 39:8 93:23 95:2 114:18 131:25 development 69:17 92:22 94:10 developments 75:19 develops 20:9 diabetes 51:10 diagnose 20:3 119:8 diagnosed 35:20 diagnosis 20:6 117:14 119:18 diagnostic 130:7 dicentric 6:20,21 6:23 7:1 11:10 80:20 die 20:9 died 55:24 56:1 diet 120:4 153:5 diets 164:12 differ 146:14,15 difference 43:2 63:12 149:7 163:5 differences 7:24,24	different 6:21 14:16 23:4 25:12 62:24 76:15 83:12 83:21,25 88:15 95:21 97:18 106:18 107:19,22 108:25 114:4,5,7 115:4 132:8 144:16,23,23 147:14,18 155:21 158:15,25 159:1 159:18,25 164:12 164:16 174:14 177:14 180:10,11 differential 83:2 differentiate 9:23 differently 147:19 difficult 13:25 14:13,13 36:16 38:10 46:19 84:6 108:10 119:24 133:8 138:17 140:16 154:22 difficulties 112:5 difficulty 19:3 dig 170:15 dilute 58:12 dilutes 152:5,16 diluting 155:23 dilution 63:21 direct 41:15 125:7 directed 170:22 direction 38:16 57:2 169:13 directly 41:21 94:18 124:10 director 100:13 disagree 106:4 114:24 134:5,17 134:22 164:8 177:12 disagreement 58:21 disagreements 58:24	disaster 110:20 discipline 20:2 disclose 32:6 disclosed 140:9,22 discovered 31:24 discrete 82:21 discuss 2:17 32:25 143:10 discussed 32:4 96:21 107:21 115:5 discussing 153:7 discussion 36:23 59:7 93:6 143:13 147:3 discussions 96:14 96:25 149:17 disease 22:17 38:7 38:8,12,16 40:4 60:9 120:14 124:23 125:6 disprove 121:21 disputes 175:25 dissolve 161:15 162:2,3 dissolves 156:1,3 distance 137:17 distinguish 117:16 159:12,16 distinguished 32:2 113:18,22,25 distributed 57:17 136:7 156:13 distribution 9:9,10 12:9 44:6 83:2 divide 148:24 154:20 divided 149:1 divider 99:10 dividing 57:24 divulged 110:4 139:1 DNA 9:20 40:10,24 41:19,23 42:7,16 45:2,9 46:12 47:9	47:22 48:23,25 49:2,7 57:23 75:22 76:3,7,16 76:19,22,23 77:7 77:19 78:8 94:20 94:20,20,22 133:18 134:1,8 135:8 154:21,22 155:3,7 157:5,6,9 157:11,18,22 158:1 165:1,5,10 165:11 166:23 167:7,9,11 document 12:20 17:14 105:12 141:22 documents 4:12 6:1 dogs 165:24 doing 50:18 60:4 70:6 74:14 88:1 116:4,4 117:17 119:1 129:16 136:20 181:22 Dolk 68:6 DoReMi 92:10 93:2 93:5,7 94:11 dosage 11:23 129:10 149:2 dose 3:22,25 4:2 5:4 6:16,19,20,22 7:6,8 8:7,16 10:4 12:15 19:15 22:4 35:24 39:20 58:11 58:13,16 63:5 68:23 69:6 80:17 80:25 81:8,25 82:23,24 92:10 103:21 107:22 111:15 119:22 125:4,24 129:5,5 129:18 130:4,9,11 130:12,14 131:2 131:13 132:1,8,15 132:22 133:5 136:24 138:11	139:24 143:20,21 144:3,4,7,10,12 144:17,18,20 145:1,3,12,12,18 145:20,21,23 146:9,20 147:4,9 147:17,25,25 148:1,8 149:10,14 150:6,8 151:19 152:10,17 153:1,9 153:25 154:1,6,12 155:10,12,14 156:4 162:19 163:4,6,7,9,10 166:16 167:3,9 175:25 176:11,24 176:25,25 177:5,7 177:16 178:20,24 179:7,10,11,14,17 179:18,19 180:6,6 180:8,8,15 doses 7:4 27:12 40:5 80:8 82:13 83:21,25 108:2,4 108:7 124:24 128:23 131:3 140:3 144:24 146:25 147:11 148:14,15 166:11 166:14 177:1,4,18 177:20 178:19,21 178:23 179:9 dosimetric 129:1 dosimetrist 146:23 147:23 151:21 154:9,16 dosimetry 2:15,16 5:18 6:13 7:23 8:17 12:5 92:24 180:2 dosing 82:22 double 9:19 158:2 double-sided 19:5 doubt 25:13 48:1 88:6 93:15,18,22
---	---	--	---	---

94:5 103:17 106:7 106:18 118:7,19 119:3,5 148:11 Doyle 85:8 Dr 1:7,21 2:12 21:19 23:19,25 25:20,21,22 26:1 26:3,6,10,15,18 26:19,21 27:2,10 27:14,20 28:3,6 28:14,22 29:12,23 29:24 30:8,9,23 31:3,6,11,12,13 31:18,20,21 32:14 34:7,8,10,13,13 64:3 66:8,10 69:8 69:12,16,19 71:11 71:23 73:15,17,21 74:6,15 96:2,12 96:13 97:3,9 98:18,25 99:1,4 113:6 123:6,8,23 124:13 125:10 126:7 128:14 129:10 141:1,5,8 141:14,18,25 142:12,13,15,18 142:21 146:2,8 150:18 156:21 158:10 168:25 169:8,16,17,20 170:10,15,24 171:6 173:6 174:3 175:10 178:9,15 179:1,23 180:17 181:4,19 182:5,17 182:21 185:5,7,8 185:11,14 draw 14:14,16 15:24 81:23 91:11 180:20 drawing 96:20 drawn 64:1 86:10 98:7 drew 61:10 173:11	drinking 180:13,14 drive 88:2 drug 144:18 due 66:23 67:8 99:13 Dundee 167:21 DUOB 72:9 75:7 75:15,18 83:1 95:13 dust 138:4 dusts 57:15 duty 32:17 47:4,20 47:24 57:7 61:5 61:12 62:5 64:24 dwelled 150:13 dwells 167:1 dye 135:14 <hr/> E E 185:1 e-mail 170:11 E3/12 17:15,19 earlier 14:3 58:25 68:22 70:7 71:7 107:21 122:4 168:1 176:4 182:6 early 23:22 52:15 earth 10:25 90:1,25 135:24 easily 14:11 easy 133:5 eat 120:4 135:25 161:7 180:12 eating 156:2 echoing 75:16 ECRR 3:1 64:7,20 65:9 74:16 75:8 75:16 ECRR's 64:4 editor 2:22 education 139:19 effect 10:18 11:6 14:5,6 25:15 32:20 50:1 56:21 57:21 64:13,17	67:4 77:1 90:13 115:7 125:24 129:4 137:24 148:6 155:15,21 176:1 177:22 effective 63:20 effects 46:5,7,8 48:16,22 49:2,5,5 49:10,11 53:23 59:14 60:1,10,13 63:15,22 67:9 72:21 74:7 75:3 84:25 87:15 94:18 96:14,20,24 108:1 108:24 111:4 115:11,11 133:7 146:25 148:9,10 148:14 efficient 49:1 effort 182:5 eight 132:18 either 46:4 88:15 101:14 102:24 105:19 117:17 135:25 140:25 170:19 177:11 elaborate 131:5 electron 40:13,18 41:4 42:10,19,25 76:24 132:25 135:8,15 electrons 40:18,25 42:22 element 55:12,17 131:23 147:10 157:3 elements 174:14,19 elevated 15:2 79:22 elevation 3:23 5:1 11:10 12:12 15:20 eliminate 116:7 Elisabeth 122:8,10 embryological 69:17 emeritus 30:25	95:4 emission 153:14 emit 132:10,20 167:5 emitters 63:17 emitting 152:22 emphatic 47:6 employees 36:20 138:25 ended 150:7 154:14 endocytosis 43:22 ends 183:17 energy 36:20 39:13 132:25 146:9,13 146:19 147:7 148:21 149:1 152:6,16 154:1,2 England 67:3,13,15 English 13:8 87:8 enormous 96:18 114:14 enormously 155:11 enquire 32:19 87:12 ensure 26:10 entering 47:16 entire 63:4 entirely 40:17 87:11 91:13 107:11 110:9 112:19 119:12 138:25 entitled 24:9 entity 159:25 entry 81:14 130:14 environment 74:8 75:4 78:11 83:4 159:11 environmental 87:12 enzymes 158:6 epidemiological 16:7 18:10 22:2,3 51:1,12 52:19,25 53:25 54:13 55:5	56:7 85:13 86:2 88:12,14,24 89:17 113:11,12,16 123:21 125:3 epidemiologist 16:14,19 51:15 84:13 89:4,5 112:22 113:8,19 113:22 120:16 epidemiologists 112:23,24 113:25 114:3,6,15 115:1 122:5 epidemiology 16:2 16:9 19:11 51:4 51:14 55:20 64:20 84:10,22 88:25 89:13 92:3,7,24 122:3,16 124:7 127:5 Equally 121:18 equals 77:3 Eric 167:20,22 Erm 56:2 error 34:5 especially 73:24 91:22 94:17 essential 49:9 essentially 83:3 establish 114:9 115:19 116:17 117:9 established 106:9 118:2 120:13 estimate 12:1 145:17 estimated 57:19 63:6 107:23 177:19 estimates 10:5 11:24 35:24 estimation 3:5 et 79:3 124:9 164:12 ethical 57:6
---	---	--	---	---

EU 43:14 93:18 94:4	181:15,23 183:3 183:18	92:20 131:5 161:17 166:15	159:9 171:12 explained 22:15 98:16	166:24 176:12,18 178:16 179:3,4
EUROCAT 68:1,3 68:4,9,12,18	evidence-in-chief 102:8	expected 46:25 145:24	explains 174:12 explanations 84:7	exposures 7:20,21 10:19 22:4 72:25 93:17,25
Europe 68:5	evidential 50:17,19 50:20	expense 91:16	explore 103:14 106:23 125:9 142:3 181:7	express 15:22 expressed 102:5 147:12
European 92:22	evidently 2:8 23:11	expensive 92:23	explored 64:5 65:1	expressing 134:18
Europeans 22:18	exactly 43:7 44:8 45:16,16 60:3 83:5 107:15 145:5 156:14	experience 5:15 7:15 41:6,15 45:12 50:12 65:3 65:10 75:5 91:10 97:22 98:7	exploring 131:8 142:4	expression 111:13 112:1 114:13
Euros 93:19	exaggeration 74:10	experienced 51:1 115:1	explosion 115:8 173:4 179:4	extend 87:24
evacuees 179:11,18 179:19	examination 19:9 156:22	experiences 88:7 88:23	explosions 130:13	extensive 91:6,10 139:5
event 19:24 24:5	Examination-in-... 30:8 71:15 100:3 185:7,10,13	experiment 77:9 118:22 119:2 151:2 153:22	export 162:21	extent 160:16
events 10:21	examine 147:4	Experimental 60:17	exposed 8:15 9:2 10:22 11:2 25:17 39:13,18,21 43:6 43:7,10 44:14 46:8 50:14 57:15 60:14,15 62:25 69:13 87:4 98:3 98:10 120:3 129:25 137:11 138:18,19 143:22 144:19,22,23 145:7,7,9,22 147:15 148:17 149:4 150:25 153:1 173:18 179:5,23	external 19:16 40:2 48:5 60:11,24 61:10,17 62:10,22 63:14 82:22 130:22 148:17,24
eventually 166:20	example 10:13,19 23:6 92:1 94:19 98:11 106:9 110:23 117:18 120:8 121:11 124:19 126:10 127:9 128:15,18 129:20 131:20,21 132:14 133:11 134:11 148:18 149:17 156:2 160:2 161:4,7,22	experiments 166:1	extra 71:3 129:25 130:12,18	extracted 16:2 17:19 36:10
everybody 38:10 91:16 172:24 180:2	exceeds 39:16	expert 33:8 37:2,16 47:2 51:3 65:4,5 66:1 73:5,16,17 74:7,11 92:20 93:1 94:14 96:2 102:23 103:22 104:4,7 118:9 122:16 123:13,21 126:21,22 127:16 142:23 143:9 145:15 146:23,24 146:25 151:24 152:2,3 160:12,15 171:9 172:2,16	exposure 10:4,8 11:24 12:7,8 14:9 15:3,5 22:5,9 24:10 39:5,17 44:5,13 46:6 49:21 57:19 58:7 61:1 62:4 63:2 64:4 97:16,20 98:12,16,16 103:18 116:17 130:14,17,18,22 130:24 145:4 147:10,19 152:6 165:15,24 166:14	extrapolate 47:11
everybody's 109:4	exceptional 24:22	expertise 40:10 41:7,12 84:21 85:13 90:21,23,24 91:2 92:4,5 96:13 126:25 137:21 140:6 160:18		extreme 84:2
evidence 3:16 19:14 22:4,8 29:1 29:3 30:2 32:9 38:15 41:24 42:6 42:15 43:5 45:1 45:22,24 46:10 47:23 49:19 50:21 59:6,13 61:8 62:7 63:13 64:3,6 65:14,19 69:21 71:16 73:6,16,17 76:2 77:19 88:11 89:14 90:1,12 91:19,24 93:16 94:1,13 96:7,9 98:20,25 99:3,4 102:8,23 103:18 106:19 108:22,23 110:14 113:7 114:4,13,18,25 118:1 122:14 128:1,21 133:9,12 133:24 134:12,14 135:7 136:8 142:5 142:6,7 143:10,18 144:4 150:23 151:22 155:6 165:14 166:10	excrete 48:6 137:3 excreted 137:6 160:25 161:2 163:21	experts 37:5 38:3 75:2 112:19 144:2		extremely 58:15 118:14 133:19 158:7 167:7
	excretion 48:11	experts' 105:3		eyes 87:18,19,20
	exercise 116:24,25	explain 46:7 143:8		
	exercised 66:23			
	exhibit 66:25			
	existence 46:6			
	expand 182:23			
	expect 48:2,14 59:3 63:21 82:13,16 83:7,15,21,24			
				F
				face 137:7
				faced 120:22
				fact 26:15 37:18 38:12 40:12 42:19 52:6 63:18 67:16 68:17 76:18,23 77:8 92:9 104:17 128:25 137:1 153:11,21 155:5 159:2 173:9,24
				factor 13:22 14:11 64:12 148:1,2
				factors 14:1 15:1

25:4,5,10 132:23 facts 33:25 46:5 65:13 168:15 factually 66:5 faeces 160:25 failed 41:4 failure 34:14 fair 65:21 93:2 97:1 114:23 121:10 126:24 fairness 61:13 fallout 2:15 7:25 27:23 44:13 45:4 46:11 47:16 77:15 77:21,21 78:4,8 82:20 83:17,20 91:5 familiar 4:25 16:15 16:18 28:17 families 57:8 72:14 72:19 95:16 family 50:17 57:8 fanciful 93:16 94:8 94:12,13 fantastically 119:24 far 6:12 9:24 24:13 24:22 28:22 69:16 114:12 118:13 135:4 147:6,9 153:4 157:4 159:5 166:22 181:8 Fascinating 87:24 fashion 5:7 146:17 fast 180:7 fate 43:15 46:20 65:3 father 31:25 32:2 56:4 federal 36:15 feeds 124:16 feel 115:20 felt 122:18 Feschenko 24:5 Feuerhake 1:3	24:20 26:17 185:3 fewer 176:20,20 field 15:24 40:10 41:3,16 51:13 90:24 114:2,13 117:1 127:6 146:24 figure 128:15 figures 28:9 128:3 128:4,9 Fijian 15:12 filed 105:3 filings 161:7 fill 55:2 filled 55:23 filling 111:18 final 111:10 156:21 156:22 170:1 find 5:3,4 7:13 9:17 12:12 22:16 25:15 25:16,17 28:15 36:15 59:2 79:12 90:16 93:21 100:7 100:25 101:8 124:10 133:8 137:1 139:17,20 140:16 171:6 172:25 178:6 finding 119:6 findings 14:20 20:17 28:7 60:18 fine 1:11 125:18 178:2 fingerprint 172:25 finish 17:6 71:7 181:12 183:13,19 finished 167:23 Fire 150:17 fireball 77:22 firm 135:17 first 4:13,14,17 6:2 12:20 13:1 21:12 25:8 31:23 36:17 51:17,24 61:4 64:8 66:13 67:10	72:6,19 73:22 75:25 95:25 101:23 102:23 105:4 106:20 108:23 122:3 124:3 127:4 131:9 133:23 134:20 135:21 136:5 141:15 171:11 173:10,12 fish 11:20 97:12 fishing 54:18 five 3:17,18 4:15 58:17 96:16,18 178:7,10,13 180:19 fix 106:3 flagged 141:25 flash 58:1 flaws 56:6 flexible 178:13 flick 59:22 flight 1:9 3:16 29:3 floating 70:25 flow 65:17 flying 1:10 focus 183:1 focused 40:18 foetus 57:22 65:6 69:13,16 foetuses 58:5 folic 25:4 follow 16:16 36:16 72:5 87:10 112:19 119:12 125:8 146:16 152:4 156:15 followed 72:9 74:3 112:11 following 19:23 104:10 110:19 129:12 follows 55:16 food 136:1 foodstuffs 180:9	footed 141:6 Forces 73:2 forefront 109:4,11 foremost 172:16 forget 52:11 57:5 77:12 167:11 Forgive 40:16 forgot 10:9 152:7 form 20:20 40:22 45:8,13,19 46:23 47:12 76:13,25 78:5 88:23 104:11 134:8 145:23 146:13 158:2 160:1,22 161:9 165:3,4 166:19,22 formal 79:12 formation 94:11 formed 43:23 76:12 former 19:24 20:2 110:13 forming 95:1 forms 133:19 forth 27:24 77:13 150:3 forthcoming 110:9 forward 18:12 29:13 63:1 99:13 114:5 134:4,21,23 167:8 181:16 fought 22:13 found 4:3 17:23 46:8 74:13 86:6 159:8 foundation 47:23 four 58:17 143:4 153:18 154:12 158:2 183:6,19 fourth 7:7 174:20 fragment 94:23 fragmented 94:24 framed 56:14 French 110:4 frequencies 13:3 14:2	frequency 9:21,22 9:22 14:24 15:2 fresh 13:24 Friday 169:13 170:23 184:3 friend 55:16 65:22 99:11 friend's 65:17 friendship 31:20 front 12:19,20 26:22 113:14 fruitfully 141:24 full 47:11 168:24 169:12,15 170:5,7 170:18,21 fuller 18:5 fully 2:6 46:21 47:14 function 41:10 funding 87:10 94:4 further 5:14 15:11 24:14 25:19 49:24 65:15 69:9 96:11 98:18 102:8 119:10 150:20
G				
Galileo 119:13 gamma 39:13 58:1 147:16,25 148:23 174:13,20 gastric 156:2,11 gastrointestinal 78:13 gene 155:16 general 45:14 46:22 48:11 67:2 67:13,14 103:24 143:15 144:12 145:11 generally 1:24 41:11 77:25 146:8 170:19 173:8 generated 77:21 generates 77:24				

generation 78:13	127:23 133:24	135:21,23 137:20	82:8,22 148:1	Haar's 18:20
generations 131:24	142:6 183:8	140:25 141:11	149:14 177:1	haematological
genetic 2:1 26:24	gives 58:11 114:11	146:12 147:6	179:20	126:21
49:22	155:3 158:13	148:8 151:8	grazing 180:10	half 132:9,11,12,14
geneticist 3:6,6	175:25	153:13 162:8	great 2:25 7:10,24	132:17,18 133:3
genetics 120:5	giving 125:5 142:5	167:24 169:18	greater 39:17 67:1	141:15 149:8
geno 48:12	169:9 173:22	170:3,9,16 172:24	greatest 174:8	150:10,11 151:14
genome 94:23,24	gland 171:23	175:20 179:8	ground 86:22	half-repaired
genomes 94:25,25	go 3:13 8:21 9:16	180:7,18 182:13	137:14	94:25
95:1	11:19 12:14,19	182:21,24 183:11	group 3:10,21,23	halfway 37:9 39:9
genomic 49:22	15:10 24:1 26:16	183:13	13:4 14:22 49:20	Hallard 103:22
100:14	28:4,22 33:2	gonna 87:19 168:8	53:18 54:14,15	128:1,25 129:10
genotoxic 46:7	44:25 48:15 53:11	good 1:12 17:21,25	55:19 62:2 85:25	131:10 137:20
49:21 134:14	54:18,25 55:9	18:9,22 46:16	88:16 102:17	141:1 148:12
165:15	62:18 66:13,20	55:20 74:13,14	110:16,18,18	175:3 181:24
genotoxicity 75:23	67:16 69:21 74:23	77:10 92:1 93:21	111:11 114:21,22	182:2,10,18
157:8	79:16,19 94:19	97:3 102:12,13	groups 60:15,17	183:12
GERALDINE	98:22 106:23	119:4 124:16,16	76:21 102:14	Hallard's 101:23
99:24 185:12	115:3,14 117:3,6	126:9 127:22	108:25	130:17 139:25
germ 84:25	124:1,19 135:4	131:21 135:10	growth 155:16	183:3
German 2:12 28:11	136:18 143:15	136:7 139:3,4	Gudzenko 35:5	Halle 2:23
87:6,7	148:9,9,10 150:20	142:19,20 145:11	guess 154:15,15	halves 170:18
Germany 23:6	151:8 152:2,19	176:9	guidance 103:10	hand 70:20 183:22
139:4	154:5 157:4	Government 36:6	guide 12:2	handed 24:6 26:12
gestation 176:15	161:25 164:18	36:16 38:3,19	guidelines 36:18	27:17 29:17 36:11
getting 4:23 19:3	169:21 170:3,18	73:19 86:4 95:18	Gulf 72:14,19,22	59:21
53:6 90:1 117:17	172:18 176:19	140:9,17	74:2 76:1 86:6,9	handle 76:20 82:19
145:13 153:3	goes 1:11 61:11	Government's	86:11 87:25 93:24	Hanford 110:25
156:8,11 179:8	62:7 92:8 143:10	36:23 104:19	95:16 97:23	hang 5:5 8:4 19:3
181:7,20 182:14	149:22 151:1	grabs 43:23	gut 95:24 151:1	42:5
give 9:13 31:12	156:15 162:19,19	grammar 76:9	160:24 161:12,14	happen 41:3 42:22
32:9 48:18 51:25	163:23 164:20,21	grandchildren	161:19,20 162:19	47:13 87:19 150:4
65:13 71:16 91:23	179:20	52:17,21	<hr/>	157:2 162:17
93:19 94:1 96:7,9	going 5:6 17:6 21:1	grants 43:14	H	168:6
113:7 117:25	21:4,5,17 24:1	granularity 152:19	H 63:8	happened 82:21
124:17 129:16,22	43:22 44:22 46:2	graph 176:14	Haar 17:22 18:1,2	104:18 149:9
130:9 132:1	54:12 58:5,15	Grapple 11:24 13:6	18:3,25 29:13,19	161:25 172:17
134:19 138:13,15	63:24 64:16 70:15	14:9,23 15:6,13	65:16 66:3,5 71:1	happening 94:16
149:2,14 168:13	77:10,17 86:19,20	15:18	71:10 102:11,12	happens 40:25
given 6:13 31:13	90:22 91:5 98:5	grass 180:12,12	102:20,22 123:17	43:13 45:16 46:23
44:5,13 59:17,18	109:17 110:6	grateful 17:1 178:8	131:9,12 139:22	149:17 153:24
67:24 102:23	113:7 114:22	gray 7:13 8:9	140:14,19 143:3	155:16 157:11
104:10 114:18	115:14 120:2,14	146:21,22,22	159:7 182:8,16	160:15,19 168:2
120:8 121:14	121:7 123:25	147:20	183:2,8,14,18	happily 137:9
125:4 126:20	133:11 134:19	grays 6:16 7:8,11	185:14	happy 28:23 32:22

99:9,25 122:20 125:5 169:1 Harrison 27:7 Hatton 126:11 Haylock 21:19 23:11 113:6,6 123:6,8,23 124:13 125:10 126:7 141:1 182:5,17,21 haystack 120:11 hazards 111:7 head 66:17 168:16 175:19 health 25:5 36:17 52:15,16,20,20,21 53:24 55:25 56:3 57:9 60:10,13 86:15,18 138:7 healthy 55:13 hear 30:5 56:2 98:4 heard 58:24 62:25 63:13 149:23 159:24 170:6 hearing 128:1 133:9 172:21 hearings 37:10 heart 44:1 heavier 114:16 heavily 154:21 heavy 8:24 11:5,17 11:17 40:21,21 41:1 134:16 137:18 162:21,22 held 31:3 115:1 Helen 68:6 helix 158:2 Hello 98:25 help 29:6 40:9 137:21 helped 31:10 helpful 18:4 71:3,4 82:4 108:20 141:14 144:8 156:5 178:24 182:17,25	helps 179:12 Heppinstall 1:5,6 1:13,21 2:2 4:8,24 5:8,22 6:1,5,7 7:7 7:9 8:6,12 9:24 11:9 12:18,22 13:1 15:21 16:5 16:13,17,23 17:1 17:8,10 18:9,15 18:22 19:1,5,7 21:7,19 23:10,18 24:1,4 25:9,19 26:6,22 30:24,25 34:17 35:15 41:21 43:5 46:1 49:17 59:11 60:5 61:4 61:21 65:15 68:14 69:1 70:11,15,18 70:21,23 72:12,13 80:2 82:5 89:13 90:11 96:11 97:2 99:7,11,22 100:3 100:4,16 101:9,17 101:22 102:7 169:11,14 181:24 182:2,4,8 185:4,8 185:11,13 hexavelent 78:2 hidden 20:4 high 2:6 9:2 11:13 12:7 13:11 19:17 39:13,20 40:13 44:9 58:7,16 67:5 67:6 76:3,7 77:21 78:2 82:17 91:6 131:13 156:12,14 163:10 166:2 175:22 higher 13:3 59:9 61:2 155:12 156:4 highest 175:25 highlighted 37:10 highly 14:1 15:2 41:19 64:19 67:4 83:8 167:5	Hiroshima 2:15 32:1 62:3 90:4,9 148:18,22 149:19 159:14 179:4,6 historically 53:23 hitting 155:3,15 Hoffmann 24:5,25 holding 31:6 home 170:12 homines 112:1 homogenesis 172:7 homogenous 8:20 honest 32:17 Hooper 1:9,11 70:16 71:12,14,23 96:6,13 185:10 hope 17:8,9 29:3,17 141:13 145:17 147:2 151:16 152:15 hoped 141:8 172:24 hopefully 59:15 100:7 hoping 90:16 146:17 148:14 183:5 hormone 172:13 hormones 132:1 hot 63:17 hours 58:4 162:20 163:24 182:15 Howard 1:8,10 29:25 30:9 76:22 85:18 134:4 174:12,21 185:6 Howard's 133:12 HPA 27:5,7 64:19 HPA/RPD066 27:8 huge 5:4 59:23 61:23 176:11 179:14,20,25 180:16 Huh 9:3 human 36:18 60:14 115:12 120:23	166:6,8 170:14 humans 11:21 60:9 164:16 165:19,20 166:14 hundred 8:14 hurry 168:20 Huxley 42:8 45:3 hydrochloric 161:13 162:1 hydrogen 43:9 161:18 hydroxylapatite 158:13,14,16,20 159:3 164:23 hypocentre 3:22 hypotheses 143:10 156:18 hypothesis 119:6,7 134:21,23,24 135:1,2 hypothetically 39:12	illnesses 83:2 143:23 illogical 57:20 illuminating 53:11 image 42:21,24 imagine 5:14 103:9 106:1 110:22 imaging 20:8 immediate 115:11 immediately 122:24 immensely 119:19 Imperial 100:11 impinged 148:22 importance 133:13 important 12:11 14:14,20 22:25 53:5,17 57:4 75:24 86:17 108:21 133:19 134:6 149:16 158:8 164:19 167:3 170:7 importantly 50:16 impossible 11:15 15:19 134:18 177:8 180:1 impression 106:24 improbable 119:15 in-homogenous 12:9 in-law 55:16 inaccurate 66:5 inappropriate 53:6 inaudible 159:21 incidence 50:9 101:10,13,20 include 109:20 157:8 included 103:3 107:17 130:8 includes 17:20 40:24 72:24,25 including 9:6 10:25 38:9 41:18
---	--	---	---	--

inconvenient 70:22	104:15	88:20 91:14,15	invasive 157:3	irritation 156:11
incorporate 46:4	INGE 1:3 185:3	95:19 115:10	investigate 93:20	IRSN 64:18
incorporated 46:9	ingest 135:23	168:15 173:7	172:20	Island 7:20 44:20
incorrect 123:3	ingested 162:13	interesting 17:20	investigated 8:23	90:6,8,10 91:7
increase 3:23 5:4	ingestion 180:6,8	120:12	46:21	106:11 109:20
14:2 21:15 24:9	inhalation 44:5	interests 72:18	investigation 139:5	110:25 111:1
87:18 172:22	136:4 150:2	interfere 77:11	investigations	130:23
173:6,10,14,19	159:11 180:6,7	intermittently 74:1	24:14	isotope 132:10
176:11	inhale 43:16 137:8	internal 5:4 7:23	involved 9:15,15	138:9 150:9
increased 4:3	149:18 161:21	8:17 12:17 18:12	31:6 73:18,22	159:21 160:8
increases 178:15	inhaled 43:25	19:16,17 27:24	74:1 95:17 109:18	175:15 176:21
incredible 107:6	94:16 138:6	40:2 46:14 61:1	109:23 113:12	isotopes 12:9 43:11
incurred 14:10	159:14 160:20	62:4,11,15,21	117:17 130:1	60:25 131:19,20
independent 59:6	162:12	63:5 64:13 130:14	139:8 140:2	132:8 133:4
59:11 88:24 91:23	inhaling 137:10,24	130:17 131:1,2,3	involvement 32:7	144:15 160:1
index 92:13	138:10	131:13	involves 48:7 62:11	175:12,15
indicates 124:22	inherent 53:18	internalised 44:23	147:11	isotopic 159:18
indicative 89:18	66:24 86:13	45:12,17 46:20,23	involving 93:5	issue 88:5,18 93:20
individual 7:24	initially 39:18	47:12 48:2,8	INWORKS 21:25	131:12 135:13
120:22 124:18	input 140:3	63:17	iodine 131:20,22,22	138:7 143:17
132:7 144:4 145:7	inquiry 155:9	international 23:15	131:23 132:1,14	151:17 156:20
147:17 148:22,25	inside 45:7 83:23	65:4 74:6,11 75:2	160:1,2,3,4	163:13 167:21
149:2 162:18	insoluble 161:16	75:11	171:22 174:5,6,7	issues 72:20 92:19
163:11,12,14	insoluble 136:17	interplay 113:2	174:8 175:11,21	Italy 172:19
178:21,22	instance 62:3	interplays 112:19	175:24 176:13,22	
individually 128:23	160:20	interpreter 1:4	178:16 179:4	J
individuals 127:2	instruct 104:18,19	5:21 9:21 11:8	180:11,12	January 22:24 23:3
inducible 22:5,8	instructed 104:9	13:9 18:14,19	iodine-131 132:17	33:20
industry 138:4	instructing 103:11	19:6 28:13 29:7	ion 76:12,13,15	Japan 109:6
inevitably 44:14	instruction 47:1	interrupt 17:22	77:5,6,8 134:16	Japanese 3:6 22:17
influence 119:2	instructions 73:9	65:17	ionisation 41:25	job 103:16 123:13
information 6:19	insult 90:2	interval 82:6	ionising 9:15,18	John 120:25
9:13 12:15 15:25	intake 135:21	intervals 6:18,22	10:22 37:13	Jolly 17:25
19:4 22:25 23:3	144:24	80:19	103:18 171:15	joule 146:20
23:13 25:14 29:21	integration 92:11	intervening 11:4	183:10	joules 146:9 149:1
31:14 34:9 43:8	integrity 91:25,25	intervention	ions 41:16 76:20	149:11,13 152:6
47:8 52:12 53:4,7	intense 63:19	177:13	Iraq 74:3 87:13	journey 137:23
54:3 56:11 70:25	interact 78:5	interventional	Iraqi 87:15	judge 105:14
91:12 95:11,14	157:16	177:18	iron 161:7	judgment 91:3
104:6 112:9,10	interacting 76:12	intestine 151:5,9	irradiated 8:20	105:13,21,23
125:22 129:1	interaction 44:10	introduced 55:17	12:11,13 59:14	183:23
130:8,10 138:12	49:6 157:17	introduction 11:20	60:9 111:12	juices 78:13
138:13,15 143:14	interest 18:11	17:20	irradiation 8:21	jump 135:20
143:19	32:10 54:1 74:4	invade 173:25	9:4	jumping 81:17
informed 1:7 91:3	interested 47:15	invaluable 11:20	irrefutably 176:14	135:12

June 1:1 184:3	141:17,19 142:2	45:16 46:2,22	language 105:24	legislation 106:21
justice 1:12,17,22	142:14,17 145:25	47:9,15,17 56:3	106:21	length 153:14
2:4,9,11,14,20	146:4 150:16	57:17 58:10 59:4	large 5:15 22:3	lesions 157:21
3:12,18 4:5,7,23	156:17 158:9	60:3 62:25 63:21	43:14 98:16	lessons 112:6
5:5,24 6:4,6 7:6,8	168:21 169:7,13	64:15 80:16 82:23	111:23 143:13	let's 5:5 6:25 10:1
8:4,11 12:17,20	169:15,18 170:3	83:11 86:7 87:18	157:21 161:24	37:21 38:23 46:3
12:23,25 15:15	170:13,25 172:8	88:5 98:4 102:14	173:16,17	50:23 57:5,5
16:4,11,15,21,25	172:11 173:5	102:21 110:15	largely 180:9	59:11 77:12,13,14
17:2,6,9,25 18:2,8	174:2 175:7 178:5	112:1,1 115:7	larger 102:17	77:18 85:4 88:2
18:20,23 19:3	178:11,24 179:16	118:9,10 119:9	149:10	120:12 121:25
20:13,18,20 21:4	179:18,22 180:22	120:17 121:7,19	largest 112:10	141:11 150:18
21:10,17 22:19,21	181:1,5,10,13,20	122:8 125:12,13	Lasjuk 24:5	158:17 175:7
22:23 23:2,16	182:1,3,7,11,22	129:5,6 130:6	lasting 14:1	letter 104:19,24
24:3 25:8,20,24	183:4,9,15,22	131:21 138:6,7	latch 48:9	143:24
26:2,5,8,13,18,20	juvenile 173:23	140:7 148:5 150:9	late 52:16 142:15	leukaemia 21:8,22
27:1,9,18 28:1,5		150:10,11 151:21	181:2	21:24 33:2 35:23
28:12,17,20,25	K	153:14 154:8,23	latency 40:6	36:6 38:20
29:6,10,18,23	K 101:2,6	157:25 165:20	Latin 112:2	level 46:24 59:9
30:1,4,22 34:12	Kaldor 113:21	166:23 167:1,18	law 93:13	92:22 103:24
35:11,13 41:6	114:20 122:6	167:22 168:6	law's 118:11,12	115:6,6 117:9,10
43:1 45:21 49:11	Kang 85:8	170:14 171:13,21	lawyers 103:11	147:5 148:12
58:18,23 59:5	Kazakhstan 110:14	174:25 175:5,10	104:19	160:10 166:16
60:3,22 61:15,19	keep 21:4 23:16	175:15 176:5,6,6	lead 44:14 48:3	177:13,18,21
66:2,7,9 69:10,20	30:5 70:19 108:21	177:2 179:6,23	87:10 107:18	levels 63:2,14
69:24 70:4,14,17	153:17	180:1 182:12,24	135:9	116:17,19 139:24
70:19,22,24 71:5	keeping 142:18	182:25	leader 4:19	140:8,15 166:2
71:13,16,19 72:8	key 33:5 34:15	knowing 65:5	leading 74:6,11	lies 93:7
72:11 76:10 79:16	151:16 156:21,22	knowledge 22:11	75:2 97:2,8	life 10:22 15:20
79:19,22,25 81:6	kidney 137:3 161:2	32:11,12,14 45:19	leads 15:1 41:9	132:10,11,13,14
81:9,12,14,17,20	kidneys 44:2 137:4	46:13 47:11 48:1	94:17 108:20	132:17,18 133:3
81:23 82:3 87:21	137:6	73:17 127:11	learn 19:22 112:6	150:10,11 151:14
87:24 88:10,14,21	kilogram 146:10,20	168:9	learned 65:17,22	183:10
89:4,10,12 90:10	149:11	known 16:5 24:25	99:11	lifelong 61:1
91:17,20 96:1	kilometres 3:21	25:15 31:21 38:7	learnt 95:15	lifespan 129:23
97:7 98:20,22,24	kind 20:8 95:21	47:14 51:19 55:13	leash 154:25	light 88:15
99:2,5,8,13,18,21	knew 20:2 173:22	55:25 65:12,12	leave 10:20 16:17	likelihood 58:6
99:23,25 100:2,14	know 2:7,8,9,12,21	73:21 113:18,21	17:4 28:23 115:16	61:2 65:6
101:5,15,18,21	2:23 3:10 4:1,18	114:2 147:12	153:22	limit 136:2
102:10,18,21	5:2 8:19,23 9:3	knows 118:13	led 94:11	limited 39:22
105:13 123:6,10	11:5 12:11,12	Komiya 124:9	left 7:7 18:11 80:14	138:21
123:14,16 129:8	15:7 19:21,25	Kulakov 24:6	114:13 119:9	limits 138:22
129:12 130:3,14	23:11 25:17 26:11		151:22 162:25	139:18
130:21 131:7,11	27:15,16 32:4	L	left-hand 6:14	line 72:6 81:9,24
139:11,15,18	33:8 41:16 42:23	laboratories 87:7,8	legal 23:13 105:17	101:2,9,19 123:11
140:13 141:4,7,11	43:7 44:6,8 45:11	lack 25:4 91:25,25	105:24 106:4,13	125:8 155:8

156:22 176:16,21 178:7 180:18,20 181:3 linear 108:8,17,18 177:6 lines 81:6 link 88:6,6 106:20 linked 91:22 liquidator 35:22 list 38:21,23,25 99:11 104:6,14 listed 11:25 23:23 24:1 55:15 104:24 104:24 105:22 listen 24:3 25:8 160:10 literally 168:2 literature 23:15 57:3 61:17,19 62:9 63:1 74:12 74:15,18 109:10 110:15 125:12 litigation 117:22 little 2:2,3 19:14 37:21 43:23 59:13 62:18 71:7 74:10 74:20 103:14 121:25 136:15 141:5 156:17 live 84:6,7 lived 129:17 138:9 liver 44:1 Liverpool 51:7,9 51:10 living 10:25 111:4 112:24 LLS 115:16 LNT 108:6 120:19 120:19 177:7 loads 107:14 local 155:11 156:3 163:9 localised 63:18 location 9:3 84:8 locations 8:19	lodged 57:16 63:19 153:19 154:9 155:25 lodges 44:7 151:2 151:10 logical 38:9,17 50:5 65:12 90:18 146:16 London 100:11,14 long 30:5 52:10 70:15 71:20 73:21 132:11 151:11,13 151:22 166:25 167:5 172:11 longer 150:13 look 5:18 6:12,25 7:3,5,9 9:9 10:1 12:15 14:19,21 21:21 25:13 34:3 34:17 35:8 36:9 36:14 37:7 38:23 43:14 47:8 50:23 56:10 59:11 60:6 61:23 78:21 79:7 80:24 84:24 87:25 88:19,21 89:6,7 91:7 92:19 99:13 104:9 105:2 108:23,24 111:3 119:13 121:17 122:17 124:10 138:12 139:4,9 143:7,19 153:16 162:22 166:11 168:14,17 169:25 178:5 181:16,21 182:11 183:4 looked 6:7 25:12 64:22 78:19 84:13 85:3 87:6 95:23 105:6,8,21,23 134:13 166:23 182:15 looking 7:6 8:7 15:24 18:21,22	39:20 51:1 52:4 57:3 59:25 87:5 88:22 92:23 106:6 108:21 110:22 112:25 115:25 119:3,4,5 120:11 124:19 126:24 127:1 131:10 136:8 163:3 172:6 172:24 173:3 looks 108:13 126:11 182:14 183:2 loose 17:14 59:15 Lord 1:15 25:19 26:19 27:2 28:22 29:12 30:7,18 32:20 38:5 43:13 48:5 49:13 57:13 59:16 61:13,18 65:2,15 66:4 69:22 70:12,23 71:11 76:8 96:11 97:1 98:19 99:1,4 99:12 102:7,22 118:13 131:9 141:6,14 146:3 168:19 169:17 170:24 178:9 179:1 180:17 Lordship 26:11,15 loss 154:24 lost 36:13 71:21 132:21 lot 7:2,10 27:22 40:13 53:12 62:1 62:25 89:13,15,16 106:1 131:4 132:24 133:6 136:19 138:2 141:16 144:7 150:19,22 155:6 165:23 172:13 lots 58:24 85:16 94:16 155:22	158:6 low 3:6 19:16 22:4 27:11 36:1,2 44:11 46:24 81:1 81:2 92:10 108:1 108:4,7 119:21 128:9 129:19 131:4,13 lower 40:5 63:2,14 131:4 LSS 21:25 22:3 109:8 112:7,15 122:1 123:2,4 124:13,22 125:4 125:14 126:15 lumps 174:1 lung 43:19 150:7 150:20 167:24 168:1,6,7,12 lungs 44:1 136:5,6 136:10,12,13,15 lying 174:17 lymph 9:1 lymphatic 21:7,22 21:24 33:2 36:5 38:20 lymphocytes 8:23 8:24 9:2 lyrical 107:14	MALCOLM 71:14 185:10 males 39:12 malformations 24:10,15 48:23 49:14 59:3 61:9 62:24 68:4 malignant 38:7,8 40:4 man 115:21 124:14 134:13 manage 18:24 Maralinga 44:20 109:23 Mark 2:2,3 59:13 74:20 markers 112:25 marks 62:1 marrow 44:3 mass 131:18 146:9 146:19 148:25 149:1 152:6 154:2 154:3 massive 89:20,22 89:23 90:2,7 match 55:10 material 32:23 104:10 108:1 111:21 112:16 113:15 150:2 156:12,14 170:18 materials 44:23 139:12 matter 18:7 32:19 46:18 65:16,18 77:9 78:10 128:9 matters 32:22 91:15 95:7 105:22 127:19 128:7 139:2 178:12 182:20 McKeegan 168:21 mean 4:2 11:2 27:22 28:7 37:17 38:6 41:16,19,25
--	---	--	---	--

46:14 48:22 49:8 49:11 50:10 52:7 52:23 53:9,20 54:2 58:9,9 62:1 62:12 63:6 89:15 98:24 99:2 107:20 112:10 125:4 126:1 144:11,11 144:14 148:15 157:15 159:2 160:16 166:11 175:14 179:10,11 179:17,18 180:5 183:11 meaning 112:2 means 18:6 38:14 91:23 108:7 144:9 meant 1:18 69:3 145:14,20 147:4 159:19 175:5 measure 38:11 93:4 144:13 measured 3:23 165:4,8 measures 27:24 mechanism 43:20 132:6 174:7 176:6 176:7 mechanisms 65:5 131:25 132:3 medic 118:16 medic's 121:1 medical 30:19 51:8 88:22 111:13 117:1,12 118:14 130:6 medicinal 95:4 medicine 20:1,1,6 51:9 100:14 119:7 133:5 medium 77:11 82:14 meeting 31:24 MELODI 93:6,7 member 64:7 95:15	members 51:20 53:14,22 54:14 74:16 86:12 membership 86:10 membrane 43:24 memory 36:14 men 39:18 112:3 mention 4:9,24 18:1 25:11 29:14 31:17 34:14 62:5 75:8 89:13,16 mentioned 1:25 16:8 25:6,6,9 26:17,23 62:6 66:18 68:22 85:2 85:7 89:16 159:9 mentions 34:25 Messieres 48:20 50:6 61:7 64:23 66:11 84:15 85:4 85:9 met 31:23 95:25 metabolism 7:25 44:22 131:24 164:16 172:13 metal 8:25 41:1 48:3 76:11,12,13 76:16,19 77:17,18 77:20 134:16 metals 40:21,21 45:12 48:8 160:19 162:21,22 method 5:2 9:17 11:11 13:11 methodological 112:14 124:12 125:10 methodology 51:18 123:2,4,21 methods 11:16 64:20 65:11 67:17 Metropolitan 181:3 Mexico 165:25 mFISH 7:3 10:7,11	10:13 mice 164:13,14 165:24 microgrey 125:1 microscope 40:18 42:19,25 45:25 47:9 microscopic 147:5 Microscopical 40:14 microscopist 40:11 microscopy 40:13 41:4,7 42:11 51:5 76:24 135:9,15 microsievert 63:8 microsieverts 58:11 63:9 68:24 midday 183:12 middle 142:5 181:15 Mile 110:25 111:1 miles 8:15 military 31:25 32:1 115:7,10 milk 180:9,12,13 180:14 mill 162:7 Miller 168:18,23 168:23 millers 136:8 milligrams 145:12 milligray 124:25 125:1,6 128:16 179:14 milligrays 177:2,3 179:12,16,24 million 93:19 millisievert 128:19 128:20,20 millisieverts 3:3,25 3:25 4:3 8:12,16 39:20 63:10,11,13 64:14,14 69:2,3,6 82:18 108:10 120:8 129:13,14	130:2,3,15 mills 136:9 mind 3:15 66:19 106:3 108:21 111:1 119:1 122:24 133:6 141:21 143:7 153:17 mine 16:25 28:11 mined 138:24 miners 138:3 139:7 miners' 138:13 139:3 minimise 177:20 minor 100:20 minute 3:19 142:15 153:7,8 177:25 minutes 3:17,18 25:25 29:1 70:8 178:7,10,13 180:19 miscarriage 67:7 miscarriages 52:14 misfortune 104:5 mislead 123:15 misleading 169:24 mismeasurement 84:5 missed 20:12,14 21:1 101:7,13 111:10 mistake 101:1 misunderstanding 144:25 misunderstood 178:2 mixed 77:24 Mm 79:4 80:12 83:19 109:25 115:18,24 164:24 Mm-hm 80:15 104:8,23 106:16 107:3 108:3 109:19 111:5,22 111:25 112:8	113:17 117:2,13 117:15,19,24 120:21 121:9,12 122:2 124:4 127:3 140:1 148:16 165:2 171:10 Mobbs 27:7 MoD's 93:22 model 39:8,10 46:4 58:9,13,21 63:3 63:21 64:11 125:15 132:24 151:18,24,25 152:3,5,15 155:4 155:13 156:8 models 148:19 165:19 166:7 173:22 molecular 100:10 172:25 molecule 41:19 moment 18:21 34:20 78:20 81:5 100:1 103:25 108:16 114:9 116:21 134:3,20 136:3 140:7 148:13 150:5 183:15 moments 178:12 Monday 29:14 money 53:12 94:7 months 62:12 176:17 morning 1:7 23:22 59:17 84:12 90:15 159:7 169:19,20 170:4 180:21,23 181:17,23 move 6:2 21:18 29:10 121:25 171:5,8 181:25 182:1 moved 181:8 moving 38:15
---	---	---	---	--

182:4 mucociliary 160:24 mucus 136:11,11 168:3 Muirhead 4:2 27:7 multi-disciplinary 92:10 multidisciplinary 92:18,18 113:4 multifactorial 38:12 119:19 multiply 148:1 mutagenes 9:14 mutagenic 9:14 mutations 155:1 myo 44:10	near 24:15 111:4 156:1 nearly 11:15 15:19 necessarily 13:15 15:17 45:5 82:15 86:12 156:16 necessary 32:13 63:3 need 13:16 17:13 30:4 34:20 61:10 92:18 93:11 101:8 111:18 112:6 115:19 117:6 131:23 141:22 143:7 146:15 147:1 152:3 157:4 165:7 177:19 178:12 182:18 needed 179:6 needle 120:11 needs 115:4 122:14 negative 41:2 42:21 negligible 4:1 58:13 neighbour 55:16 neoplastic 172:5,9 nerve 98:1 nervous 95:24 neutrons 148:23 never 45:10 118:16 118:19 139:1 167:16 173:19 177:24 nevertheless 166:10 new 2:1 3:14 4:16 5:9 8:14 10:10 14:22 16:1,6,7,9 16:20 20:2 22:25 79:2,13 82:9 84:11 92:22 110:3 165:25 newer 2:24 NIH 59:20 nil 7:3 82:16 nils 81:1	NIOSH 23:8 36:7 37:2 117:21 nitrate 77:6 nitrates 77:13 nitric 77:5 nobody's 45:15 66:18 Nodded 102:16 nodes 9:1,3 nodules 174:1 non-radioactive 160:8 non-scientist 124:6 non-zero 37:23 normal 11:16 15:20 67:15 162:1 normally 9:7 55:7 131:23 note 13:21 56:9,9 56:16 noted 35:3 notes 18:6 52:5 noticed 6:20 100:24 notwithstanding 38:2 November 65:25 NRPB 54:4 nub 121:24 nuclear 4:16 10:14 19:25 20:1,6 30:20 53:15 54:5 54:7,16 78:17 79:2,13 84:11 90:22 103:7,19 109:18 110:6,23 111:4,8 115:8,22 137:15,16 nucleic 42:10 number 9:6 32:5 34:22 51:21 61:23 82:24 96:19 108:25 109:1 111:23 128:14 129:17 136:2 137:8 149:12	159:22 174:21 175:10,22 176:23 numbers 5:23 35:20 36:3 97:11 175:15 NZNTVA 79:13 NZTV-026 81:2,12 NZTVO26 8:10	171:6 183:8 Okajima 2:22,23 okay 21:17 28:6 50:21 69:18,19 70:17 71:18 101:21 124:16 136:5 144:7,18 157:4 160:9,9 163:17 164:11 170:25 182:7 omission 72:3 once 106:8 134:7 166:21 one's 10:21 ones 26:6 64:22 95:22 98:2 128:24 ongoing 111:11 116:16 online 65:24 66:1 onset 39:22 onwards 37:3 59:23 open 34:20 94:23 opens 94:20 operates 116:25 operation 11:23 13:6 14:9,23 15:6 15:13,18 176:15 opinion 2:5 57:20 58:8 62:20 114:5 122:20 125:13,14 126:16,22 160:5 opinions 64:9 102:4 107:1,2,22 112:3 114:16 126:1 127:20,24 opportunity 26:11 102:1 133:22 134:19 options 136:3 oranges 91:10 order 9:22 37:22 63:12 76:25 148:9 154:25 155:18 162:10 169:6
N			O	
N 185:1 NAIAD 97:25 naive 32:22 name 63:7 named 4:14,17 nanometres 43:17 168:12 nanoparticles 43:10,13,15,18 46:20 49:3 168:4 nanopathology 65:10 narrative 88:24 narrow 158:9 nation 115:7 national 54:7 68:12 72:13 74:6,11 75:2,11 95:16 natural 129:24 165:16 naturally 131:22 nature 38:12 77:9 173:12 naval 13:23 14:10 14:22 30:19 navigate 82:3 NBC 98:6			o'clock 1:9 17:4,5 25:25 70:21 71:8 99:7,8 181:1,4 183:6,19 objectives 72:16 observations 24:20 observed 24:23 49:10 obtaining 54:16 obvious 54:21 140:23 obviously 26:13 53:8 86:17 103:9 109:4 126:24 181:11 occupation 51:21 occupational 36:20 36:24 39:5 111:6 115:17 116:18 occur 31:16 44:12 45:20 57:21 occurred 9:4 157:21 occurring 167:12 occurs 44:23 off-chance 121:15 offhand 153:16 179:25 office 31:4,7 officer 30:19 73:4 offshore 97:25 offspring 48:24 59:14 60:9,13,16 66:25 85:1 Oh 18:15 22:10	

permanently 163:21	physics 174:17	127:23 137:23	95:23	primarily 157:17
permitted 55:23	pick 170:11 180:20	140:3 146:17	power 36:2 111:4,7	primary 112:9
person 123:1,3,7	picked 121:15	147:3 155:8 156:5	115:22 174:20	162:21
124:1 125:20	picking 97:25	156:11 164:5	practicable 117:10	principal 49:15
142:4 151:20	piece 149:13 150:7	166:17 178:6,6	practical 137:25	principally 112:6
152:11,12,13	pilot 32:3	180:17 181:22	practice 55:5,20	prior 31:19 32:7
personnel 14:10,23	pitched 59:9	183:3	precisely 60:23	49:20
84:8	place 10:8,11 18:7	pointed 37:18	predicted 63:3	prisoner 32:1
perspective 118:11	44:19 78:14 96:15	116:21	prefer 30:2,3 181:1	probabilities 39:7
118:12,14	98:12 180:19	pointer 52:8	Preferential 42:9	106:15 117:21,23
persuade 91:18	places 109:10	points 84:2 176:16	preferentially	probability 36:19
persuading 128:10	159:18	pool 53:24 54:12,13	43:18 44:3	39:2,11 118:18
persuasive 49:19	planet 10:25	54:18 85:23 86:1	pregnancy 51:10	121:14 156:7,10
pesticides 172:14	129:18	population 55:8	preliminary 24:17	179:7
Petrova 24:6	planned 29:1	67:2,13,14 87:16	preparation 171:1	probable 11:18
Pflugbeil 2:13	planning 92:21	112:11 167:16	prepare 61:14	120:18 136:22
23:20	181:6	173:2,17,18	prepared 2:17	probably 20:11
pharmacologist	plate 87:21 106:1	176:19	26:16 61:16 103:1	34:20 41:4 46:24
136:19 145:24	plausibly 46:7	populations 60:14	103:2,4	50:1 56:20 64:12
151:4 160:14	please 1:14 3:19	portrayal 122:19	preparing 99:9	71:10 120:20
pharmacology	17:16 21:7,21	pose 141:21	104:4	121:8 127:15
163:5	23:18 30:4 32:24	position 12:3 31:18	presence 130:23	139:16 141:5
PhD 31:10 172:5,9	34:18 36:9 38:24	41:22 56:7 61:5	present 2:5 49:3	143:16 154:14
phosphate 76:21	44:25 50:23 60:20	71:20 75:20 89:9	58:3 78:11,12	161:11 164:5
135:7 158:3,4,5	71:20 72:17 75:21	91:21 100:18	89:2 130:19	170:7 178:9
158:11,12,14,18	76:4 89:7 99:22	118:6,17	131:20	182:11,12,17
158:21 159:3	100:5,23 124:1	positions 32:11	presentation	problem 7:23 8:22
163:19 164:22	142:3,6 171:2,19	positive 58:19	143:15	61:3 82:19 83:4
165:1,5 166:25	179:16	possibilities 95:2	presented 4:16 6:3	119:24 120:22
phosphates 41:17	plenty 41:18 78:12	97:16	27:5 79:12 96:21	121:22 135:11,11
41:18	plot 176:14	possibility 105:2	presenting 40:3	149:16 152:21
phosphorised	plumb 127:15	136:23 165:10	presided 105:14	182:15
41:19	plus 77:3,3	167:8 170:14	president 40:14	problematic 37:19
phosphorylated	plutonium 8:25	possible 8:18 9:1	72:13 85:24 91:11	83:11
158:7	pm 70:3 99:15,17	10:16 11:23,24	91:21 95:15	problems 66:23
Phosphorylation	142:9,11 184:1	12:8 13:15 28:8	Preston 21:13	70:7 83:1 108:4
158:7	pocket 43:23	42:4 54:13,18	presumably 21:20	112:15 119:18
photographs 91:8	point 2:15 7:22	55:20 66:12	154:12	124:12 126:21
phrase 118:9	20:18 22:12 23:4	121:19 166:19,25	presume 4:25	137:3,5,24 150:1
physical 90:21	23:5 34:13 47:20	169:21	pretty 64:10 110:15	156:2 165:17
132:9,11,17 133:3	57:2 65:21 66:5	possibly 30:18	prevalence 66:25	procedure 105:25
134:15 150:10	81:1 91:19 94:14	107:1 137:14	previous 35:19	procedures 111:13
151:14	107:8,8,10,12,13	posted 51:19	37:10 40:3 56:10	proceed 5:6 89:9
physically 17:3	108:21 109:13	potential 15:1 32:9	63:1 103:4 105:4	proceedings 3:1,14
	118:18 120:1	54:20,21,23 87:4	105:8,9	21:20 31:14 96:2

107:21	85:18 89:23 90:17	pros 52:9	pursuing 141:24	59:8 62:1 67:10
process 18:24 42:3	90:22 91:1,9 93:2	protected 154:21	push 166:16	76:4,8 82:19
43:22 45:7 47:21	94:1 95:4,4 96:1,6	protection 113:3	put 15:15 17:12	86:16 88:3 90:23
47:21 48:7 49:1	96:13 99:22,24	proteins 42:2	18:16 26:13,18	97:1,8,9 104:10
68:14,18,18 77:17	100:4,10 102:12	protocol 47:1	34:12 40:17 41:21	104:21 106:10,14
78:15 103:9,25	113:16,21 122:6,6	proud 20:7	47:24 50:9 59:8	118:21,23 121:23
119:13	125:16 126:13,16	prove 121:21	62:16 63:1 65:18	121:25 127:24
processes 172:5,10	131:12 133:12	proved 11:20	65:22 85:21 92:5	129:8 130:21
procure 31:6	134:4 139:22	proves 119:15	92:6,7 109:1	133:17 135:1
procured 32:14	140:19 141:9,16	provide 22:4 27:10	112:21 114:5,16	136:21 145:25
produce 136:11	142:19 149:23	49:19 52:19 59:20	115:21,22 134:4	151:16 153:13
produced 9:18	152:21 153:6	64:3 73:1	134:23 135:16	154:6 155:18
11:14 74:15	155:5 156:23	provided 73:5,15	146:4 147:19	160:19 175:8,8
176:24	173:7,10 174:12	104:15 105:9,13	153:22,23 167:8	178:25
produces 11:6,6,7	174:21 175:3	128:21,22,24	170:19 174:11	questioned 25:1
151:11	181:19,20 182:20	130:9 143:20	175:7,8	questioning 103:25
producing 42:13	185:3,6,10,12	168:25 169:6,12	putting 10:12 92:3	180:18
profession 112:21	professorial 31:4	171:4	102:20 134:21	questionnaire
120:16	Professors 114:20	provisional 14:15	137:23 138:23	51:20 55:2
professional 31:19	profile 162:23	181:5	143:11	questionnaires
professions 113:3	progeny 48:24	Provisionally 71:5		51:19 55:23 56:13
professor 1:3,8,9	program 36:21,24	Prudent 13:9	Q	questions 1:22
1:10,11,14 3:4	37:7	PRV 126:12 127:9	qualified 84:14	25:19,23 46:14,18
4:25 6:8 7:14 8:1	progress 41:5	public 32:11,12,14	126:3 176:8	65:15 69:9,11
8:12 9:24 10:17	project 4:19 53:13	59:20 64:25	qualify 1:20 34:2	74:2 82:25 85:16
12:3 14:4,12 15:6	92:22 93:20	publication 2:25	37:22 45:21	96:11 98:18 102:9
16:10 19:18 23:10	proliferative 172:9	65:21	qualitative 9:17	106:24 107:25
23:12 24:12 26:16	proof 13:15 166:22	published 3:7 4:12	qualitatively 66:25	123:1,9,25 125:8
29:25 30:9,25	propagation	4:13 5:20,22 6:2	quality 17:21 18:9	125:21 140:25
31:1,8,15 32:10	154:25	12:14,15,16 23:19	51:2 170:5	141:4,16,20,23,25
32:25 33:4,8,11	proper 56:24 171:1	24:19 51:4,11,13	quantitative 8:21	156:19 168:9
33:14,23 34:3,14	properly 160:10	65:24 95:9	12:10 171:13	170:8 178:7 183:1
34:17 36:13,22	properties 41:12	pump 174:7	quantitatively 8:18	185:9
38:18 41:21 42:5	43:2 90:21 134:15	pure 122:3	39:10	quick 181:21
42:14 43:5 44:25	134:16	purely 156:18	quantities 163:3	quicker 37:21
45:9 46:1 47:1,15	property 115:12	purpose 37:6 86:24	quantity 146:20	quickly 8:5 10:8
48:13 50:24 51:9	proportion 162:13	103:1 115:10,25	147:12	17:13 21:7 150:16
54:4,10,19,22	162:15,16 164:20	116:15 117:12	quarrel 135:16	quiet 70:19
55:11,21 56:6,16	174:20	170:25	query 105:25	quite 8:7 18:22
57:5 61:5 62:6,16	proposals 94:12	purposes 38:1	question 1:18 4:21	22:18 28:6 36:16
63:25 64:18 65:19	propose 11:13	108:18 115:4,15	5:6 8:4 23:13,18	37:19 46:24 47:5
66:3 68:6 69:20	proposed 31:8	116:16 150:6	24:3 25:8 26:3,14	76:20 81:1 82:21
70:12,16 71:2,12	proposing 70:10	pursue 141:23	26:18,21 27:2,4	86:16 87:21 89:5
71:14,23 74:11,22	proposition 119:14	146:1 182:13	28:2 34:13,15	104:9 105:11
76:22 78:9,18	135:16 146:5,7	pursued 29:15	37:14 41:11 45:11	106:25 118:12

121:19 122:23 129:19,19 131:4 133:20 134:10 135:14 137:18 138:2,4,11 140:13 141:23 145:3,13 149:8,16 150:15 150:18 154:22 156:12 157:6 158:8 162:9 173:2 174:23 181:8	radiation-exposed 60:16 radiation-induced 157:8 radiation-related 87:15 radiation-specific 13:11 radio 179:3 radio-iodine 132:2 radioactive 111:15 137:10 138:6 145:3 159:10,12 160:2,3,6,7 176:13 178:16 radioactivity 74:7 75:3 radiodiagnostics 111:17 radiogenic 22:15 23:6,8 38:16 144:15 171:21 radiogenicity 17:11 37:23 93:19 144:11 165:16 radioiodine 173:16 173:23 radioisotopes 20:8 144:16 171:22 radiologically 120:18 radiology 130:7 radiotherapy 60:14 111:16 117:6 radium 166:1 radon 138:7,9,10 rain 89:21 90:2,4,7 90:10,20 150:1 180:11 rainfall 180:10 raining 90:20 raise 65:16 178:12 raised 50:9 103:17 105:25 raising 94:5	ran 16:22 51:6,11 random 83:8 randomness 55:17 82:20 83:5 range 7:4,10 43:17 58:16 80:25 82:14 82:16 84:1,2 95:1 97:15,20 98:15 154:4 165:24 178:20,24 179:14 179:19 180:15 rare 19:24 22:17,18 131:23 rarely 151:13 154:20 rareness 37:20 rate 9:2 124:17 149:2 rates 4:4 11:13 67:6 87:14 ratio 116:22 133:1 Rayner 29:23,24 69:12,16,19 re-examination 25:21 66:8 96:12 97:8 185:5,8,11 reached 58:19 98:24 99:2 105:18 react 44:18,19 reactor 179:13 180:4 read 6:11 26:13 35:7 41:8 47:1 58:24 60:20,22 74:15,18 85:11 90:8,9,13,15 122:17,23 126:19 126:23 143:3,6 144:2 164:3 165:18 169:4 174:11,16 reading 10:3 11:21 14:25 24:12 37:11 39:13,15 51:14 60:17 64:1 66:19	74:12 81:21 85:14 124:5 125:3 ready 29:10 70:12 141:8 really 8:1,6 20:5 25:22 26:3 45:16 55:19 56:8 58:8 62:22 72:7 78:7 82:16,19 84:12,14 94:23 98:7 105:2 108:7,20 122:25 124:6 129:21 133:7 146:2,2,12 155:8 156:6,21 161:2 166:16 179:1,8 reason 10:17 18:1 46:9 54:17 59:1 92:17 96:7 130:23 134:6 139:22 149:3 175:21 176:11 reasonable 47:25 67:24 93:15 94:5 103:17 106:7,18 117:10 118:7,19 121:23 174:23,25 175:1,2 reasoned 105:19 reasons 89:8 110:8 122:4 125:10 126:4 140:23 156:1 recall 31:22 33:21 64:9 122:23 164:5 164:6 174:15 179:25 received 24:4 63:5 84:12 89:19 119:15 124:24 129:9,23 130:1,12 145:18 receiving 10:25 111:15 recognise 79:9	recognised 49:12 49:13 65:4 recognising 116:6 recommendations 144:2 reconsideration 37:3 reconstruct 11:23 record 20:22 recording 52:5 records 130:6 recruit 55:1,6 reduce 169:8 reduced 94:19 refer 15:23 19:2 21:2 33:4,14,23 50:24 108:4 127:20 reference 19:21 35:8,9,13 42:8,8 48:18,18 92:11,12 124:9 139:20 referenced 139:11 139:13 references 20:16 74:17 92:9,16 126:20 referred 3:1 104:21 reflected 1:19 refresh 143:7 refuse 165:19 refused 87:10 refutes 19:20 regard 65:20 75:24 137:7 143:18 regarded 140:21 region 58:16 77:22 171:8 regions 25:5 registers 36:15 registry 54:7 regressed 28:15,16 regulatory 75:12 related 93:13 155:19
R				
Rabbitt 48:19 50:7 56:13 61:7 84:19 85:5 radiation 9:6,15,18 10:19,23 11:1,23 14:9 15:3,5,9,16 15:17 19:15,16,17 22:5,9 25:16 26:24 27:11 37:13 38:6,7 40:2,3 49:12 57:25 58:1 58:3 60:11,24 61:1,10,18 62:10 62:12,15,21,23 63:2,14,19 64:4 64:13 75:23 87:14 94:18 103:18 108:24 119:22 120:9 129:18,23 132:11,20,23 133:7 145:6,8,10 145:16,22 146:13 147:10,15,18 148:17,23 157:10 157:16 167:4 171:15 172:25 174:14,20 183:10				

<p>relates 111:11 relating 61:9 73:2 108:1 143:16 relation 13:15 19:16 110:1 111:6 111:11 118:5 126:10,12 128:14 relationship 31:19 32:7 108:17 125:23 173:9 release 91:3 released 97:23 154:2 173:17 relevant 9:22 12:6 30:18 31:16 40:17 59:13 62:15 90:23 reliable 59:6 74:13 103:18 106:19 114:21 reliance 127:4 relied 104:20 169:11 relief 41:2 relinquished 68:7 rely 26:23,24,25 36:5 46:22 56:8 64:21 84:15,18 171:3 relying 126:13 remain 72:13 100:10 remainder 163:24 remaining 163:4 remains 67:4 remark 3:20 remember 63:7 79:5 101:4 141:19 157:5 165:12 176:4 remind 139:6 removed 101:3 renal 162:20 repaired 94:25 repairs 157:5,6 repeat 12:8 13:11</p>	<p>76:4 87:9 replaced 132:17 replicate 166:8 report 2:23 4:10,15 4:20,24 5:23 6:3 6:11 15:22,23 16:6,8,11 17:13 21:14,19 24:18 30:9,12,16 31:11 31:15 32:20,23,24 32:25 33:5,9,15 33:16,18 34:9 45:9 47:24 49:4 50:8 58:20 61:16 62:13,17 64:1,8 66:3,4 71:24 74:5 78:9,17,22 79:12 86:14,17,23 92:3 92:8 93:9 95:13 100:7,21,24 101:22,24 102:5,7 103:2,4,11 104:1 104:4 105:9 113:10 123:5 124:1 126:19,23 130:18 139:25 141:21 142:23 143:12,12,23 148:13,21 164:3 reported 35:19 53:20 67:7 90:4,5 98:2 REPORTER 171:19 reports 34:4 61:14 62:6 88:23 90:9 102:2 103:1 105:3 113:16 122:17 128:22 143:4,5 144:3,5 172:21 represent 11:15 72:18 102:14,21 114:25 147:20 representation 73:1</p>	<p>representative 32:8 represented 28:13 67:12 73:5 representing 31:13 represents 5:3 152:8 reputation 73:22 required 37:13 143:9 144:3 requires 170:14 RERF 2:21 3:7 research 37:13 41:15 45:16 46:20 47:23 53:13 92:10 95:7 96:14 109:10 109:16 110:10,12 110:19,22 111:3,6 111:11,24 115:5 117:8 172:23 174:12 researched 109:1 researchers 14:18 15:23 127:11 resemblance 63:23 reservations 15:21 15:22 28:1,3 reserve 30:19 170:17 residual 115:20 resolution 40:13 respect 20:23 33:1 37:12 47:7 109:16 114:10 157:11 respective 52:4 respects 162:10 182:17 response 177:5 responses 67:5 114:7 159:7 rest 4:20 69:25 151:23 156:4 166:13 result 14:19 60:14 67:8 84:3 111:13 130:12 137:15</p>	<p>results 6:14 7:2 13:10 39:11,15 56:8,9,9 68:17 80:23,25 84:4,4,5 84:6 110:23 resume 99:5 resurgent 137:14 resuspended 137:14 resuspension 150:2 reticent 9:25 reticuloendothelial 44:2 reverse 12:4 55:14 revert 18:15 review 25:7 59:24 60:7 61:19 70:19 71:5 124:11 reviewed 60:13 61:24 66:17 reviewers 2:8 reviews 19:10 revise 182:23 Richardson 22:13 Rick 103:22 right 1:12 4:5 6:6 9:5,7 12:23 13:7 16:17 17:18 21:4 21:17 22:10 30:4 30:13 31:3 35:25 41:6 45:15 49:7 51:3,24 53:24 66:16 68:16 71:10 71:19,22,23 78:25 80:1,5 81:14 87:23 89:5,10 95:6 101:18,24 107:19 109:4,10 111:12 118:12 123:25 125:14 127:10 128:4 129:12 133:16,17 133:20,24 134:7 135:14 140:13 141:24 142:4,18</p>	<p>144:7 145:11 147:9 148:5,17 151:1,6 152:12 154:5,17 157:13 158:17,17 159:7 159:23 160:11,14 162:9,24 163:12 164:6,10,25 165:7 166:16,17,21 168:17,21 169:3 169:15 176:7 178:15 180:3 182:3,7 rightly 116:21 134:20 140:4 ring 80:16 rings 6:20 rise 58:11 59:2 141:12 142:2 risk 28:9 37:23 39:1,8,10,14 46:4 108:18 115:21,21 116:8,11,13,25 117:3 120:5,6 124:23 125:5 145:16 148:19 151:18 risk/benefit 116:4 116:22 risks 26:24 27:11 27:23 60:16 64:4 116:2,7 River 101:1 road 116:11,12 rockets 91:4 Roff 48:19 50:7 56:13 61:7 84:19 85:5 role 31:4 112:18 118:5 120:4,5 room 64:15 112:13 roughly 171:13 175:11 round 46:2,2 98:5 121:18 159:17</p>
--	--	--	--	---

route 53:11 162:21	177:12,15	scientist 114:10,11	seemingly 117:20	shared 5:15 7:15
Rowland 4:8,18,18	SB 26:17	114:12 119:4	seen 74:21 80:4,5	49:20 50:11
5:18,19 78:18	SB/84 66:16	135:2	123:6 173:19	126:19
80:2	SB1 34:20	scope 107:23	selected 68:14	shed 71:9 88:15
Rowlands 97:13	SB2 21:8,19 34:18	scored 80:14	85:22	shells 91:4
Royal 30:19 40:14	34:20 100:5	scores 81:21	selecting 53:18	shielded 149:6
164:3	SB21 17:24 18:25	scoring 6:15	selection 52:9 67:5	ship 83:22,23,23
rubbish 175:23	19:6,7,7	seamlessly 182:2	67:9	84:9 98:4,11
ruled 96:1	SB22 16:23	search 66:1	selective 67:11	ships 82:10 97:16
rules 142:23	SB22s 16:23	seas 5:11	self-report 85:23	97:19,24
run 68:4,5 116:10	SB4 65:23	Sebastian 23:20	self-reporting 52:9	short 1:15 61:14
172:23	SB5/101 168:18	second 27:4 34:25	53:1	70:2 82:14 99:16
running 23:17	SB6 23:18	38:24 39:9 46:18	send 90:18	142:10
runs 21:25	SB6/84 50:23	49:18 50:8 51:17	sense 5:16 68:13	short-lived 60:25
	SB7 1:13 4:8	60:8 66:3 67:17	157:15 172:20,20	176:21
	168:23	78:24 101:1	181:7	shortcomings 53:8
S	SB7/123 79:7	109:16 110:16	sensitive 5:3 11:12	shorter 138:9
Sabolla 164:17	scale 22:3	115:17	171:15,17 172:1	shortly 19:2 24:21
safe 29:3 116:17,19	scan 10:20	secret 140:18	175:21 176:2,5	show 3:5 12:6 16:1
117:9	scans 111:18	Secretary 41:22	sensitivity 171:11	22:14 74:17 89:16
sailing 5:10	scheme 37:22 38:1	45:5 148:20 169:9	171:13,14 174:4	91:2 92:5,6 93:15
sailor 8:14 115:22	38:4 39:5 117:18	section 4:9 18:11	sentence 35:1 49:24	166:2
sailors 7:14 109:17	117:21	21:23 56:18 60:20	62:16 75:17	showed 3:20
saliva 78:12	Schmitz 1:3 26:16	67:17 133:21	124:21	showing 65:24 89:1
salt 42:13 77:2,3,18	185:3	see 6:12,13,15,23	sententiae 112:2	shown 40:23 48:16
salts 77:12	school 76:9 107:18	7:1,4,9 9:8 12:24	sequence 55:15	49:5 81:25
sample 14:22 138:1	Schroeder 86:5,8	13:23 19:9 21:12	57:23 182:13	shows 14:23 29:17
sampling 51:3,5	87:6	28:10 33:6 37:5,8	serious 75:10 84:2	40:4 68:17
satisfy 38:24	science 32:4 59:12	39:8 40:19 41:1	84:5,14	Si 155:2
saving 18:3	64:21 74:14 94:4	42:19,23 45:24	serve 30:18	sick 72:22
saw 21:14,14 85:21	94:6	46:3 47:10 48:19	service 13:22 32:2	side 1:24 6:14
105:1 141:20	scientific 31:23	48:20 59:23 60:7	51:21 106:11	70:23 73:8,11
Sawada 3:4 149:23	38:15 57:11 65:13	60:12,19 70:14	servicemen 88:7	112:12 116:12
saying 14:3,5 15:5	73:12,13 75:19	71:6 77:1 79:11	services 36:18	128:22
15:16 56:2,10	86:20,24 93:20	79:14 80:17,23,25	51:22	sievert 39:13,21
59:1 60:23 69:12	94:1 96:19 106:13	81:2,4 82:5,7 83:7	set 37:5 65:1 95:14	40:5 147:16
93:11 94:4 107:11	107:8 108:22	83:15,21 84:16,18	104:6 106:25	sieverts 82:22
150:5 152:24	119:13 122:20	87:13 106:5,6	107:2,4,22 108:5	147:13,21,25
156:6 158:20,23	125:13,23 126:2	128:21 137:20	108:14 128:12,18	sight 105:1
158:24 164:20	135:5,6 148:11	144:4 145:15	130:11 133:13	sign 97:25
168:1 176:2,10	156:18 157:14,14	160:9 162:22	sets 37:2 80:8	significance 133:11
177:17,21	157:19 181:13	166:12,14,23	setting 36:18 53:12	133:23
says 10:2 34:17	scientifically 59:10	176:16	107:17 118:22	significant 3:23 5:4
45:1 53:7 67:19	118:20 145:14	seeing 53:7 95:19	severe 28:9	11:10 12:12 14:1
113:13 137:22	146:8	99:13 181:17	share 17:9 126:18	21:14 43:1 67:4
164:7 169:5,22				

<p>96:19 138:7,16 significantly 13:3 67:1 163:10 signs 89:1,1 similar 13:25 15:12 56:14 82:13 110:1 110:10,22 116:24 Similarly 110:8 simple 77:2 78:10 78:15 155:2,4 156:9 163:16 173:2 180:5 simpler 76:6 102:20 Simply 183:9 single 9:9 14:17 58:1 69:8 152:13 152:16,18,20,22 153:2,10 159:25 176:25 sir 51:8 59:1 sit 30:2,4 70:10 100:1 132:19 site 165:13 sites 90:5 165:25 sits 151:10 sitting 58:15 71:17 152:14 situation 56:1,4 57:14 116:7 118:11 137:12,25 138:18,19 166:8 situations 137:8 six 1:9 size 168:6 skeleton 158:10 sky 90:22 slightly 97:2 103:24 114:3 135:17 144:16 158:25 174:3 slot 16:21 slow 171:19 172:8 179:16 slowly 76:5 148:10</p>	<p>small 20:4 35:21 44:9,15 72:3 132:25 135:25 136:9,14 138:5 151:5,8 153:4,9 153:11,12 154:4 160:25 161:9 162:5,15,16 163:3 163:17 166:18 Smith 63:5,6 102:19 120:25 smoke 120:3 smoking 13:19 so-called 3:21 Society 40:14 164:3 sold 51:6 soldiers 109:17 solely 64:2 solicitors 104:18 solubilisation 44:12 solubilise 48:8 solubility 44:11 161:3 soluble 48:10 76:13 76:14 136:17 160:22 161:4,5,10 161:19,20 162:10 166:19 somebody 25:12 98:5 106:9 117:25 118:5 119:14 122:7,8,10 123:12 152:1 170:11 soon 20:10 183:23 sooner 181:11,12 sorry 1:14 5:21 9:16 17:2,22 23:2 26:2 34:22 63:11 67:18 81:21 87:23 89:23 99:1 134:3 140:14 144:25 147:22 156:15 163:23 168:19 169:23 172:7</p>	<p>177:23 180:7 sort 45:7 47:8 52:2 92:19 97:3 99:12 119:15 137:12 148:10 153:16 155:18 158:1 163:7,8 166:10 168:13 170:2 179:9 sorts 97:17 111:19 sound 47:6 50:17 50:20 57:11 source 13:12 54:20 54:21,22,24 68:9 73:9 90:7,11,12 96:13 112:10 sources 129:24 south 5:11 82:10 83:17 Soviet 110:13 sparse 80:23 speak 123:25 131:18 speaking 145:2 170:19 special 85:15 specialisation 112:22 specialised 127:5 specialist 122:5 127:20 172:19 speciality 122:15 131:15 specific 13:22 69:17 85:6 103:16 127:8 145:3 149:5 specifically 103:21 specious 94:8 speech 1:16,17 spelling 100:25 101:5 spent 136:19 sphere 168:8 spinning 91:18 spotted 170:22</p>	<p>spouses 55:23 spread 8:6 131:18 132:5 154:12 square 84:18 stable 137:11 159:10,14,19,21 159:24 160:1,5,7 stage 3:14 22:11 41:9 stages 78:8 134:3 134:25 stain 135:8 staining 40:21 42:9 42:12 stand 30:1,3,12 47:7 102:7 standard 66:1 117:22 standing 71:17,18 99:25 start 70:13 71:7 109:15 118:16 119:14 142:13,21 145:17,19 148:14 156:23,24 163:16 181:10,11 182:9 182:18 183:2,5,11 started 16:25 115:3 115:16 starting 66:21 starts 13:2 19:9 35:1 39:9 79:20 113:10 156:25 157:1 state 45:5,22 48:1 78:2,3 108:9 148:20 169:9 State's 41:22 statement 22:24 33:22 34:1 45:1 45:14 50:6,15 56:18,25 57:7 84:24 90:14 100:17,18 143:2 159:8 174:22</p>	<p>175:5,5 statements 57:10 90:13 States 22:14 36:16 38:13,19 station 115:22 stations 111:4,7 statistical 13:14 36:2 108:1 138:1 138:16 statistically 37:19 67:4 119:25 138:20 statistician 120:16 statistics 16:16 139:1 statutory 38:1 stay 44:24 132:16 136:10 163:24 167:4 stays 136:25 151:23 163:20,25 steaming 83:17 stem 153:20 154:19 154:20,24 stenographers 69:25 step 24:23 174:3 stick 149:9 sticking 81:24 sticks 166:25 stock 70:21 stolen 182:16 stomach 161:25 stop 134:18 store 131:25 stores 174:7 story 14:19 25:14 94:20,20 straight 136:13 161:11 164:15 166:5,6 straightforwardly 78:14 strange 33:4,13,22</p>
---	--	---	---	---

97:13 170:15 171:2 teams 92:19 tears 71:9 Techa 101:1,6 Techka 101:6 technically 173:24 technique 10:4 teeth 111:18 117:4 tell 1:19 17:22 32:18 63:25 67:23 68:3 81:6 121:6 121:13 122:18 126:4 129:20 134:5 139:9 144:9 154:9,10 172:2 173:1 177:7 178:19,20,20 179:11 telling 22:21,23 23:2 76:22 90:25 96:24 98:9 148:6 177:15,17 tells 29:20 176:21 temperature 77:22 temporarily 36:13 ten 141:12 178:11 181:1,4 tend 55:7 tendency 44:10 tenet 48:11 tenfold 175:24 tentative 12:4 14:14 24:13 36:1 ter 17:22 18:1,2,3 18:20,25 29:13,19 65:16 66:3,5 71:1 71:10 102:11,12 102:20,22 123:17 131:9,12 139:22 140:14,19 143:3 159:7 182:8,16 183:2,8,14,18 185:14 teratogen 49:15	teratogenesis 57:21 teratogenic 49:14 50:12 57:20 teratology 65:5 term 45:21 69:17 116:3 157:13 terms 36:5 56:14 58:14 122:3 132:15 137:25 138:16 144:11,12 147:20 153:25 165:15 171:13 territory 12:23 125:11 127:1 test 4:17 5:9,11 10:11 16:1,10 48:16,24 49:20 53:15 54:5,7,16 78:17 79:2,13 82:9 84:11 93:23 95:21,21,22 106:18 118:15,19 118:24 119:6 126:5 tested 39:10 testing 80:21 97:12 109:18 110:6,14 tests 51:23 52:1 53:24 54:17 82:11 103:19 130:1,20 tetravalent 78:3 text 92:12,14,16 thank 4:6,7 19:1 25:20 28:23,23 29:2,5,6,6 30:1,7 30:22,23 36:12 66:7 68:21 69:10 69:19,20,21,22 71:18,22 72:11 80:1 82:4 98:18 98:20,21 99:5,23 100:16 102:10 126:9 127:17,22 141:1,3,10 142:7 180:22 181:16,18	181:19 183:22 theme 2:17 theories 64:4,5 theory 134:4 165:6 thereabouts 183:6 thereof 74:16 thesis 28:11 63:4 thick 2:22 thin 133:21 thing 34:19 42:13 44:21 64:8 94:9 97:3 116:8 117:3 153:17 155:16 158:1 168:14,15 things 2:22 8:25 9:6 10:18 11:3 38:11,21 42:19 43:12 44:25 45:19 46:16,23 47:5,16 52:10 76:15 82:21 83:13 92:25 93:1 94:16 97:18 107:14 111:19 113:1 114:8 119:1 119:8,12 121:17 132:5 136:12 138:3 157:1,16 158:6 161:5 166:2 166:11 169:25 171:3 172:14 175:18 think 2:24 6:19 7:16,19 8:9 11:18 15:15 16:3,11,23 17:6 20:24 22:19 23:13 28:7,22 29:21,23 31:22,23 31:25 32:6,13,17 32:20 33:10,16 34:12,15,16 35:5 36:5 37:2,9 38:5 38:10 40:1 41:11 42:11 44:13 45:14 46:16 47:25 49:23 50:10,11,17,19,21	51:24 52:12 53:11 53:17 56:24 57:1 57:6,6,9,14 58:9 58:14,18 59:7,25 61:5,12,19 62:10 62:13,15 63:6 64:7,9,15 66:2 67:23 70:6,15 71:8,18 75:1 79:20 81:25 83:11 83:16 84:1 85:15 85:25 86:13,20 88:2 89:15 91:9 91:13,14,21 92:1 94:8,8,12,13,13 97:5,6 98:13 100:20 103:3 104:22 107:4,10 107:12,23 108:9 108:14 109:15 111:10 113:18,24 114:23 116:4,12 116:19 118:4 121:23 123:3,8,22 126:14 127:17 128:14 129:6,12 131:2,14 133:10 134:24 135:4 137:16 140:14,16 141:5,25 142:3,15 142:22 143:1 146:5,13 149:23 150:19,22 151:25 152:3,7,25 153:1 153:11 156:5,5 157:4,13 158:24 163:7,14 164:13 164:17,21 166:17 167:19 170:4,6,22 170:24 171:2 175:3,23,23 177:10,10 178:9 178:22,23 179:10 180:17 182:4,11 183:8,20	thinking 89:8 152:23,24 158:24 159:1 third 37:8,8 67:18 72:6 76:9 101:19 110:18,18 Thomas 34:17 70:12 71:2 99:22 99:24 100:4 102:12 125:16 131:12 141:9,16 142:19 152:21 153:6 155:5 156:23 182:20 185:12 thorium 8:25 thought 68:24 70:5 76:17 87:1 92:2 104:15 107:18 123:17 138:20 140:25 151:2 153:21 163:8,22 167:16 169:7 170:13 177:23,25 thoughts 183:1 three 14:24 21:23 61:24 78:1 80:20 110:25 111:1 141:12 176:17 182:12 three-dimensional 51:5 threshold 108:7,7 115:25 116:3 177:9,13,14,16,21 throw 94:7 Thursday 1:1 182:6 thyroid 127:14 131:21,22 132:2 171:9,14,16,20,21 171:22,24 172:4,6 172:7,10,13,16,19 172:22,25 173:7 173:15,24,25
---	---	--	--	--

174:1,4,4,9 175:21 176:2,12 176:22,23 177:7 177:19 178:15 179:17,19,20 tidying 60:4 Tier 105:4,14,17 tight 21:5 time 3:2,8 10:10 17:3,7 18:3 23:17 25:22 30:20 52:11 53:12 61:13 62:14 62:16,19 70:6,8 71:1 73:22 82:10 90:15 97:21 101:22 125:20 130:13 131:6 132:19 136:20 141:2 142:18 143:6 149:24 150:13 151:11 154:21 164:2 165:21 172:15 173:6 175:19 176:17,19 178:5 181:6 182:14,16 182:19,24 times 14:24 19:24 20:3 39:17 timetable 183:20 tiny 11:6 138:1 153:2 162:25 tissue 40:20 131:1 132:22 145:22 150:8 152:7 155:11 163:9,11 173:1 tissued 40:17 tissues 8:19 40:24 132:8 137:1 144:19,21,23 145:7 171:21 title 79:24 today 1:10 70:9 71:3,6 96:7	100:18 told 16:12 19:19 22:19 46:10 49:4 58:20 84:21 88:10 90:2,17 143:3 167:14 170:23 tomorrow 70:9 71:2,4,7 143:16 169:18,20 170:3 170:10,17,20 180:21,23 181:17 181:22,23,24 182:18 183:3,7,12 183:13,19 tonight 116:10 141:8,12 170:12 top 81:7 83:24 topic 14:17 22:25 43:2 51:16 123:7 170:17 171:5 topics 171:6 tot 112:2 total 14:24 35:23 63:22,22,23 129:14 130:4,9 165:21 totally 139:23 155:21 touch 16:20 touched 17:11 toxic 137:2 toxicity 162:20 toxicology 136:20 163:6 166:15 track 68:23 69:8 139:18 153:14 154:13,14 156:16 156:19 tract 78:13 traffic 116:11 transfer 136:12 147:7 transferring 164:15 transformation	41:13 135:18 transgenerational 59:14 60:1 translated 6:16 7:4 translocation 5:2 11:11,11 13:3 14:2 79:23 translocations 9:5 9:12 14:25 transmissible 49:21 transports 43:24 travel 43:20,21 treat 114:13 treated 37:6 131:16 treatment 117:12 130:7 171:24 tremendous 123:24 Tribunal 17:23 18:5,7 24:7 26:15 32:18,19 33:1 34:8 47:5,15 49:4 50:16 61:6,11 62:11 64:25 65:2 69:11 89:14 90:25 91:24 93:21 94:2 96:24 100:8 102:24 103:4 105:4,9,15,17,18 106:4,17 113:14 121:22 122:14 126:23 128:13 133:9 137:13 143:25 144:8 145:2 185:9 Tribunal's 125:20 trick 19:5 178:3 tried 62:13 93:11 140:19,20 tries 48:5 true 1:24,25 12:3 21:11 24:12 49:10 84:23 112:13 126:10 167:19 170:1	trust 114:16 truth 91:15,17,20 96:10 100:18 try 13:19 23:16 36:14 37:21 44:25 55:7 106:3 115:19 116:16 117:8 147:4 148:14 156:19 trying 18:23 20:20 20:21 31:22 41:8 48:7 55:10 64:12 81:23 82:3 95:10 114:9 117:8 125:19 129:16 137:3 139:15 145:17 152:4,24 153:7 178:3,22,23 179:2 tube 180:25 tumour 157:3 turn 4:8,15 17:16 18:12 19:8 21:23 44:16 45:7 47:21 60:19 77:17 79:11 80:6 93:9 100:4 121:18 123:5 turned 64:10 164:1 turning 46:11 164:1 turns 34:23 twins 50:2 56:22 two 4:12 5:10,16 6:1 7:15 43:14 46:14 49:15 67:20 67:22,23 76:15 78:1,2 82:10 83:9 83:12 99:7,8 102:1,14 109:5 122:10 135:22 163:20,25 170:18 171:16,20 173:12 type 67:24 132:23 147:10 types 9:10,11,19	147:14,18 <hr/> U U308 77:24 UK-based 113:22 Ulster 31:1,9 32:15 68:7 174:13 unaware 145:23 uncertain 9:25 uncertainties 12:1 underestimation 28:10 undergo 45:13 48:3 48:10 161:9 undermine 88:11 88:16 underneath 176:20 underpin 148:19 understand 8:9 24:7 28:6 31:1 36:22,25 37:24 47:4 50:4 51:15 53:16 86:16 88:11 93:11 97:18 101:23 105:11 106:20 107:8,10 107:12 114:20,24 130:16 131:16,19 133:7 134:5,17,20 134:23 139:23 140:7 143:9 145:24 148:15 151:4 159:5,23 understandable 110:8 understanding 27:11 88:3,4 93:13 96:23 97:15 97:20 103:14 107:16 124:7 145:20,21 understood 105:24 174:17,18 undertake 95:20 undertaken 73:15
---	--	---	--	--

unequivocal 42:6 42:15 45:1,22,24 47:6	57:15,16 72:4,21 72:23,24,25 73:3 73:19,23 76:3,7 76:11,11,13,13 77:4,14,24 78:2,4 78:5 86:22 87:3 87:25 89:20,21 91:3,23 93:19 94:17,22 96:14,15 96:20,25 133:16 133:18 134:1,7,12 135:7,10,14,21,23 136:8,9,9,16 137:2,8,11,11,13 137:25 138:2,6,24 140:8,9,11,15 149:18,19,20 151:13 152:13 153:2 159:10,10 159:11,13,15,17 159:20,21,24 160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	utero 176:17	vets 44:14 50:10 vicinity 153:24 view 15:1 43:1 45:23 91:19 94:14 107:8 108:6 118:18 126:5 128:13 134:9,19 135:5,6 140:3 156:5 views 107:5 113:25 114:25 VII 64:18 120:7 villi 151:3 villus 153:19 viruses 43:21 visiting 31:3,8 visualise 76:23 voice 30:6 volume 1:13 63:22 63:23 vulnerability 57:23 58:6 65:7 69:14 VYVYAN 29:25 185:6	142:3,21 146:1,7 146:16 151:17 153:23 157:25 159:12 168:4,17 178:11 182:12 wanted 6:4 27:20 34:10 97:9,13 130:4 155:10 159:16,16 wants 182:9 war 32:2 72:14,19 73:1 74:2 76:1 86:6,9,11 87:25 93:24 95:16,18 97:23 warfare 30:21 warn 182:5 warning 181:16 warnings 27:25 washed 90:20 wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unfair 66:6	76:11,11,13,13	vale 78:2	view 15:1 43:1 45:23 91:19 94:14 107:8 108:6 118:18 126:5 128:13 134:9,19 135:5,6 140:3 156:5 views 107:5 113:25 114:25 VII 64:18 120:7 villi 151:3 villus 153:19 viruses 43:21 visiting 31:3,8 visualise 76:23 voice 30:6 volume 1:13 63:22 63:23 vulnerability 57:23 58:6 65:7 69:14 VYVYAN 29:25 185:6	
unfamiliar 28:20 103:9	77:4,14,24 78:2,4 78:5 86:22 87:3 87:25 89:20,21 91:3,23 93:19 94:17,22 96:14,15 96:20,25 133:16 133:18 134:1,7,12 135:7,10,14,21,23 136:8,9,9,16 137:2,8,11,11,13 137:25 138:2,6,24 140:8,9,11,15 149:18,19,20 151:13 152:13 153:2 159:10,10 159:11,13,15,17 159:20,21,24 160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	V	W	
unfortunate 65:22 148:22	91:3,23 93:19 94:17,22 96:14,15 96:20,25 133:16 133:18 134:1,7,12 135:7,10,14,21,23 136:8,9,9,16 137:2,8,11,11,13 137:25 138:2,6,24 140:8,9,11,15 149:18,19,20 151:13 152:13 153:2 159:10,10 159:11,13,15,17 159:20,21,24 160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	valid 126:3 172:22 validated 165:20 validity 68:16 vanishingly 153:11 153:12 163:3 variable 176:25 varies 132:13 164:12 177:1 variety 14:18 various 43:11 57:23 58:5 69:13 70:7 95:2 128:7 136:25 175:14 vary 159:18 verb 13:7 version 114:4 vessel 83:16 vessels 13:23 83:9 83:12 veteran 6:13 8:2 16:1 55:1 56:3 73:8 81:7,8 veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	vicinity 153:24 view 15:1 43:1 45:23 91:19 94:14 107:8 108:6 118:18 126:5 128:13 134:9,19 135:5,6 140:3 156:5 views 107:5 113:25 114:25 VII 64:18 120:7 villi 151:3 villus 153:19 viruses 43:21 visiting 31:3,8 visualise 76:23 voice 30:6 volume 1:13 63:22 63:23 vulnerability 57:23 58:6 65:7 69:14 VYVYAN 29:25 185:6	W
unfortunately 2:7 8:8,22 122:12	94:17,22 96:14,15 96:20,25 133:16 133:18 134:1,7,12 135:7,10,14,21,23 136:8,9,9,16 137:2,8,11,11,13 137:25 138:2,6,24 140:8,9,11,15 149:18,19,20 151:13 152:13 153:2 159:10,10 159:11,13,15,17 159:20,21,24 160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W-I-S-M-E-T 139:7 Wahab 4:14 78:16 79:3,9 80:3 wait 5:5 8:4 walk 116:10 want 1:14 3:13,15 16:1,20 18:16 21:21 25:3 26:10 35:8 60:19,20 65:16 71:16,19 85:9 94:7 100:20 101:12 103:14 106:3,23 115:7 116:2,12 120:17 122:25 123:15 125:9 129:7 130:15 131:5,6 136:12 141:23	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unpleasant 115:6	159:11,13,15,17 159:20,21,24 160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unreliability 84:3	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unsafe 52:24	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
UNSCEAR 17:15 19:9 20:14,23 21:11,13 64:18	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
untargeted 59:13 59:25	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unusual 118:9,10 118:15	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
unwound 57:24	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21 116:9 119:6,7 121:7,18 126:24 131:16 135:17
update 35:6,15	160:5,7,8,20 161:4,22 162:6,12 162:13 163:3,17 164:4 165:15,16 165:23 166:1,19 166:20,24 167:23	veteran's 51:21 veterans 4:17 5:9 11:24 13:4 16:7 16:10 43:6 48:17 48:24 49:20,25 53:15,21,22 54:5 54:7,17 55:24 56:20 57:9 67:7 72:14,18,22 73:5 73:11 74:2 75:25 75:25 76:1 78:17 79:2,13 82:9 83:20 84:11 85:25 86:6,9,11 89:19 89:19 91:22 93:23 93:24 95:16,18,20 96:4,8 103:7 109:21 140:12 veterans' 66:24	W	wasn't 31:16 92:5 103:3 104:14 128:21 139:13 142:18 169:13 173:11,21 waste 125:19 131:6 165:21 wasting 131:7 watch 142:16 water 48:10 77:3 78:6 136:17 161:4 161:5,6 waxed 107:14 way 7:11 13:18 16:24 25:12 32:9 40:20 43:25 48:4 52:5,24 53:6 57:9 61:11 62:7,18 68:16 81:1,2 82:17,20 85:21,22 88:10 92:8 102:20 109:1 112:21

150:25 152:23,24 154:5 155:17 161:24 173:23 179:2 ways 135:22 we'll 16:17 27:16 36:14 69:24 137:20 148:9 163:16 181:10 we're 5:6 39:19 40:1,2 46:2 57:13 58:2 60:23,25 95:22 98:15 120:3 137:11 138:9 150:5 153:7 157:17 171:25 173:3 183:12 we've 16:2 28:25 29:2 33:25 36:10 62:25 63:13 64:22 70:7 87:21 88:10 89:8 94:24 98:24 99:2 144:7 145:25 154:1 156:17 163:7 166:17 177:9 181:8 182:16 wealth 61:8 week 58:4 70:7 104:20 113:2,7 127:25 128:6 131:9 133:10 170:21 183:21 week's 137:22 weeks 10:15 weigh 149:12 weight 22:2 38:15 97:7 114:1,16 weighted 121:14 weighting 132:23 148:2 well-established 10:4 went 45:6 103:15 weren't 53:15	180:14 Wertelecki 24:6 West 100:14 Western 109:17 whatsoever 165:15 whilst 41:22 66:21 66:22 83:17 133:10 wide 8:7 88:7 widely 87:3 140:22 widows 29:15,21 wife 50:1 56:21 Williams 173:7,10 window 39:23 windows 57:22 58:6 65:6 69:13 wisdom 119:15 wish 30:15 72:2 81:5 98:25 100:2 122:20 wishes 182:8 Wismet 139:3,7 withdraw 33:13,22 withdrew 29:9 69:23 98:23 witness 29:5,9,11 29:13 40:3 56:10 63:1 65:18 69:22 69:23 70:5,9 74:13 90:13,14 98:21,23 102:24 104:4 141:24 146:6 156:20 170:7,20 180:24 181:2,7,9,12,18 181:21 183:23 witnesses 47:2 wondered 159:19 word 28:11 101:7 101:13 121:23 127:10 words 10:3 11:21 14:25 37:12 39:14 39:15 42:5 60:17 159:22 172:11	work 1:24 2:7 4:14 7:1,1 9:24 14:17 31:9,11 55:16 73:15,18 74:3 75:6,11 109:13 116:16 122:9 131:24 155:17 worked 2:18 19:25 80:10 112:23 worker 10:14 workers 4:2 22:1 35:22 working 111:7 164:9 173:22 works 15:23 world 159:9 167:20 worry 142:17 worse 54:13,18 55:11 worthwhile 29:7 would've 32:21 wouldn't 53:5 64:16 83:15 86:4 121:11 129:7 140:5 159:6 162:3 168:12,13 wrapped 163:11 Wright 167:20,22 write 62:12 writing 34:9 41:8 103:25 written 22:24 37:17 105:24 129:1 wrong 88:4 105:19 125:2,16 141:5 151:20 wrongly 105:19 wrote 21:16 101:22 104:19	111:18 172:1 176:3,5 <hr/> Y <hr/> year 21:13 33:17 76:9 years 7:18 10:12,20 11:4 20:1 22:14 30:20 31:21 32:5 39:12,17,22 40:6 43:12 51:11 68:7 96:16,18 129:17 139:2 163:20,25 164:7 173:3 yesterday 1:16 2:1 3:3 17:12 19:11 22:19 23:22 25:13 27:5,6 28:18 59:18 105:1 <hr/> Z <hr/> Zablotska 33:5,11 33:20,23 34:15,18 35:1,6,16,20,25 65:20,23 Zabolstaska 21:25 Zealand 4:16 5:9 8:14 14:22 16:1,7 16:9 79:2,13 82:9 84:11 110:3 Zealand-sponsor... 16:6 Zealanders 10:10 zero 3:21,22 37:25 39:1 98:16 zeros 7:10 <hr/> 0 <hr/> 0 81:1 0.1 7:11 0.5 82:6 162:5,18 026 81:7,8,9,24 0s 81:8 <hr/> 1 <hr/> 1 11:25 23:23 24:2	24:9 39:13,21 40:5 43:17 58:10 63:8 74:5 76:1 146:20,21,22 147:20 163:1,24 185:3,4 1,000 51:19 1,400 8:12,16 82:17 1.11 124:3,3 1.13 124:3 1.15 7:11 1.24 81:4 1.4 8:9,9 81:2,9,25 82:6 1/5th 167:15 10 34:23 35:2 64:12 69:25 101:16 128:20 141:13 142:2 10,000 51:6 10.00 1:2 100 43:17 108:10 120:8,8,13 132:14 132:16,21 168:11 185:13 1000 39:20 102 185:14 11 17:4,5 25:25 100:17 11.30 183:12 110,000 35:21 12 69:25 12,000 50:10 12.10 70:3 12.50 99:15 12.55 70:1 123 1:13 4:8 124 81:6 127 160:2,3 129 160:4 13 23:24 35:13 81:6 164:7 131 160:2 176:22 137 35:23 14 60:20
---	---	--	---	--

142 185:14	75:19	4.08 184:1	8 4:9 48:18 49:17
146 129:13,24	2007 21:13 79:14	4.1 49:18	65:25 81:9,24
148 130:5	2008 79:3	4.30 1:8	92:15
15 30:20 39:17,22	2009 24:19	40 11:4 39:12 63:8	80 132:21
40:6 43:12 51:11	201 81:9,17,19,24	64:13	84 12:16,17,22 13:1
15269 37:3,8	2011 33:10 66:2	400 64:14	86 14:21
15272 38:24	2012 65:25	42 10:1,1 120:10,20	87 79:19,25
16 1:1 22:10	2013 33:12,19,20	43 120:13,17 121:4	89 23:18
17 25:25 100:8	35:21 66:4	121:7,16	
184:3	2015 93:5 100:8	43rd 121:13,20	<u>9</u>
1956/57 10:11	2016 1:1 22:24 23:3	48 182:15	9 4:9 48:18,19
1970s 20:3	184:3		9.45 70:10,20,22
1980s 2:18 3:1	203 81:16	<u>5</u>	71:7,11 180:23
1986 35:22	21 101:2	5 3:3 93:3 161:25	181:9 183:5,23
1992 172:17 173:12	22 99:10	162:5,6,18	184:3
1997 95:18	226 19:12	5,000 77:23	95 6:18
	24 58:4 162:20	50 10:12,20 11:4	96 185:11
<u>2</u>	163:23	39:3,16 70:8	99 39:16 185:12
2 67:18 129:13,19	25 185:5	177:2,2,3	
130:2,3,15 163:1	250,000-fold 87:18	500 58:11 68:24	
163:24	26 59:23 81:18	69:6 124:25 125:6	
2.00 99:17	29 185:6	128:16 179:12,14	
2.1 82:6 129:13		179:16,24	
130:22	<u>3</u>	528 16:7	
2.11.1 101:9,17	3 23:24 32:24 142:2	56 88:7	
2.12.2 34:25 101:1	3.10 142:11		
2.18 34:18,23 100:5	3.2 60:20	<u>6</u>	
2.2 124:20 129:13	3.30 183:19	6 75:8 93:9,12	
130:15	3.5 49:6 56:17	124:19 129:19	
2.21 21:19	30 17:24 18:25 19:1	60 88:7	
2.22 141:22	19:7 170:1 173:3	66 185:8	
2.4 126:11	185:7,8	67 18:14	
2.5 3:21	30-year 132:18	68 18:12,14,15 19:8	
2.55 142:9	300 145:12	19:10	
20 3:25,25 4:3	33 81:17	69 18:14 185:9	
31:21 35:8,9,13	34 5:19,22,25 6:4		
39:12,18,21	80:6	<u>7</u>	
128:20 148:1	365 58:4	7 33:20	
20,000 54:8	39 65:23	70 18:17,18 19:12	
200 59:25		137:6 162:18	
2000 17:17 36:21	<u>4</u>	163:23	
2001 72:4,8	4 42:8,8 56:18	71 185:10,10	
2002 73:25 75:19	70:21 71:8 78:21	72 185:11	
2006 17:18 19:9	124:1 128:19	79 35:23	
35:22 72:5,9 74:1	141:13		
		<u>8</u>	