

1 on Rowland, whether throwaway or otherwise.
 2 MR JUSTICE BLAKE: Of any comment?
 3 MR HEPPINSTALL: Of any comment.
 4 MR JUSTICE BLAKE: Right.
 5 MR HEPPINSTALL: You will find at 103 that we rely on
 6 Dr Darroudi and something that Dr Haylock said, but
 7 beyond all of that we have been very careful to put into
 8 the bundle in SB22 the Health Protection Agency's
 9 response to Rowland --
 10 MR JUSTICE BLAKE: Yes.
 11 MR HEPPINSTALL: -- which is -- it's worth repeating -- the
 12 quality of mFISH is not in doubt. Where you go from
 13 mFISH to dose reconstruction is something we do have
 14 something to say on. But --
 15 MR JUSTICE BLAKE: But as we identified last night, that is
 16 not part of mFISH. You get some data from mFISH and
 17 then you seek to --
 18 MR HEPPINSTALL: There will be scientists right now at HPA
 19 using mFISH to deal with potential emergencies at
 20 Sellafield and other places. So it's a British
 21 Government paid-for technique.
 22 MR JUSTICE BLAKE: Well --
 23 MR HEPPINSTALL: So hopefully that deals with the issue.
 24 MR JUSTICE BLAKE: Thank you.
 25 I think we will go outside just for a moment if we

Page 5

1 can to see where we are. I think I know where we are
 2 but I think I would like to check. But as I understand
 3 it, the material that you are presently in possession of
 4 is simply directed to whether the mFISH technique -- can
 5 we please ensure that mobile phones are turned off,
 6 please do not come into this courtroom until you have
 7 done that -- is directed to the reliability of the mFISH
 8 technique for identifying chromosomal aberrations.
 9 MR TER HAAR: Would you forgive me a moment? The answer is
 10 yes, that what we are concerned is what might have been
 11 an attempt based on Professor Thomas' evidence to rule
 12 out Wahab and Rowland on the basis that mFISH is
 13 an outdated technique.
 14 MR JUSTICE BLAKE: Right, I have that point. If that's all
 15 that it's about then that focuses what we we'll just
 16 briefly discuss amongst ourselves.
 17 MR TER HAAR: That leaves the possibility which, if you like
 18 I need clarity on, that the Tribunal which has to an
 19 extent an inquisitorial role might still be worrying
 20 about this from the point of view of the Tribunal, which
 21 may be why your Lordship was thinking of rising.
 22 MR JUSTICE BLAKE: We'll just adjourn for a few moments.
 23 (10.10 am)
 24 (A short break)
 25 (10.12 am)

Page 6

1 MR JUSTICE BLAKE: I can clarify that we are collectively of
 2 the view that we will give no account to
 3 Professor Thomas' observation as to the reliability of
 4 mFISH. Even on its face it didn't seem to suggest it
 5 was an unreliable technique.
 6 MR TER HAAR: I'm grateful.
 7 MR JUSTICE BLAKE: There are other reasons why we are not
 8 going to diminish the weight we attach to the
 9 Wahab/Rowland report by reason of that observation.
 10 MR TER HAAR: I'm grateful.
 11 Can I then clarify what appear to be, if I can put
 12 it this way, the battle lines in relation to the Wahab
 13 study.
 14 The criticism in relation to using mFISH having
 15 gone, it appears that -- again always remembering what
 16 the test is -- it is at least a view which could be held
 17 credibly that the group of sailors who were studied
 18 suffered chromosomal abnormality or aberrations, or
 19 there are aberrations in their cells. Thus far I think
 20 there is then no dispute.
 21 Secondly, I believe it to be not in dispute between
 22 us that such aberrations, at least arguably, can be
 23 caused by ionising radiation. I don't, of course, for
 24 the reasons I gave yesterday I don't need to go further
 25 than saying it's arguable that they are.

Page 7

1 MR JUSTICE BLAKE: Yes.
 2 MR TER HAAR: Thirdly, if that be right then it follows
 3 logically that those studied had been subject to
 4 ionising radiation at some point.
 5 Fourthly, those studied might at least in theory
 6 have been exposed to ionising radiation in some other
 7 context but that is something which is considered by the
 8 authors of the paper, and indeed by those commenting
 9 upon it, and has, some would say, been excluded but at
 10 least it's left open that it's arguable that the only
 11 source of radiation that they were exposed to was in
 12 connection with the Christmas Island nuclear tests.
 13 Thus far I believe the propositions, remembering the
 14 right test, are either unarguable or at least are
 15 capable of being argued and raising a question mark.
 16 That means that there is an arguable case or
 17 a reasonable doubt that these people were exposed to
 18 ionising radiation in the course of being involved in
 19 the test.
 20 The next step, once one has gone through those
 21 steps -- and this is all before you get to dosimetry --
 22 MR JUSTICE BLAKE: Yes.
 23 MR TER HAAR: -- as to whether they would have been exposed
 24 to ionising radiation on the vessels, the
 25 Secretary of State has himself put from the archives

Page 8

| | |
|--|---|
| <p>1 into the bundle, in bundle 22, the record of what the 2 sailors did on their vessels which, as I understand it, 3 was put in by the Secretary of State on the basis that 4 it could show that they were not exposed to radiation 5 and therefore, tracking back, that the cause of the cell 6 aberrations could not have been exposure to nuclear 7 test-related ionising radiation.</p> <p>8 However, there is an obvious corollary which is that 9 it is at least an open question as to whether what was 10 happening was that the authorities were not measuring 11 properly what was happening and did not actually fully 12 understand the exposures that were actually taking 13 place. That is as rational an explanation as any other 14 and is certainly a credible explanation.</p> <p>15 There is also finally the point which is on the 16 question of exposure to be borne in mind that these 17 sailors came offshore at Christmas Island, so even if 18 the contemporaneous documentation that my learned friend 19 relies upon shows that they probably weren't exposed to 20 radiation on board the vessels, that becomes stronger 21 from my point of view because the other clear 22 possibility is that they were exposed when they got onto 23 Christmas Island.</p> <p>24 So I say, when you put all those logical steps 25 together, each step of which is -- I only need to go</p> <p style="text-align: center;">Page 9</p> | <p>1 MR JUSTICE BLAKE: Yes.</p> <p>2 MR TER HAAR: I think you have the logic of that.</p> <p>3 I want to move on, though, to just one other 4 clearing up reference if I can put it that way. The 5 question was raised yesterday about urine samples and 6 there was a suggestion -- I think my Lord said 7 Mr Johnston was very rude about that suggestion. We did 8 actually deal with this at some length in our closing 9 submissions.</p> <p>10 Now, I commend, if I can put it that way, to the 11 Tribunal our closing submissions in the previous 12 hearing.</p> <p>13 MR JUSTICE BLAKE: They are quite lengthy, I've noticed.</p> <p>14 MR TER HAAR: They are, but they are very thorough and they 15 cover absolutely every point we say arises. They are in 16 a bundle SB19, and on the point of urine samples dealing 17 I think with Mr Battersby's case, at section E, page 92, 18 paragraph 28.19, you'll find a robust answer to the 19 question of whether urine samples should have been 20 taken, et cetera.</p> <p>21 While on that, we also deal with the Phelps Brown 22 paper at page 80 of those closings.</p> <p>23 MR JUSTICE BLAKE: Even though you didn't have it at the 24 time?</p> <p>25 MR TER HAAR: We had the Rowland paper and we'd seen what</p> <p style="text-align: center;">Page 11</p> |
| <p>1 this far -- a credible and logical step raising 2 a possibility, you have a reasonable doubt as to whether 3 or not this group of people, that's to say the New 4 Zealanders, were exposed to radiation on 5 Christmas Island.</p> <p>6 The question of dosimetry which my learned friend 7 referred to, and the second stage for the Tribunal --</p> <p>8 MR JUSTICE BLAKE: Yes.</p> <p>9 MR TER HAAR: -- is then I cannot say that it establishes on 10 a balance of probabilities that they were exposed to 100 11 or 400, whatever --</p> <p>12 MR JUSTICE BLAKE: Well, let's just take for the sake of 13 argument 170.</p> <p>14 MR TER HAAR: The mean figure. What I can say, though, is 15 that there is a credible scientific case, which cannot 16 be dismissed as fanciful, which has been recognised by 17 all the experts that I've referred to yesterday and 18 during our submissions, that they may well have been 19 exposed to a level on average, on a mean, of 170 20 millisieverts.</p> <p>21 If all those steps are right, unless the Tribunal 22 can find that somewhere along the line there is a gaping 23 flaw in the logic it gives rise to a reasonable doubt 24 about the levels of exposure for everybody involved on 25 Christmas Island.</p> <p style="text-align: center;">Page 10</p> | <p>1 was -- Dr Lindahl had raised issues about it. But we 2 cover it at paragraph 23.13 at page 80.</p> <p>3 Now, my Lord, I'm conscious that the Tribunal wants 4 to finish all the submissions this week and I said 5 yesterday what I would do is I would finish by the break 6 today and that's my intention.</p> <p>7 What I want to do is to take you to the 8 Secretary of State's closing submissions in this hearing 9 and comment upon that because it's --</p> <p>10 MR JUSTICE BLAKE: So leave the rest of your written 11 submissions as written. All right.</p> <p>12 MR TER HAAR: If I could ask you to turn it up first of all 13 at page 2, paragraph 3.</p> <p>14 Now, by way of background, what the Tribunal may 15 need to keep in mind is this: that at the previous FTT 16 the Secretary of State was constantly pressing first of 17 all for the claimants, the appellants, to declare what 18 they said was the minimum level of exposure necessary to 19 be established in order to establish causation, and 20 pressing the Tribunal to require such a threshold. That 21 approach was again advanced in front of Mr Justice 22 Charles, and rejected by him, and it comes back again in 23 paragraph 3.</p> <p>24 It's correctly recorded that the Upper Tribunal 25 found that the mere raising of possibility of causation</p> <p style="text-align: center;">Page 12</p> |

| | |
|--|--|
| <p>1 is insufficient to raise a reasonable doubt, if by that 2 is meant simply a possibility without any foundation. 3 What we'll find throughout these submissions is the 4 passages are taken, but not put in context. 5 Then it goes on to say: 6 "Any dose or any risk above zero is insufficient to 7 raise a reasonable doubt. The mere possibility of 8 exposure above zero raising a possibility or probability 9 above zero is not enough to cross the reasonable doubt 10 threshold." 11 That is a statement which ignores the context. 12 If the possibility is one which is based on -- we 13 went through this yesterday -- a reasonable hypothesis 14 then it may be what I am sure the Secretary of State 15 regards as a mere possibility, and if what this is doing 16 is an attempt to come back to the argument which has 17 been rejected, that you cannot base a finding of 18 reasonable doubt upon a hypothesis, the 19 Secretary of State is ignoring the careful reasoning of 20 Mr Justice Charles that I took the Tribunal through 21 yesterday. 22 MR JUSTICE BLAKE: At the moment, deliberately I've read 23 your submissions, I haven't read Mr Heppinstall's, but 24 looking at that sentence as a piece of legal reasoning 25 it doesn't say anything about you can't take into</p> <p style="text-align: center;">Page 13</p> | <p>1 quantum of dose and of risk (probability) of causation 2 sufficient to raise a reasonable doubt." 3 Absolutely not. That's exactly the argument that 4 was rejected by the Upper Tribunal. This Tribunal does 5 not have to decide what the quantum of dose was. That 6 is exactly the challenge that was put before the 7 Upper Tribunal, and if you recall, the Upper Tribunal 8 was critical of the Secretary of State's approach to 9 saying you must make findings -- findings of fact, 10 findings of this, findings of that. It is absolutely 11 ignoring the test of possibilities and certainties. 12 And then it goes on to say at 5: 13 "It is anticipated that the HL appellants will urge 14 the Tribunal to a conclusion that it has no 15 responsibility to assess such quantum of dose or 16 probability of causation. The SSD disagrees. First, 17 failure to do so cuts across the concession accepted by 18 Mr Justice Charles recorded at paragraph 101 of the UT's 19 decision above." 20 Absolutely it doesn't. 21 I do take exception, first of all to this being said 22 without actually setting out what the concession is, 23 which is a wholly impermissible way of making such 24 a submission. Because the Tribunal here is likely to 25 assume that they've seen what the concession is.</p> <p style="text-align: center;">Page 15</p> |
| <p>1 account hypotheses which have an evidential foundation. 2 MR TER HAAR: No. 3 MR JUSTICE BLAKE: The sentence from my present state of 4 learning -- I can only speak for myself -- seems to be 5 a reflection of conventional wisdom, that the mere fact 6 that there is some exposure to some ionising radiation 7 above background doesn't of itself indicate causation of 8 medical conditions. 9 MR TER HAAR: I'm going to come back to that because that's 10 exactly the way in which, if we move on to paragraphs 4 11 and 5, the Secretary of State would wish to have it, and 12 that is not the basis of the scientific position or the 13 right legal test. So if I can just take you to 4 and 5. 14 4: 15 "The Tribunal has to decide whether an overview or 16 cumulative consideration of all the evidence, of the 17 combined effects of doubts, and so the possibilities 18 they give rise to, may or may not establish a reasonable 19 doubt or reliable evidence that the conditions set by 20 Article 41(1) are met." 21 That's paragraph 101 but as I showed you yesterday 22 there's a lot of reasoning which goes before that which 23 has to be taken into account. 24 Then Mr Heppinstall goes on to say this: 25 "This means that the Tribunal must decide the</p> <p style="text-align: center;">Page 14</p> | <p>1 All the concession was that we made was of course at 2 the end of it you have to take an overall view of 3 matters. We were never suggesting that it was necessary 4 to decide a quantum of dose or of risk. 5 And if we go on in the same paragraph: 6 "Second, to fail to assess that quantum of dose and 7 probability of causation would be an abdication of the 8 Tribunal's duties under the SPO." 9 Absolutely not. Quite the opposite. To accept this 10 submission would be an abdication of the Tribunal's 11 duties to follow the guidance given by the Upper 12 Tribunal. It's a wholly misleading, with the greatest 13 of respect, way of dealing with this case; an argument 14 which has been absolutely rejected by the Upper Tribunal 15 as I took care to point out yesterday. 16 It goes on to say: 17 "It is for the Tribunal to issue the certificate 18 under Article 43 as to entitlement and that requires not 19 mere acceptance of any risk of causation being 20 sufficient but a quantification of what level of risk 21 passes the reasonable doubt threshold." 22 No, it doesn't. What the Tribunal has to do is to 23 issue a certificate saying what level of disablement has 24 been attributed to war service and where there is any 25 doubt about that you will err to the highest point of</p> <p style="text-align: center;">Page 16</p> |

| | |
|---|---|
| <p>1 disablement. That's the whole point of the balance 2 being in favour of the pensioner. 3 This is a total distortion not only of the article 4 itself but also the guidance given by the Upper 5 Tribunal. 6 Then 6: 7 "I certainly agree with the proposition. Before 8 doing so, however, the Tribunal must stress the 9 logically prior question of deciding which parts of the 10 evidence led before it are reliable and what parts are 11 unreliable (evidence that is fanciful or worthless)." 12 I totally agree with that for the reasons I gave 13 yesterday. 14 "The SSD regretfully submits below that some of the 15 evidence led by the Appellants before this Tribunal can 16 be properly characterised as worthless, not least 17 because of a failure to adhere to the Ikarian Reefer 18 rules on expert evidence." 19 As I pointed out yesterday, the Secretary of State's 20 legal advisers weren't too hot on CPR 35 themselves and 21 certainly weren't terribly hot on complying with Ikarian 22 Reefer. 23 MR JUSTICE BLAKE: Yes, well, we have that point. 24 MR TER HAAR: Yes. 25 What then follows is a question of some submissions.</p> <p style="text-align: center;">Page 17</p> | <p>1 MR JUSTICE BLAKE: 21/30? 2 MR TER HAAR: 32. 3 MR JUSTICE BLAKE: Tab 32? 4 MR TER HAAR: Tab 32. 5 It's the very last paragraph of this section which 6 is the annex, annex C, to the UNSCEAR report of 2006, 7 and page 57 of tab 32. 8 It's absolutely vital one does not do what the 9 Secretary of State has done and make a broad, sweeping 10 remark without actually drawing attention to what the 11 report actually said. 12 MR JUSTICE BLAKE: Sorry -- 13 MR TER HAAR: Sorry, tab 32. 14 MR JUSTICE BLAKE: 57, "Concluding remarks", the page 15 numbers have gone to the bottom. 16 MR TER HAAR: Sorry, yes, sometimes it's at the top, 17 sometimes it's at the bottom. Does my Lord now have it? 18 MR JUSTICE BLAKE: I have it. 19 MR TER HAAR: Good. 20 "In the light of these considerations the overall 21 view of the committee is that the data currently 22 available [a very important word -- "currently 23 available"] do not require changes in radiation risk 24 coefficients for cancer and hereditary effects of 25 radiation in humans. The committee will maintain</p> <p style="text-align: center;">Page 19</p> |
| <p>1 Then at page 5 an attack is made on what is described as 2 the BS appellants' thesis, the alternative model, and 3 there is an ad homines attack on a group of witnesses 4 which includes Professor Mothersill. 5 MR JUSTICE BLAKE: Yes. 6 MR TER HAAR: Then in part of that attack in paragraph 14 -- 7 MR JUSTICE BLAKE: 14? 8 MR TER HAAR: Paragraph 14, page 5. 9 MR JUSTICE BLAKE: Oh right, yes. 10 MR TER HAAR: In the last sentence Mr Heppinstall says this: 11 "Specifically, the new paradigm propounded by 12 Professor Mothersill relating to non-targeted and 13 bystander effects has been considered but has not caused 14 the risk model to change [reference to UNSCEAR] and the 15 old paradigm remains the currently scientifically 16 reliable paradigm and the only reliable evidence of 17 radiation risk." 18 That is, as I will show you, not in any way 19 an accurate record of what UNSCEAR decided, nor applies. 20 If you would be kind enough, please, to go to bundle 21 SB21 and first of all go to the citation which is at 22 tab 32. 23 MR JUSTICE BLAKE: Yes. I am going to catch up. I just 24 want to get a note, please. 25 MR TER HAAR: Bundle SB21.</p> <p style="text-align: center;">Page 18</p> | <p>1 surveillance of developments in the area of non-targeted 2 and delayed effects and recommends that future research 3 pay particular attention to a study design emphasising 4 replication low dose responses and associations with 5 health effects, particularly in the human population. 6 Ultimately, understanding the range and multitude of 7 multicellular responses to radiation will provide 8 mechanistic insights into how radiation induces its 9 observed health effects." 10 So the authors were far from saying, as is implied, 11 that what Professor Mothersill describes as the new 12 paradigm is to be rejected. What they were saying is 13 it's a hypothesis that has not yet got to the point 14 where it can be accepted as the consensus view -- 15 completely different and vitally different in the 16 context of the test in these proceedings. 17 MR JUSTICE BLAKE: The authors of this report had the 18 benefit of a great many reports from 19 Professor Mothersill from 2001, looking at page 70, M17 20 through to M25. 21 MR TER HAAR: Yes. 22 MR JUSTICE BLAKE: But there was nothing -- was there 23 anything new that she was telling the Tribunal about in 24 her evidence last time round? Or is her hypothesis and 25 the supporting material for it adequately reflected in</p> <p style="text-align: center;">Page 20</p> |

| | |
|--|---|
| <p>1 the material that the authors of this report were 2 reviewing? 3 MR TER HAAR: The answer -- certainly the thrust of what she 4 was saying in her report is reflected here. 5 MR JUSTICE BLAKE: Yes. 6 MR TER HAAR: Let me -- 7 MR JUSTICE BLAKE: It's not a question of subsequent 8 developments since this report? 9 MR TER HAAR: No, it's an ongoing picture. 10 I am going to come back to this report in 11 a different context almost immediately, but going back 12 to what Mr Heppinstall says in that sentence: 13 "Specifically, the new paradigm propounded by 14 Professor Mothersill relating to non-targeted and 15 bystander effects [I emphasise "bystander effects"] has 16 been considered but has not caused the risk model to 17 change ..." 18 The bystander effects were dealt with not just by 19 Professor Mothersill but also by Dr Brenner, but were 20 also considered in this report, not in that section, but 21 if you go, please, to tab 30. 22 At page 127, top right-hand corner, paragraph 557, 23 in this paragraph the authors consider the bystander 24 effect, and stepping back for a moment, what -- 25 MR JUSTICE BLAKE: I have page 127. The paragraph is?</p> <p style="text-align: center;">Page 21</p> | <p>1 [that's of course our old friend Dr Brenner] proposed 2 a model for the bystander effect based on the oncogenic 3 transformation data of Sawant et al and Miller et al for 4 in vitro exposure of C3H 10T and a half cells to alpha 5 particles. Brenner et al discussed evidence from 6 experimental systems consistent with concluding that the 7 linear extrapolation of high dose effects to low doses 8 underestimate oncogenic transformation rates by a factor 9 of between 60 and 3,000." 10 Now stopping there, that is clearly a body of 11 opinion. We know that Dr Brenner is recognised as being 12 well respected, so we are not looking at a theory put 13 forward by somebody whose views are not respected in the 14 scientific community. But I accept that they are not -- 15 it's not a consensus because what it goes on to say is 16 this: 17 "However, Little and Wakeford assessed the ratio of 18 the lung cancer risks for persons exposed to low 19 (residential) doses of radon daughters to that for 20 persons (underground miners) exposed to high doses of 21 radon daughters; the ratio lay in the range 2 to 4. 22 This implies that low dose rate lung cancer risks 23 associated with alpha particle exposure are not 24 seriously underestimated by extrapolation from the high 25 dose miner data. It also implies that the bystander</p> <p style="text-align: center;">Page 23</p> |
| <p>1 MR TER HAAR: 557, bottom left-hand corner. 2 MR JUSTICE BLAKE: Yes. 3 MR TER HAAR: What Mr Heppinstall is saying is one of the 4 ways in which you can show that Professor Mothersill is 5 out on a limb is that she refers to a bystander effect, 6 and the bystander effect is that you can have one 7 infected cell and it can infect the one next door. 8 MR JUSTICE BLAKE: Got that. 9 MR TER HAAR: He is saying the scientific world has rejected 10 that, therefore you reject Professor Mothersill. That's 11 absolutely not how it's approached by UNSCEAR. 557 says 12 this: 13 "Although it is generally assumed that protraction 14 of radiation dose results in a reduction of effect ... 15 largely as a result of the extra time that protraction 16 allows for cellular repair processes to operate, there 17 are biological mechanisms that could increase the effect 18 when dose is protracted ... Bystander effects, whereby 19 cells that are not directly exposed to radiation 20 exhibit adverse biological effects, have been observed 21 in a number of experimental systems in vitro and in 22 vivo. The bystander effect implies that the dose 23 response after broad-beam irradiation could be highly 24 concave at low doses because of saturation of the 25 bystander effect at low doses. Recently Brenner et al</p> <p style="text-align: center;">Page 22</p> | <p>1 effect observed in the C3H 10T and a half cell system 2 cannot play a large part in the process of lung 3 carcinogenesis in humans due to radon exposure. The 4 bystander effect and other 'non-targeted' effects are 5 discussed at greater length in annex C of the UNSCEAR 6 2006 Report." 7 Annex C is what we were looking at earlier at 8 tab 32. 9 So the effect of this -- you'll find the discussion, 10 if you go back to tab 32, the discussion is at length 11 starting at page 23 at the bottom -- the conclusion, 12 dealing with the in vitro research, is at page 33, 13 includes a reference to Professor Mothersill at page 33, 14 paragraph 70, and concludes at 73: 15 "Attempting to reconcile these conflicting results 16 raises a number of questions. While the quality of 17 radiation and the cell types under investigation are 18 different, these studies highlight the family responses 19 characterised in the bystander effect." 20 Then it goes on at the bottom of that paragraph: 21 "Clearly, bystander effects can modify cellular 22 responses to radiation and it remains to be determined 23 whether these effects, characterising non-irradiated 24 cells in vitro, have a major role in the response of 25 irradiated cells in vitro or in irradiated and</p> <p style="text-align: center;">Page 24</p> |

| | |
|---|---|
| <p>1 non-irradiated cells in vivo." 2 Then there is a discussion at the next section of 3 the in vivo effects, bystander effects, and at page 35 4 the conclusion is this. At the top right numbering, top 5 right paragraph, B43, you'll see it's the last 6 paragraph. It's actually paragraph 78, but the very 7 last conclusion is: 8 "Thus, at the present state of our knowledge, it is 9 reasonable to assume that any bystander effect induced 10 in vivo is accounted for in models of organ risk 11 evaluation." 12 So it's dealing with risk evaluation. 13 "As a result, it is unlikely that the resurgence of 14 interest in these non-targeted radiation effects will 15 substantially alter risk estimates as discussed in 16 detail in the BEIR VII report. Nevertheless, it cannot 17 be excluded that increasing the knowledge basis for in 18 vivo bystander effects at low doses and low dose rates 19 in specific organs may affect current organ risk 20 estimates." 21 So the conclusion is: we haven't got there yet, but 22 there's a lot that needs to be considered, questions 23 raised. 24 Now, going back to -- we can now put SB21 away. 25 That's the only reference I want to make.</p> <p style="text-align: center;">Page 25</p> | <p>1 The Secretary of State's approach is always focused 2 on a war which they won in relation to the negligence 3 litigation of the balance of probabilities and these 4 submissions carry on, whilst paying lip service to the 5 Upper Tribunal, in fact ignoring the whole effect of 6 what the Upper Tribunal dictated. 7 Now, the attack on Professor Mothersill continues 8 over the page at paragraph 6. 9 MR JUSTICE BLAKE: Paragraph? 10 MR TER HAAR: Sorry page 6, paragraph 16. 11 He says this at paragraph 17: 12 "[Professor Mothersill] is a believer in an apparent 13 'new paradigm' that seeks to usurp the current ICRP, 14 UNSCEAR, PHE, IRSN and BEIR [et cetera]. She posits 15 a theory of greater risk at low dose than that predicted 16 by the LNT model. The new paradigm, of bystander 17 effects and genomic instability, only exists, however, 18 in the laboratories of Professor Mothersill and others 19 carrying out such research." 20 What on earth, with the greatest respect, has that 21 got to do with the test in this case? What it's saying 22 is that there are people who are carrying out research 23 who believe that the paradigm of bystander effects is 24 worthy of investigation on the basis that it may be 25 a real phenomenon.</p> <p style="text-align: center;">Page 27</p> |
| <p>1 Let's go back to see how Mr Heppinstall uses that. 2 Going back to page 5 of his submissions, this is 3 a section aimed at saying that you can throw out as 4 unreliable the evidence of a number of witnesses 5 including Professor Mothersill. 6 But the sentence that I was referring to, 7 paragraph 14, which is part of his submissions as to why 8 you should throw out Professor Mothersill on the basis 9 of the scientific credibility -- going back to the 10 discussion we had yesterday when distinguishing between 11 the credibility of the theory and the credibility of the 12 person -- he is here seeking to destroy the credibility 13 of the person by reference to the credibility of her 14 scientific theory. 15 "Specifically, the non-paradigm propounded by 16 Professor Mothersill based on non-targeted bystander 17 effects has been considered but has not caused the risk 18 model to change and the old paradigm remains the 19 currently scientifically reliable paradigm and the only 20 reliable evidence of radiation risk." 21 Yet again my learned friend is failing to address 22 what he has been told to address by the Upper Tribunal: 23 namely, is there a doubt? Is there a possibility? Is 24 there a group of qualified experts who form a different 25 view?</p> <p style="text-align: center;">Page 26</p> | <p>1 As I said, my learned friend could not have possibly 2 written that paragraph if he had kept in mind the 3 guidance of the Upper Tribunal. 4 MR JUSTICE BLAKE: Well, hang on. What's wrong with the 5 paragraph or the statement? Is it inaccurate? The new 6 paradigm only exists in the laboratories and it hasn't 7 gone from glass into animal or into humans. 8 MR TER HAAR: Well, the answer is as we saw a moment ago in 9 annex C of the UNSCEAR report, even in vivo there are 10 still questions being raised, so actually as 11 a hypothesis the questions are still being raised in 12 vivo. But the clear thrust of this, in the context of 13 this being an attack on Professor Mothersill -- 14 MR JUSTICE BLAKE: Yes. 15 MR TER HAAR: -- it's suggesting that this is to be sneered 16 at because it's simply only something in laboratories. 17 MR JUSTICE BLAKE: Yes. 18 MR TER HAAR: Then if we go on, we can see just how far away 19 he is from understanding the test: 20 "Professor Mothersill can only offer evidence of 21 theoretical effects at cellular levels (often single 22 cell level) which radiation may or may not have in any 23 one individual." 24 All right; "may or may not" is good enough for the 25 test in this Tribunal.</p> <p style="text-align: center;">Page 28</p> |

| | |
|---|---|
| <p>1 There are then further attacks, and as I pointed out 2 yesterday the attacks at page 7 were simply not heralded 3 in an appropriate way and I'm not going to deal with 4 them in this case. 5 Now it then moves on to deal with a number of 6 Dr Busby's witnesses. I will leave him to deal with 7 that. 8 If we go to page 13, paragraph 55, my learned friend 9 starts to deal with Professor Parker. 10 MR JUSTICE BLAKE: Yes. 11 MR TER HAAR: "Professor Parker has been called as 12 an epidemiologist and no criticism of her evidence is 13 made insofar as it was confined to that area of 14 expertise." 15 I hope when he makes his submissions he is going to 16 point out that he accepts that Mr Hallard went outside 17 his areas of expertise and we'll see whether there is 18 even-handedness about that. 19 "Whilst epidemiology might involve expertise in the 20 design of studies, and while she might have acquired 21 some experience of dosimetry whilst conducting the 22 Sellafield project, there is no indication she has any 23 experience in relation to dosimetry and exposure at the 24 British nuclear tests." 25 Well, Mr Hallard had no expertise in dosimetry at</p> <p style="text-align: center;">Page 29</p> | <p>1 MR HEPPINSTALL: Only if this helps because my intention -- 2 if Mr ter Haar's intention is, and I think it is from 3 his closing submissions, not to rely on 4 Professor Parker's evidence which is criticised here, if 5 that evidence is essentially withdrawn then so is the 6 criticism. I've made it clear in this submission that 7 we have no criticism of her work as an epidemiologist 8 and expertise as an epidemiologist. This was only 9 a frolic of her own into dosimetry. I don't see any of 10 that relied upon by Mr ter Haar. If it is not relied on 11 then all of this is withdrawn as well. That may be the 12 easiest way of -- 13 MR TER HAAR: I assume there will be a similar withdrawal 14 where Mr Hallard has gone into areas of exposure. I'm 15 happy to hear that. 16 I'll move on because I'm limited in time. 17 In relation to page 15, other experts, paragraph 68 18 says this -- 19 MR JUSTICE BLAKE: So I mean, I am having to keep a note of 20 where the balance is going, so insofar as what is set 21 out here is an attack on Parker on dosimetry we don't 22 need to go there if you are not relying on Parker on 23 dosimetry. 24 MR TER HAAR: No, what I do rely upon is -- 25 MR JUSTICE BLAKE: Parker on epidemiology. I read your</p> <p style="text-align: center;">Page 31</p> |
| <p>1 the British nuclear tests, he had no expertise in 2 exposure at the British nuclear tests. My learned 3 friend does not appear to be applying consistent 4 standards. 5 MR JUSTICE BLAKE: Well, I am not sure that that's your best 6 point. Hallard had expertise in dosimetry. As 7 I understand it what is being said here is that this 8 witness doesn't. She has an expertise in epidemiology. 9 We noted that divide when we had the live witnesses 10 before us. 11 MR TER HAAR: The difference is, of course, that whereas 12 Dr Haylock came from a purely mathematical background, 13 which is one way in which you come to epidemiology, 14 Professor Parker has medical qualifications as her CV 15 shows. 16 MR JUSTICE BLAKE: Yes, all right, a medical epidemiologist 17 but I am simply trying to look at the sentence that you 18 are directing your fire on. 19 MR TER HAAR: Well, certainly it is right -- 20 MR JUSTICE BLAKE: And I don't see -- I mean if it's wrong 21 that she has no expertise in dosimetry that's a good 22 point but if it's not wrong, it's a point. Where it 23 takes us we'll have to go -- 24 MR TER HAAR: The answer is it depends what you mean by 25 dosimetry --</p> <p style="text-align: center;">Page 30</p> | <p>1 submissions upon that and as I understand it, not 2 directed to you but directed to Mr Heppinstall, there's 3 no similar attack that she doesn't have the expertise. 4 MR HEPPINSTALL: Absolutely. 5 MR JUSTICE BLAKE: So she's within a body of responsible 6 opinion, whether you agree with her results or not. 7 MR HEPPINSTALL: Yes, an eminent epidemiologist, well within 8 her expertise. 9 MR JUSTICE BLAKE: There we are. That's a bit of progress 10 then. 11 MR TER HAAR: That's progress. 12 Can I go on to page 15, paragraph 68. 13 MR JUSTICE BLAKE: Once I've recorded that. 14 MR TER HAAR: Sorry. (Pause) 15 MR JUSTICE BLAKE: Yes. 16 MR TER HAAR: At paragraph 68 it says this: 17 "The Tribunal will also note the SSD relies on 18 Dr Lindahl and Dr Darroudi in relation to radiobiology 19 ..." 20 But of course what my learned friend doesn't do is 21 to address the fact that on radiobiology Dr Brenner's 22 evidence is there so we have different views at any 23 rate. And then it says: 24 "... Professor Kaldor on epidemiology ..." 25 And Professor Kaldor, you will recall, says that the</p> <p style="text-align: center;">Page 32</p> |

| | |
|---|--|
| <p>1 Wahab/Rowland study raises questions which need to be 2 answered. So we'll see how my learned friend deals with 3 that. But he has a real difficulty of putting forward 4 Professor Kaldor and then seeking to push to one side 5 the Wahab/Rowland study.</p> <p>6 MR JUSTICE BLAKE: Right. For me personally -- ah well, 7 yes, I see. You are commenting upon a submission which 8 I was waiting to have made. So you are certainly in 9 advance of my reading. But just to get my bearings, 10 I see that the Secretary of State's comments on Rowland 11 are at paragraph 96 onwards. You say that those 12 comments don't take into account the support for Rowland 13 that you got from some of his own witnesses.</p> <p>14 MR TER HAAR: Yes, absolutely right. If we just go ahead to 15 paragraph 96, you look in vain for any recognition of 16 the views expressed for example by Professor Kaldor. 17 You look in vain for any recognition of Dr Braidwood's 18 evidence at the last Tribunal that these were areas 19 where he would have wished further research to be 20 carried out.</p> <p>21 So you cannot take these submissions as being 22 an attempt to summarise all the evidence which is 23 relevant on both sides, or even to deal with the 24 evidence on the Secretary of State's side that are 25 unhelpful to his case.</p> <p style="text-align: center;">Page 33</p> | <p>1 And this is again an area where, if we go on to the 2 second part, "the risks that that upper limit assessment 3 posed of causation of the claimed condition", constantly 4 in the evidence and in submissions the 5 Secretary of State ignored the prior requirement to 6 plead his case. He did eventually set out by reference 7 to Mr Hallard's report a cross-reference to our 8 possibilities and certainties document.</p> <p>9 MR JUSTICE BLAKE: Yes.</p> <p>10 MR TER HAAR: But only in relation to how it interplayed 11 with Mr Hallard's evidence. He did not, for example, 12 address whether Professor Mothersill's evidence was 13 possible or not. He didn't address whether 14 Professor Parker's evidence was possible or not, and 15 a long list of similarities.</p> <p>16 MR JUSTICE BLAKE: We know the outcome on Parker 17 epidemiology, you just clarified that.</p> <p>18 MR TER HAAR: Well, we don't know how far he is accepting it 19 is a possible view. He just says he accepts it.</p> <p>20 MR JUSTICE BLAKE: I thought we had just had it clarified.</p> <p>21 MR TER HAAR: Can I go on to page 17. The same point comes 22 up again, but then a different point is now raised and a 23 fundamentally and thumpingly bad point, with great 24 respect to my learned friend. Halfway through 25 paragraph 77 it says this:</p> <p style="text-align: center;">Page 35</p> |
| <p>1 Can I take you on, please, to page 16. Again, some 2 important points. Towards the top of page 16 is a cross 3 heading: "Why does an assessment of dose and risk 4 matter?" In paragraph 74 this submission is made: 5 "Accordingly, there is a real causation threshold 6 which the appellants must overcome to succeed in these 7 appeals." 8 No, there's not a threshold. It's a repetition of 9 the false test which was rejected by the Upper Tribunal. 10 "That threshold is unsurmountable without some 11 assessment of (a) the highest possible dose of ionising 12 radiation to which the appellant was exposed to by 13 reason of attendance at the Grapple or in the case of 14 Battersby, Buffalo, tests and (b) the risks that that 15 upper limit assessment of dose posed of causation of the 16 claimed condition." 17 Now, if all that is being said is that the Tribunal 18 must take into account what the highest possible dose 19 was, I have no difficulty. If what is being said, which 20 I believe it is, is that you must reach a finding as to 21 what the highest possible dose was, that, for reasons 22 I've already submitted, is not what you are required to 23 do. It is sufficient for you to say, "I cannot be sure 24 what the highest possible dose is." Because, if so, you 25 add it to the basket of possibilities and certainties.</p> <p style="text-align: center;">Page 34</p> | <p>1 "The Tribunal has to take into account the fact that 2 causation of the opponents' claimed condition is 3 complicated. True it is that the appellants only have 4 to prove a reasonable doubt on reliable evidence that 5 exposure at the test was a cause, not the cause. But 6 nevertheless, the HL appellants have to prove that 7 exposure had at least a role in causation ..." 8 Stopping there. No, we don't have to prove that 9 exposure had a role in causation. Constantly addressing 10 the wrong test. 11 Then the next point: 12 "... when compared with all the other competing 13 causes." 14 Then they go on to say: 15 "That analysis not only includes ..." 16 MR JUSTICE BLAKE: Let's try and rework that in the light of 17 our discussion yesterday. 18 Nevertheless, HL appellants have to prove that 19 exposure may have had some role in causation when 20 compared with all the other competing causes, in the 21 sense that there could be no certainty that it didn't 22 play a role. 23 MR TER HAAR: I think that's still not quite getting the 24 test right. But it's not far out. 25 MR JUSTICE BLAKE: That's moving in the right direction.</p> <p style="text-align: center;">Page 36</p> |

| | |
|---|--|
| <p>1 I'm trying to do this ad libbing. 2 MR TER HAAR: Can I tell you how I would think that sentence 3 should read? 4 "But nevertheless the HL appellants have to prove 5 that there is a reasonable doubt as to whether exposure 6 had a role in causation." 7 MR JUSTICE BLAKE: All right. 8 MR TER HAAR: But not the burden that they had to prove. 9 But the other point which is raised, though, which 10 is what I described as a thumpingly bad point -- 11 MR JUSTICE BLAKE: But if it was certain that it didn't have 12 any role then there could be no reasonable doubt. 13 MR TER HAAR: Absolutely. 14 MR JUSTICE BLAKE: I was trying to get that way round, but 15 I'm not sure -- 16 MR TER HAAR: The difficulty is that what the 17 Secretary of State is constantly trying to do is get the 18 Tribunal to a mindset which is subliminally the 19 reasonable probability test. 20 MR JUSTICE BLAKE: Right. So ignore the siren voices 21 leading us onto the rock of reasonable doubt. 22 MR TER HAAR: Absolutely. 23 MR JUSTICE BLAKE: Stuff our ears, bind ourselves to the 24 mast and go through Scylla and Charybdis. 25 MR TER HAAR: Absolutely.</p> <p style="text-align: center;">Page 37</p> | <p>1 have got cancer anyway, you can't have a war pension. 2 That's simply not the right test. 3 Now I may be misreading my learned friend's 4 submissions but -- 5 MR JUSTICE BLAKE: But if it means that the only reason that 6 you would have got cancer, it anyway, and there is no 7 causal connection with the cancer in Christmas Island, 8 that's uncontroversial. 9 MR TER HAAR: Then it's saying nothing extra and is 10 unobjectionable. 11 MR JUSTICE BLAKE: Yes. But if you may have been exposed to 12 radiation, pace what you say about dosimetry, of at 13 least a sufficient amount (however amount is sufficient 14 to cause a radiogenic disease) and you've got such 15 a response illness, whether it's leukaemia or a solid 16 cancer or something, it doesn't matter that you might 17 have died from some other cause anyway. 18 MR TER HAAR: Yes. 19 MR JUSTICE BLAKE: All right? 20 MR TER HAAR: Yes. 21 MR JUSTICE BLAKE: If we've unpacked the two approaches, 22 I'll bear that in mind when we hear -- 23 MR TER HAAR: I have almost finished with this and I want to 24 come back to one other point but yesterday I took you to 25 the Upper Tribunal's decision and in particular where</p> <p style="text-align: center;">Page 39</p> |
| <p>1 MR JUSTICE BLAKE: Well, I think I have that point. 2 MR TER HAAR: But there's now another point, though, which 3 is different. This is what I described as a thumpingly 4 bad point: 5 "That analysis not only includes all of the other 6 hazards in life, including all of the unknown causes of 7 ill-health, especially in carcinogenesis, but also the 8 reality of the risks of potentially radiation-induced 9 disease which the appellants will have faced but for the 10 tests." 11 That appears to be saying that if you might have got 12 the disease anyway, that's not sufficient. 13 Let me give an example. It may be that my learned 14 friend's drafting was a little sloppy at this point, but 15 assume that you are on Christmas Island and a lorry runs 16 you down while you are standing in uniform on war 17 service. No question, you get a War Pension as 18 a result. 19 Assume that if you hadn't been standing on 20 Christmas Island you would have been standing in the 21 middle of the road outside the law courts and a lorry 22 would have hit you. It doesn't matter that you would 23 have still been struck by the lorry. What matters is 24 that you were struck by the lorry while on war service. 25 And what appears to be said here is, well, if you might</p> <p style="text-align: center;">Page 38</p> | <p>1 the Upper Tribunal deals with the case of Sienkiewicz. 2 If you go to my learned friend's submissions at 3 page 36, this is the point which we raised earlier as to 4 the Supreme Court's decision in Sienkiewicz, and that 5 was death with, just for the Tribunal's note, at 6 paragraph 210 of the Upper Tribunal decision, and it 7 appears to us that my learned friend is trying to 8 re-visit submissions that he already made below but 9 we'll see how he develops that. 10 My Lord, I want to just finally leave those 11 submissions and come back to one final area, which may 12 or may not be important, and I say may or may not be 13 important for this reason. 14 MR JUSTICE BLAKE: So we move away from -- 15 MR TER HAAR: From his submissions, yes. 16 MR JUSTICE BLAKE: Can I just put them away then. 17 MR TER HAAR: And this is the last point I want to make in 18 my oral submissions at this stage. 19 MR JUSTICE BLAKE: Yes. 20 MR TER HAAR: I preface it by saying "may or may not be 21 important" for this reason: it's back to low dose. 22 If you follow what may be the most central part of 23 our case, which is Wahab/Rowland, then low dose as an 24 issue falls away in this case. In that context, a 25 comment more about Professor Thomas, in fact in the end</p> <p style="text-align: center;">Page 40</p> |

| | |
|---|---|
| <p>1 Professor Thomas' evidence added nothing in this case 2 whatsoever because what she revealed was that she was 3 simply giving voice to what were in fact epidemiological 4 conclusions which as she accepted wasn't her speciality. 5 So when you are dealing with low dose you are dealing 6 with epidemiology and therefore Dr Haylock. 7 Now if we go -- 8 MR JUSTICE BLAKE: Low dose for the purpose of understanding 9 the submission is below 100 millisieverts for the sake 10 of argument. 11 MR TER HAAR: That is certainly where Dr Haylock put it. 12 MR JUSTICE BLAKE: Yes. 13 MR TER HAAR: Now, if you accept our submissions on 14 Wahab/Rowland, which I've been over at some length, 15 under 100 millisieverts isn't in play, if I can put it 16 that way. 17 MR JUSTICE BLAKE: Yes. 18 MR TER HAAR: So what I'm about to say may be totally 19 irrelevant if you accept that central part of our case. 20 MR JUSTICE BLAKE: Right. This is, if not -- 21 MR TER HAAR: If not. 22 MR JUSTICE BLAKE: -- route 2. 23 MR TER HAAR: What do we say, though, about low dose? It's 24 important, we submit, to understand the thrust of 25 Dr Haylock's evidence. Dr Haylock's evidence everybody</p> <p style="text-align: center;">Page 41</p> | <p>1 saw earlier described as the mechanistic effect becomes 2 important. Because it is when the science of 3 epidemiology ceases to provide you with an answer that 4 other sciences come into play. Hence, all the interest 5 there is in bystander effects and low dose. And the 6 state of science at the moment is for our purposes 7 summarised if we go back again to the UNSCEAR report 8 that's in bundle SB21. 9 MR JUSTICE BLAKE: Yes. 10 MR TER HAAR: It's again tab 30. After a very lengthy 11 analysis of all the material, at page 137 -- it's the 12 bottom numbering on this occasion -- 13 MR JUSTICE BLAKE: Yes. 14 MR TER HAAR: -- at paragraph 589, the conclusion is this: 15 "The increased statistical precision associated with 16 the longer follow-up and resulting larger number of 17 cancer cases observed in the above studies have also 18 been useful in the examination of dose response 19 relationships, particularly at lower doses. For 20 example, the most recent data for the survivors of the 21 atomic bombings are largely consistent with linear or 22 linear quadratic dose trends over a wide range of doses. 23 However, analyses restricted solely to low doses are 24 complicated by the limitations of statistical precision, 25 the potential for misleading findings owing to any small</p> <p style="text-align: center;">Page 43</p> |
| <p>1 accepts of the LNT, the no threshold starting point, 2 that you can't say at what level radiation will have no 3 effect. Epidemiology doesn't help you to get there and 4 the assumption is that it may have some effect at any 5 dose. The difficulty, as Dr Haylock accepted and 6 explained, is that there's a limit to what 7 epidemiologists can do because they are bound to be 8 looking at cohort sizes in order to try and determine 9 effects. 10 The more information you get, the more accurate your 11 estimate of chances of a disease become but nevertheless 12 there's a point at which the science of epidemiology has 13 to stop. 14 All that he was saying if you go back to the 15 transcript of his evidence was this: 16 "In the absence of any other indication I can tell 17 you that certainly at high dose and medium dose the 18 effects of radiation appear to be linear, or possibly 19 linear quadratic." 20 The difference for our purposes doesn't matter. 21 We're not dealing with that scientific qualification. 22 What the epidemiologists can't tell you is once you 23 get to the area where the science of epidemiology stops, 24 they cannot say there is no effect below that and it is 25 at that point that what is in some of the passages we</p> <p style="text-align: center;">Page 42</p> | <p>1 undetected biases, and the effects of performing 2 multiple tests of statistical significance when 3 attempting to establish a minimum dose at which elevated 4 risk can be detected. 5 "Longer follow-up of large groups such as the 6 survivors of the atomic bombings should hopefully 7 provide more information at low doses. However, 8 epidemiology alone will not be able to resolve the issue 9 of whether there are dose thresholds for risk. In 10 particular, the inability to detect increased risk at 11 very low doses using epidemiological methods does not 12 mean that the underlying cancer risks are not elevated. 13 However, the high dose radiotherapy studies of patients 14 indicate that for some cancers, for example, bone and 15 connective tissue, rectum, uterus and small intestine, 16 any risks at doses of below several grays, if they 17 exist, are small." 18 This is vitally important when assessing 19 Dr Haylock's evidence. He didn't disagree with this 20 approach. There is a point which epidemiology cannot 21 reach. If we were in the balance of probabilities 22 territory I would be in terrible difficulty, but what it 23 comes to is that the science cannot tell you whether or 24 not the exposure to radiation at low doses carries no 25 risk, some risk, enhanced risk. It simply can't tell</p> <p style="text-align: center;">Page 44</p> |

| | |
|---|---|
| <p>1 you that. All you can do -- that comes back to 2 Professor Mothersill -- is look at what you can tell 3 mechanistically, and it's not just Professor Mothersill, 4 it's also Dr Brenner. 5 MR JUSTICE BLAKE: Well, could you just hold your thoughts 6 whilst I seek to introduce a couple of questions, 7 please. I think I have the direction of travel. 8 In your written submissions which I have read, but 9 you haven't developed them orally this morning, at 10 paragraph 133, that section deals with epidemiology 11 using Professor Parker's comment and reading it, 158, 12 even taking out of the equation particular propositions, 13 you have this irreducible minimum as I read it, if it's 14 accurate, that whatever the criticisms of NRPB, NRPB, 15 Pearce and Carter, have all suggested increases in 16 leukaemia by epidemiological methods. 17 Now, just trying to link all this together, is it 18 your case that those are findings based on dosimetry 19 estimates above 100 millisieverts and therefore if you 20 are into that territory epidemiology supports you, or is 21 it your case that those epidemiological findings, just 22 taking the paragraph as it stands for the time being, do 23 support the possibility of a causal nexus, certainly in 24 the case of leukaemia and perhaps similar cancers? 25 MR TER HAAR: The latter.</p> <p style="text-align: center;">Page 45</p> | <p>1 possibility to the relevant reasonable doubt standard -- 2 I don't know whether it will or won't but let's assume 3 it -- then epidemiology doesn't positively help and you 4 have a blank space. In that blank space you need to 5 rely on Mothersill in some form to show the possibility 6 which can't be excluded because medical science hasn't 7 yet gone that far. 8 MR TER HAAR: I would say you absolutely accurately 9 summarised my submission with one qualification. 10 MR JUSTICE BLAKE: Yes? 11 MR TER HAAR: Of course I rely upon Professor Mothersill but 12 even if you were to exclude her evidence for the -- 13 MR JUSTICE BLAKE: Yes. 14 MR TER HAAR: -- attack upon her personal credibility which 15 is made, you would still be left with the theory 16 explained by her, Dr Brenner's endorsement of it and the 17 UNSCEAR acceptance in the passage I took you to earlier 18 that Dr Brenner has published papers which support, for 19 example, the bystander effect which is in effect 20 a mechanistic effect which if you like ducks under the 21 radar of even epidemiology. 22 MR JUSTICE BLAKE: Sorry to prolong the debate but I think 23 it may be important as you are getting towards your 24 final point and I for one would like to just tease this 25 out a little longer.</p> <p style="text-align: center;">Page 47</p> |
| <p>1 MR JUSTICE BLAKE: The latter. So be careful not to saw off 2 the tree on which you wish to stand, if you are saying 3 when we get to low doses, for the present argument below 4 100 millisieverts, epidemiology, we don't know where -- 5 MR TER HAAR: I think perhaps a more accurate way to put it 6 is this. Even if you get to a point where epidemiology 7 can't help, it can't help because of the statistical 8 clutter. The background noise becomes too loud for the 9 statistician to be able to distinguish causation. 10 MR JUSTICE BLAKE: Low power. 11 MR TER HAAR: Yes, low power. And in that territory the 12 science of microbiology cell research comes in to help 13 at least as to whether there's a possibility. The 14 difficulty is always whether you get as far as 15 probability. 16 MR JUSTICE BLAKE: Yes, right, because that was the second 17 part of my question. You therefore say that 18 epidemiology as a whole, at least whatever differences 19 there may be between Haylock and Parker, there is 20 a residual view which can't be dismissed as fanciful or 21 trivial to suggest that epidemiology does point to the 22 possibility of enhanced risk of leukaemia at low doses. 23 If, per contra, and this is very much a hypothetical 24 question to tease out where you stand, the analysis that 25 we'll have to undertake in due course eliminated that</p> <p style="text-align: center;">Page 46</p> | <p>1 So we now have two hypotheses of possible 2 conclusions to which we might be persuaded to come when 3 we've done all the work. Right? So we've now said the 4 epidemiological data at low doses isn't probative of 5 a causal nexus. So we exclude that on the (inaudible). 6 We then look at some of Professor Mothersill's 7 hypothesis about: if there's any exposure to radiation 8 then you simply can't exclude the risk of chromosomal 9 changes. See the in vitro tests, et cetera, and 10 bystander effects. Let's assume for the moment we put 11 a red line or we delete her evidence. 12 We're then left with Brenner because as I understand 13 it the bystander effect is an observable phenomenon. 14 MR TER HAAR: Or at least an arguably observable phenomenon. 15 MR JUSTICE BLAKE: Okay, but Brenner argues for it, not just 16 Mothersill. 17 So you have the bystander effect as a plausible 18 hypothesis with a reputed radiobiologist advancing it. 19 And you've taken us to UNSCEAR. 20 Just from memory, I thought we had a short report 21 from Brenner on mFISH. Do we have more from Brenner on 22 this broader issue? 23 MR TER HAAR: All you have is what he deals with in that. 24 But if we go back to it he doesn't deal with it at 25 length but he is dealing with low dose effects.</p> <p style="text-align: center;">Page 48</p> |

| | |
|--|--|
| <p>1 MR JUSTICE BLAKE: Since this may be the -- if on the 2 process of elimination we've deleted X and then Y and 3 then we have to deal with Brenner it's important that 4 I think we know all the assistance that we get from -- 5 is it Professor Brenner? 6 MR TER HAAR: He is a professor, yes. What he discusses -- 7 I mean he deals with the mFISH technique as a way of 8 detecting lower dose exposures. That's to be found in 9 his report at pages 4 and 5. But I do not suggest that 10 he deals with this in depth. 11 MR JUSTICE BLAKE: Well, I mean from recollection -- and my 12 recollection may well be faulty -- he is focusing upon 13 mFISH as giving support to the technique as being a way 14 of determining chromosomal aberrations. 15 MR TER HAAR: That is undoubtedly the main point of his 16 report, I agree. 17 MR JUSTICE BLAKE: Does he deal separately with bystander 18 effects on cells supporting the hypothesis that whether 19 or not you go through an mFISH analysis of chromosomal 20 aberration, if you have any exposure to radiation above 21 the background level the present science of chromosomal 22 changes establishes a possibility of effect whether 23 through bystander or other means? I mean, sorry, I am 24 trying to summarise it to ask the question, but 25 hopefully you have the question.</p> <p style="text-align: center;">Page 49</p> | <p>1 epidemiological studies that individuals exposed 2 radiation doses in this dose range have an increased 3 lifetime risk to both cancers and cancer mortality. For 4 example, the atomic bomb survivors exposed in 1945 in 5 the dose range of 5 to 150 show statistically increased 6 risks of both cancer incidence and cancer mortality." 7 Then he goes on -- 8 MR JUSTICE BLAKE: Is that another epidemiological study 9 that you would add to your list of epidemiological 10 pointers? I rather though that you hadn't included that 11 one. 12 MR TER HAAR: We've only referred to Christmas Island. This 13 is the general evidence of atomic bomb survivors. But 14 the answer to that question is we haven't added that to 15 the pile. 16 MR JUSTICE BLAKE: But you might do? 17 MR TER HAAR: I think the time has come not to. 18 MR JUSTICE BLAKE: Right. Okay. Yes. 19 MR TER HAAR: (b): 20 "In addition to the relevance of chromosome 21 aberrations as biomarkers of past exposure to radiation 22 there is a well established mechanistic link between 23 chromosome aberrations and cancer. In particular, the 24 majority of all human cancers contain one or more of the 25 same chromosomal aberrations in virtually all the tumour</p> <p style="text-align: center;">Page 51</p> |
| <p>1 MR TER HAAR: Well, what he -- he does deal with low doses 2 in passing. If you go to his report, for example, at 3 bundle SB11, tab 1. 4 MR JUSTICE BLAKE: SB11. 5 MR TER HAAR: SB11, tab 1. 6 At the bottom of page 4 of that, just by the bottom 7 hole punch: 8 "I will comment here on the links between excess 9 chromosome aberrations and human health. Chromosome 10 aberrations are relevant to the current issue in two 11 related ways. Measured excess chromosome aberrations 12 are used by Rowland and colleagues and many others (see 13 above) as biomarkers of past exposure to radiation." 14 So he's not at that point saying at what level. 15 MR JUSTICE BLAKE: Yes. 16 MR TER HAAR: "Thus to link from the Rowland results to a 17 conclusion about human health has two steps: 18 2(1) the excess chromosome aberrations measured by 19 Rowland and colleagues provide evidence that individuals 20 have in the past been exposed to ionising radiation over 21 and above natural background, in particular a median 22 estimated dose of up to 150 millisieverts with the 23 highest dose estimate being 431." 24 Then (2): 25 "There is independent evidence from large scale</p> <p style="text-align: center;">Page 50</p> | <p>1 cells. These chromosome aberrations must have been 2 present in the original damaged cells from which the 3 tumour originated." 4 So there he is dealing with the mechanistic 5 approach. He does not, I accept, deal there with what 6 he deals with in other papers referred to in UNSCEAR 7 about the bystander effect. But clearly those papers 8 inform his views about there being a mechanistic effect. 9 MR JUSTICE BLAKE: Right, well ... 10 MR TER HAAR: I need to go no further in this regard than to 11 accept my learned friend's proposition that UNSCEAR 12 represents a view by a distinguished committee of 13 specialists who accept that there may be an effect. One 14 always has to remember what UNSCEAR is trying to do. 15 UNSCEAR is trying to give advice in a practical world as 16 to what the safe level of radiation, insofar as there 17 can ever be a safe level of radiation, would be, for 18 example, occupational or medical purposes. 19 The starting point is a common assumption that we're 20 all going to be exposed to radiation on this earth 21 anyway but also there are uses for radiation which are 22 to the benefit of mankind. It may be an arguable 23 proposition but say, for example, you have nuclear power 24 stations at which people will be exposed, you have CT 25 scans where people will be exposed, and the attempt is</p> <p style="text-align: center;">Page 52</p> |

| | |
|--|--|
| <p>1 to find out what you can say is a safe level of 2 exposure, and as Dr Haylock says the figures keep coming 3 down as we learn more and more about radiation. But 4 that's the purpose of UNSCEAR.</p> <p>5 What we're trying to do is see what we can derive 6 from it the other way round in the Secretary of State's 7 approach as to whether you can find a minimum that's 8 necessary for exposure. We say you can't -- you don't 9 get that. All they are saying is that: "We cannot show 10 that there is a particular danger below a certain level. 11 We can't exclude it. What we can tell you is that the 12 risk levels we're presently advising either don't need 13 revision or need revision as the case may be."</p> <p>14 That's what the purpose of UNSCEAR is. There's 15 a real danger of taking that practical, necessary 16 approach, which is looking for what is the ALARP level 17 of exposure and turning it round and saying: that proves 18 beyond a doubt that my clients cannot have been exposed 19 to a sufficient level of radiation to cause cancer or 20 other conditions.</p> <p>21 What is being done is to try to turn what is 22 a safety guidance on the ALARP basis, as I say, into 23 a weapon to destroy our causation case. That's entirely 24 wrong. That's why the passages I took you to earlier 25 this morning are so important. Because what they are</p> <p style="text-align: center;">Page 53</p> | <p>1 scientific consensus and say it removes all doubt as to 2 whether there could be a connection.</p> <p>3 That's not what UNSCEAR is trying to do. Hence all 4 the references I've shown you as to the need for further 5 research: we need to investigate this, we need to delve 6 into mechanistic aspects. That is a completely 7 different issue but it comes back at its most raw, if 8 I can put it that way, to the hypothesis point which 9 I started with.</p> <p>10 So, my Lord, unless you or your colleagues have any 11 further questions for me on my submissions, I'm 12 conscious of the time, we've put a lot on paper. I do 13 commend to the Tribunal our closing submissions for the 14 last hearing which I'm afraid were even longer than our 15 present ones but hope you'll find that they are cogent 16 and comprehensive.</p> <p>17 MR JUSTICE BLAKE: Thank you very much. We'll take a break 18 now. Ten minutes. 11.40 am. 19 (11.28 am) 20 (A short break) 21 (11.40 am)</p> <p>22 MR TER HAAR: My Lord, can I just deal with a couple of 23 points of housekeeping and one point of expansion, all 24 very brief. 25 First of all, I think you should find on your desk</p> <p style="text-align: center;">Page 55</p> |
| <p>1 saying is the present risk profile doesn't need to 2 change. Nobody is suggesting that you actually go out 3 and establish a rule that nobody is going to be exposed 4 to any additional radiation anywhere. Nobody is saying 5 cut out all CT scans, destroy all nuclear power 6 stations. That's not the UNSCEAR approach. They are 7 saying: "Doing the best we can, the consensus of opinion 8 is that this is the safe level in all the 9 circumstances."</p> <p>10 But it is recognising -- this is important -- that 11 further research may prove that even those levels are 12 too high to avoid people suffering cancer from 13 radiation. It's that last part which is always 14 forgotten in this debate by the Secretary of State, that 15 it's recognised by the scientists that, as has been 16 apparent over the years, assumptions as to what is safe 17 keep coming, keep needing to be revisited and come down.</p> <p>18 There is not a trend of the level of safe radiation 19 going upwards if you look at all these papers. It's 20 always being shown that actually we have been 21 overconfident in the past. But you still need to try to 22 get a balance and UNSCEAR, as I say, is concerned with 23 trying to assist in the real world where that balance 24 should be struck. That's what it's about. We have to 25 be very careful not to turn it round and take that</p> <p style="text-align: center;">Page 54</p> | <p>1 some additions for bundle SB24, tab 56 and tab 57. 2 Tab 56 is Professor Rowland's comments on Phelps Brown. 3 Tab 57 is the Phelps Brown paper itself. I hope that is 4 convenient.</p> <p>5 MR HEPPINSTALL: Can I just say two things about the Phelps 6 Brown paper. It's marked with all sorts of dire 7 warnings about reading it and using it, all of which 8 were overridden by its disclosure before Mr Justice 9 Foskett. Unfortunately, the only surviving copy is one 10 that is marked by another counsel for the Ministry of 11 Defence in those proceedings but it's only marked by 12 underlining rather than anything more privileged.</p> <p>13 MR JUSTICE BLAKE: All right, thank you. There's nothing we 14 shouldn't be reading in it?</p> <p>15 MR HEPPINSTALL: No.</p> <p>16 MR JUSTICE BLAKE: Do we understand that, just flicking 17 through the title page, it was Phelps Brown, Natarayan 18 and Darroudi? Is that the same Darroudi that we have 19 heard about?</p> <p>20 MR HEPPINSTALL: Yes, it's the same Darroudi and the same 21 Cox and the same Little as you've seen on many other 22 papers.</p> <p>23 MR JUSTICE BLAKE: 24?</p> <p>24 MR TER HAAR: It should be --</p> <p>25 MR JUSTICE BLAKE: Oh yes, 24, I have it. (Pause) Yes.</p> <p style="text-align: center;">Page 56</p> |

14 (Pages 53 to 56)

| | |
|---|---|
| <p>1 MR TER HAAR: The second point of housekeeping is this. The 2 two non-legal members of the Tribunal now have 3 A5 bundles of the transcripts. I hope you'll find they 4 are sufficiently legible. If you don't, we'll start 5 again. Certainly my experience is that A5 is a magical 6 thing in these sort of cases. 7 Does that seem to be all right? Good. Well, I hope 8 that's of assistance. We'll make sure you are updated 9 with the last couple of days of transcripts of the 10 submissions. 11 The last thing, which is a slight expansion, is 12 this. If you would be kind enough to take my closing 13 submissions in the black file and go, please, to page 7, 14 there's a footnote at the bottom of page 7, footnote 12, 15 referring to Professor Parker. The last sentence says 16 this: 17 "At the time of writing her report she was working 18 on a project funded by the US National Institute of 19 Health and the UK Department of Health into cancer 20 experienced by children and the young who have been 21 exposed to ionising radiation through CT scans." 22 Just for completeness, the report that she was 23 working --or the project she was working on -- is in 24 fact in the bundle and the reference is bundle SB22, 25 tab 16.</p> <p style="text-align: center;">Page 57</p> | <p>1 take us to midday and then I can pick up on the actual 2 points. 3 MR JUSTICE BLAKE: That's 15 minutes, yes? 4 DR BUSBY: If that's okay. Until lunchtime, yes, until the 5 next break. 6 MR JUSTICE BLAKE: Yes. 7 Closing submissions by MS BUSBY 8 MS BUSBY: Just the first issue is that we do have a couple 9 of extra bits which were appendices to our closing 10 submissions. They are very short. We just forgot to 11 put them in yesterday. It is a document which was 12 written for us by a solicitor, Mr Manson, on the 13 standard of proof and particularly the SSD's argument 14 that that implies a threshold. I won't read it out but 15 it's there for you to look at if you wish. (Handed) 16 Simply put, we support the arguments that 17 Mr ter Haar has made that it's the reverse criminal 18 standard that's the relevant standard. That is that the 19 Tribunal must be sure beyond reasonable doubt that the 20 appellants' cancers were not contributed to by their 21 Army service and it's not a question of a threshold 22 which must be exceeded. 23 In this respect, we note that the task before the 24 Tribunal is not to adjudicate the different scientific 25 opinions. The Tribunal, with respect, are not experts</p> <p style="text-align: center;">Page 59</p> |
| <p>1 It may be of interest because, although one has to 2 remember she's dealing with the experience of children 3 and the young, she has established on an epidemiological 4 basis a very significant increase in the risk of cancer 5 at 50 milligrays or 50 millisieverts and an even greater 6 risk of cancer at 60 millisieverts in children. 7 So there is -- 8 MR JUSTICE BLAKE: From CT scans? 9 MR TER HAAR: From CT scans. 10 So work is ongoing and we are beginning to get the 11 results of some research into the low dose area, even on 12 an epidemiological basis. But it's obviously very much 13 work in progress. 14 Unless the Tribunal on reflection had anything 15 further you wanted to ask me, those are now my 16 submissions. Thank you very much. 17 MR JUSTICE BLAKE: Yes. 18 DR BUSBY: My daughter, Cecilia, is an understudy, as you 19 know, for Group Captain Ades who has followed these 20 proceedings quite closely from his sick bed and has 21 raised a number of points about issues relating to 22 standard of proof and philosophy and science generally, 23 which in the context of the current appeals we feel to 24 be important, so I would like to give my daughter the 25 first presentation here. Probably I think maybe she'll</p> <p style="text-align: center;">Page 58</p> | <p>1 in the area even if some of them may be scientifically 2 trained. 3 To adjudicate the scientific debate is to in effect 4 prefer the evidence of one expert over another, 5 something very specifically ruled out in the decision of 6 Mr Justice Charles in the UT which has been examined in 7 some depth. 8 MR JUSTICE BLAKE: That's because of the nature of the 9 standard of proof rather than the Tribunal's expertise 10 or lack of it. We have that point. 11 MS BUSBY: Okay, sure, yes. 12 So we would also argue that it's not for the 13 Tribunal to disregard or rule out the scientific work of 14 relevant experts published in the accepted peer reviewed 15 scientific literature. 16 The Tribunal may take forward the criticisms of 17 other experts with regard to this material, or the 18 arguments of the SSD that certain witnesses are not 19 regarded by the scientific consensus as right, and 20 consider whether, in the final weighing up process, 21 these arguments reduce the existence of doubt. 22 But it's not for them to decide that those experts' 23 views have no merit whatsoever, i.e. that they can be 24 afforded a value of zero, simply on the basis that the 25 SSD's experts regard them as wrong. And I am saying</p> <p style="text-align: center;">Page 60</p> |

| | |
|--|---|
| <p>1 that not really with respect to the Ikarian Reefer 2 arguments that were made but just with respect to the 3 idea that they've been criticised for being wrong. 4 I'll return to the issue of carrying forward values 5 of 1 or zero as discussed by Mr Justice Charles. 6 But the task of the Tribunal, it seems to us, is to 7 say: is there a body of scientific opinion, based on 8 what appears to be non-fanciful and non-trivial 9 evidence, that raises reasonable doubt of attribution? 10 In this respect they must give reasons for their 11 rejection of any arguments or experts that tend towards 12 the raising of doubt. They must not only give reasons 13 for their rejection of these opinions but must give 14 reasons as to why they are absolutely certain that those 15 views can be rejected as having no validity whatsoever. 16 So that is our understanding of the standard at 17 issue. 18 I just want to go on to look at an issue about the 19 combination of possibilities because this has been 20 raised also. 21 Mr Justice Charles made remarks in his decision and 22 it might help to go to it. It's SB1, tab 110. 23 MR JUSTICE BLAKE: Yes. 24 MR TER HAAR: Page 37. It's paragraph 103. He says: 25 "At stage 5 the decision maker will form views that</p> <p style="text-align: center;">Page 61</p> | <p>1 on each other or are completely independent and separate 2 factors to be taken into consideration. I want to give 3 you an example of both. 4 In the former case, the combination of them, that is 5 in the case where they are dependent on each other, the 6 combination does indeed lead to a greater likelihood 7 that the case advanced is too far-fetched. To 8 illustrate, the argument might run: it is possible that 9 X dropped his watch. It is then possible that Y picked 10 it up. It is then possible that Y left it in a shop. 11 It is then possible that Z entered the shop. It is then 12 possible that Z picked it up by accident. 13 We might say that for all these possible things to 14 happen in combination is very unlikely. 15 However, in the case where the possibilities are 16 independent of each other, many small possibilities 17 which may be minor in isolation together increase the 18 likelihood that there may be reasonable doubt. And most 19 of the possibilities advanced by our evidence are of 20 such an independent form. They are separate 21 possibilities, not dependent on each other, which tend 22 rather to accumulate in the way that Nicholls describes 23 above. 24 So we argue, for example, that our appellants may 25 have received an extra dose of ionising radiation from</p> <p style="text-align: center;">Page 63</p> |
| <p>1 can be expressed by reference to the circumstances. 2 I repeat that, as was accepted by the HL Appellants, at 3 that stage it may be that the decision will be that the 4 combined effects of the possibilities carried forward do 5 not found a reasonable doubt because for example the 6 combination of those possibilities is too far-fetched." 7 MR JUSTICE BLAKE: Yes. 8 MS BUSBY: We would argue that that has to be read in 9 conjunction with the judgment by Lord Nicholls, also 10 quoted by Justice Charles in paragraph 84, and this is 11 in the middle of page 32, just to go back a little bit. 12 Just at the end of that quote, just above where it says 13 "In Re B Children", he says: 14 "Facts which are minor or even trivial if considered 15 in isolation when taken together may suffice to satisfy 16 the court of the likelihood of future harm." 17 MR JUSTICE BLAKE: "The court will attach to all relevant 18 facts the appropriate weight when coming to an overall 19 conclusion on the crucial issue." 20 MS BUSBY: Yes. So some facts or possibilities may in 21 combination appear to diminish rather than enhance the 22 likelihood of a case being true. But some taken 23 together may increase the likelihood that it is true. 24 And we would suggest that the difference relates to 25 whether or not the possibilities advanced are dependent</p> <p style="text-align: center;">Page 62</p> | <p>1 inhalation. Even if that were not true they may have 2 received a dose from sea-to-land transfer, and even if 3 that were not true, they may have received a dose from 4 substantial quantities of carbon-14, not considered by 5 the SSD's experts. 6 And even if none of those pathways are accepted it 7 remains possible that the ICRP risk model relied on by 8 the SSD is unsafe for internal emitters. And even if 9 that is not true, it is possible that the risk model is 10 unsafe for uranium nanoparticles. 11 Even if that were not true, it is still possible 12 that it is unsafe for uranium ions bound to DNA. 13 Such possibilities, even if they are themselves 14 considered to be of low probability, are in combination 15 we would argue more likely to found a reasonable doubt 16 than each one separately. 17 So I want to go on to look at arguments relating to 18 the nature of science and scientific expertise. 19 We are not going to respond directly to the SSD's 20 allegations about our experts, but since Mr Heppinstall 21 has called into question the expertise of Professors 22 Schmitz Feuerhake, Sawada and Howard, I would just like 23 to refresh the Tribunal's memory of their CVs. 24 So if we can go to SB1, tab 2.6. Sorry, not 2.6, 25 2.1, Professor Schmitz Feuerhake and her CV is at</p> <p style="text-align: center;">Page 64</p> |

| | |
|--|--|
| <p>1 page 16. 2 Professor Schmitz Feuerhake took her doctorate 3 degree in physics in 1966. Her thesis was the dosimetry 4 of radioactive fallout. 5 Sorry, you haven't got there yet. It's page 16 of 6 SB1, tab 2.1. 7 MR JUSTICE BLAKE: Yes. 8 MS BUSBY: So if you just look at where it says "1966" on 9 the left-hand side: doctor degree in physics, thesis was 10 about the dosimetry of radioactive fallout. 11 From 1966 to 1963 she was a physicist at the Medical 12 Academy of Hanover in the Institute of Nuclear Medicine 13 and she carried out research on dosimetry and diagnostic 14 applications of radioactive nuclides. She was also the 15 manager of a nuclear research reactor. 16 MR JUSTICE BLAKE: Yes. 17 MS BUSBY: Since 1973 she was Professor of Experimental 18 Physics at the University of Bremen and her research was 19 in the area of radiation dosimetry, radiation risk and 20 health physics. 21 She has published over 20 peer reviewed papers in 22 those areas. 23 If you can turn now to tab 2.6, which is 24 Professor Sawada, and his CV is given on page 18. If 25 you look up at page 19 at the top you'll see that his</p> <p style="text-align: center;">Page 65</p> | <p>1 a PhD on those issues. 2 He has been invited to contribute a chapter on 3 cancer and environmental influences published in the 4 Springer Encyclopedia of Bioinformatics. 5 I raise these CVs, this expertise, because the 6 Secretary of State has implied that ECRR is 7 a campaigning organisation. 8 MR JUSTICE BLAKE: Yes. 9 MS BUSBY: It is not a campaigning organisation in any real 10 sense of that word. There is no membership available 11 for politically motivated persons. There is no 12 organisation of campaigns. There are no posters, there 13 are no press releases. 14 MR JUSTICE BLAKE: Don't spend your time knocking things 15 which are not critical to the argument. The question 16 is: is the ECRR campaigning in the sense that they share 17 a joint view that ICRP is getting it wrong and they have 18 a better model? 19 MS BUSBY: Of course. Of course they share a joint view. 20 MR JUSTICE BLAKE: But it's a campaign to promote that view. 21 MS BUSBY: It's more -- I would say that this is 22 a scientific research group. It is a number of 23 scientists who share a view. They have come together to 24 discuss the science, to exchange ideas and debate the 25 issues. It is quite wrong to imply either that they are</p> <p style="text-align: center;">Page 67</p> |
| <p>1 professional field is elementary particle physics and 2 the study of radiation effects. 3 He was from 1966 to 1990 the Associate Professor in 4 the Department of Physics at Nagoya University. From 5 1991 to 1995 he was Professor of the Department of 6 Physics at Nagoya University and since 1995 he has been 7 Emeritus Professor in that institution. 8 Professor Sawada actually told us while he was here 9 giving evidence that two of the students that he had 10 supervised during his time as Professor at Nagoya 11 University have very recently been awarded the Nobel 12 Prize in physics. 13 If we turn to Professor Howard, that's SB1, tab 2.4, 14 and he doesn't actually -- I couldn't find his CV. It 15 says it's attached but I couldn't find it, but he gives 16 a fairly detailed breakdown of his qualifications on 17 page 1: 18 "I qualified in medicine in 1970." 19 MR JUSTICE BLAKE: I think we can read that. 20 MS BUSBY: Okay. He is a fellow of the Royal College of 21 Pathologists. He is familiar with the pathology of 22 leukaemia. He has published in the field. He has 23 published a number of papers on cancer and environmental 24 influences. He has done research at the University of 25 Ulster into the effects of nanoparticles and supervised</p> <p style="text-align: center;">Page 66</p> | <p>1 somehow the equivalent of Friends of the Earth or that 2 their entire purpose is to bring litigation. This is 3 not the major purpose of the ECRR. It is to seek to 4 persuade the scientific community of the evidence of 5 problems with the ICRP. They are first and foremost 6 scientists, I would argue. 7 And this goes to the heart of the issue about 8 paradigms. We've already heard from Mr ter Haar about 9 ideas of an old or a new paradigm. 10 Science proceeds by the elaboration of what have 11 been called paradigms, and the reference is, if you are 12 interested, to Thomas Kuhn in a book called The 13 Structure of Scientific Revolutions published by the 14 University of Chicago Press in 1962. It's a very, very 15 well known model in the study of science. He argues 16 that models which appear to explain all the available 17 evidence in a particular area are relatively stable over 18 time. An example of a paradigm would be Newtonian 19 physics before the shift to Einstein's new model. 20 The overthrow of a paradigm is preceded by a period 21 when contrary evidence potentially calls into question 22 the basis of the paradigm is effectively explained away 23 or dismissed, or seen as an anomaly or sometimes 24 incorporated into the paradigm through increasingly 25 complex, postulated mechanisms. This occurs, Kuhn</p> <p style="text-align: center;">Page 68</p> |

| | |
|---|---|
| <p>1 argues, precisely because there is a general consensus 2 that the paradigm is right, it's useful, it works, and 3 there is a commitment to the maintenance of that 4 paradigm on the part of scientists involved in the area. 5 It is through the lens of the paradigm itself that 6 this troublesome new evidence is generally analysed. 7 And often an alternative hypothesis which better 8 explains the new evidence will be rejected for some 9 considerable time before it finally overthrows the 10 original paradigm and we have what has been called 11 a paradigm shift. 12 Now Mr Heppinstall, in cross-examining 13 Professor Schmitz Feuerhake, put it to her that her 14 theories were not accepted by the scientific authorities 15 and I want to turn to the transcript which would be Day 16 3 -- 17 MR JUSTICE BLAKE: Just let me put something away, please. 18 (Pause) Yes. 19 MS BUSBY: Page 120 and it starts at line 16. So that's 20 internal page 120. 21 MR JUSTICE BLAKE: Yes. 22 MS BUSBY: It's actually been quoted by the SSD in their 23 closing statement. 24 MR JUSTICE BLAKE: Yes. 25 MS BUSBY: So it's Mr Heppinstall.</p> <p style="text-align: center;">Page 69</p> | <p>1 What was published in the world was what was found and 2 our argument, it's said these words did not use the 3 whole body of information which is available because 4 they neglect perhaps the findings after Chernobyl, they 5 neglect, they cannot really explain why in European 6 countries everywhere there is leukaemia near nuclear 7 installations and they are not willing, they are trying 8 to depress [and we later had a discussion of what she 9 meant; she didn't mean suppress, she meant leave out] 10 the information that diagnostic x-raying at the present 11 level is harmful and should be reduced. So what we 12 demand only is a kind of fair debate on equal levels and 13 not that there is a board who says what is the truth and 14 what judges have to take for the risk figures in order 15 to decide if this person has been damaged by this 16 occasion or damaged by his life." 17 So the point that Professor Schmitz Feuerhake is 18 making is of course the ICRP and UNSCEAR and BEIR and 19 the NRPB assert that her science has no merit. That 20 they do not accept her hypotheses does not make her 21 wrong. She believes, as do many other researchers and 22 experts that we have brought to the Tribunal's 23 attention, that the ICRP, UNSCEAR and the NRPB are 24 mistaken in this view and that the available evidence 25 supports the contention that the ICRP and others have</p> <p style="text-align: center;">Page 71</p> |
| <p>1 MR JUSTICE BLAKE: Yes. 2 MS BUSBY: "So it's right, isn't it, Professor, that EEC and 3 its risk analysis has been reviewed by both ICRP, CERRIE 4 and the NRPB and it has been found to have no sound 5 scientific basis." 6 She answered: 7 "Yes. So what?" 8 Professor Schmitz Feuerhake's response was 9 admittedly a little blunt but she went on to explain, 10 and she is asked: 11 "That criticism, do you not accept, is being made by 12 a very significant body of international scientific 13 opinion." 14 MR JUSTICE BLAKE: Yes. Her answer is over the page, 121. 15 MS BUSBY: Yes: 16 "We wouldn't be here if we agreed with this 17 criticism and what you want to know, I think, is who 18 defines the standard of knowledge of science and is it 19 true that such words define the standard of science, 20 because they are a majority in between the scientists? 21 Or is it not true that all scientists have to draw their 22 conclusions from the same material of evidence and 23 research? This is -- I think it's consensus that this 24 should be the way to come to the true result, and what 25 we criticise is we use the same basis of knowledge.</p> <p style="text-align: center;">Page 70</p> | <p>1 seriously underestimated the risks of low dose internal 2 radiation. 3 And we would suggest to the Tribunal that it's 4 extremely plausible that the mounting evidence will 5 force a paradigm shift in this area of science in the 6 future. What the Tribunal is witnessing in this court 7 case is precisely arguments between one paradigm and 8 another, between one scientific culture or mindset and 9 another. 10 And in this respect there are question marks over 11 the whole issue of CPR 35 and the neutrality of 12 witnesses on both sides. 13 We would submit that the experts called by the SSD 14 are committed to the ICRP risk model, to the mainstream 15 paradigm. It's clear that despite the direction from 16 Justice Charles that all the possibilities should be 17 taken into account and discussed they have not been 18 asked, as Mr ter Haar made clear yesterday, to engage 19 with alternatives; they have simply been asked to carry 20 out a narrow assessment exercise based on the premise 21 that their model is correct. 22 MR JUSTICE BLAKE: Well, many of the experts in terms said 23 that the model that the ECRR group of scientists was 24 promoting was in their view wholly incorrect, not 25 scientifically founded. So that's more than</p> <p style="text-align: center;">Page 72</p> |

| | |
|---|--|
| <p>1 a disagreement with it, it's quite a caustic 2 observation. 3 MS BUSBY: I think if you look through the transcripts that 4 what they actually said was it was not accepted as the 5 scientific model. I think at times they said that some 6 of the studies that were put forward were of no value 7 but on the whole they generally accepted that there was 8 a possibility that these might be true. There were 9 plenty of occasions where they said "Yes, it's possible 10 that this is an effect; yes, it's possible that that 11 might be true." 12 They were very firm that their model was the right 13 one, was the accepted one, was the consensus one, but 14 I don't think that's the case that they all universally 15 dismissed it as of no relevance whatsoever or completely 16 incorrect. 17 And perhaps they would have said that in their 18 report had they addressed the issue. They simply didn't 19 address the issue and we think that that's a mistake. 20 They should have done. It's a large part of our case 21 that they were asked to looked at all the available 22 issues. 23 So, for example, epidemiological studies evidencing 24 the greater health effects of low dose internal 25 radiation surveyed by Professor Schmitz Feuerhake were</p> <p style="text-align: center;">Page 73</p> | <p>1 refusal to engage at all. 2 We would argue that it's not for the Tribunal to 3 adjudicate between our experts and those of the SSD. We 4 would suggest, for example, that it is not for the 5 Tribunal to decide if they find the Rowland study 6 convincing or not. There are very many eminent experts 7 in the field who find it convincing, and it would be 8 quite wrong for them to overrule such experts by 9 reference to other experts whose evidence they may 10 personally find more convincing. 11 And I just want to point to a couple of traps that 12 I think exist for those trying to make sense of this 13 debate, and so one of them relates to the -- if we can 14 go to the transcript from Day 9 at page 89. It's 15 an exchange between Dr Rayner and Dr Haylock. 16 Dr Rayner asked some questions which arose I think 17 out of reading Dr Brenner's report. No, it's not. It's 18 a report on Dr Brenner, but it makes the point that 19 there was a lower frequency of translocations in the 20 cohort in the control cohort compared with the general 21 population. She asked a few questions about what effect 22 that might have on the results. And Dr Haylock has 23 said: 24 "When you compare the two things ..." 25 And if we go to page 90 this is where he starts to</p> <p style="text-align: center;">Page 75</p> |
| <p>1 not discussed in their reports. They may have been 2 discussed in evidence but they were not discussed in the 3 reports. 4 Evidence of the greater health effects of internal 5 radiation from black rain deposition for people at 6 Hiroshima, which undermines the ICRP model, was not 7 discussed in the reports. 8 The elucidation of sophisticated mechanisms in cell 9 biology, bystander effects and generic instability 10 pointed to by Professor Mothersill, and evidence for the 11 photoelectron effect of uranium brought by 12 Professor Howard were not considered or critiqued in the 13 experts' reports. Insofar as it's been engaged with in 14 evidence before the court it has been in an ad hoc and 15 offhand manner, a kind of "I haven't really read this 16 but I don't think it's right" sort of way. 17 That leaves the Tribunal in a difficult situation. 18 Thoughtful critique and a real engagement with the 19 scientific ideas of our experts is missing. It's a case 20 of ships in the night. And there's a danger, we would 21 argue, as Mr ter Haar has also alluded to, that the 22 offhand, dismissive comments of the witnesses in their 23 evidence and their pointing to consensus views that back 24 up those evaluations may be taken as proper scientific 25 engagement when in fact they came closer to a simple</p> <p style="text-align: center;">Page 74</p> | <p>1 talk about it: 2 "If you compare the two things and you see 3 a difference, that might well be because the control 4 group is lower and not because the exposed group is 5 higher. That's my understanding." 6 My Lord intervened: 7 "Right." 8 And he went on to say. 9 "So you need to make sure that your control group is 10 representative of some larger population." 11 And you answered: 12 "The background population?" 13 But Dr Haylock is simply wrong to say "yes" to the 14 interjection "The background population?" As he well 15 knows, the control population needs to be representative 16 of the particular group you are studying and may in fact 17 be rather different to the general population. And in 18 fact the paper makes clear that the controls were very 19 carefully chosen to match the age and occupational 20 background of the veterans tested. It's well known that 21 service personnel are in general a healthier cohort than 22 an average member of the population. This is 23 acknowledged in many studies of the nuclear industry. 24 It's known there as "the healthy worker effect", the 25 idea that workers in the nuclear industry are generally</p> <p style="text-align: center;">Page 76</p> |

| | |
|--|---|
| <p>1 healthier than the background population. 2 So it's not actually surprising that the control 3 might have had slightly fewer abnormalities than the 4 general population. This doesn't in the slightest bit 5 invalidate the findings of the study. 6 Yet Dr Haylock for some reason was either unaware of 7 this issue or didn't recall it at that moment and 8 a rather misleading impression might have resulted in 9 the mind of the Tribunal. 10 So there is a danger that has already been raised 11 and we would concur in warning against it that evidence 12 given in a slightly offhand manner in the witness box 13 may seem to have more weight than it should. 14 So I want to look a little bit at the issue of 15 experts and what experts can be expected to do, in 16 effect the issue of expert neutrality. 17 Court Procedure Rules 35 have been accepted as 18 relevant and they indicate that an expert should assist 19 the court by providing an objective, unbiased opinion on 20 matters within their expertise and should not assume the 21 role of an advocate. 22 We would submit that the SSD's experts have all 23 acted in effect as advocates for the validity of the 24 ICRP model, and so in doing they have strayed, through 25 what we might call an excess of enthusiasm and</p> <p style="text-align: center;">Page 77</p> | <p>1 references we can look them up. 2 MS BUSBY: So Day 4, page 119, line 3 to 7. 3 MR JUSTICE BLAKE: Yes. 4 MS BUSBY: "I would agree you are always looking for doubt. 5 If you are a good scientist you are always looking for 6 doubt, you are always looking for the alternative 7 hypothesis, and finding a way to test so that you can 8 take a hypothesis way." 9 However, her attitude to doubt was in fact very much 10 to dismiss it, and that was quite evident in the 11 exchanges over the epidemiological evidence for greater 12 congenital malformations from exposure to internal 13 ionising radiation, both after Chernobyl and as a result 14 of service in the Gulf War. You'll find those in the 15 transcript from Day 5 from page 39 onwards. 16 Professor Thomas, although many of the papers were 17 ones she had not seen before and had only had a short 18 time to look through, was emphatic in her claims that 19 the studies were of no value whatsoever. In general she 20 claimed that the studies showed no useful evidence 21 because the study populations were too small and 22 therefore could be unrepresentative. 23 So there's a slightly longer extract which you might 24 want to look at, if you like, which is Day 5, and that's 25 page 43, line 13 onwards. Dr Busby put to her that the</p> <p style="text-align: center;">Page 79</p> |
| <p>1 campaigning zeal, into areas in which they were expert 2 and have occasionally made incorrect assertions from the 3 same desire to make their case. 4 There are numerous points in the transcript and 5 reports where we might point to the unreliability and 6 the failure of neutrality of the SSD's expert witnesses 7 and I shall just point to a few. 8 I am going to start with Professor Thomas, and 9 I just want to note in starting that we on this side are 10 very sorry indeed that Professor Thomas was upset on 11 Friday morning, and we want to just make clear that the 12 e-mail she received was not about this case nor 13 instigated by us. But many of the points I raise in 14 regard to her evidence relate equally to Day 4 and Day 5 15 and if her evidence on Day 5 was skewed by her emotional 16 response to what she perceived as an attack then we are 17 sorry for it and we still feel that she allowed herself 18 to stray into areas she was not expert in and to make 19 some contentious remarks. 20 She made a point early in her evidence to the effect 21 that a good scientist is always looking for doubt. 22 Now I'm quoting from transcripts but they are small 23 sections. I don't know if you want me to take you to 24 them before I quote. 25 MR JUSTICE BLAKE: Well, if you want to give me the</p> <p style="text-align: center;">Page 78</p> | <p>1 P value for this study is .0001. 2 "Answer: I don't care what it says about the P 3 value, I'm telling you the study is badly designed, and 4 I'm sorry, you shouldn't be drawing conclusions from 5 badly designed studies. 6 "Question: Is it true to say that a P value of 7 .0001 means it couldn't have occurred by chance except 8 in one in 10,000 times? Is that what a P value means?" 9 MR JUSTICE BLAKE: The answer is yes. 10 MS BUSBY: Yes. 11 "Question: But if the design is not suitable to 12 test your hypothesis it doesn't tell you anything." 13 "It's wrong," she simply says. 14 MR JUSTICE BLAKE: Well, she says: 15 "You won't be able to cure a badly-designed study by 16 applying a P value." 17 MS BUSBY: No. 18 MR JUSTICE BLAKE: That's right -- if it is badly designed 19 you, presumably, dispute that it was badly designed. 20 MS BUSBY: Well, she's saying it's a small study. A small 21 study with a very highly statistically relevant result, 22 i.e. a very large result, a result you would really not 23 expect to see, may not give you enough evidence to 24 overturn the whole of ICRP, but it certainly gives you 25 some evidence. In fact, Dr Haylock, later on, taken to</p> <p style="text-align: center;">Page 80</p> |

| | |
|--|--|
| <p>1 these same studies, said that, yes, these are not, you 2 know, this is not evidence that you would want to, you 3 know -- you would absolutely take as the truth, but it's 4 a hypothesis-generating study, it's a study that shows 5 an effect which might lead you to go and do a larger 6 study. 7 It would indicate to you that something is going on. 8 It would be something that might give you pause for 9 thought. But not Dr Thomas, who simply thinks it's 10 wrong. 11 MR JUSTICE BLAKE: She says "badly designed". 12 MS BUSBY: Yes. She thinks. 13 MR JUSTICE BLAKE: Yes. 14 MS BUSBY: Taken to a paper where the study population was 15 15,000, carried out by the Environmental Epidemiology 16 Service of the US Department of Veteran Affairs, she was 17 still sceptical, even without reading the paper. This 18 is the same day, page 47 to 48. 19 "Question: A paper about genetic effects in Gulf 20 War veterans, a population-based survey of 30,000 21 veterans, would that be a large enough study? 22 "Answer: "Yes, but there's a problem with this. 23 This is a survey, a questionnaire-based project. Again, 24 unless you validate the responses in the questionnaire, 25 it's difficult to be sure that what you are looking at</p> <p style="text-align: center;">Page 81</p> | <p>1 particular areas of expertise and scientific views and 2 tend to defer to each other. We might note in passing 3 that this is the same Elisabeth Cardis whose 15 4 countries study provides some evidence for our 5 contention that pancreatic cancer is radiogenic. 6 In addition to a combative approach to the evidence 7 Professor Thomas also displayed a tendency to make 8 mistakes and defend them vigorously. She stated during 9 her cross-examination that natural uranium was not 10 radioactive. The reference is Day 4, page 160. She was 11 asked. 12 "Question: So are you of the opinion that stable 13 uranium is not radioactive? 14 "Answer: Stable uranium is not radioactive, it is 15 the non-radioactive isotope of uranium." 16 She repeated this assertion, and despite clear 17 scepticism from Dr Busby, whom she knows to have a PhD 18 in physical chemistry, she didn't check her facts that 19 evening but returned the next day to state even more 20 emphatically that there was a stable non-radioactive 21 form of uranium. The reference is Day 5, page 21. She 22 comments of a particular study she's asked to look at: 23 "Answer: It's interesting that they use depleted 24 uranium. I would have liked to see a control where they 25 used stable uranium and then you could have a handle on</p> <p style="text-align: center;">Page 83</p> |
| <p>1 is genuine." 2 And she says: 3 "Answer: "You haven't given me time to read this 4 paper at length. 5 "Question: Do you want to read it now or not? 6 "Answer: No, I don't think it's worthwhile." 7 I think that to assume that a study carried out by 8 the US Department of Veteran Affairs on such a large 9 cohort, to be not even worth going to read, is somewhat 10 surprising for an open-minded scientist. 11 Again, displaying a tendency to prefer certain 12 ideas, theories or personnel over others in a way that 13 could be said not to be neutral, Professor Thomas 14 suggested that although she couldn't fault the expertise 15 of professors Parker and Kaldor, and this quote is from 16 Day 4, page 122, lines 7 to 11: 17 "Answer: I would actually choose somebody else. 18 I would choose Elisabeth Cardis, somebody who I know 19 very well and I'm aware of all her work. So yes, 20 I would defer to somebody like Elisabeth Cardis rather 21 than the two you cited." 22 Now, the SSD has repeatedly sought to undermine our 23 experts on the basis that they are known associates, yet 24 here is their own expert making clear that, in reality, 25 informal networks of colleagues coalesce around</p> <p style="text-align: center;">Page 82</p> | <p>1 whether it was related to the radiation or whether it 2 was related..." 3 And she is interrupted. 4 Taken to a set of decay tables of uranium isotopes 5 indicating that all of them were radioactive she simply 6 stated that they had left out stable uranium. This is 7 page 23: 8 "Answer: You don't have decay table where there is 9 a stable isotope because it does not decay. 10 "Question: I see. But actually may I put it to you 11 that there is no such thing as stable uranium? 12 "Answer: I think you probably need to check because 13 I think that is untrue." 14 Experts can of course make mistakes, and being in 15 the witness box is stressful, slips are easy to make; 16 but this is a very serious mistake for an expert in the 17 health effects of radiation to make about the nature of 18 an extremely common radioactive element. It's also one 19 she appeared to have no doubt about whatsoever, and 20 despite the repeated challenges still maintained, even 21 given an evening to go and check her facts. This is 22 not, we would suggest, the behaviour of reliable 23 witness. 24 Another example is Professor Thomas's insecure 25 understanding of dosimetry, another surprising failing</p> <p style="text-align: center;">Page 84</p> |

| | |
|--|---|
| <p>1 in an expert on radiation effects in people. Day 4, 2 page 147. So Dr Busby asks her: 3 "Question: Of course if the dose is from an element 4 or from a type of radiation exposure that involves alpha 5 particles you would agree that the doses calculated are 6 expressed in a quantity known as sieverts." 7 I think the Tribunal is probably familiar with the 8 conversion from gray to sieverts. 9 "Answer: No, that's when you sum all the different 10 types of radiation together. So if you are exposed to 11 both alpha and gamma and beta the sievert is the sum of 12 the individual components of dose which come from those 13 different types of radiation. That's the definition." 14 Now, Professor Thomas may not be an expert 15 dosimetrist, but I think it might be expected of an 16 expert in radiation and health that they understood the 17 concept of sievert, which relates only to alpha emission 18 and has nothing whatsoever do with adding it to beta and 19 gamma. Perhaps we can allow Professor Thomas the 20 mistake in dose units, but as a scientist who has 21 published widely on the health effects of Chernobyl we 22 might reasonably expect her to know exactly how many 23 children were affected by the disaster. In discussing 24 the evidence from Fukushima Professor Thomas asserted 25 that 10 million children were exposed to fallout from</p> <p style="text-align: center;">Page 85</p> | <p>1 to radioactive materials. 2 The WHO report on Chernobyl, which we do have in the 3 bundle at SB22, tab 23, says: 4 "Currently about 5 million people live in areas of 5 Belarus, the Russian Federation and Ukraine, with levels 6 of radioactive caesium deposition more than 37 7 kilo-becquerels per square metre." 8 I hope we don't need to debate the proportion of 9 children in the population in order to conclude that it 10 really isn't possible to have 10 million children in 11 a population of 5 million. 12 This could be said to be just another forgivable, 13 silly mistake, albeit not perhaps one you'd expect of 14 an expert in this area. But it's not just that 15 Professor Thomas made a mistake, it's the combination of 16 being wrong while maintaining with absolute certainty 17 that she's right that makes Professor Thomas a somewhat 18 unreliable witness whose assertions should be treated 19 with some caution. 20 Mr Hallard, to move to him, was an altogether more 21 cautious witness, and one who was scrupulous in 22 documenting how he had come to his conclusions and where 23 he was prepared to concede expertise to others. But 24 it's clear from Mr ter Haar's arguments yesterday that 25 there were a great many areas where he exceeded his</p> <p style="text-align: center;">Page 87</p> |
| <p>1 Chernobyl. This is Day 4, page 14. She says: 2 "Answer: For a comparison, in the areas around 3 Chernobyl, 10 million children were exposed to varying 4 doses." 5 When the number was challenged she continued to 6 assert in a quite an exasperated way that this was the 7 number given in UNSCEAR documentation. When it was 8 suggested that the whole population of Belarus was only 9 3 million she repeated that this number of 10 million 10 included northern Ukraine and the Bryansk region of 11 Russian. Finally pressed she made an emphatic statement 12 on the issue, and this is page 17: 13 "DR BUSBY: Do you agree that the population of 14 children exposed to radio-iodine following the Chernobyl 15 accident cannot possibly be anywhere near the 10 million 16 that you have just told us? 17 "Answer: No, I absolutely do not, and I think you 18 should read that document. I'm sorry, that is common 19 knowledge." 20 The document referred to is not in the bundle, but 21 if I were able to produce it you would find that at 22 page 107 the figure is given. 23 Following the 1986 accident at Chernobyl about 24 5 million people living in Belarus and in extensive 25 areas of Ukraine and the Russian Federation were exposed</p> <p style="text-align: center;">Page 86</p> | <p>1 expertise, partly because of the very difficult position 2 he had been put in by the nature of the exercise he had 3 been asked to carry out. There's no doubt he was a man 4 of integrity, attempting to do his best; but it's also 5 clear that in some respects he was at sea. He admitted 6 to being unable to use deposition velocity as a method 7 to calculate the level of fallout in the air as he 8 didn't understand the method. That you will find on Day 9 6, page 108, line 2 onwards. 10 "Answer: You are going outside my expertise, I'm 11 afraid. Going in that direction, I've seen the formulae 12 and I've got a broad understanding, but in terms of how 13 it's used I'm afraid that's outside my expertise." 14 He similarly left out carbon-14 because he couldn't 15 work out how to include it. The reference is Day 7, 16 page 107, line 2, onwards. 17 "Answer: I couldn't find any information which 18 I felt was helpful enough. I haven't produced any 19 assessment of the dose based on carbon-14. I looked at 20 it and just felt that I couldn't produce an assessment 21 of the dose." 22 If we turn to Dr Haylock, he is, as was made clear 23 in evidence, a biostatistician. He's a member of 24 epidemiological teams but not an expert in 25 epidemiological methodology. But he certainly takes</p> <p style="text-align: center;">Page 88</p> |

| | |
|--|--|
| <p>1 part in epidemiological studies; he has a particular 2 interest in the health effects of radiation. He accepts 3 the ICRP model, which is based on the Japanese A bomb 4 studies, that is on epidemiological studies of the 5 affected population known as the LSS. 6 Since Dr Thomas had in effect passed on all the 7 issues to do with questions about the LSS methodology to 8 Dr Haylock when cross-examined by Mr ter Haar the 9 previous week, the SSD ought perhaps to have warned 10 Dr Haylock that he might expect questions in this area. 11 Regardless of that, the reports of Professor Sawada and 12 his scientific paper on the LSS and radiation dosimetry 13 have been part of the BS submissions for some months. 14 Dr Haylock might reasonably, as a neutral expert, have 15 been expected to engage with his arguments since they 16 are crucial to a criticism of the ICRP model on which he 17 relies for his statistics. Yet Dr Haylock was 18 apparently unfamiliar with the argument, and the 19 transcript is Day 8, page 58. You might want to look at 20 it, it's quite lengthy. The quote is going to be quite 21 lengthy, but if you don't want it read out, that's fine. 22 MR JUSTICE BLAKE: Do you want to take me there now? 23 MS BUSBY: It's Day 8, page 58. 24 I'm sorry, I've forgotten to put the line number, 25 but hopefully -- it's the question from yourself:</p> <p style="text-align: center;">Page 89</p> | <p>1 "MR JUSTICE BLAKE: Have you read the report that he 2 prepared for us which I think includes at table 6 the 3 epilation graph?" 4 "Answer: No, I haven't read it in detail. 5 "MR JUSTICE BLAKE: And have you read the evidence 6 that we've managed to get out with some difficulty in 7 translation? 8 "Answer: Well, I read what I could of it but it 9 didn't all make a lot of sense to me, I'm afraid." 10 And even given a break to examine it in detail he 11 refused to engage saying it was too complicated -- 12 MR JUSTICE BLAKE: No, he said he couldn't understand the 13 text. 14 MS BUSBY: Still didn't really understand it. Yes, yes, 15 yes. Well, I'm sorry -- 16 MR JUSTICE BLAKE: You are sorry what? 17 MS BUSBY: That is -- okay, I'm not sorry, I'll just say -- 18 this is an extraordinary position for a statistician in 19 the area of environmental radiation epidemiology. Not 20 only that but one giving expert evidence in a case where 21 regard must be given to the arguments of the other side, 22 and where one of the central arguments of the other side 23 is that the ICRP risk model is wrong. One of the 24 central pieces of evidence for that is faulty dosimetry 25 in the LSS study, and that faulty dosimetry is</p> <p style="text-align: center;">Page 91</p> |
| <p>1 "Question: Are you familiar with the comment on the 2 LSS study?" 3 "Answer: Not particularly, no, I'm not, I'm 4 afraid." 5 Oh, it's a question from Mr ter Haar. 6 And Mr ter Haar goes on: 7 "Question: Certainly it sounds logical, doesn't it? 8 If people have been assuming on the one hand you need 9 a certain level of dose in order to lose your hair and, 10 on the other hand, there's a fall off in exposure 11 geographically and you find that people at the outer end 12 of that geographical limit are also losing their hair, 13 the two things don't seem to go together. That's the 14 point he's making. 15 "Answer: On the face of. 16 "Question: If true, it does cause some questions? 17 "Answer: On the face of it, yes, but I think often 18 you have to look deeper into these issues to really 19 understand them." 20 Well, maybe you do, the question is perhaps why 21 didn't he? 22 MR JUSTICE BLAKE: Couldn't understand it. 23 MS BUSBY: Yes, exactly, and I am coming to that. 24 MR JUSTICE BLAKE: 18 and 19. 25 MS BUSBY: You go on to say:</p> <p style="text-align: center;">Page 90</p> | <p>1 explicitly addressed in a report that the SSD's expert 2 has not even bothered to try and understand. 3 I am aware that the Tribunal had problems with 4 Professor Sawada's English, even after the services of 5 an interpreter had been engaged, but his written report 6 is not difficult for a scientifically trained person to 7 negotiate. And it is accompanied by a published paper 8 which is even clearer as to Professor Sawada's 9 methodology and his arguments. Even given the 10 difficulties of communication it is clear that 11 Mr ter Haar understood the major point that 12 Professor Sawada was making and, with the greatest 13 respect to Mr ter Haar, he is not an expert scientist. 14 It is inconceivable that Dr Haylock would not have 15 been able to understand Professor Sawada's paper if he 16 had taken the time and trouble to do so. The fact that 17 he did not, despite this paper making some serious 18 criticisms of the risk model he employs every day, 19 despite the fact that it is based on careful research by 20 an eminent physicist -- one who has himself been part of 21 the expert group who were responsible for setting up the 22 new dosimetry protocols, the DSO2, which I think he did 23 say he was part of that group -- and a man who I've 24 already said has taught two Nobel Prize winning 25 physicists is, we would suggest, evidence that</p> <p style="text-align: center;">Page 92</p> |

| | |
|--|--|
| <p>1 Dr Haylock's confidence in his risk model is not based 2 on personally engaging with the scientific debate but on 3 simply accepting the consensus as true. 4 In this we would argue that Dr Haylock struck very 5 much, as all the SSD's experts, to an extremely narrow 6 remit of applying the numbers given and doing the 7 calculations they were asked to on the basis of the 8 currently accepted risk model. 9 This takes me to my penultimate point about the 10 standard of proof implicitly used by the SSD's experts. 11 The expert witnesses who testified for the SSD have 12 time and again made the point that the ICRP risk model 13 is the one they use because it is the accepted model of 14 the scientific community. They say there is no other 15 accepted model, there is nothing else that is based -- 16 that is considered sufficiently robust to replace it. 17 So Haylock on Day 8, and the reference is page 112, 18 says: 19 "Answer: There may be other hypotheses, but they 20 have not demonstrated they are better than what we 21 already have at the moment, they are still hypotheses." 22 It's clear that the standard applied here by 23 Mr Haylock is whether there is anything that is better 24 than the ICRP model. Whether, on the balance of 25 probabilities, taking into account all the evidence,</p> <p style="text-align: center;">Page 93</p> | <p>1 because it is satisfied by establishing on reliable 2 evidence possibilities that found a reasonable doubt." 3 He reiterates this on page 34 at paragraph 87 where 4 he says, number (ii) in his little list, is: 5 "Neither side takes forward a score of 1 or 0 based 6 on the normal civil standard (balance of 7 probabilities)." 8 The Tribunal should carry forward and explicitly 9 consider possibilities that are not necessarily accepted 10 as facts. The SSD's scientific experts are in essence 11 operating a civil standard of proof with respect to the 12 ICRP risk model. They have, on the balance of 13 probabilities, assigned it a value of 1 and assigned to 14 the alternative that it may be wrong or unsafe for low 15 dose internal emitters a value of 0. They have then 16 carried forward these values into their consideration of 17 the likelihood that our appellants' cancers were caused 18 by their exposure to ionising radiation during their 19 service. 20 We would argue that they have not in fact considered 21 all the possibilities but have considered a limited 22 range of possibilities predicated on the assumption that 23 the ICRP risk model is correct, i.e. that it carries 24 a value of 1, rather than the acknowledgement that it is 25 merely the consensus view.</p> <p style="text-align: center;">Page 95</p> |
| <p>1 there is a model that is more true than the ICRP. The 2 SSD's experts didn't engage in their written reports 3 with any alternative to the ICRP, despite being directed 4 to consider all the possibilities, and despite a large 5 part of the appellants' case being that the ICRP risk 6 model may not be safe for low doses of internal 7 radiation and for uranium. In their verbal statements 8 they explained that they had not done so because no 9 alternative model is accepted by the scientific 10 consensus. This is to misunderstand the nature of the 11 standard of proof at issue in this case. 12 I want to go back to Justice Charles's decision in 13 the UT at paragraph 84, which is page 32, and it's back 14 to SB1/110. At the bottom of that page there's a quote 15 from Lord Hoffmann: 16 "If a legal rule requires a fact to be proved ... 17 a judge or jury must decide whether or not it happened. 18 There is no room for a finding that it might have 19 happened. The law operates a binary system in which the 20 only values are 0 and 1. The fact either happened or it 21 did not." 22 But he goes on in paragraph 86 and the next page, 23 page 33, to say: 24 "In my view an approach of carrying forward facts in 25 that way does not apply to the Article 41(5) test</p> <p style="text-align: center;">Page 94</p> | <p>1 This tendency to evaluate a given piece of evidence, 2 or theory, or model, in terms of a binary true or not 3 true distinction, can be seen to run through all of the 4 expert witness statements of the SSD and their evidence 5 in court. Evidence potentially undermining the validity 6 of the model is criticised, and potential flaws and 7 problems are pointed out; but those flaws or problems do 8 not necessarily totally invalidate those studies. Yet, 9 for the experts, they are categorised merely as 10 hypothesis-generating studies or, at worst, as rubbish. 11 They are, in effect, accorded a value of zero, allowing 12 the experts to assert that there is no evidence for the 13 alternative models. Despite the fact that, if pressed, 14 they will allow, they provide some indication or 15 a possibility. 16 We have numerous occasions on which the experts have 17 admitted that the evidence put forward by our experts 18 raises issues which might be finally proved or disproved 19 by further more secure epidemiological studies. So if 20 we look at Professor Thomas talking about the Zaire 21 Notter study -- and I'm very sorry but I haven't got the 22 reference here to the transcript, I've just got the 23 quote, but I will give that to you afterwards -- but it 24 was a discussion in which she said the study was too 25 small. Your Lordship said:</p> <p style="text-align: center;">Page 96</p> |

| | |
|---|---|
| <p>1 "If you were presented with information of such a 2 medical finding and you were curious to know more about 3 whether the proposition was correct, what would you need 4 to do?" 5 And she answered: 6 "You'd fund a bigger study." 7 Dr Haylock has responded to those small scale 8 studies as hypothesis-raising studies. 9 So if a large number of small scale studies all 10 raise a the same issue with a particular paradigm it is 11 reasonable to consider that they raise a reasonable 12 doubt about the validity of that paradigm, and further 13 study may be necessary, and indeed further study has 14 been funded for the DoReMi investigation that Dr Haylock 15 has himself engaged in. 16 Yet in this context, where doubts clearly exist and 17 are acknowledged, where further study might be needed, 18 where further study has indeed been funded, a very large 19 further study requiring an awful lot of investment, the 20 SSD and his experts continue to claim that the ICRP 21 model, as the best available, is simply to be preferred 22 as right. 23 We would argue that this position that it is the 24 only valid model preempts the decision-making process of 25 the Tribunal as laid out by Justice Charles, which is</p> <p style="text-align: center;">Page 97</p> | <p>1 The Edwards discussion makes it clear that at the 2 very beginning of this new hypothesis being put forward 3 it cannot raise reasonable doubt. But it makes it 4 equally clear that reasonable doubt is raised in the 5 interim period after this first stage and well before 6 the consensus stage is reached. Arguably, it is reached 7 as soon as the hypothesis ceases to be based on only one 8 limited study. 9 The criticisms of the ICRP risk model advanced by 10 our experts go back some considerable time and are based 11 on numerous peer reviewed papers. 12 MR JUSTICE BLAKE: Before 2002? 13 MS BUSBY: Yes. I mean, Inge Schmitz Feuerhake raised the 14 issue of the problems with the LSS dosimetry in A bomb 15 studies and the undermining of the ICRP risk model in 16 the 80s, late 80s, I think. '73 was the first. 17 We would submit that these more than fulfil the 18 criteria for founding a reasonable doubt based on the 19 Edwards decision. 20 So that's really the end of what I wanted to say, 21 and it's for Dr Busby to elucidate the scientific 22 arguments and that body of evidence that I have alluded 23 to. 24 MR JUSTICE BLAKE: Right, well thank you very much. We 25 might as well take a break now. We'll continue at</p> <p style="text-align: center;">Page 99</p> |
| <p>1 precisely not to carry forward any facts as if they had 2 a binary value of 1 or 0., but to carry forward the 3 possibilities and doubts that attend these facts in 4 order to finally weigh them up at the end of the 5 process. 6 I just want finally very briefly to look at the 7 relevance of reasonable doubt in the context of new 8 hypotheses in science, because it is one of the things 9 that was argued in the Upper Tier. At paragraph 20 of 10 Justice Charles's decision, which would be page 10 -- 11 MR JUSTICE BLAKE: Yes. 12 MS BUSBY: -- he talks about the Edwards case and says: 13 "... it was accepted by all parties that the test 14 laid down in the penultimate paragraph of R v DSS ex 15 parte Edwards is the basis on which the FTT should 16 [measure reasonable doubt]." 17 This is the context. 18 This test refers to the development of what is 19 essentially a new paradigm in a scientific area, 20 a development from a mere hypothesis based on a limited 21 study which might not be considered to raise 22 a reasonable doubt, through a period when the growing 23 evidence for this new hypothesis or paradigm is causing 24 it to become more plausible to a point when it becomes 25 accepted as the new model.</p> <p style="text-align: center;">Page 98</p> | <p>1 two o'clock. 2 How far do you think you are going to get by 4.45? 3 DR BUSBY: By 4.45? 4 MR JUSTICE BLAKE: Yes. 5 DR BUSBY: I think probably I'll finish by then, my Lord. 6 MR JUSTICE BLAKE: I don't think we should sit beyond that. 7 If you think there's a prospect of finishing by then, if 8 you haven't finished by 4.30, we'll try and do that. 9 Thank you. 10 (12.45 pm) 11 (The short adjournment) 12 (2.00 pm) 13 Closing submissions by DR BUSBY 14 DR BUSBY: This is the final submission now on the part of 15 the appellants Battersby and Smith. The Tribunal will 16 have been given our final submission document which was 17 handed up. 18 MR JUSTICE BLAKE: This is the table of issues for closing 19 statement? 20 DR BUSBY: Yes. It was an attempt that we made to try and 21 follow the valuable suggestion your Lordship made about 22 laying out the cases in a way that appeared to be 23 related to sequences of issues which were relevant to 24 the final understanding of the case. 25 MR JUSTICE BLAKE: Right.</p> <p style="text-align: center;">Page 100</p> |

| | |
|--|--|
| <p>1 DR BUSBY: And this we've done. Although I have to say it 2 isn't quite finished in terms of the references, and we 3 can finish that later on. We are a bit short-staffed. 4 But I won't be speaking directly to this table. The 5 table is more of our case in the format that 6 your Lordship suggested we present it. 7 Instead I will be speaking about the scientific 8 issues and some of the issues which are raised and which 9 are listed in this table. 10 But before I go there, I first want briefly to 11 address the issue of documentary evidence about what 12 happened at the test site. 13 MR JUSTICE BLAKE: Is that one of your topics between 4 and 14 11? 15 DR BUSBY: No, this is quite separate. What I am going to 16 say now I won't need to -- I will only refer to this 17 document when necessary and probably not at all. 18 MR JUSTICE BLAKE: Right. 19 DR BUSBY: But my concern is this. It's about the issue of 20 the documentary evidence that was or was not available 21 and made available by the Secretary of State from the 22 previous First Tier and Upper Tier hearings. We have 23 attempted throughout these appeals, and indeed from the 24 time of the AB and Others case when I was commissioned 25 by Rosenblatts, my Lord, to obtain information about the</p> <p style="text-align: center;">Page 101</p> | <p>1 Rosenblatts and then it was submitted to the First Tier 2 and it disappeared from the First Tier bundle and 3 then -- 4 MR JUSTICE BLAKE: I don't quite know what you mean. Are 5 you taking us to this document for a proposition 6 contained in it? 7 DR BUSBY: I am, my Lord, but -- 8 MR JUSTICE BLAKE: Or for a proposition that is being -- 9 inadequate disclosure? I've just lost what I am -- 10 DR BUSBY: I'm sorry, my Lord. Well, then in that case let 11 me take you to what it says, the important thing that it 12 says at the bottom of the page. 13 MR JUSTICE BLAKE: Yes. "Other subjects were touched upon." 14 DR BUSBY: Yes. Essentially what it says is this: that the 15 hazard from enriched uranium is a radioactive hazard 16 rather than a toxic one and relates to the presence of 17 U-234. 18 Well, we submit this is extremely important for our 19 case, an extremely important statement. What we say is 20 that we don't understand how it could have disappeared 21 from all of these bundles on several occasions and even 22 in this hearing it also disappeared from the bundle and 23 from the index and had to be put back by Mr Heppinstall 24 which is why it's in SB22. 25 So what we say to this is that this difficulty in</p> <p style="text-align: center;">Page 103</p> |
| <p>1 measurements made at the test sites. And your Lordship 2 knows that there have been various directions made to 3 the Secretary of State to release documents which would 4 enable us to obtain information about this but we have 5 been told by them and by a representative which was 6 brought in from the Atomic Weapons Establishment that 7 these documents just do not exist, either that or they 8 are secret. 9 So we've had to fall back on the Bevis Parker gist 10 which was obtained following a letter that I wrote to 11 the previous judge in the First Tier, Mr Justice Stubbs, 12 to tell us that there were 8 tons of uranium dissipated 13 over Christmas Island cumulatively over the time of the 14 testing. And we were grateful to Mr Hallard to do that 15 calculation but it's a fairly straightforward one which 16 you can derive from the Bevis Parker gist. 17 So what I have to say is that documents relative to 18 our case having been submitted, even those ones that 19 have been obtained have often disappeared from the 20 bundles and even from the index. We saw this most 21 recently in the case of the Morgan meeting, the Karl 22 Morgan meeting at Harwell, which I would just like to 23 take you to which is SB22/11. 24 MR JUSTICE BLAKE: Yes. 25 DR BUSBY: This document was originally obtained by me from</p> <p style="text-align: center;">Page 102</p> | <p>1 obtaining documents and then the volatility of the 2 documents -- 3 MR JUSTICE BLAKE: It's not apparently the difficulty in 4 obtaining the document. You had the document -- 5 DR BUSBY: One point is the difficulties of obtaining the 6 documents, and the other point is their apparent 7 volatility in that they appear to keep disappearing. 8 MR JUSTICE BLAKE: I have no idea, and I don't imagine my 9 colleagues do, as to the process which went from the 10 library to the SBs, but everyone was able to make their 11 selections of material and if things were missed out 12 that were important, that was capable of supplementing 13 or correction. But I don't understand this is now 14 a topic at this stage in the proceedings that's going to 15 be worthy of further investigation and debate. 16 DR BUSBY: I'm not expecting anybody to investigate 17 anything, my Lord. I am just making the point that it 18 makes it more difficult for us to conduct our case, 19 given that we haven't been able to find documents which 20 show the presence of radioactive materials at the sites 21 and we frankly don't believe that such documents didn't 22 exist at one time. That's the only point I wanted to 23 make, my Lord. 24 So we can put that one to bed. 25 My second point is this. It seems to me that the</p> <p style="text-align: center;">Page 104</p> |

| | |
|---|---|
| <p>1 respondent has refused the direction to reply to our 2 statement of case and to the specific issues that it 3 raises. Nor, it seems from the cross-examination of his 4 witnesses, has the respondent asked them to comment or 5 refute the evidence and the arguments. 6 These arguments from the two sides are almost like 7 ships that pass in the night, but not quite. One of the 8 ships -- our ship -- has all its navigation lit up and 9 is signalling away but the other one steams silently on 10 in the darkness, its track and purpose defined by 11 instructions based on, we say, an obsolete, incorrect 12 and unsafe system of radiation protection. 13 All of the experts brought by the SSD have agreed 14 that if the ICRP risk model is unusable for explaining 15 or predicting the health effects of internal exposures, 16 all of their reports are worthless. They have all 17 agreed this from the witness box. 18 I don't intend to go through every piece of evidence 19 which we have drawn attention to regarding this issue 20 and as I said earlier in the table we list the main 21 evidence and refer to the transcripts as we were asked 22 to by your Lordship. 23 The table is there, as you suggested, to ensure that 24 none of the evidence we point is to overlooked by the 25 Tribunal. That was the purpose of putting this down,</p> <p style="text-align: center;">Page 105</p> | <p>1 DR BUSBY: Right. I'm sorry, my Lord. 2 So what I would like to take us to now is the SSD's 3 arguments to dismiss Professor Schmitz Feuerhake's 4 research. 5 MR JUSTICE BLAKE: Right. 6 DR BUSBY: Now in her genetic effects paper which I now seem 7 to have lost the reference of ... (Pause) 8 MR JUSTICE BLAKE: Do you want to take us to the 9 Secretary of State's or ...? 10 DR BUSBY: It's SB6/89. 11 MR JUSTICE BLAKE: You want to go there. Right. 12 DR BUSBY: Yes. 13 MR JUSTICE BLAKE: All right, we'll go there. 14 DR BUSBY: Yes, that's right. 15 I don't want to do more than here just take the 16 Tribunal to the references at the back of this paper. 17 I don't ask them to do anything more than just to look 18 and see how many references there are here that 19 Professor Schmitz Feuerhake's paper -- that this paper 20 relies on. 21 MR JUSTICE BLAKE: Yes. 22 DR BUSBY: Professor Schmitz Feuerhake's paper concludes 23 that there are serious problems in the ICRP risk model 24 as it applies to genetic effects and congenital 25 malformations following Chernobyl and from other</p> <p style="text-align: center;">Page 107</p> |
| <p>1 making that table. 2 So, as I said, despite being directed to, the 3 Secretary of State has not responded to any of our 4 evidence or the arguments which were set out in the 5 original statement of case and in the final revised 6 statement of case. 7 The SSD's experts were clearly instructed -- clearly 8 instructed -- not to address the many examples of 9 important, relevant and critical peer reviewed evidence 10 which showed the ICRP model on which all of their work 11 depends to be incorrect when applied to the kinds of 12 internal exposure to particles, to uranium suffered at 13 the contaminated test sites. 14 What could the SSD strategy be here then, we asked 15 ourselves, if not to depend upon ad hominem attacks on 16 the credibility of the witnesses? Our witnesses are 17 eminent scientists as -- 18 MR JUSTICE BLAKE: I think we had submissions on that topic, 19 yes. 20 DR BUSBY: -- Dr Cecilia has pointed out. With respect, 21 my Lord, if I'm allowed to repeat that at -- 22 MR JUSTICE BLAKE: I don't think it's a good idea. I mean 23 I gave you the leeway to have two advocates directing, 24 if you divided the issues up, so I don't think 25 repetition is going to be helpful to us.</p> <p style="text-align: center;">Page 106</p> | <p>1 sources. 2 If we look through these references, we see there 3 are lots and lots and lots of papers in which 4 independent researchers from different countries and 5 with different techniques and with different methodology 6 and statistics all showed that over the period of 7 Chernobyl, taken from before Chernobyl to after 8 Chernobyl, in all these different countries in Europe 9 and in the ex-Soviet Union there was a sudden increase 10 in congenital malformations. 11 My point is not that there was a sudden increase or 12 wasn't, it was that an awful lot of people who were not 13 anything to do with the ECRR or with Professor Schmitz 14 Feuerhake or myself all came to the same conclusion, 15 that there were these increases in congenital 16 malformations which could not be explained on the basis 17 of the very small doses that the parents of these 18 children received in the countries that they lived in. 19 So what I am saying is that the evidence that is 20 before the Tribunal is not just evidence from the 21 scientists who were engaged on behalf of the appellants 22 to discuss these issues or to give evidence, but there's 23 a massive amount of data out there, as it were, in the 24 scientific literature which is completely independent of 25 our experts.</p> <p style="text-align: center;">Page 108</p> |

| | |
|--|---|
| <p>1 MR JUSTICE BLAKE: I understood that in respect of one or 2 two of these papers the suggestion is that a wrong 3 conclusion is being drawn from the paper read as a whole 4 and there have been selective fillets for bits which 5 support the direction in which ECRR witnesses want to go 6 and other material is missing. 7 Are you telling us that we've got to read all these 8 37 papers? 9 DR BUSBY: No, my Lord. 10 MR JUSTICE BLAKE: Sorry, 84 papers. 11 DR BUSBY: No, but eight of those papers were actually 12 submitted, handed up during the hearing. 13 MR JUSTICE BLAKE: All right. Well, we have those eight 14 papers. 15 DR BUSBY: Those eight papers all show that there was 16 an increased risk of congenital malformations following 17 the Chernobyl accident. 18 MR JUSTICE BLAKE: So if we can focus upon that submission, 19 you say: here is a review paper, reviewing a number of 20 papers, eight of them you've made available to us. If, 21 therefore, those eight papers are sufficiently 22 identified and abstracted in this review article that is 23 evidence of some independent scientific basis for the 24 opinions contained in the article? 25 DR BUSBY: Correctly put, my Lord. That is my point.</p> <p style="text-align: center;">Page 109</p> | <p>1 all things together, that there is a... 2 MR JUSTICE BLAKE: All right. 3 DR BUSBY: Now, I think my point, my Lord, is that 4 Professor Schmitz Feuerhake and indeed our other experts 5 were in a way categorised or classified or attacked by 6 the Secretary of State as being part of some campaigning 7 group. 8 MR JUSTICE BLAKE: Yes. 9 DR BUSBY: On the basis that they -- well, in some cases 10 that they were just friendly with me, but I think what 11 I am saying is that these people who they rely upon, if 12 you like the eight papers which we chose, those people 13 are not part of a campaigning group. They cannot be, 14 I mean we don't know who they are -- 15 MR JUSTICE BLAKE: I have the point. So I put to you 16 earlier what I understood your submission was, that 17 those eight papers were evidence, independent evidence, 18 of scientific support for the propositions advanced in 19 this and one or two other papers. 20 DR BUSBY: Yes, that's the point. 21 MR JUSTICE BLAKE: I have the submission. 22 DR BUSBY: Okay. 23 The SSD has also said something that has gone 24 further, as I understand him. He has said that the 25 Tribunal itself cannot assess the importance of any fact</p> <p style="text-align: center;">Page 111</p> |
| <p>1 MR JUSTICE BLAKE: Right. But by contrast, if the review of 2 the eight articles doesn't support the use or the 3 conclusions sought to be abstracted from them in this 4 debate, then so far, so bad. 5 DR BUSBY: Absolutely. Absolutely, my Lord, yes. 6 MR JUSTICE BLAKE: Okay, so the eight papers concerned with 7 the testing ground, yes? 8 DR BUSBY: Yes, that's the sort of background. There are 9 more papers than that -- 10 MR JUSTICE BLAKE: Well, I appreciate there are more papers 11 than that but the question is, what homework are you 12 setting us? 13 DR BUSBY: Well ... I think my point here is that, rather as 14 Dr Cecilia pointed out, that there is an addition of 15 evidence. A lot of papers which each perhaps might on 16 their own be considered to be only hypothesis-forming, 17 when there are an lawful of them, the hypothesis that 18 they point at becomes more likely to be real, to lead to 19 some sort of change of assessment of the health effects. 20 MR JUSTICE BLAKE: Yes, but it may not just be numbers, it 21 may be what the papers contain. 22 DR BUSBY: Well, of course, my Lord, yes. Of course that's 23 true. That's when we come back down to the argument 24 that is advanced by Professor Schmitz Feuerhake, where 25 she says that they do actually suggest very strongly,</p> <p style="text-align: center;">Page 110</p> | <p>1 that has been presented in the peer review literature 2 because the Tribunal is not an expert. But I was a bit 3 confused by this, I must say, so it would be good to 4 have some kind of response to it from the Tribunal. 5 I mean, the way I see it is that if the Tribunal is 6 not allowed to listen to any of the BS appellants' 7 experts -- 8 MR JUSTICE BLAKE: Don't worry about what we're allowed to 9 do. We'll decide that ourselves. But the problem is 10 that one may only be able to go so far with a paper 11 before that leads off to a paper trail elsewhere which 12 will take us beyond what we can effectively do. But -- 13 DR BUSBY: Yes, I understand that -- 14 MR JUSTICE BLAKE: -- don't worry about us feeling 15 constrained from doing what we think we need to do. 16 DR BUSBY: Well, the SSD, although he argued that the 17 European Committee on Radiation Risk was a campaigning 18 group has not brought an evidence to that effect. None 19 of his experts have stated that it's a campaigning 20 group, nor is there any evidence that the ECRR is 21 a campaigning group. 22 MR JUSTICE BLAKE: I seem to remember Dr Lindahl making some 23 fairly strong comments below, but perhaps that was 24 directed at you and Professor Sawada. 25 DR BUSBY: Well, I don't see that Sawada is a member of</p> <p style="text-align: center;">Page 112</p> |

| | |
|---|---|
| <p>1 a campaigning group, and indeed his original report on 2 this issue -- not report, his original scientific paper 3 that he wrote on this issue when he first presented his 4 evidence that there were these increases in epilation 5 and other radiation-associated effects at distances from 6 the hypocentre that couldn't possibly be associated with 7 gamma radiation, he wrote that in 2007 into a scientific 8 journal. 9 MR JUSTICE BLAKE: Yes, I know he wrote the paper. It's got 10 quite a loaded title, hasn't it? 11 DR BUSBY: I don't know about loaded title. His title 12 referred to what he showed in his paper, surely. 13 MR JUSTICE BLAKE: Well, it starts off, doesn't it, with an 14 interesting hypothesis about suppression of evidence by 15 the US Government after the Second World War? For us 16 I can perfectly understand how, given his biography, 17 Professor Sawada has more than an interest in these 18 matters and a strong sense of personal connection with 19 them. Given the experiences he had as a child that's 20 perfectly understandable. But that's the way in which 21 the paper is couched. 22 DR BUSBY: Well, if somebody finds something which shows 23 that there's a significant problem and then he goes to 24 look at that problem and finds that it has been covered 25 up by various people at some point --</p> <p style="text-align: center;">Page 113</p> | <p>1 at it differently. Of course then various experiments 2 can be advanced so as to try and distinguish between the 3 validity of either of these two ways of looking at 4 things. And I've always had a problem, in fact 5 I suggested this when I was cross-examined in the Upper 6 Tier, and in fact many reports and books have been 7 written about this, about how people are emotionally 8 attached or even attached as a result of their group or 9 their employment or, as I said, their interpretation of 10 the facts to a particular way of seeing things. In that 11 regard I would say that it's almost impossible for 12 a scientific expert to be entirely unbiased. The bias 13 may of course be quite -- well, I would say innocent, 14 but unknown even to the person who has the bias, but 15 nevertheless they have a particular position on the 16 interpretation of the facts. I won't go any further. 17 MR JUSTICE BLAKE: Just for your benefit, I believe that 18 I haven't seen the transcript of evidence from the 19 Upper Tribunal. I am not asking for it but it's only 20 those passages that are cited in Mr Justice Charles' 21 decision that I have picked up on so far. 22 DR BUSBY: Would it be helpful to the Tribunal if we asked 23 the SSD to provide the transcript? 24 MR JUSTICE BLAKE: Well, I don't know. 25 DR BUSBY: I know it's a lot more stuff to read, my Lord.</p> <p style="text-align: center;">Page 115</p> |
| <p>1 MR JUSTICE BLAKE: That's quite strong words. That's the 2 point. 3 DR BUSBY: You are saying it's intemperate, but I don't 4 think being intemperate, especially since he's Japanese 5 and they have a different culture, being intemperate in 6 the paper as you might see it doesn't detract from 7 the -- 8 MR JUSTICE BLAKE: Well, it might be evidence of a crusading 9 campaigning role. Nothing wrong with that per se, but 10 it's the kind of commitment to a direction, a cause or 11 a proposition which makes it difficult to accept the 12 maker of such statement as a dispassionate expert on 13 these very difficult issues into which we are being 14 drawn. 15 I think that's really the point. 16 DR BUSBY: Well, as to that, my Lord, I have to say -- 17 I don't have to say, but I will say -- that no 18 scientist, and in fact no person, is independent of 19 their culture and so the set of interpretations that any 20 scientist makes on a selection of evidence, so long as 21 they all select the same evidence, their interpretation 22 can be different. So they could be members of a group 23 who believe a certain interpretation on the basis of 24 a certain way of looking at it, or another group that 25 have a different interpretation because they've looked</p> <p style="text-align: center;">Page 114</p> | <p>1 MR JUSTICE BLAKE: Well -- 2 DR BUSBY: It does make these points at some length, to save 3 me boring on about them. 4 MR JUSTICE BLAKE: I think it's better in your present role 5 as advocate for you to make points rather than us trawl 6 through whatever you said as a witness. But I am just 7 alerting you to the fact that if you'd imagined that 8 we'd read it or that you were able to cross-refer 9 I don't think that's a supposition you can rely upon. 10 DR BUSBY: I think I have in fact condensed more or less the 11 position. 12 MR JUSTICE BLAKE: I think I have the proposition and 13 I understand it. So if that's what it's directed to, if 14 you have the essence, the distillation, across to us 15 just now, I've recorded it. 16 DR BUSBY: Yes. It's really quite simple. What I'm saying 17 is that there is no such thing as an unbiased expert. 18 MR JUSTICE BLAKE: I have that point. 19 DR BUSBY: In the United States it's accepted that that is 20 the case so they always go through a sort of 21 oppositional process. 22 MR JUSTICE BLAKE: Quite. That's not the way we do it or 23 the Australians do it. 24 DR BUSBY: I know, my Lord. I would say actually the 25 United States system is probably better if one wanted to</p> <p style="text-align: center;">Page 116</p> |

| | |
|---|--|
| <p>1 get to the truth.</p> <p>2 MR JUSTICE BLAKE: Well, there's debate about that.</p> <p>3 DR BUSBY: Yes.</p> <p>4 MR JUSTICE BLAKE: If you have infinite resources and an</p> <p>5 infinite amount of money and an infinite amount of time</p> <p>6 there might be something to be said for it. But ...</p> <p>7 DR BUSBY: I was going to say with regard to this issue of</p> <p>8 the campaigning group and the ECRR, and so on, that in</p> <p>9 fact a lot of this work was done -- this work</p> <p>10 criticising the ICRP model for various reasons goes</p> <p>11 right back to the '60s.</p> <p>12 MR JUSTICE BLAKE: The '60s? You are pushing it back.</p> <p>13 I thought it was some time in the '90s it was emerging,</p> <p>14 that then led to the CERRIE report debates which you</p> <p>15 have taken us to, but then your daughter told us it was</p> <p>16 1973 but it's going right back, all this had become</p> <p>17 visible by the mid '60s?</p> <p>18 DR BUSBY: It does go back. It goes back much further, it</p> <p>19 goes back to the '60s. Probably the first person to</p> <p>20 raise attention to it was Professor Ernest Sternglass of</p> <p>21 the University of Pittsburgh, but this is really another</p> <p>22 matter. But just for the interest of the Tribunal the</p> <p>23 concerns about the ICRP model go right back to the '60s,</p> <p>24 and in fact Dr Karl Morgan, who we have just seen</p> <p>25 talking at Harwell about uranium-234, resigned from the</p> <p style="text-align: center;">Page 117</p> | <p>1 risk model was not correct.</p> <p>2 These are not people who are anything to do with me.</p> <p>3 In fact, I only started my interest in this in about the</p> <p>4 1990s, the beginning of the 1990s and I was lucky enough</p> <p>5 to talk to Michael Meacher, the Environment Minister,</p> <p>6 and you know all about the CERRIE Committee.</p> <p>7 MR JUSTICE BLAKE: Yes, well, I think we have how that led</p> <p>8 to the CERRIE minority report, et cetera.</p> <p>9 DR BUSBY: So let me just move to say a few words about</p> <p>10 science and scientific method. My daughter said some</p> <p>11 things about this but I have something to say which is</p> <p>12 not quite the same thing and it's relevant.</p> <p>13 This case is entirely or mostly dependent upon</p> <p>14 science. It's a case where there is a very large number</p> <p>15 of scientific facts and frankly, I mean I'm not sure if</p> <p>16 I can imagine there has ever been a case with quite so</p> <p>17 many scientific facts and bits of paper that I really do</p> <p>18 sympathise with your Lordship and the Tribunal having to</p> <p>19 make sense of.</p> <p>20 I mean, it's a task which has taken me 25 years to</p> <p>21 work my way through and to be --</p> <p>22 MR JUSTICE BLAKE: I hope we might just be able to beat</p> <p>23 that!</p> <p>24 DR BUSBY: So the arguments are or could be -- I mean the</p> <p>25 arguments between us and the experts of the SSD, if you</p> <p style="text-align: center;">Page 119</p> |
| <p>1 American BEIR committee over the issue of tritium. In</p> <p>2 fact Morgan wrote a book about this in 1997, called The</p> <p>3 Angry Genie, in which he pointed out that it was the</p> <p>4 pressure from the nuclear industry on the ICRP, if you</p> <p>5 like, to prevent them from increasing the risk</p> <p>6 coefficient of tritium by a factor of 10, which all of</p> <p>7 the evidence he says showed that they should have done,</p> <p>8 and he actually was told, and he writes this in his</p> <p>9 book, that they couldn't do it because it would</p> <p>10 seriously have affected the ability of the nuclear</p> <p>11 industry to continue to function because the nuclear</p> <p>12 industry produces a very large amount of tritium as</p> <p>13 a result of making energy.</p> <p>14 That was in 1997. But Morgan retired, resigned, was</p> <p>15 kicked out of the BEIR Committee in the '70s. So this</p> <p>16 sort of thing has been going on for a very long time and</p> <p>17 various other people have been involved in it who you</p> <p>18 could hardly call campaigning groups.</p> <p>19 Professor Ed Radford also resigned from the BEIR</p> <p>20 Committee and Dr Gofman, Dr John Gofman, who was a very</p> <p>21 senior person in the Atomic Energy Commission, and went</p> <p>22 right back to the Manhattan Project. He was in charge</p> <p>23 of chemistry, the biochemical radiation health effects</p> <p>24 for the Manhattan Project. He also was kicked out</p> <p>25 because he started to complain about the fact that the</p> <p style="text-align: center;">Page 118</p> | <p>1 like our experts and the experts of the SSD, the</p> <p>2 non-ICRP versus the ICRP, those arguments are</p> <p>3 essentially arguments between sort of armchair</p> <p>4 predictions using mathematics and complex theoretical</p> <p>5 models based on a simplistic modelling method of dose,</p> <p>6 and on the other side a sort of biological and</p> <p>7 epidemiological evidence as shown in literally hundreds</p> <p>8 of peer reviewed reports, many of them cited in this by</p> <p>9 us in this Tribunal and many of them handed up.</p> <p>10 There were for example a very large number of</p> <p>11 reports written in the Russian language which never made</p> <p>12 it into the United Nations or the ICRP --</p> <p>13 MR JUSTICE BLAKE: There has to be a limit. You have</p> <p>14 identified the reports which you referred to, and that</p> <p>15 at least we can examine for the propositions. We're</p> <p>16 doing so, but if you are going to refer to a report in</p> <p>17 Russian which is not in the bundle --</p> <p>18 DR BUSBY: My Lord, I am not --</p> <p>19 MR JUSTICE BLAKE: Try to deal with the material you have,</p> <p>20 please -- you have quite a lot of it -- rather than</p> <p>21 material we don't have for one reason or another,</p> <p>22 otherwise we'll never finish the task of setting the</p> <p>23 target.</p> <p>24 DR BUSBY: I am just referring to the quantity of these</p> <p>25 papers, that's all, my Lord. I certainly don't expect</p> <p style="text-align: center;">Page 120</p> |

| | |
|---|--|
| <p>1 anyone to go and look at the Russian language 2 literature. 3 Well, I am sure -- I mean there is no way I would 4 have suggested any of these. But the CERRIE minority 5 report, and indeed the CERRIE report itself, should have 6 referred to a very large number of Russian language peer 7 reviewed papers which showed significantly high health 8 effects occurring in the territories contaminated by the 9 Chernobyl accident and these were brought to the CERRIE 10 meeting in Oxford, St Catherine's College, Oxford, in 11 2004. There was a big international conference called 12 by CERRIE and four Russians or -- yes, Russian-speaking 13 experts, including the Head of Biological Radiation 14 Effects of the Russian Academy of Sciences we invited to 15 come there and they presented a lot of these papers but 16 they simply did not get considered. They were not taken 17 in by the main CERRIE Committee as evidence, although 18 we've listed them as brief abstracts in the minority 19 report, and they just sort of disappeared. They have 20 not been considered by those people if you like on the 21 other side, on the ICRP side. 22 In a discussion that I had with the ex Scientific 23 Secretary of the ICRP, Dr Jack Valentin, and I won't 24 take you there -- it's in the bundle. 25 MR JUSTICE BLAKE: I've read it.</p> <p style="text-align: center;">Page 121</p> | <p>1 them to accommodate the existence of them in some way, 2 do you see? 3 MR JUSTICE BLAKE: Well, the impression I personally have is 4 that on a number of occasions, including in the CERRIE 5 report, consideration was given to critiques of the 6 methodology and predictability of the ICRP model, but 7 they concluded that on analysis the model remained 8 sound, good and the critiques were unsound. 9 Now, that seems to be the conclusion. 10 They then go on to say such studies, epidemiological 11 studies and others, have tended to support in broad 12 terms the model. 13 So I just don't get a sense of a type of mentality 14 established in the early '60s of refusing to engage with 15 criticisms or other comments and simply ignoring the 16 onward march of scientific critique, which is the 17 picture you are painting to us now. 18 DR BUSBY: I think that's my point, my Lord, that they don't 19 see it because they refuse to see it. For example, 20 again and again in this area of the adequacy of safety 21 of the model we see the calculations of dose are held up 22 as evidence that the epidemiological observations cannot 23 be real. We see that in the case of all of the clusters 24 of child leukaemia around nuclear sites of which there 25 are a very large number of papers now that show there</p> <p style="text-align: center;">Page 123</p> |
| <p>1 DR BUSBY: In that discussion Valentin, as he had then 2 retired as the Scientific Secretary of the ICRP stated 3 quite clearly two things. The first thing was that the 4 risk model was possibly insecure for internal 5 radionuclides by as much as 100-fold, and he states this 6 and he is the Scientific Secretary. You can read it in 7 the transcript and in fact many people, many activist 8 friends of mine have put the video up because it was 9 videoed so it's actually on the Internet and we give the 10 place where you can see it if you want to. 11 The other thing he said was that he thought it was 12 quite wrong that the ICRP had not considered all of the 13 evidence of these increased ill-health occurrences in 14 the various countries that were exposed to the Chernobyl 15 fallout. 16 So these two things were things that were clearly 17 absent from the ICRP discussion, which goes to my point, 18 and one that was made in the paper by Professor Schmitz 19 Feuerhake, that if you see the world through 20 a particular prism, through the prism of the ICRP 21 approach, then anything that doesn't fit that approach 22 is dismissed. As we've seen, many of the papers were 23 dismissed by the experts for the SSD in a sort of 24 offhand manner, or else they are just simply ignored, 25 they are invisible, because the risk model doesn't allow</p> <p style="text-align: center;">Page 122</p> | <p>1 are clusters of childhood leukaemia in nuclear sites, 2 but what always happens is that those who are the 3 agencies, who are if you like the official agencies in 4 this area, they say that these increases cannot be 5 caused by the exposure to radiation because the doses 6 are too low. 7 Professor Thomas told us, for example, that the huge 8 increase in thyroid cancer after Fukushima -- she says 9 it's not a real increase but let's leave that to one 10 side, whatever it is -- it cannot be real because again 11 the doses are too low. The SSD's position with the 12 veteran cancers is also the same one. 13 So there's evidence for instance in the Pearce study 14 of the New Zealand veterans, we see a 5.6-fold excess of 15 leukaemia. Now, the doses to those people, I think we 16 would have to assume that the SSD would say that the 17 doses to those people were very low, that they couldn't 18 have caused a 5.6-fold excess of leukaemia. But we also 19 see in a selection of those New Zealand veterans, we see 20 in the Wahab and Rowland chromosomes study, again we see 21 a very large increase or at least a significant 22 threefold increase in evidence, objective evidence now, 23 of prior radiation exposure and we're told that that's 24 not possible because the doses are too low, or another 25 way of putting it that the doses cannot be as high as</p> <p style="text-align: center;">Page 124</p> |

| | |
|---|---|
| <p>1 those results might indicate. 2 I'll come back to that. 3 So what I'm saying really is that the analysis 4 always goes from the dose to the results. It doesn't go 5 from the results to the dose. If the dose is too low, 6 the results must be wrong. This is the argument of the 7 ICRP and of the agencies that support it. They always 8 go from the dose to the effect. If effect is flagged 9 up, even by 10 or 12 or 15 or 100 studies, it is always 10 ignored because the prism through which they are 11 observing these very real pieces of evidence is one that 12 does not admit the possibility that these are causal 13 effects; they cannot be because the dose is too low. 14 So on what basis do they say that the dose is too 15 low? It's because their relationship between the dose 16 and the amount of cancer is based on the LSS model, it's 17 based on the risk model, essentially on the risk model 18 of the Japanese survivors. 19 Well, we will put aside for now the fact that there 20 are some studies of nuclear workers and so forth but 21 those are external dose studies, by and large. In fact 22 they all are external dose studies. 23 So their position that the dose is too low and they 24 are therefore able to deny what is in front of their 25 eyes in the peer review literature, that is based</p> <p style="text-align: center;">Page 125</p> | <p>1 dropped the original one -- and then they measured the 2 radiation, the gamma radiation dose at different 3 distances from the bomb. So they placed all sorts of 4 shielding in the way too, so they could tell how much 5 the radiation would be reduced for example if someone 6 was behind a wall and so forth and that produced the 7 dosimetry. 8 But what it also showed is that nobody at a distance 9 of more than 3 kilometres, 3,000 metres from that 10 particular bomb -- and it was quite a small bomb 11 compared to the ones we're talking about at 12 Christmas Island; it was 15 kilotons, the Grapple Y bomb 13 was 3 megatons, so we're talking about quite a small 14 bomb and the effects -- there were no gamma radiation 15 effects measurable in the Nevada Desert or in the 16 dosimetry further than 3 kilometres. Well, let's be 17 conservative and say 4 kilometres. But Professor Sawada 18 came along and he had a look -- he started to quite 19 cleverly look at the immediate effects of radiation. 20 Now one of the immediate effects of radiation -- the 21 gamma radiation that is -- is to cause epilation and to 22 cause diarrhoea and immediate what they call 23 deterministic effects. So Sawada discovered that 24 6 kilometres, 7 kilometres, 8 kilometres from the bomb 25 people were suffering from these same effects, from</p> <p style="text-align: center;">Page 127</p> |
| <p>1 entirely on a study which Professor Sawada shows quite 2 clearly is faulty. Professor Sawada's study might seem 3 technologically abstruse, it might look a bit 4 mathematical, but really, as Mr ter Haar said, it's 5 quite simple. 6 What Professor Sawada did, and in fact the SSD seems 7 to have tried to divert the attention of the Tribunal 8 from what he really did by suggesting that it was some 9 kind of abstruse mathematical chicanery, what he did was 10 he took real data on epilation and diarrhoea and 11 immediate effects of radiation, data that was published 12 by the Atomic Bomb Casualty Commission Radiation Effects 13 Research Foundation, so these are real numbers -- he 14 started with the numbers, he started with the 15 evidence -- and what he did, I mean in a very simple way 16 is he looked at the rates of epilation, let's say 17 6 kilometres from the hypocentre, somewhere where there 18 couldn't be any immediate radiation from the bomb. When 19 these bombs explode they produce gamma radiation which 20 goes out approximately as an inverse square law. So 21 when the Americans tried to figure out what the doses 22 were originally, the initial dosimetry, what they did is 23 they put various kinds of dosimeters in a desert and 24 they blew up another bomb of about the same capacity, 25 a similar bomb -- they knew how to make one because they</p> <p style="text-align: center;">Page 126</p> | <p>1 these effects of radiation, which could not have been 2 caused by the gamma radiation from the bomb. 3 Now it's the gamma radiation from the bomb that 4 defines the groups that are used to determine the risk 5 model for the ICRP. Therefore the risk model of the 6 ICRP cannot be valid, he argues, because all of those 7 people were exposed to whatever it was and at that point 8 we -- let's not ask what it was but something that was 9 causing these radiation effects, 6 kilometres up to 10 10 kilometres away from the bomb. 11 Then he had a look to see -- well, of course he 12 already knew, but he then argued that the reason that 13 these people were suffering these untoward effects from 14 a long way away when they couldn't have been exposed to 15 the initial radiation is they were being exposed to the 16 black rain. So it was the black rain that had a very, 17 very much higher effect on the basis of its apparent 18 dose as calculated by the ICRP, if you like, than it 19 should have. 20 People were exposed to the black rain, and a later 21 paper which we submitted by a different Sawada shows 22 quite clearly that the black rain contained the uranium 23 that the bomb had been made from and those bombs when 24 they explode, as Professor Regan tells us, the actual 25 fissioning is only 10 per cent of the bomb so</p> <p style="text-align: center;">Page 128</p> |

| | |
|---|---|
| <p>1 90 per cent of the uranium in the bomb gets dissipated 2 as uranium. 3 Then of course there are various quite well known 4 mechanisms described in Glasstone and elsewhere and by 5 our expert Dr Ash and by Mr Nicholson and Mr Stretch, 6 where you get self-induced rainout. So in other words 7 in tropical climates these bombs cause an enormous 8 suction of air, the air is moist, it comes off the sea, 9 it goes up and it cools as it gets colder with altitude 10 and it then picks up particles of the bomb casing which 11 have been dissipated as nanoparticles and down it all 12 comes. 13 It was that black rain which Professor Sawada makes 14 his little maps of and which he puts his maps into the 15 PowerPoint which we never showed that explains these 16 unusual and anomalous health effects from the exposure 17 to this internal radiation from -- well, we say uranium 18 but presumably also there were various other 19 radionuclides. 20 The point not being any more than the exposure to 21 this to material carried a very, very much larger hazard 22 than would be accountable for on the basis of its dose. 23 Of course, we saw also that in the case of the test 24 veterans -- I'll come to that too and it's a major 25 platform of the Hogan Lovells argument -- there was</p> <p style="text-align: center;">Page 129</p> | <p>1 "expert ping pong". But the advantage of expert ping 2 pong is at least it enables the Tribunal to see the 3 evidence from one side and then the response to that 4 evidence from the other side and the response to the 5 response and possibly only the response to the response 6 to the response because by that time whatever has been 7 discussed becomes clear. But in this case we didn't 8 have ping pong, we had ping, that was it. We didn't get 9 any more response from the -- so we pinged our ball over 10 the net and it never came back. 11 So we were at a loss to understand quite how we 12 could deal with this, until we came to the point where 13 we realised that what the Secretary of State intended to 14 do was merely to conduct an ad hominem attack against 15 our experts so they didn't need to pong because they 16 just shot them all, if I might put it so crudely. 17 So the Tribunal is apparently invited to do what the 18 Upper Tier asked it to do; it's asked to merely rule on 19 whether to admit any evidence whatever from the eminent 20 scientists who gave evidence on behalf of the 21 appellants. 22 MR JUSTICE BLAKE: We have admitted the evidence, it's there 23 before us. What we I think are going to have to do is 24 to evaluate what support it gives to the propositions 25 that you advance. But if it turns out not to be</p> <p style="text-align: center;">Page 131</p> |
| <p>1 an equivalently and extremely unusual apparently high 2 level of congenital -- of chromosome aberration in the 3 New Zealand veterans. 4 By using a sort of ICRP approach on the basis of 5 dose -- and this is how they come to this assessment, 6 the Wahab/Rowland assessment of dose where the SSD has 7 said these doses are far too high to be credible -- they 8 write down doses of 1,400 millisieverts, 700 9 millisieverts, very, very large doses. The point is 10 that if Sawada is right, if we go to Sawada's argument, 11 you do not have to have a very large dose of 1,400 12 millisieverts to get that chromosome damage. All you 13 have to do is to be exposed to the internal uranium. 14 MR JUSTICE BLAKE: I have the headline theory. 15 DR BUSBY: Right. 16 Now I want to just say that we are concerned about 17 the fact that the SSD did not respond to the arguments 18 advanced by our experts in our statement of claim 19 because if the SSD had done that, as he was directed to, 20 then our experts could have responded point by point. 21 This was kind of the way in which the previous -- of 22 course I'm not suggesting -- the Tribunal can make its 23 own decision about how it conducts the case, but that 24 was the way in which the Stubbs First Tier seemed to 25 work is that it was what Judge Wikeley referred to as</p> <p style="text-align: center;">Page 130</p> | <p>1 evidentially supportive and it remains therefore 2 a hypothesis that has arisen since 1973, if it doesn't 3 have support outside the community of scientists that 4 you referred to, and if the conclusion is that the 5 epidemiological or other data upon which you rely as 6 support doesn't support, then that will be highly 7 material in driving the evaluation process. 8 DR BUSBY: Of course, my Lord. 9 Let me turn to Mr Battersby. 10 MR JUSTICE BLAKE: Yes. 11 DR BUSBY: I want to draw attention to what I see as some 12 logical problems with the Secretary of State's case. 13 Mr Battersby, whose appeal was and is for chronic 14 lymphocytic leukaemia, died last year from pancreatic 15 cancer. The Secretary of State awarded him a pension 16 for this on 23 April 2014. 17 MR JUSTICE BLAKE: Yes. 18 DR BUSBY: Therefore the Secretary of State conceded that, 19 firstly, pancreatic cancer is radiogenic, and secondly 20 that he received a sufficient dose to raise reasonable 21 doubt. 22 In fact, Mr Williams in the previous First Tier also 23 had his appeal allowed for pancreatic cancer. Therefore 24 it seems logical to me that the Battersby appeal now 25 devolves into a question of the radiogenicity of chronic</p> <p style="text-align: center;">Page 132</p> |

| | |
|---|--|
| <p>1 lymphocytic leukaemia. 2 We've heard evidence that three out of five experts 3 advising the United States Center for Disease Control 4 have decided that CLL is radiogenic. 5 But we would argue on the basis of the Article 45 6 test that even if one out of five had argued that CLL 7 was radiogenic that should raise reasonable doubt. But 8 here we actually have a majority. 9 In addition, there are several scientific papers in 10 the peer review literature that we have submitted and 11 which Professor Howard has drawn attention to that give 12 epidemiological evidence that CLL is radiogenic. 13 Therefore, we feel that apart from any other arguments 14 about scientific credibility of experts and so forth, in 15 awarding Mr Battersby a pension in April 2014 that the 16 SSD has essentially shot himself in the foot if I might 17 put it quite so crudely. 18 MR JUSTICE BLAKE: Well, in the light of what I understand 19 to be the position before us they say that was 20 an overgenerous response. They say that we are not 21 bound by that decision -- it's not a question of 22 irrevocable estoppel or some such concept -- we have to 23 evaluate the evidence for ourselves. 24 What do you say as that response to the "get out of 25 the bind" point, which I understand, for the reason that</p> <p style="text-align: center;">Page 133</p> | <p>1 and entirely provisional thoughts are that even with CLL 2 and pancreatic cancer if you blast enough radiation at 3 a human body you might well get a cancerous response. 4 But that may depend, therefore, on whether you are 5 in the sievert or half sievert category or something 6 even above that, rather than what I'd understood to be, 7 although you will no doubt clarify this in your 8 submission, the problem of low dose cause and effect. 9 And I know you are riding two horses. The radiation may 10 have been considerably higher than others have assessed 11 it to be and (2) at low levels of radiation, for the 12 sake of argument we'll define that as below 100 13 millisieverts although I appreciate there are further 14 debates within that category, medical causation moves in 15 a different way. 16 But to some extent, in order to unpack the argument 17 you are putting to us, I suppose we'd welcome 18 clarification as to whether you are saying there was 19 a high dose but it was somehow missed by the 20 measurements or the calculation and the assessments, or 21 they may well have been a very low dose but a very low 22 dose of uranium ingestion can nevertheless cause 23 cancerous defects. Yes? 24 I think that's the territory in which we have to 25 engage rather than saying: well, you gave an award to</p> <p style="text-align: center;">Page 135</p> |
| <p>1 we raised it ourselves at the outset. 2 DR BUSBY: I'm not a lawyer but to me as a scientist it 3 seems like a very curious position and I go no further. 4 MR JUSTICE BLAKE: Well, curious, I think you might strike 5 a chord somewhere there. Is it curious enough to say 6 that there is a flaw in the arguments that are now being 7 presented to us? Because if it's not then we've got to 8 deal with what we've got to deal with. 9 DR BUSBY: Right. 10 MR JUSTICE BLAKE: We did explore whether there was 11 a potential shortcut at the outset. There isn't. 12 DR BUSBY: I say no more about that, my Lord. I just 13 thought I would raise the issue. 14 MR JUSTICE BLAKE: Well, we are aware of it. 15 DR BUSBY: Of course the other thing is that if 16 Mr Battersby's pancreatic cancer -- and of course again 17 I'm just taking this forward from what I was saying 18 earlier, but if Mr Battersby's pancreatic cancer is 19 sufficient to give him a pension award, it must surely 20 follow that in the case of Mr Smith's pancreatic cancer 21 the issue devolves on to whether he received sufficient 22 dose or indeed, as we argue, a sufficient internal 23 exposure to residual radioactive contamination at 24 Christmas Island. 25 MR JUSTICE BLAKE: If it helps, at the moment my personal</p> <p style="text-align: center;">Page 134</p> | <p>1 him, therefore give it to -- if you gave it to X you 2 must give it to Y. 3 DR BUSBY: Very good. I think we need to try and nail this 4 point now because I think it's perhaps the critical one. 5 You see when these issues of dose are discussed they 6 are always discussed in terms of high dose and low dose. 7 And as soon as we are in the area of high dose and low 8 dose we are in the area of the ICRP way of looking at 9 the world: this is what dose is and this is high dose 10 and this is low dose. 11 It's very important in our submission, and in fact 12 indeed this is the core of our submission, that the 13 concept of dose for internal radionuclides, particularly 14 for uranium, should be abandoned. The effect would be 15 the same. So in other words the ICRP would say "Oh this 16 guy only inhaled 1 gram of uranium and therefore his 17 dose was only 1 millisievert". I mean I am making these 18 figures up now, but we say that if he inhaled 1 gram of 19 uranium his dose was the same as if he had received 20 an external dose of 1,000 millisieverts. This is the 21 essence of the results that were obtained by Sawada. 22 Those people who were 6, 7, 8 kilometres from the 23 hypocentre, the ICRP would say that they had a very low 24 dose exposure but what we say is let's throw away this 25 whole concept of dose; let's assume, like</p> <p style="text-align: center;">Page 136</p> |

| | |
|---|---|
| <p>1 Professor Thomas said, that uranium is a heavy metal and 2 we're dealing with heavy metal toxicity. Now we don't 3 believe that but it's a convenient way of explaining 4 what it is we are saying. We're saying that the effects 5 of exposure to low amounts of these internal 6 radionuclides are the same as if they got high doses 7 from external radiation. 8 I think that's the most important point because we 9 get lost again and again in these arguments about high 10 dose and low dose. So when we look at the nuclear 11 workers and they show us these straight lines going down 12 to low dose, that is accurate, those are low doses 13 because those people's doses were established in terms 14 of actual measurements where they had film badges and 15 they could go to the film badges and say "Hey, this guy 16 his dose was 5 millisieverts, it's really small." 17 What we're saying is that when Professor Canu, when 18 Irena Canu went to the French nuclear workers and she 19 studied leukaemia and lymphoma in these people who were 20 not just nuclear workers but actually were only uranium 21 workers, what she found is that they had significantly 22 high levels of leukaemia and lymphoma even though their 23 doses were really small, about 15 millisieverts as her 24 papers show, and as Professor Hooper related. 25 So it's very important. I mean I urge the Tribunal</p> <p style="text-align: center;">Page 137</p> | <p>1 MR JUSTICE BLAKE: And since they come up to a mean figure 2 over our 100 millisieverts level, that was considered to 3 be high. 4 So that paper doesn't seem -- at least part of that 5 paper is about what level of dose, what degree, 6 i.e. a dosimetry-based estimate as opposed to simply 7 saying we chuck out the concept of dosimetry because you 8 can get these genetic mutations on microsieverts -- 9 DR BUSBY: Yes -- 10 MR JUSTICE BLAKE: -- or very, very, very, low levels. So 11 I mean that doesn't seem to be your case, so why don't 12 you leave that bit alone, but I mean -- 13 DR BUSBY: I think I can't really leave it alone because it 14 may be that the Tribunal will think that the submission 15 by the SSD that these doses were too low, or too high to 16 be credible, as I just said, with all the alarms going 17 on, that it doesn't have to go there. 18 You see when you -- 19 MR JUSTICE BLAKE: So you say to strip Rowland and Wahab of 20 its dosimetry, retrospective dosimetry, and you say that 21 that might be caused by -- 22 DR BUSBY: Yes, I do. 23 MR JUSTICE BLAKE: -- a different form. 24 DR BUSBY: The dosimetry that Wahab and Rowland used is 25 based on studies where they irradiate animals with</p> <p style="text-align: center;">Page 139</p> |
| <p>1 to sort of get a handle, and if I haven't explained it 2 properly please ask me and I'll go through it again, 3 that what we're talking about is the apparently high 4 dose effects of exposure to small amounts of uranium 5 particles. This is what Professor Sawada found. 6 It actually also relates very importantly to this 7 Wahab/Rowland study because, as I said earlier, one of 8 the concerns of the SSD is that the apparent doses are 9 so high and what they say is: look, if these doses had 10 really been 1400 millisieverts all the alarms on the 11 ships would have gone off, everybody would have been 12 screaming and yelling and running about the place, all 13 the red lights would have been flashing and they 14 weren't. 15 Of course they weren't because it wasn't a high 16 dose; it wasn't a high amount of radioactivity. What we 17 say is that there was a sufficiently high amount of 18 uranium particulates for these people to inhale. 19 MR JUSTICE BLAKE: My understanding is that is a comment you 20 are making on the Wahab/Rowland debate which is pretty 21 central to the Hogans appellants. The second part, 22 having got the evidence of mutations in the DNA, is the 23 attempt to work out how much dose caused that in 24 millisieverts. 25 DR BUSBY: Yes.</p> <p style="text-align: center;">Page 138</p> | <p>1 external radiation. So in other words, just like with 2 the A bomb, in order to get a threefold excess of 3 chromosome translocations in the animal you have to 4 whack it with 1400 millisieverts external radiation. 5 Our point is you could achieve the same effect by 6 feeding it uranium particles. Does that make it clear 7 where we are coming from? 8 MR JUSTICE BLAKE: Mm. 9 DR BUSBY: So the argument about all the alarm bells going 10 off and whatnot is a spurious one, because apart from 11 the fact that uranium particles do not emit gamma 12 radiation so they wouldn't set off the detectors anyway, 13 the fact is you don't need to have that enormous 14 external dose in order to get the effect that they got. 15 Also the other thing about those New Zealand 16 veterans is that we know from the studies by Rabbitt 17 Roth, which I won't go to but they're in the bundle -- 18 in fact I asked Professor Thomas about this -- that they 19 suffered an enormously high level of congenital 20 malformation and birth defects in their children, a 21 truly astonishingly high level. 22 MR JUSTICE BLAKE: Obviously you are aware that Rabbitt Roth 23 is heavily criticised as a form of reliable epidemiology 24 because of self-reporting, self-selection and other 25 matters.</p> <p style="text-align: center;">Page 140</p> |

| | |
|--|---|
| <p>1 DR BUSBY: Yes.</p> <p>2 MR JUSTICE BLAKE: I won't try to reproduce it. It was</p> <p>3 dealt with in Mr Haylock's report and you didn't</p> <p>4 actually ask him any questions about it.</p> <p>5 DR BUSBY: Yes, my Lord. Anyway, I agree that's part of the</p> <p>6 general ping pong and I'll come to that issue about the</p> <p>7 different views of the same pieces of evidence. If</p> <p>8 I could get a glass of water I would be grateful.</p> <p>9 MR JUSTICE BLAKE: Do you have water down there?</p> <p>10 DR BUSBY: Yes.</p> <p>11 Because that conveniently brings me to a point about</p> <p>12 the experts and the Article 41 test which is not the</p> <p>13 same point that my daughter made.</p> <p>14 Now, as I understand it -- I mean the way in which</p> <p>15 I categorise the Article 41 test as laid down by Judge</p> <p>16 Charles is the binomial gate -- you either get through</p> <p>17 or you don't get through. The two items which you have</p> <p>18 to fulfil in order to get through or not go through</p> <p>19 are: is the evidence fanciful or worthless, or is it not</p> <p>20 fanciful or worthless? In other words, if it's fanciful</p> <p>21 or worthless it doesn't get through the gate. If it's</p> <p>22 not fanciful or worthless, even if it might be opposed</p> <p>23 by people or, you know, for whatever reason, if it's not</p> <p>24 fanciful or worthless it makes it through the gate.</p> <p>25 Now, I would argue that rather than arguing about</p> <p style="text-align: center;">Page 141</p> | <p>1 Professor Sawada or Professor Schmitz Feuerhake or any</p> <p>2 of these experts are biased or not credible. You can</p> <p>3 then just only deal with their evidence, and say "Well,</p> <p>4 look here, this evidence that she's brought forward, is</p> <p>5 that fanciful or credible?" The fact she refers to 18</p> <p>6 papers that say that there was an increase of congenital</p> <p>7 malformation --</p> <p>8 MR JUSTICE BLAKE: I really think you have probably made</p> <p>9 this point.</p> <p>10 DR BUSBY: I won't bore on then.</p> <p>11 I was just getting going there. All right.</p> <p>12 MR JUSTICE BLAKE: Well, I mean I'm just conscious that</p> <p>13 we'll take a break in 20 minutes and then if you are</p> <p>14 still on target you've got another hour when we get</p> <p>15 back, and you probably should decide how best to use</p> <p>16 your time, you see.</p> <p>17 DR BUSBY: Thank you, my Lord. I will bear that in mind.</p> <p>18 I'm pretty sure that I will be able to finish by the</p> <p>19 time. (Pause)</p> <p>20 Well, I've covered the issue of Sawada's evidence,</p> <p>21 I think. (Pause)</p> <p>22 So as I argued, the concerns about the LSS model and</p> <p>23 the Hiroshima basis -- not the LSS model, the ICRP model</p> <p>24 and the Hiroshima concerns raised by Professor Sawada,</p> <p>25 pointed us to the idea that it was the fallout and</p> <p style="text-align: center;">Page 143</p> |
| <p>1 whether a particular fact is fanciful or worthless in</p> <p>2 this way of going across the stopping stones, starting</p> <p>3 with the first stepping stone and then jumping to the</p> <p>4 second and so on and not falling down into the chasm,</p> <p>5 the first question that you need to ask or the Tribunal</p> <p>6 might have to ask is: is it fanciful or worthless to</p> <p>7 assume that, say, Professor Sawada is a genuine expert</p> <p>8 in the area he is giving his evidence on in the case?</p> <p>9 So rather than asking whether or not the evidence</p> <p>10 itself is fanciful or worthless, given that the</p> <p>11 Secretary of State has raised the issue of the expertise</p> <p>12 or bias or, you know, various credibility issues</p> <p>13 relating to the expert, should we not ask ourselves</p> <p>14 whether the question of their expertise might be</p> <p>15 considered to be fanciful or worthless? In other words,</p> <p>16 if someone said, "Look here, Professor Sawada is</p> <p>17 obviously a member of a campaigning group" and you said,</p> <p>18 "No, she's not", is the second statement fanciful or</p> <p>19 worthless? Because if it's not, if there's some</p> <p>20 possibility, any possibility that Professor Sawada is</p> <p>21 not a member of a campaigning group, is not biased, is</p> <p>22 actually a genuine scientist who has worked on this</p> <p>23 issue almost since her first PhD, then she makes it</p> <p>24 through that binomial gate and then you can put that to</p> <p>25 bed, you don't have to ask any more about whether</p> <p style="text-align: center;">Page 142</p> | <p>1 rainout of uranium from the Hiroshima bomb that caused</p> <p>2 the apparent high doses.</p> <p>3 Now this is relevant to the test sites. We submit</p> <p>4 that there was contamination of the test sites and that</p> <p>5 the veterans were exposed to internal radioactivity from</p> <p>6 the uranium. I believe that this is accepted now by the</p> <p>7 SSD, and indeed Mr Hallard has made an attempt to</p> <p>8 quantify the dose from this. In fact the only</p> <p>9 differences between us -- that is Hallard and the</p> <p>10 opposition -- are firstly some issues with missing</p> <p>11 routes, principally sea-to-land transfer of material</p> <p>12 which had fallen in the sea and contaminated the</p> <p>13 seashore later on, and the problem with the ICRP dose</p> <p>14 co-efficients which do not include the various aspects</p> <p>15 of local dose from particles and local DNA dose from the</p> <p>16 DNA seeping nuclides like uranium and strontium 90.</p> <p>17 So that leads me to the anomalous radiogenic</p> <p>18 toxicity of uranium. As Mr Hallard calculated, and as</p> <p>19 I said earlier, the quantity of uranium cumulatively</p> <p>20 exploded over Christmas Island by the time Mr Smith</p> <p>21 arrived there, for example, was 8 tons.</p> <p>22 It was therefore arguably a significant possible</p> <p>23 exposure, and as you know our experts have presented</p> <p>24 a large amount of evidence that uranium causes anomalous</p> <p>25 genotoxic effects, for example in cell culture shown by</p> <p style="text-align: center;">Page 144</p> |

| | |
|---|--|
| <p>1 the work of Professor Miller, and Professor Miller by 2 the way works for the United States military. 3 And then I mentioned Dr Irina Canu, who worked for 4 the French nuclear industry, and her 2008-2010 study 5 shows a significant excess of leukaemia in uranium 6 workers, and incidentally I met Dr Canu in Paris in 2010 7 and she said to me then that she was finding great 8 difficulty in getting these results published in the 9 peer review literature and asked if she could give me as 10 a reference for a paper so that I could write a review 11 and I told her that it's probably best not to because if 12 she gave me as a reference they would be less likely to 13 publish it. 14 MR JUSTICE BLAKE: That might have been a wise move on your 15 part, Dr Busby, but I'm not going to -- 16 DR BUSBY: I thought that might entertain you, my Lord. 17 But I mean we can't argue that these two scientists 18 are members of campaigning groups, just to come back and 19 make that point, you know, rather tediously again. 20 MR JUSTICE BLAKE: Well, is that the best way you are going 21 to use the time? Because I think I have just about got 22 your submission. If they've got good science, the fact 23 that they are campaigning in support of good science is 24 irrelevant. 25 DR BUSBY: Very good.</p> <p style="text-align: center;">Page 145</p> | <p>1 to return to the issue since Dr Rayner raised the 2 question of the controls. I think on Day 9 on 23 June 3 at page 88 -- oh, Cecilia says she's already done that. 4 I was going to take you to the HPA's review, but do 5 I need to do that, my Lord? It was just that the 6 controls were carefully selected and the lower levels 7 relative to the national background population might 8 have been a consequence of the healthy soldier effect. 9 You have that, do you, from the earlier discussion? 10 Okay, I'll leave that. 11 Well, the dose calculations by Mr Hallard are the 12 starting point for the Secretary of State's case. 13 Mr Hallard agreed that he was a kind of sophisticated 14 calculator. He subjectively decides on all the possible 15 inputs and turns the handle, as it were, to get a dose 16 which then pops out of the calculations algorithm. 17 He has agreed already that if the ICRP model fails 18 his results also are wrong and it then follows, as we 19 say, that all the subsequent calculations and 20 conclusions of Dr Haylock and Professor Thomas are 21 similarly insecure. So this whole case of the SSD 22 actually sits upon the shoulders of poor Mr Hallard. 23 But there are also concerns about his calculation. 24 First of all, he omitted some very major inputs. As my 25 daughter says, he excluded, he left out carbon-14 and he</p> <p style="text-align: center;">Page 147</p> |
| <p>1 MR JUSTICE BLAKE: Right? Got it. If the science isn't bad 2 and they are campaigning with nothing then it is 3 relevant. 4 DR BUSBY: Very good, right. 5 To go on -- yes, I'm sorry, I couldn't resist this, 6 but chromosome aberrations, as we've pointed out, have 7 been found in uranium miners also and in Gulf War 8 veterans and, as I said, in radiation workers. So this 9 suggests that uranium causes chromosome damage, and this 10 is perhaps another stepping stone or binomial gate, 11 where the Tribunal have to ask the question whether this 12 is fanciful or worthless evidence, especially since 13 chromosome damage in the New Zealand veterans is 14 a pivotal issue in these hearings. 15 Of course, as I said earlier, the New Zealand 16 veterans will have shared an exposure to uranium which 17 raises a connection with the doses calculated by the 18 Wahab team. 19 So I've already covered the issue of this question 20 of dose and the doses that were referred to or deduced 21 from the chromosome studies by the Wahab team and 22 pointed out that we have to be cautious about the 23 concept of dose as related to the idea of exposure to 24 internal radionuclides. 25 Whilst I'm addressing this Wahab study, I just want</p> <p style="text-align: center;">Page 146</p> | <p>1 agreed there had been exposure to carbon-14 and it was 2 potentially a very significant hazard as we are all made 3 of carbon and our DNA is made of carbon-14. He told the 4 Tribunal that there were 1,500 moles of carbon-14 5 produced in all the Christmas Island tests. The 6 Tribunal might wonder why -- 7 MR HEPPINSTALL: Well, I in re-examination made sure that 8 Mr Hallard was taken back to that document, which did 9 not say that. So his evidence in the end was confined 10 to the document that he was recollecting and then put to 11 him in re-examination. It wasn't the Christmas Island 12 tests. 13 DR BUSBY: It wasn't at Christmas Island? 14 MR HEPPINSTALL: No, it was the earlier Australian tests 15 that the moles were based on. 16 DR BUSBY: I wanted to point out that in my calculation, but 17 I'm not allowed to make one, it was certainly as much as 18 that and if it were 1,500 moles it would be a very 19 significant exposure, it would be 10 to the 15 20 becquerels, so it would be quite good to find out how 21 many moles or how many becquerels of carbon-14 were 22 involved in the cumulative production of carbon-14 by 23 the various tests at Christmas Island. 24 If it was 1,500 moles in Australia we know that the 25 total quantity of bombing in Australia was absolutely</p> <p style="text-align: center;">Page 148</p> |

| | |
|---|---|
| <p>1 tiny compared to the quantities that were exploded in 2 Christmas Island so at the very minimum we have 10 to 3 the 15 becquerels and it probably is multiplied by the 4 ratio of the quantity of material or the megatonnage 5 ratio between Christmas Island and Australia. So we're 6 talking about even more -- even more carbon-14. 7 This is a substance which can become a component of 8 exposure through the method of carbon production or 9 carbon dioxide or getting into plants that they eat, 10 coconuts and so forth, or fish. 11 We would say that Mr Hallard, who said he did not 12 model these doses as he did not know how to, ignored or 13 omitted to include a significant exposure. 14 Secondly, Mr Hallard originally omitted a number of 15 exposures, including the hair cutting, from Mr Smith -- 16 snip, snip. Mr Smith in his statement and his wife's 17 statement also complained about the dustiness of where 18 he cut people's hair and of course it's quite obvious 19 that lots of people whose hair he cut would have been 20 people who might well have visited parts of the Island 21 that were significantly contaminated. So the fact that 22 he was not himself stationed somewhere which might have 23 been very contaminated is not necessarily evidence that 24 he wasn't exposed through inhalation to the material 25 from the hair of people who had been in areas which were</p> <p style="text-align: center;">Page 149</p> | <p>1 was not clear from his report that he hadn't done so. 2 So let's take Mr Battersby's dose as eventually 3 calculated by Mr Hallard. This was 38 millisieverts. 4 But the inclusion of an uncertainty of eight-fold, to 5 take the most conservative -- I mean that's, as 6 I understand it, what the law states in these appeals, 7 in these pensions cases -- the inclusion of the 8 Environmental Protection Agency uncertainty of 9 eight-fold would take the dose of Mr Battersby from 38 10 millisieverts to 300 millisieverts. 11 Right. But we don't have to go there either -- 12 although we do ask why he didn't use that uncertainty -- 13 because there's more. Now, the CERRIE main report -- so 14 this is not the dissenting report by the campaigning 15 group or whoever -- stated that for some internal 16 exposures an uncertainty in the dose coefficient of 17 ten-fold might be possible. So this could, in 18 principle, take us to 3,000 millisieverts. The Lesvos 19 Declaration of the European Committee on Radiation Risk, 20 also in the bundle, and also signed by 21 Professor Mothersill, amongst other eminent scientists, 22 takes us to a minimum error in ICRP for internal 23 radiation of ten-fold. So again they agree with CERRIE. 24 So that would take us to the 3,000 millisieverts. 25 These are minimum effects.</p> <p style="text-align: center;">Page 151</p> |
| <p>1 highly contaminated. 2 So after his first report we asked Mr Hallard about 3 uncertainties. His second and third reports which were 4 also very large, 250 pages, 170 pages, whatever, had had 5 new and revised sets of doses, so the doses all went up. 6 So what we would say now is: what weight is anyone to 7 put on a dosimetrist who significantly increases the 8 results of his calculations after being asked about 9 uncertainties? I mean, perhaps if we were to make some 10 other question and ask about something else the doses 11 would increase again. 12 So it doesn't sound to us like this is a terribly 13 secure set of calculations. 14 Astonishingly -- and this was not clear in the 15 reports he wrote -- he did not include the uncertainties 16 that we had asked him to provide, and the ones that he 17 put down in a table in his report. In that table -- and 18 we have gone to this in cross-examination -- he cited 19 a list of uncertainties, including those of the US 20 Environmental Protection Agency, the EPA, of 5 to 8 21 fold. And his own choice would have been, although he 22 didn't use it, an uncertainty of 2 to 3 times. It was 23 only during the course of cross-examination that it 24 emerged that he didn't actually apply these 25 uncertainties to his calculations at all. Although it</p> <p style="text-align: center;">Page 150</p> | <p>1 The question is, then, what weight should we put on 2 the doses produced by Mr Hallard which are the rock upon 3 which the SSD's arguments stand? We would argue very 4 little. 5 Now, let's look at another missing route which 6 Mr Hallard overlooked. This is sea-to-land transfer, 7 an issue raised by Dr Ash, and can I take you now to 8 SB1/2.10. 9 MR JUSTICE BLAKE: Which tab do you want to take us to? 10 DR BUSBY: SB1/2.10. 11 MR JUSTICE BLAKE: Yes. Right. 12 DR BUSBY: A short way down, on page 13, Dr Ash says: 13 "A factor that appears to have received limited 14 attention is the capacity for dissolved radioactive 15 solids entrained in seawater to be deposited on the 16 atoll. Some of this material may have been the result 17 of fallout into the sea. The predominantly west set 18 south equatorial current, which has a velocity of up to 19 1 knot for much of the year, could have washed 20 irradiated material back towards the atoll. Indeed, any 21 contamination in the sea to the east of the atoll could 22 have been so transported." 23 Now, let's have a look and see what that means in 24 terms of Grapple Y. If I could take you to SB13 -- we 25 can put that aside now -- and go to SB13/40B.</p> <p style="text-align: center;">Page 152</p> |

| | |
|--|--|
| <p>1 MR JUSTICE BLAKE: Yes.</p> <p>2 DR BUSBY: This is a map of Grapple Y produced by</p> <p>3 Mr Johnston for the First Tier.</p> <p>4 MR JUSTICE BLAKE: Yes.</p> <p>5 DR BUSBY: If you look at this you'll see two circles, one</p> <p>6 of which is the start of the explosion off the south</p> <p>7 southern tip of the Island.</p> <p>8 Then, after a while, we see another circle which on</p> <p>9 this is written: trajectory of main cloud at</p> <p>10 50,000 feet. So this is the spread-out cloud that --</p> <p>11 MR JUSTICE BLAKE: I'm not sure I've studied this before.</p> <p>12 DR BUSBY: Right. Perhaps I should just wait a minute.</p> <p>13 MR JUSTICE BLAKE: I have the plan. Are you looking at the</p> <p>14 solid red circles or the circles with the white middle?</p> <p>15 Or the As?</p> <p>16 DR BUSBY: No. We're looking at the two circles that -- oh,</p> <p>17 sorry, this is figure 2 I'm looking at, my Lord. I'm</p> <p>18 sorry, I should have said. Figure 2.</p> <p>19 MR JUSTICE BLAKE: Cloud trajectories.</p> <p>20 DR BUSBY: Yes, that's right. Well, you can see there are</p> <p>21 two circles here. One is the cloud as it was first</p> <p>22 produced, and that's approximately the radius that</p> <p>23 Mr Johnston gave it. Then what happened is that the</p> <p>24 upper winds carried it off to the east. That gives us</p> <p>25 the trajectory of the main cloud as it spread out. You</p> <p style="text-align: center;">Page 153</p> | <p>1 (3.28 pm)</p> <p>2 (A short break)</p> <p>3 (3.40 pm)</p> <p>4 MR JUSTICE BLAKE: Right.</p> <p>5 DR BUSBY: Well, this chart, my Lord, figure 2, cloud</p> <p>6 trajectories, is a chart that was prepared by</p> <p>7 Mr Johnston in response to other charts that were put in</p> <p>8 by Mr Williams.</p> <p>9 MR JUSTICE BLAKE: Does Mr Johnston explain what it is</p> <p>10 somewhere?</p> <p>11 DR BUSBY: Well, if you go to SB13/37, the chart itself --</p> <p>12 MR JUSTICE BLAKE: One moment. (Pause) Yes.</p> <p>13 DR BUSBY: Whilst this does not -- at section 5.3</p> <p>14 Mr Johnston says this:</p> <p>15 "The recorded results of the various measurements</p> <p>16 and surveys support a self-consistent picture of minor</p> <p>17 radioactive fallout derived from residual debris in the</p> <p>18 cloud stem being transported west or south west of the</p> <p>19 Island by the intermediate level winds and falling out</p> <p>20 mainly in the predicted sea area around 100 kilometres</p> <p>21 to the south west of Christmas Island. The northern</p> <p>22 edge of this very dilute fallout cloud was responsible</p> <p>23 for the only very significant deposition at the Decca</p> <p>24 master site."</p> <p>25 MR JUSTICE BLAKE: That is in Vaskess Bay.</p> <p style="text-align: center;">Page 155</p> |
| <p>1 can see it has moved away to the east.</p> <p>2 In passing may I point the Tribunal to the red</p> <p>3 square which says "aerial radiological survey area" on</p> <p>4 the left-hand side. There was considerable discussion</p> <p>5 earlier in the Tribunal about the Shackletons that flew</p> <p>6 to measure the radioactivity. I think they were part of</p> <p>7 the presentations made by the Secretary of State about</p> <p>8 the levels of radio activity and so on.</p> <p>9 MR JUSTICE BLAKE: Yes.</p> <p>10 DR BUSBY: You will see quite clearly that actually -- that</p> <p>11 whilst the radioactivity moved to the east the</p> <p>12 Shackletons flew to the west. So the radioactivity that</p> <p>13 was detected by the Shackletons was not radioactivity</p> <p>14 which was really relevant to the fallout.</p> <p>15 MR JUSTICE BLAKE: I don't know about that.</p> <p>16 MR HEPPINSTALL: Well, this is, you know, almost expert --</p> <p>17 expert interpretation of --</p> <p>18 MR JUSTICE BLAKE: Right. I mean, this is the raw material.</p> <p>19 I think we're going to have to take a break here. We'll</p> <p>20 come back in ten minutes.</p> <p>21 You have got to point to the evidence behind this</p> <p>22 plan if you are going to make a point about it rather</p> <p>23 than you giving your analysis. Yes?</p> <p>24 DR BUSBY: All I was --</p> <p>25 MR JUSTICE BLAKE: I am going to rise now. Okay?</p> <p style="text-align: center;">Page 154</p> | <p>1 DR BUSBY: Right. We go on:</p> <p>2 "The vast bulk of the debris from Grapple Y</p> <p>3 contained in the main cloud around 55,000 feet and</p> <p>4 consisting of sub-micrometre particulates would have</p> <p>5 been transported well to the east of the Island falling</p> <p>6 out progressively over a period of weeks to the east of</p> <p>7 the Island."</p> <p>8 He put in this figure 2, as I understand it, as part</p> <p>9 of his evidence about where the main cloud at</p> <p>10 55,000 feet and consisting of sub-micrometre</p> <p>11 particulates would have ended up, travelling to the east</p> <p>12 of the Island.</p> <p>13 MR HEPPINSTALL: My Lord, could I try and assist. If you</p> <p>14 look at paragraphs 1.6 and 1.7 of that report earlier</p> <p>15 on, at 1.6 he explains what his figure 1 is to this</p> <p>16 report. At 1.7 he explains what his figure 2 is to this</p> <p>17 report.</p> <p>18 If you turn to figure 1 and figure 2 you get the two</p> <p>19 components of the diagram which Dr Busby is now taking</p> <p>20 us to.</p> <p>21 So figure 1 is actually correcting a diagram that</p> <p>22 Dr Busby had attempted and he is showing the actual</p> <p>23 position of the clouds that move east.</p> <p>24 Then in figure 2 he is showing how the recorded wind</p> <p>25 trajectory is cut into the stem, and that is how the</p> <p style="text-align: center;">Page 156</p> |

| | |
|--|---|
| <p>1 Shackletons discover radioactivity in their survey area 2 and it's also how the deposition on Vaskess Bay -- 3 MR JUSTICE BLAKE: Well, I had certainly seen a plan of 4 Mr Johnston, showing, I think, the black arrow line 5 clears(?) to the Island showing movement to the west 6 with a deposition -- yes, yes -- yes, figure 2, is it in 7 this report? In tab 37. 8 MR HEPPINSTALL: So -- 9 MR JUSTICE BLAKE: So -- 10 MR HEPPINSTALL: -- it's a difference between stem 11 contamination and of course the canopy which has long 12 since crossed the tropopause. 13 MR JUSTICE BLAKE: So the stem is moving -- 14 MR HEPPINSTALL: Well, the stem and canopy are moving 15 together, but -- 16 MR JUSTICE BLAKE: But then they end up on different sides 17 of the Island. 18 MR HEPPINSTALL: Well, that's because the low level winds 19 cut across through the stem, as you can see happening in 20 figure 2, and push the radioactivity the other way. 21 Because it took quite a long time to analyse the 22 meteorological data and get to the bottom of this, but 23 the winds are going in different directions at different 24 heights. It took us to get to Mr Stretch at the Met 25 Office --</p> <p style="text-align: center;">Page 157</p> | <p>1 falling out progressively over a period of weeks." 2 Now, what Dr Ash is saying is that the equatorial 3 current over that part of the ocean flows as 1 knot to 4 the east to the west; in other words, it's flowing 5 towards Christmas Island. It would seem, therefore, 6 that what he is saying, that whatever proportion of that 7 vast bulk of Mr Johnston's debris actually landed in the 8 sea over the next few weeks would have been transported 9 at 1 knot back towards Christmas Island where it would 10 have ended up on the beach and been transported ashore 11 through sea-to-land transfer, which Mr Hallard conceded 12 under cross-examination was in fact a very real 13 phenomenon. And that he said was -- or I think he 14 agreed was a factor in exposure to plutonium in the 15 Irish Sea from Sellafield where it got brought ashore by 16 sea-to-land transfer and contaminated the 1 to 2 to 3 17 kilometre region from the sea coast in the Irish Sea. 18 So we might therefore assume that all of this 19 material, or it's certainly a proportion of the 20 material, would have ended up on the eastern coast of 21 Christmas Island, which you can see here is a sort of 22 hook, and ended up in that sort of bay there, to the 23 north of which was where all these people were living 24 and in the sea nearby where everybody was swimming. 25 This, I submit, is an entirely missing component of</p> <p style="text-align: center;">Page 159</p> |
| <p>1 MR JUSTICE BLAKE: I certainly don't think we looked at this 2 before. 3 MR HEPPINSTALL: No. I have no idea what is going to happen 4 next and why we are going to it, but that is what it is. 5 MR JUSTICE BLAKE: I will try and absorb that information. 6 MR HEPPINSTALL: I don't know what point is being made. 7 MR JUSTICE BLAKE: Are we going to finish in the next hour 8 now? 9 DR BUSBY: Yes, my Lord, absolutely, I promise you. Scout's 10 honour. 11 MR JUSTICE BLAKE: Let's get on. 12 DR BUSBY: I mean, I can take your Lordship to the different 13 wind directions at different heights, but I think we can 14 just accept that that is happening -- 15 MR JUSTICE BLAKE: Just tell us the points you are making. 16 DR BUSBY: Right. Well, the point I am making has to do 17 with Dr Ash's concern about sea-to-land transfer and the 18 fact that Mr Hallard didn't model it. Because if the 19 trajectory of the main cloud, if we look at figure 2, 20 moved to the east, then all the time it was moving to 21 the east the particulates that we see Mr Johnston 22 talking about, what he calls "the vast bulk of the 23 debris from Grapple Y", and he says: 24 "Consisting of sub-micrometre particulates would 25 have been transported well to the east of the Island,</p> <p style="text-align: center;">Page 158</p> | <p>1 Mr Hallard's dosimetry, which may well have been 2 extremely significant. 3 Now, as I say, Mr Hallard was aware of sea-to-land 4 transfer through his work at Sellafield where the 5 plutonium particles end up on the coast. It is somewhat 6 of concern that Mr Hallard didn't consider this 7 exposure, especially since it had been -- well, I'm not 8 sure if it had been raised by Dr Ash at the time that he 9 made his report, so perhaps that's unfair. 10 That finishes my point about sea-to-land transfer 11 and Mr Hallard's dosimetry. 12 So our overall submission with regard to dosimetry 13 is, first of all, that it misses an awful lot of 14 components; secondly, that it uses the ICRP risk 15 co-efficients, which we argue are uncertain; thirdly, 16 that it didn't include the uncertainties that Mr Hallard 17 had agreed existed; and, of course, finally, the point 18 about the sea-to-land transfer. 19 MR JUSTICE BLAKE: Well, that, I thought, was a missing 20 pathway to exposure. That's your first point. 21 DR BUSBY: Yes. 22 I have already referred to -- I won't bother to 23 refer to these again, I've more or less covered that. 24 So, finally, I want to deal with the area, the field 25 of scientific method and causation, because that's</p> <p style="text-align: center;">Page 160</p> |

| | |
|--|---|
| <p>1 actually what this case is about, it's about causation 2 and it's about scientific method. So may I take you to 3 John Stuart Mill at SB10/163. 4 MR JUSTICE BLAKE: Well, what do you want to get from John 5 Stuart Mill? 6 DR BUSBY: John Stuart Mill talked -- he writes about 7 scientific method and causation, my Lord. So in the 8 area of understanding the ways in which scientists 9 approach the concept of causation -- and I am not 10 talking about the way in which the ICRP approach it but 11 the way in which science approaches it, I just felt it 12 might be valuable to just briefly cover this issue as it 13 applies to the evidence that's been before this 14 Tribunal. 15 So if we might go to chapter 3 of the ECRR report, 16 which is page 9. 17 MR JUSTICE BLAKE: Yes. 18 DR BUSBY: This lays out the classical exposition of the 19 scientific or inducted method which was originally due 20 to the English Oxford philosopher William of Ockham. 21 These were laid out by John Stuart Mill in his system of 22 logic in the late 19th Century, which is a cornerstone 23 now or, if you like, the rock upon which all 24 philosophical theories of causation are set. 25 What Mills' canon say is, firstly, that the first</p> <p style="text-align: center;">Page 161</p> | <p>1 MR JUSTICE BLAKE: I have the point, yes. 2 DR BUSBY: -- because the dose is too low. So this is the 3 canon of agreement. 4 Now, I will leave the canon of difference, because 5 although it applies I don't want to bore everybody with 6 it, but the most important bit here is just below, in 7 the third bullet point, is it says: 8 "The principle of instance confirmation that the 9 degree of belief in the truth of a law [or, if you like, 10 an interpretation, in our case] is proportional to the 11 number of favourable instances of the law..." 12 Which I would interpret in this case: the number of 13 scientific papers or studies which point to the 14 possibility or the likelihood that there is some major 15 error associated with the interpretation of the effects 16 of internal exposure. 17 So there we are, if we apply the principles of 18 science and what has now become the classical philosophy 19 of causation, we must conclude that the case is made 20 that the ICRP model is wrong, or at minimum questionable 21 on the Article 41 test. 22 So there are two possibilities here, it seems to me, 23 or I submit. The first possibility is that all the 24 hundreds of scientists and experts in this area who 25 believe that the ICRP model is wrong is false for</p> <p style="text-align: center;">Page 163</p> |
| <p>1 one, the canon of agreement, states that "whatever there 2 is in common between the antecedent conditions of 3 a phenomenon can be supposed to be the cause or related 4 to the cause of the phenomenon". In other words, if you 5 have lots and lots of instances, he would say, or this 6 would say, of increased levels of cancer or genetic 7 damage, congenital malformation, or chromosome defects, 8 or other objective evidence of genetic harm following 9 exposure to small amounts of internal radiation, this 10 would suggest that that phenomenon can be supposed to be 11 the cause of these effects, or related to the cause. 12 That's simple logic of science; that's how science 13 works. 14 The power of science derives from its reliance upon 15 empirical data. In other words, you cannot take as the 16 Spanish inquisition, as the inquisition did, you cannot 17 go to Galileo and say, "Look here, what you are telling 18 us as a result of looking through your telescope cannot 19 be right because our theory says it is wrong because God 20 does not allow this to happen", you have to go to the 21 empirical evidence and say, "Well, what does this tell 22 us about the theory that we have?" 23 As I said earlier in my submission, what happens 24 again and again in this area is that we go from the dose 25 to the effect. We are told the effect cannot exist --</p> <p style="text-align: center;">Page 162</p> | <p>1 internal exposures, and these include also those at 2 least on the Article 41 test who decided to throw a lot 3 of money at research at the uranium genotoxicity 4 project, the CURE process, the MELODI process that we 5 have referred to, are also her(?) friends of Dr Busby 6 and part of a campaigning cabal -- I am sorry to bring 7 this up again, my Lord, but it is a major point that we 8 want to. The alternative, of course which we embrace, 9 has to do with the consideration of the dismissal by the 10 SSD and his experts of the many pieces of evidence we 11 have brought to these hearings, which have all been 12 different, controls were wrong in one case, methodology 13 was suspect in other cases, the numbers were too low in 14 another case, or statistical procedures were incorrect, 15 we were told by Dr Haylock in the case of the Wahab 16 study originally, and most often that the doses are too 17 low for the effect. What we say is that we apply 18 Occam's razor to this, which is entia non sunt 19 multiplicanda praeter necessitatem, which is to say that 20 if there is one explanation for all of these things then 21 that is the most likely explanation for them. We don't 22 have to have all of these different -- reasons why each 23 particular instance of evidence is wrong or can be 24 dismissed. 25 We submit that in ten years the ICRP model will have</p> <p style="text-align: center;">Page 164</p> |

| | |
|--|--|
| <p>1 been swept away when the effects of Fukushima and 2 Chernobyl become manifest, and that the veterans have 3 been treated shabbily, we say, through questionable 4 behaviour by those who have used many tricks to cover up 5 evidence. 6 MR JUSTICE BLAKE: I don't know what that means, but if it 7 it's making an allegation of bad faith by somebody you 8 are going to have to either plead -- put up by 9 particulars or withdraw the suggestion. 10 DR BUSBY: I withdraw it, yes, it was just a little bit of 11 irritated spin-off. 12 MR JUSTICE BLAKE: That isn't going to help your 13 submissions. 14 DR BUSBY: No, and in fact that ends my submissions, my 15 Lord, I have nothing further to say on this issue and 16 I leave it at that. 17 MR JUSTICE BLAKE: Okay. 18 DR BUSBY: Oh yes. Well, Cecilia reminded me that I haven't 19 covered all of the arguments that I could have made and 20 there was clearly insufficient time to do so, but 21 essentially we rely upon the arguments that we put in 22 our statement of case, which none of which have been -- 23 MR JUSTICE BLAKE: Do you mean the closing statement or 24 something else? 25 DR BUSBY: No, I mean the statement of case that we</p> <p style="text-align: center;">Page 165</p> | <p>1 MR HEPPINSTALL: Not least because, like Mr ter Haar, I am 2 aiming to be elsewhere on Friday and Mr Sage may reply 3 to -- 4 MR JUSTICE BLAKE: Ah, well hang on, do you think you have 5 got all your retaliation in that you wanted to? 6 MR HEPPINSTALL: I think Mr Sage is going -- 7 MR TER HAAR: Mr Sage is going to be here to cover for me. 8 So there will be a more effective fighter in the ring. 9 MR JUSTICE BLAKE: Fine. 10 MR HEPPINSTALL: Before you rise, I think you made 11 a comment -- I can't remember which day it was this 12 week -- about not having the index to the library. We 13 have three copies of the consolidated index to the 14 library, if you would like it. 15 MR JUSTICE BLAKE: In the event, just sometimes one just 16 needs to check one's -- thank you. (Handed) 17 MR HEPPINSTALL: A bit more paper. 18 MR JUSTICE BLAKE: Yes. 19 It is not that I'm necessarily (inaudible) from 20 reading it, it's just that when we complete the oral 21 submissions we'll be alone and we'll just have to see 22 what there is. But there we are. 23 Okay. But with this we've -- there's no more 24 handouts you envisage handing up tomorrow? 25 MR HEPPINSTALL: Well, there are going to be one or two</p> <p style="text-align: center;">Page 167</p> |
| <p>1 provided. The final revised statement of case that we 2 provided, I think it was in April, that one. 3 So all of the points that we made there we believe 4 still stand, and we hope that the Tribunal will be able 5 to gain some assistance in this area from the table that 6 we produced where we lay out the various arguments in 7 the different areas that your Lordship helpfully 8 suggested that we approach this issue through. 9 So thank you very much for your patience, my Lord, 10 and members of the Tribunal. 11 MR JUSTICE BLAKE: Thank you. 12 DR BUSBY: I have finished my submission. 13 MR JUSTICE BLAKE: Right. Well, if that's the conclusion of 14 your submissions, thank you for getting there. We've 15 noted that and we might as well finish tonight and come 16 back tomorrow. Yes? 17 MR HEPPINSTALL: I'm in your hands, my Lord. 18 MR JUSTICE BLAKE: I think it has been a bit of a long day. 19 Do you think you will finish tomorrow? 20 MR HEPPINSTALL: Yes, my Lord. 21 MR JUSTICE BLAKE: 10 o'clock start? 22 MR HEPPINSTALL: 10 o'clock start, my Lord. 23 MR JUSTICE BLAKE: And come 4.30 -- 24 MR HEPPINSTALL: That is my target. 25 MR JUSTICE BLAKE: Yes.</p> <p style="text-align: center;">Page 166</p> | <p>1 things in the morning but they are just to bring the 2 closing submissions up-to-date. But they are not 3 real -- they are not evidence, they are just -- 4 MR JUSTICE BLAKE: They are not more stuff to keep one's 5 distracted mind on. Okay, well thank you for the index. 6 You put in some authorities into -- 7 MR HEPPINSTALL: SB18. 8 MR JUSTICE BLAKE: -- SB 18. 9 MR HEPPINSTALL: Yes. 10 MR JUSTICE BLAKE: Are you going to refer to those tomorrow? 11 MR HEPPINSTALL: Yes, I am, my Lord. I think we sent you up 12 an amended index, some bigger files, and the insert. I 13 have made my own ... I have mine now in a big lever arch 14 because that's the only way it now works. I think you 15 were sent up the additions to SB18, the new SB18 index, 16 and then a big -- 17 MR JUSTICE BLAKE: Yes. So what are the authorities you are 18 going to refer to tomorrow? 19 MR HEPPINSTALL: Tomorrow, I think, 5A -- 20 MR JUSTICE BLAKE: Kennedy? 21 MR HEPPINSTALL: Yes, Kennedy, Dugdale, EXP, Field, the rest 22 I think you have all you need in the -- 23 MR JUSTICE BLAKE: UT -- 24 MR HEPPINSTALL: No, in my submissions. 25 MR JUSTICE BLAKE: All right.</p> <p style="text-align: center;">Page 168</p> |

| | |
|--|--|
| <p>1 MR HEPPINSTALL: There's also 9 and 10, Jacobs and the Crown 2 Court Bench Book. 3 There's no mystery, they are all in my written 4 closing. 5 MR JUSTICE BLAKE: Jacobs is Tribunal procedure, is it? 6 MR HEPPINSTALL: Yes, Judge Jacobs. 7 MR JUSTICE BLAKE: Crown Court Bench Book. 8 MR HEPPINSTALL: Well, it's all there in the written 9 closing. 10 MR JUSTICE BLAKE: Right. Just give me a moment to tidy up 11 here. 12 MR HEPPINSTALL: If we are in hand-up mode why don't I hand 13 up the other things rather than everybody wondering what 14 I'm talking about? 15 So our submissions, there's the main submission 16 document, there's an appendix A, which was the skeleton 17 you got at the beginning, just for convenience. There's 18 a long appendix B, I'm afraid, which is actually 19 addressed to the individual appeals. Appendix C, those 20 are our submissions we made on exposure below. Because 21 of what Mr ter Haar has said alleging novelty in the 22 attack on Professor Mothersill I am going to add 23 an appendix D, which were our submissions on 24 radiogenicity and causation before the 25 First Tier Tribunal as well, so that will become our</p> <p style="text-align: center;">Page 169</p> | <p style="text-align: center;">I N D E X</p> <p>1 2 3 Closing submissions by MR TER HAAR1 4 (continued) 5 Closing submissions by MS BUSBY59 6 Closing submissions by DR BUSBY100 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25</p> <p style="text-align: center;">Page 171</p> |
| <p>1 appendix and D and we can hand that up. 2 In fact, you'll have the entirety of both parties' 3 submissions before the FTT because you have the 4 Hogan Lovells submissions in SB19. So we will then be 5 at parity, so I can hand that up. 6 But also it has a purpose, in reply to Mr ter Haar. 7 Then finally, although you may not need copies, you 8 will recall that we annexed to the skeleton a table that 9 looks like this. I don't know whether you have retained 10 them. It's a handy summary of our position, but we can 11 hand you up further copies if, in the three weeks, they 12 have disappeared. 13 MR JUSTICE BLAKE: This one? No. 14 MR HEPPINSTALL: Oh, that is another ... (Handed) 15 MR JUSTICE BLAKE: Is it BS? No, no. 16 MR HEPPINSTALL: It was with our skeleton, but it may have 17 gone missing. 18 MR JUSTICE BLAKE: I thought I had been carefully collecting 19 these things. 20 MR HEPPINSTALL: So at least now we're all ready to go in 21 the morning. 22 MR JUSTICE BLAKE: Okay. Thank you. Ten o'clock tomorrow. 23 (4.05 pm) 24 (The court adjourned until 25 Thursday, 30 June 2016 at 10.00 am)</p> <p style="text-align: center;">Page 170</p> | |

| A | | | | |
|---------------------------|----------------------------|----------------------------|---------------------------|-----------------------------|
| A5 57:3,5 | accepted 15:17 | added 41:1 51:14 | advocate 77:21 | 96:14 122:25 |
| AB 101:24 | 20:14 41:4 42:5 | adding 85:18 | 116:5 | 162:20 |
| abandoned 136:14 | 60:14 62:2 64:6 | addition 51:20 83:6 | advocates 77:23 | allowed 78:17 |
| abdication 16:7,10 | 69:14 73:4,7,13 | 110:14 133:9 | 106:23 | 106:21 112:6,8 |
| aberration 49:20 | 77:17 93:8,13,15 | additional 54:4 | aerial 154:3 | 132:23 148:17 |
| 130:2 | 94:9 95:9 98:13 | additions 56:1 | Affairs 81:16 82:8 | allowing 96:11 |
| aberrations 6:8 | 98:25 116:19 | 168:15 | affect 25:19 | allows 22:16 |
| 7:18,19,22 9:6 | 144:6 | address 26:21,22 | afforded 60:24 | alluded 74:21 |
| 49:14 50:9,10,11 | accepting 35:18 | 32:21 35:12,13 | afraid 55:14 88:11 | 99:22 |
| 50:18 51:21,23,25 | 93:3 | 73:19 101:11 | 88:13 90:4 91:9 | alpha 23:4,23 85:4 |
| 52:1 146:6 | accepts 29:16 35:19 | 106:8 | 169:18 | 85:11,17 |
| ability 118:10 | 42:1 89:2 | addressed 73:18 | age 76:19 | alter 25:15 |
| able 44:8 46:9 | access 1:14 | 92:1 169:19 | agencies 124:3,3 | alternative 4:4 18:2 |
| 80:15 86:21 92:15 | accident 63:12 | addressing 36:9 | 125:7 | 69:7 79:6 94:3,9 |
| 104:10,19 112:10 | 86:15,23 109:17 | 146:25 | Agency 150:20 | 95:14 96:13 164:8 |
| 116:8 119:22 | 121:9 | adduced 2:18 4:13 | 151:8 | alternatives 72:19 |
| 125:24 143:18 | accommodate | adequacy 123:20 | Agency's 5:8 | altitude 129:9 |
| 166:4 | 123:1 | adequately 20:25 | ago 28:8 | altogether 87:20 |
| abnormalities 77:3 | accompanied 92:7 | Ades 58:19 | agree 17:7,12 32:6 | amended 168:12 |
| abnormality 7:18 | accorded 96:11 | adhere 17:17 | 49:16 79:4 85:5 | American 118:1 |
| absence 42:16 | account 7:2 14:1,23 | adjourn 6:22 | 86:13 141:5 | Americans 126:21 |
| absent 122:17 | 33:12 34:18 36:1 | adjourned 170:24 | 151:23 | amount 39:13,13 |
| absolute 87:16 | 72:17 93:25 | adjournment | agreed 70:16 | 108:23 117:5,5 |
| absolutely 11:15 | accountable 129:22 | 100:11 | 105:13,17 147:13 | 118:12 125:16 |
| 15:3,10,20 16:9 | accounted 25:10 | adjudicate 59:24 | 147:17 148:1 | 138:16,17 144:24 |
| 16:14 19:8 22:11 | accumulate 63:22 | 60:3 75:3 | 159:14 160:17 | amounts 137:5 |
| 32:4 33:14 37:13 | accurate 18:19 | admit 125:12 | agreement 162:1 | 138:4 162:9 |
| 37:22,25 47:8 | 42:10 45:14 46:5 | 131:19 | 163:3 | analyse 157:21 |
| 61:14 81:3 86:17 | 137:12 | admitted 88:5 | ah 33:6 167:4 | analysed 69:6 |
| 110:5,5 148:25 | accurately 47:8 | 96:17 131:22 | ahead 33:14 | analyses 43:23 |
| 158:9 | achieve 140:5 | admittedly 70:9 | aimed 26:3 | analysis 36:15 38:5 |
| absorb 158:5 | acknowledged | advance 2:12 4:1 | aiming 167:2 | 43:11 46:24 49:19 |
| abstracted 109:22 | 76:23 97:17 | 4:13 33:9 131:25 | air 88:7 129:8,8 | 70:3 123:7 125:3 |
| 110:3 | acknowledgement | advanced 12:21 | al 22:25 23:3,3,5 | 154:23 |
| abstracts 121:18 | 95:24 | 62:25 63:7,19 | alarm 140:9 | Angry 118:3 |
| abstruse 126:3,9 | acquired 29:20 | 99:9 110:24 | alarms 138:10 | animal 28:7 140:3 |
| Academy 65:12 | acted 77:23 | 111:18 115:2 | 139:16 | animals 139:25 |
| 121:14 | activist 122:7 | 130:18 | ALARP 53:16,22 | annex 19:6,6 24:5,7 |
| accept 16:9 23:14 | activity 154:8 | advancing 48:18 | albeit 87:13 | 28:9 |
| 41:13,19 52:5,11 | actual 59:1 128:24 | advantage 131:1 | alerting 116:7 | annexed 170:8 |
| 52:13 70:11 71:20 | 137:14 156:22 | adverse 22:20 | algorithm 147:16 | anomalous 129:16 |
| 114:11 158:14 | ad 18:3 37:1 74:14 | advice 52:15 | allegation 165:7 | 144:17,24 |
| acceptance 16:19 | 106:15 131:14 | advisers 17:20 | allegations 64:20 | anomaly 68:23 |
| 47:17 | add 34:25 51:9 | advising 53:12 | alleging 169:21 | answer 6:9 11:18 |
| | 169:22 | 133:3 | allow 4:4 85:19 | 21:3 28:8 30:24 |

| | | | | |
|--|--|--|--|--|
| 43:3 51:14 70:14 80:2,9 81:22 82:3 82:6,17 83:14,23 84:8,12 85:9 86:2 86:17 88:10,17 90:3,15,17 91:4,8 93:19 answered 33:2 70:6 76:11 97:5 antecedent 162:2 anticipated 15:13 anybody 104:16 anyway 2:8 38:12 39:1,6,17 52:21 140:12 141:5 apart 4:19 133:13 140:10 apparent 27:12 54:16 104:6 128:17 138:8 144:2 apparently 1:16 3:17 89:18 104:3 130:1 131:17 138:3 appeal 132:13,23 132:24 appeals 34:7 58:23 101:23 151:6 169:19 appear 7:11 30:3 42:18 62:21 68:16 104:7 appeared 84:19 100:22 appears 7:15 38:11 38:25 40:7 61:8 152:13 appellant 34:12 appellants 3:1 12:17 15:13 17:15 34:6 36:3,6,18 37:4 38:9 62:2 63:24 100:15 108:21 131:21 | 138:21 appellants' 18:2 59:20 94:5 95:17 112:6 appendices 59:9 appendix 169:16 169:18,19,23 170:1 applications 65:14 applied 93:22 106:11 applies 18:19 107:24 161:13 163:5 apply 94:25 150:24 163:17 164:17 applying 30:3 80:16 93:6 appreciate 110:10 135:13 approach 12:21 15:8 27:1 44:20 52:5 53:7,16 54:6 83:6 94:24 122:21 122:21 130:4 161:9,10 166:8 approached 22:11 approaches 39:21 161:11 appropriate 29:3 62:18 approximately 126:20 153:22 April 132:16 133:15 166:2 arch 168:13 archives 1:22 8:25 area 20:1 29:13 35:1 40:11 42:23 58:11 60:1 65:19 68:17 69:4 72:5 87:14 89:10 91:19 98:19 123:20 124:4 136:7,8 142:8 155:20 | 157:1 160:24 161:8 162:24 163:24 166:5 area"on 154:3 areas 29:17 31:14 33:18 65:22 78:1 78:18 83:1 86:2 86:25 87:4,25 149:25 166:7 arguability 4:9 arguable 7:25 8:10 8:16 52:22 arguably 7:22 48:14 99:6 144:22 argue 60:12 62:8 63:24 64:15 68:6 74:21 75:2 93:4 95:20 97:23 133:5 134:22 141:25 145:17 152:3 160:15 argued 8:15 98:9 112:16 128:12 133:6 143:22 argues 48:15 68:15 69:1 128:6 arguing 141:25 argument 10:13 13:16 15:3 16:13 41:10 46:3 59:13 63:8 67:15 71:2 89:18 110:23 125:6 129:25 130:10 135:12,16 140:9 arguments 59:16 60:18,21 61:2,11 64:17 72:7 87:24 89:15 91:21,22 92:9 99:22 105:5 105:6 106:4 107:3 119:24,25 120:2,3 130:17 133:13 134:6 137:9 152:3 165:19,21 166:6 | arisen 132:2 arises 11:15 armchair 120:3 Army 59:21 arose 75:16 arrived 144:21 arrow 157:4 article 14:20 16:18 17:3 94:25 109:22 109:24 133:5 141:12,15 163:21 164:2 articles 110:2 Ash 129:5 152:7,12 159:2 160:8 Ash's 158:17 ashore 159:10,15 aside 125:19 152:25 asked 70:10 72:18 72:19 73:21 75:16 75:21 83:11,22 88:3 93:7 105:4 105:21 106:14 115:22 131:18,18 140:18 145:9 150:2,8,16 asking 3:22 115:19 142:9 asks 85:2 aspects 55:6 144:14 assert 71:19 86:6 96:12 asserted 85:24 assertion 83:16 assertions 78:2 87:18 assess 15:15 16:6 111:25 assessed 23:17 135:10 assessing 44:18 assessment 34:3,11 34:15 35:2 72:20 88:19,20 110:19 | 130:5,6 assessments 135:20 assigned 95:13,13 assist 54:23 77:18 156:13 assistance 49:4 57:8 166:5 Associate 66:3 associated 23:23 43:15 113:6 163:15 associates 82:23 associations 20:4 assume 15:25 25:9 31:13 38:15,19 47:2 48:10 77:20 82:7 124:16 136:25 142:7 159:18 assumed 22:13 assuming 90:8 assumption 42:4 52:19 95:22 assumptions 54:16 astonishingly 140:21 150:14 atoll 152:16,20,21 atomic 43:21 44:6 51:4,13 102:6 118:21 126:12 attach 7:8 62:17 attached 66:15 115:8,8 attack 2:14 18:1,3 18:6 27:7 28:13 31:21 32:3 47:14 78:16 131:14 169:22 attacked 111:5 attacks 29:1,2 106:15 attempt 6:11 13:16 33:22 52:25 100:20 138:23 144:7 |
|--|--|--|--|--|

| | | | | |
|--|---|--|---|---|
| attempted 101:23 156:22 | 13:16 14:9 21:10 21:11,24 24:10 | basis 4:11 6:12 9:3 14:12 25:17 26:8 | 166:3 | 163:6 165:10 |
| attempting 24:15 44:3 88:4 | 25:24 26:1,2,9 39:24 40:11,21 | 27:24 53:22 58:4 58:12 60:24 68:22 | believer 27:12 | 166:18 167:17 |
| attend 98:3 | 42:14 43:7 45:1 | 70:5,25 82:23 | believes 71:21 | bits 59:9 109:4 119:17 |
| attendance 34:13 | 48:24 55:7 62:11 | 93:7 98:15 108:16 | bells 140:9 | black 57:13 74:5 128:16,16,20,22 |
| attention 19:10 20:3 71:23 105:19 117:20 126:7 132:11 133:11 152:14 | 74:23 94:12,13 99:10 102:9 103:23 107:16 110:23 117:11,12 117:16,18,18,19 117:23 118:22 | 109:23 111:9 114:23 125:14 128:17 129:22 130:4 133:5 143:23 | Bench 169:2,7 | 129:13 157:4 |
| attitude 79:9 | 125:2 131:10 | basket 34:25 | benefit 20:18 52:22 115:17 | BLAKE 1:4,23 2:21,23,25 3:3 4:14,18,23 5:2,4 5:10,15,22,24 6:14,22 7:1,7 8:1 8:22 10:8,12 11:1 11:13,23 12:10 13:22 14:3 17:23 18:5,7,9,23 19:1,3 19:12,14,18 20:17 20:22 21:5,7,25 22:2,8 27:9 28:4 28:14,17 29:10 30:5,16,20 31:19 31:25 32:5,9,13 32:15 33:6 35:9 35:16,20 36:16,25 37:7,11,14,20,23 38:1 39:5,11,19 39:21 40:14,16,19 41:8,12,17,20,22 43:9,13 45:5 46:1 46:10,16 47:10,13 47:22 48:15 49:1 49:11,17 50:4,15 51:8,16,18 52:9 55:17 56:13,16,23 56:25 58:8,17 59:3,6 60:8 61:23 62:7,17 65:7,16 66:19 67:8,14,20 69:17,21,24 70:1 70:14 72:22 78:25 79:3 80:9,14,18 81:11,13 89:22 90:22,24 91:1,5 91:12,16 98:11 99:12,24 100:4,6 |
| attributed 16:24 | 143:15 145:18 | Battersby 34:14 100:15 132:9,13 132:24 133:15 151:9 | beta 85:11,18 | |
| attribution 61:9 | 148:8 152:20 154:20 159:9 166:16 | Battersby's 11:17 134:16,18 151:2 | better 67:18 69:7 93:20,23 116:4,25 | |
| Australia 148:24 148:25 149:5 | background 12:14 14:7 30:12 46:8 49:21 50:21 76:12 76:14,20 77:1 110:8 147:7 | battle 7:12 | Bevis 102:9,16 | |
| Australian 148:14 | bad 35:23 37:10 38:4 110:4 146:1 165:7 | bay 155:25 157:2 159:22 | beyond 5:7 53:18 59:19 100:6 112:12 | |
| Australians 116:23 | badges 137:14,15 | beach 159:10 | bias 115:12,14 142:12 | |
| authorities 9:10 69:14 168:6,17 | badly 80:3,5,18,19 81:11 | bear 39:22 143:17 | biased 142:21 143:2 | |
| authors 8:8 20:10 20:17 21:1,23 | badly-designed 80:15 | bearings 33:9 | biases 44:1 | |
| available 19:22,23 67:10 68:16 71:3 71:24 73:21 97:21 101:20,21 109:20 | balance 10:10 17:1 27:3 31:20 44:21 54:22,23 93:24 95:6,12 | beat 119:22 | big 121:11 168:13 168:16 | |
| average 10:19 76:22 | ball 131:9 | becquerels 148:20 148:21 149:3 | bigger 97:6 168:12 | |
| avoid 54:12 | base 13:17 | bed 58:20 104:24 142:25 | binary 94:19 96:2 98:2 | |
| award 134:19 135:25 | based 2:14 6:11 13:12 23:2 26:16 45:18 61:7 72:20 88:19 89:3 92:19 93:1,15 95:5 98:20 99:7,10,18 105:11 120:5 125:16,17,25 139:25 148:15 | beginning 58:10 99:2 119:4 169:17 | bind 37:23 133:25 142:24 146:10 | |
| awarded 66:11 132:15 | | behalf 108:21 131:20 | binomial 141:16 142:24 146:10 | |
| awarding 133:15 | | behaviour 84:22 165:4 | biochemical 118:23 | |
| aware 82:19 92:3 134:14 140:22 160:3 | | BEIR 25:16 27:14 71:18 118:1,15,19 | biography 113:16 | |
| awful 97:19 108:12 160:13 | | Belarus 86:8,24 87:5 | Bioinformatics 67:4 | |
| <hr/> B <hr/> | | belief 163:9 | biological 22:17,20 120:6 121:13 | |
| b 34:14 51:19 62:13 169:18 | | believe 7:21 8:13 27:23 34:20 104:21 114:23 115:17 137:3 144:6 163:25 | biology 74:9 | |
| B43 25:5 | | | biomarkers 50:13 51:21 | |
| back 3:13 9:5 12:22 | | | biostatistician 88:23 | |
| | | | birth 140:20 | |
| | | | bit 32:9 62:11 77:4 77:14 101:3 112:2 126:3 139:12 | |

| | | | | |
|---|--|--|---|--|
| 100:18,25 101:13 101:18 102:24 103:4,8,13 104:3 104:8 106:18,22 107:5,8,11,13,21 109:1,10,13,18 110:1,6,10,20 111:2,8,15,21 112:8,14,22 113:9 113:13 114:1,8 115:17,24 116:1,4 116:12,18,22 117:2,4,12 119:7 119:22 120:13,19 121:25 123:3 130:14 131:22 132:10,17 133:18 134:4,10,14,25 138:19 139:1,10 139:19,23 140:8 140:22 141:2,9 143:8,12 145:14 145:20 146:1 152:9,11 153:1,4 153:11,13,19 154:9,15,18,25 155:4,9,12,25 157:3,9,13,16 158:1,5,7,11,15 160:19 161:4,17 163:1 165:6,12,17 165:23 166:11,13 166:18,21,23,25 167:4,9,15,18 168:4,8,10,17,20 168:23,25 169:5,7 169:10 170:13,15 170:18,22 blank 47:4,4 blast 135:2 blew 126:24 blunt 70:9 board 9:20 71:13 body 23:10 32:5 61:7 70:12 71:3 | 99:22 135:3 bomb 51:4,13 89:3 99:14 126:12,18 126:24,25 127:3 127:10,10,12,14 127:24 128:2,3,10 128:23,25 129:1 129:10 140:2 144:1 bombing 148:25 bombings 43:21 44:6 bombs 126:19 128:23 129:7 bone 44:14 book 68:12 118:2,9 169:2,7 books 115:6 bore 143:10 163:5 boring 116:3 borne 9:16 bother 160:22 bothered 92:2 bottom 19:15,17 22:1 24:11,20 43:12 50:6,6 57:14 94:14 103:12 157:22 bound 42:7 64:12 133:21 box 77:12 84:15 105:17 Braidwood's 33:17 break 6:24 12:5 55:17,20 59:5 91:10 99:25 143:13 154:19 155:2 breakdown 66:16 Bremen 65:18 Brenner 2:9 3:8,12 3:21 21:19 22:25 23:1,5,11 45:4 47:18 48:12,15,21 48:21 49:3,5 | 75:18 Brenner's 2:1,18 32:21 47:16 75:17 brief 55:24 121:18 briefly 6:16 98:6 101:10 161:12 bring 68:2 164:6 168:1 brings 141:11 British 5:20 29:24 30:1,2 broad 19:9 88:12 123:11 broad-beam 22:23 broader 48:22 brought 71:22 74:11 102:6 105:13 112:18 121:9 143:4 159:15 164:11 Brown 1:6,13,14,16 1:17,21 2:3 11:21 56:2,3,6,17 Bryansk 86:10 BS 18:2 89:13 112:6 170:15 Buffalo 34:14 bulk 156:2 158:22 159:7 bullet 163:7 bundle 5:8 9:1,1 11:16 18:20,25 43:8 50:3 56:1 57:24,24 86:20 87:3 103:2,22 120:17 121:24 140:17 151:20 bundles 57:3 102:20 103:21 burden 37:8 Busby 58:18 59:4,7 59:8 60:11 62:8 62:20 65:8,17 66:20 67:9,19,21 69:19,22,25 70:2 | 70:15 73:3 79:2,4 79:25 80:10,17,20 81:12,14 83:17 85:2 86:13 89:23 90:23,25 91:14,17 98:12 99:13,21 100:3,5,13,14,20 101:1,15,19 102:25 103:7,10 103:14 104:5,16 106:20 107:1,6,10 107:12,14,22 109:9,11,15,25 110:5,8,13,22 111:3,9,20,22 112:13,16,25 113:11,22 114:3 114:16 115:22,25 116:2,10,16,19,24 117:3,7,18 119:9 119:24 120:18,24 122:1 123:18 130:15 132:8,11 132:18 134:2,9,12 134:15 136:3 138:25 139:9,13 139:22,24 140:9 141:1,5,10 143:10 143:17 145:15,16 145:25 146:4 148:13,16 152:10 152:12 153:2,5,12 153:16,20 154:10 154:24 155:5,11 155:13 156:1,19 156:22 158:9,12 158:16 160:21 161:6,18 163:2 164:5 165:10,14 165:18,25 166:12 171:4,5 Busby's 29:6 bystander 18:13 21:15,15,18,23 22:5,6,18,22,25 | 23:2,25 24:4,19 24:21 25:3,9,18 26:16 27:16,23 43:5 47:19 48:10 48:13,17 49:17,23 52:7 74:9 <hr/> C C 19:6 24:5,7 28:9 169:19 C3H 23:4 24:1 cabal 164:6 caesium 87:6 calculate 88:7 calculated 85:5 128:18 144:18 146:17 151:3 calculation 102:15 135:20 147:23 148:16 calculations 93:7 123:21 147:11,16 147:19 150:8,13 150:25 calculator 147:14 call 77:25 118:18 127:22 called 29:11 64:21 68:11,12 69:10 72:13 118:2 121:11 calls 68:21 158:22 campaign 67:20 campaigning 67:7 67:9,16 78:1 111:6,13 112:17 112:19,21 113:1 114:9 117:8 118:18 142:17,21 145:18,23 146:2 151:14 164:6 campaigns 67:12 cancer 19:24 23:18 23:22 39:1,6,7,16 43:17 44:12 51:3 |
|---|--|--|---|--|

| | | | | |
|--|---|--|--|--|
| 51:6,6,23 53:19 54:12 57:19 58:4 58:6 66:23 67:3 83:5 124:8 125:16 132:15,19,23 134:16,18,20 135:2 162:6 cancerous 135:3,23 cancers 44:14 45:24 51:3,24 59:20 95:17 124:12 canon 161:25 162:1 163:3,4 canopy 157:11,14 Canu 137:17,18 145:3,6 capable 8:15 104:12 capacity 126:24 152:14 Captain 58:19 carbon 148:3 149:8 149:9 carbon-14 64:4 88:14,19 147:25 148:1,3,4,21,22 149:6 carcinogenesis 24:3 38:7 Cardis 82:18,20 83:3 cards 2:11,13 care 16:15 80:2 careful 5:7 13:19 46:1 54:25 92:19 carefully 76:19 147:6 170:18 carried 2:23 33:20 62:4 65:13 81:15 82:7 95:16 129:21 153:24 carries 44:24 95:23 carry 27:4 72:19 88:3 95:8 98:1,2 | carrying 27:19,22 61:4 94:24 Carter 45:15 case 8:16 10:15 11:17 16:13 27:21 29:4 33:25 34:13 35:6 40:1,23,24 41:1,19 45:18,21 45:24 53:13,23 62:22 63:4,5,7,15 72:7 73:14,20 74:19 78:3,12 91:20 94:5,11 98:12 100:24 101:5,24 102:18 102:21 103:10,19 104:18 105:2 106:5,6 116:20 119:13,14,16 123:23 129:23 130:23 131:7 132:12 134:20 139:11 142:8 147:12,21 161:1 163:10,12,19 164:12,14,15 165:22,25 166:1 cases 43:17 57:6 100:22 111:9 151:7 164:13 casing 129:10 Casualty 126:12 catch 18:23 categorise 141:15 categorised 96:9 111:5 category 135:5,14 Catherine's 121:10 causal 39:7 45:23 48:5 125:12 causation 12:19,25 14:7 15:1,16 16:7 16:19 34:5,15 35:3 36:2,7,9,19 37:6 46:9 53:23 | 135:14 160:25 161:1,7,9,24 163:19 169:24 cause 9:5 36:5,5 39:14,17 53:19 90:16 114:10 127:21,22 129:7 135:8,22 162:3,4 162:11,11 caused 7:23 18:13 21:16 26:17 95:17 124:5,18 128:2 138:23 139:21 144:1 causes 36:13,20 38:6 144:24 146:9 causing 98:23 128:9 caustic 73:1 caution 87:19 cautious 87:21 146:22 ceases 43:3 99:7 Cecilia 58:18 106:20 110:14 147:3 165:18 cell 9:5 22:7 24:1 24:17 28:22 46:12 74:8 144:25 cells 7:19 22:19 23:4 24:24,25 25:1 49:18 52:1,2 cellular 22:16 24:21 28:21 cent 128:25 129:1 Center 133:3 central 40:22 41:19 91:22,24 138:21 Century 161:22 CERRIE 70:3 117:14 119:6,8 121:4,5,9,12,17 123:4 151:13,23 certain 37:11 53:10 60:18 61:14 82:11 | 90:9 114:23,24 certainly 9:14 17:7 17:21 21:3 30:19 33:8 41:11 42:17 45:23 57:5 80:24 88:25 90:7 120:25 148:17 157:3 158:1 159:19 certainties 15:11 34:25 35:8 certainty 36:21 87:16 certificate 16:17,23 cetera 11:20 27:14 48:9 119:8 challenge 15:6 challenged 86:5 challenges 84:20 chance 80:7 chances 42:11 change 18:14 21:17 26:18 54:2 110:19 changes 19:23 48:9 49:22 chapter 67:2 161:15 characterised 17:16 24:19 characterising 24:23 charge 118:22 Charles 12:22 13:20 15:18 60:6 61:5,21 62:10 72:16 97:25 141:16 Charles' 115:20 Charles's 94:12 98:10 chart 155:5,6,11 charts 155:7 Charybdis 37:24 chasm 142:4 check 6:2 83:18 84:12,21 167:16 | chemistry 83:18 118:23 Chernobyl 71:4 79:13 85:21 86:1 86:3,14,23 87:2 107:25 108:7,7,8 109:17 121:9 122:14 165:2 Chicago 68:14 chicanery 126:9 child 113:19 123:24 childhood 124:1 children 57:20 58:2 58:6 62:13 85:23 85:25 86:3,14 87:9,10 108:18 140:20 choice 150:21 choose 82:17,18 chord 134:5 chose 111:12 chosen 76:19 Christmas 8:12 9:17,23 10:5,25 38:15,20 39:7 51:12 102:13 127:12 134:24 144:20 148:5,11 148:13,23 149:2,5 155:21 159:5,9,21 chromosomal 6:8 7:18 48:8 49:14 49:19,21 51:25 chromosome 50:9 50:9,11,18 51:20 51:23 52:1 130:2 130:12 140:3 146:6,9,13,21 162:7 chromosomes 2:7 124:20 chronic 132:13,25 chuck 139:7 circle 153:8 circles 153:5,14,14 |
|--|---|--|--|--|

| | | | | |
|--|---|---|--|--|
| <p>153:16,21 circumstances 54:9 62:1 citation 18:21 cited 82:21 115:20 120:8 150:18 civil 2:21 95:6,11 claim 97:20 130:18 claimants 12:17 claimed 34:16 35:3 36:2 79:20 claims 79:18 clarification 135:18 clarified 35:17,20 clarify 7:1,11 135:7 clarity 6:18 classical 161:18 163:18 classified 111:5 clear 9:21 28:12 31:6 72:15,18 76:18 78:11 82:24 83:16 87:24 88:5 88:22 92:10 93:22 99:1,4 131:7 140:6 150:14 151:1 clearer 92:8 clearing 11:4 clearly 23:10 24:21 52:7 97:16 106:7 106:7 122:3,16 126:2 128:22 154:10 165:20 clears 157:5 cleverly 127:19 clients 53:18 climates 129:7 CLL 133:4,6,12 135:1 closely 58:20 closer 74:25 closing 1:3 4:16 11:8,11 12:8 31:3</p> | <p>55:13 57:12 59:7 59:9 69:23 100:13 100:18 165:23 168:2 169:4,9 171:2,4,5 closings 11:22 cloud 153:9,10,19 153:21,25 155:5 155:18,22 156:3,9 158:19 clouds 156:23 clusters 123:23 124:1 clutter 46:8 co-author 1:12 co-efficients 144:14 160:15 coalesce 82:25 coast 159:17,20 160:5 coconuts 149:10 coefficient 118:6 151:16 coefficients 19:24 cogent 55:15 cohort 42:8 75:20 75:20 76:21 82:9 colder 129:9 colleagues 50:12,19 55:10 82:25 104:9 collecting 170:18 collectively 7:1 College 66:20 121:10 combative 83:6 combination 61:19 62:6,21 63:4,6,14 64:14 87:15 combined 14:17 62:4 come 6:6 13:16 14:9 21:10 30:13 39:24 40:11 43:4 48:2 51:17 54:17 67:23 70:24 85:12</p> | <p>87:22 110:23 121:15 125:2 129:24 130:5 139:1 141:6 145:18 154:20 166:15,23 comes 12:22 35:21 44:23 45:1 46:12 55:7 129:8,12 coming 53:2 54:17 62:18 90:23 140:7 commend 11:10 55:13 comment 5:2,3 12:9 40:25 45:11 50:8 90:1 105:4 138:19 167:11 commenting 8:8 33:7 comments 4:2,25 33:10,12 56:2 74:22 83:22 112:23 123:15 Commission 118:21 126:12 commissioned 101:24 commitment 69:3 114:10 committed 72:14 committee 19:21,25 52:12 112:17 118:1,15,20 119:6 121:17 151:19 common 52:19 84:18 86:18 162:2 communication 92:10 community 23:14 68:4 93:14 132:3 compare 75:24 76:2 compared 36:12,20 75:20 127:11 149:1</p> | <p>comparison 86:2 competing 36:12 36:20 complain 118:25 complained 149:17 complaint 2:10 complete 167:20 completely 20:15 55:6 63:1 73:15 108:24 completeness 57:22 complex 68:25 120:4 complicated 36:3 43:24 91:11 complying 17:21 component 149:7 159:25 components 85:12 156:19 160:14 comprehensive 55:16 concave 22:24 concede 87:23 conceded 132:18 159:11 concept 85:17 133:22 136:13,25 139:7 146:23 161:9 concern 101:19 158:17 160:6 concerned 3:15 6:10 54:22 110:6 130:16 concerns 117:23 138:8 143:22,24 147:23 concession 15:17 15:22,25 16:1 conclude 87:9 163:19 concluded 123:7 concludes 24:14 107:22</p> | <p>concluding 19:14 23:6 conclusion 15:14 24:11 25:4,7,21 43:14 50:17 62:19 108:14 109:3 123:9 132:4 166:13 conclusions 41:4 48:2 70:22 80:4 87:22 110:3 147:20 concur 77:11 condensed 116:10 condition 34:16 35:3 36:2 conditions 14:8,19 53:20 162:2 conduct 104:18 131:14 conducting 29:21 conducts 130:23 conference 121:11 confidence 93:1 confined 29:13 148:9 confirmation 163:8 conflicting 24:15 confused 112:3 congenital 79:12 107:24 108:10,15 109:16 130:2 140:19 143:6 162:7 conjunction 62:9 connection 8:12 39:7 55:2 113:18 146:17 connective 44:15 conscious 12:3 55:12 143:12 consensus 20:14 23:15 54:7 55:1 60:19 69:1 70:23 73:13 74:23 93:3</p> |
|--|---|---|--|--|

| | | | | |
|---|---|---|---|---|
| 94:10 95:25 99:6 consequence 147:8 conservative 127:17 151:5 consider 21:23 60:20 94:4 95:9 97:11 160:6 considerable 69:9 99:10 154:4 considerably 135:10 consideration 14:16 63:2 95:16 123:5 164:9 considerations 19:20 considered 8:7 18:13 21:16,20 25:22 26:17 62:14 64:4,14 74:12 93:16 95:20,21 98:21 110:16 121:16,20 122:12 139:2 142:15 consistent 23:6 30:3 43:21 consisting 156:4,10 158:24 consolidated 167:13 constantly 12:16 35:3 36:9 37:17 constrained 112:15 contact 3:8 contacted 3:12,21 contain 51:24 110:21 contained 103:6 109:24 128:22 156:3 contaminated 106:13 121:8 144:12 149:21,23 150:1 159:16 contamination | 134:23 144:4 152:21 157:11 contemporaneous 9:18 contention 71:25 83:5 contentious 78:19 context 8:7 13:4,11 20:16 21:11 28:12 40:24 58:23 97:16 98:7,17 continue 97:20 99:25 118:11 continued 1:3 86:5 171:3 continues 27:7 contra 46:23 contrary 68:21 contrast 110:1 contribute 67:2 contributed 59:20 control 75:20 76:3 76:9,15 77:2 83:24 133:3 controls 76:18 147:2,6 164:12 convenience 169:17 convenient 56:4 137:3 conveniently 141:11 conventional 14:5 conversion 85:8 convincing 75:6,7 75:10 cools 129:9 copies 1:10 167:13 170:7,11 copy 1:16 56:9 core 136:12 corner 21:22 22:1 cornerstone 161:22 corollary 9:8 correct 72:21 95:23 | 97:3 119:1 correcting 156:21 correction 104:13 correctly 12:24 109:25 couched 113:21 counsel 56:10 countries 71:6 83:4 108:4,8,18 122:14 couple 45:6 55:22 57:9 59:8 75:11 course 1:11 4:11 7:23 8:18 16:1 23:1 30:11 32:20 46:25 47:11 67:19 67:19 71:18 84:14 85:3 110:22,22 115:1,13 128:11 129:3,23 130:22 132:8 134:15,16 138:15 146:15 149:18 150:23 157:11 160:17 164:8 court 2:5 62:16,17 72:6 74:14 77:17 77:19 96:5 169:2 169:7 170:24 Court's 40:4 courtroom 6:6 courts 38:21 cover 11:15 12:2 161:12 165:4 167:7 covered 113:24 143:20 146:19 160:23 165:19 Cox 56:21 CPR 17:20 72:11 credibility 26:9,11 26:11,12,13 47:14 106:16 133:14 142:12 credible 9:14 10:1 10:15 130:7 | 139:16 143:2,5 credibly 7:17 criminal 59:17 criteria 99:18 critical 15:8 67:15 106:9 136:4 criticise 70:25 criticised 31:4 61:3 96:6 140:23 criticising 117:10 criticism 7:14 29:12 31:6,7 70:11,17 89:16 criticisms 2:5 4:19 45:14 60:16 92:18 99:9 123:15 critique 74:18 123:16 critiqued 74:12 critiques 123:5,8 cross 13:9 34:2 cross-examination 83:9 105:3 150:18 150:23 159:12 cross-examined 89:8 115:5 cross-examining 69:12 cross-refer 116:8 cross-reference 35:7 crossed 157:12 Crown 169:1,7 crucial 62:19 89:16 crudely 131:16 133:17 crusading 114:8 CT 52:24 54:5 57:21 58:8,9 culture 72:8 114:5 114:19 144:25 cumulative 14:16 148:22 cumulatively 102:13 144:19 | cure 80:15 164:4 curious 97:2 134:3 134:4,5 current 25:19 27:13 50:10 58:23 152:18 159:3 currently 18:15 19:21,22 26:19 87:4 93:8 cut 54:5 149:18,19 156:25 157:19 cuts 15:17 cutting 149:15 CV 30:14 64:25 65:24 66:14 CVs 64:23 67:5 |
| | | | | D |
| | | | | D 169:23 170:1 171:1 damage 130:12 146:9,13 162:7 damaged 52:2 71:15,16 danger 53:10,15 74:20 77:10 darkness 105:10 Darroudi 4:20 5:6 32:18 56:18,18,20 data 5:16 19:21 23:3,25 43:20 48:4 108:23 126:10,11 132:5 157:22 162:15 daughter 58:18,24 117:15 119:10 141:13 147:25 daughters 23:19,21 day 69:15 75:14 78:14,14,15 79:2 79:15,24 81:18 82:16 83:10,19,21 85:1 86:1 88:8,15 89:19,23 92:18 93:17 147:2 |

| | | | | |
|--|--|---|---|--|
| 166:18 167:11 days 57:9 deal 5:19 11:8,21 29:3,5,6,9 33:23 48:24 49:3,17 50:1 52:5 55:22 120:19 131:12 134:8,8 143:3 160:24 dealing 3:24 11:16 16:13 24:12 25:12 41:5,5 42:21 48:25 52:4 58:2 137:2 deals 2:2 5:23 33:2 40:1 45:10 48:23 49:7,10 52:6 dealt 2:4 21:18 141:3 death 40:5 debate 47:22 54:14 60:3 67:24 71:12 75:13 87:8 93:2 104:15 110:4 117:2 138:20 debates 117:14 135:14 debris 155:17 156:2 158:23 159:7 decay 84:4,8,9 Decca 155:23 decide 14:15,25 15:5 16:4 60:22 71:15 75:5 94:17 112:9 143:15 decided 18:19 133:4 164:2 decides 147:14 deciding 17:9 decision 4:11 15:19 39:25 40:4,6 60:5 61:21,25 62:3 94:12 98:10 99:19 115:21 130:23 | 133:21 decision-making 97:24 Declaration 151:19 declare 12:17 deduced 146:20 deeper 90:18 defects 135:23 140:20 162:7 Defence 56:11 defend 83:8 defer 82:20 83:2 define 70:19 135:12 defined 105:10 defines 70:18 128:4 definition 85:13 degree 65:3,9 139:5 163:9 delayed 20:2 delete 48:11 deleted 49:2 deliberately 13:22 delve 55:5 demand 71:12 demonstrated 93:20 deny 125:24 Department 57:19 66:4,5 81:16 82:8 depend 106:15 135:4 dependent 62:25 63:5,21 119:13 depends 30:24 106:11 depleted 83:23 deposited 152:15 deposition 74:5 87:6 88:6 155:23 157:2,6 depress 71:8 depth 49:10 60:7 derive 53:5 102:16 derived 155:17 derives 162:14 | described 18:1 37:10 38:3 43:1 129:4 describes 20:11 63:22 desert 126:23 127:15 design 20:3 29:20 80:11 designed 80:3,5,18 80:19 81:11 desire 78:3 desk 55:25 despite 72:15 83:16 84:20 92:17,19 94:3,4 96:13 106:2 destroy 26:12 53:23 54:5 detail 25:16 91:4 91:10 detailed 66:16 detect 44:10 detected 44:4 154:13 detecting 49:8 detectors 140:12 determine 42:8 128:4 determined 24:22 determining 49:14 deterministic 127:23 detract 114:6 developed 45:9 development 98:18 98:20 developments 20:1 21:8 develops 40:9 devolves 132:25 134:21 diagnostic 65:13 71:10 diagram 156:19,21 | diarrhoea 126:10 127:22 dictated 27:6 died 39:17 132:14 difference 30:11 42:20 62:24 76:3 157:10 163:4 differences 46:18 144:9 different 20:15,15 21:11 24:18 26:24 32:22 35:22 38:3 55:7 59:24 76:17 85:9,13 108:4,5,5 108:8 114:5,22,25 127:2 128:21 135:15 139:23 141:7 157:16,23 157:23 158:12,13 164:12,22 166:7 differently 115:1 difficult 74:17 81:25 88:1 92:6 104:18 114:11,13 difficulties 92:10 104:5 difficulty 3:19 33:3 34:19 37:16 42:5 44:22 46:14 91:6 103:25 104:3 145:8 dilute 155:22 diminish 7:8 62:21 Dingemans 3:3,4 dioxide 149:9 dire 56:6 direct 3:8 directed 6:4,7 32:2 32:2 94:3 106:2 112:24 116:13 130:19 directing 30:18 106:23 direction 36:25 45:7 72:15 88:11 | 105:1 109:5 114:10 directions 102:2 157:23 158:13 directly 3:15 22:19 64:19 101:4 disablement 16:23 17:1 disagree 44:19 disagreement 73:1 disagrees 15:16 disappeared 102:19 103:2,20 103:22 121:19 170:12 disappearing 104:7 disaster 85:23 disclosure 56:8 103:9 discover 157:1 discovered 127:23 discuss 6:16 67:24 108:22 discussed 23:5 24:5 25:15 61:5 72:17 74:1,2,2,7 131:7 136:5,6 discusses 49:6 discussing 85:23 discussion 24:9,10 25:2 26:10 36:17 71:8 96:24 99:1 121:22 122:1,17 147:9 154:4 disease 38:9,12 39:14 42:11 133:3 dismiss 79:10 107:3 dismissal 164:9 dismissed 4:10 10:16 46:20 68:23 73:15 122:22,23 164:24 dismissive 74:22 dispassionate 114:12 |
|--|--|---|---|--|

| | | | | |
|----------------------------|----------------------------|---------------------------|-------------------|----------------------------|
| displayed 83:7 | 54:7 77:24 93:6 | 130:7,8,9 137:6 | 47:16,18 53:2 | 164:5,15 165:10 |
| displaying 82:11 | 112:15 120:16 | 137:12,13,23 | 58:18 59:4 75:15 | 165:14,18,25 |
| disproved 96:18 | door 22:7 | 138:8,9 139:15 | 75:15,16,17,18,22 | 166:12 171:5 |
| dispute 7:20,21 | DoReMi 97:14 | 144:2 146:17,20 | 76:13 77:6 79:25 | drafting 38:14 |
| 80:19 | dose 5:13 13:6 15:1 | 149:12 150:5,5,10 | 80:25 81:9 83:17 | draw 70:21 132:11 |
| disregard 4:2 60:13 | 15:5,15 16:4,6 | 152:2 164:16 | 85:2 86:13 88:22 | drawing 19:10 80:4 |
| dissenting 151:14 | 20:4 22:14,18,22 | dosimeters 126:23 | 89:6,8,10,14,17 | drawn 105:19 |
| dissipated 102:12 | 23:7,22,25 25:18 | dosimetrist 85:15 | 92:14 93:1,4 97:7 | 109:3 114:14 |
| 129:1,11 | 27:15 34:3,11,15 | 150:7 | 97:14 99:21 100:3 | 133:11 |
| dissolved 152:14 | 34:18,21,24 40:21 | dosimetry 8:21 | 100:5,13,14,20 | driving 132:7 |
| distance 127:8 | 40:23 41:5,8,23 | 10:6 29:21,23,25 | 101:1,15,19 | dropped 63:9 127:1 |
| distances 113:5 | 42:5,17,17 43:5 | 30:6,21,25 31:9 | 102:25 103:7,10 | DSO2 92:22 |
| 127:3 | 43:18,22 44:3,9 | 31:21,23 39:12 | 103:14 104:5,16 | DSS 98:14 |
| distillation 116:14 | 44:13 48:25 49:8 | 45:18 65:3,10,13 | 106:20,20 107:1,6 | dual 3:2 |
| distinction 96:3 | 50:22,23 51:2,5 | 65:19 84:25 89:12 | 107:10,12,14,22 | ducks 47:20 |
| distinguish 46:9 | 58:11 63:25 64:2 | 91:24,25 92:22 | 109:9,11,15,25 | due 4:11 24:3 46:25 |
| 115:2 | 64:3 72:1 73:24 | 99:14 126:22 | 110:5,8,13,14,22 | 161:19 |
| distinguished | 85:3,12,20 88:19 | 127:7,16 139:7,20 | 111:3,9,20,22 | Dugdale 168:21 |
| 52:12 | 88:21 90:9 95:15 | 139:20,24 160:1 | 112:13,16,22,25 | dustiness 149:17 |
| distinguishing | 120:5 123:21 | 160:11,12 | 113:11,22 114:3 | duties 16:8,11 |
| 26:10 | 125:4,5,5,8,13,14 | dosimetry-based | 114:16 115:22,25 | |
| distortion 17:3 | 125:15,21,22,23 | 139:6 | 116:2,10,16,19,24 | E |
| distracted 168:5 | 127:2 128:18 | doubt 5:12 8:17 | 117:3,7,18,24 | E 11:17 171:1 |
| divert 126:7 | 129:22 130:5,6,11 | 10:2,23 13:1,7,9 | 118:20,20 119:9 | e-mail 3:12 4:5 |
| divide 30:9 | 132:20 134:22 | 13:18 14:19 15:2 | 119:24 120:18,24 | 78:12 |
| divided 106:24 | 135:8,19,21,22 | 16:21,25 26:23 | 121:23 122:1 | earlier 24:7 40:3 |
| DNA 64:12 138:22 | 136:5,6,6,7,8,9,9 | 36:4 37:5,12,21 | 123:18 129:5 | 43:1 47:17 53:24 |
| 144:15,16 148:3 | 136:10,13,17,19 | 47:1 53:18 55:1 | 130:15 132:8,11 | 105:20 111:16 |
| doctor 65:9 | 136:20,24,25 | 59:19 60:21 61:9 | 132:18 134:2,9,12 | 134:18 138:7 |
| doctorate 65:2 | 137:10,10,12,16 | 61:12 62:5 63:18 | 134:15 136:3 | 144:19 146:15 |
| document 35:8 | 138:4,16,23 139:5 | 64:15 78:21 79:4 | 138:25 139:9,13 | 147:9 148:14 |
| 59:11 86:18,20 | 140:14 144:8,13 | 79:6,9 84:19 88:3 | 139:22,24 140:9 | 154:5 156:14 |
| 100:16 101:17 | 144:15,15 146:20 | 95:2 97:12 98:7 | 141:1,5,10 143:10 | 162:23 |
| 102:25 103:5 | 146:23 147:11,15 | 98:16,22 99:3,4 | 143:17 145:3,6,15 | early 78:20 123:14 |
| 104:4,4 148:8,10 | 151:2,9,16 162:24 | 99:18 132:21 | 145:16,25 146:4 | ears 37:23 |
| 169:16 | 163:2 | 133:7 135:7 | 147:1,20 148:13 | earth 27:20 52:20 |
| documentary | doses 22:24,25 23:7 | doubts 14:17 97:16 | 148:16 152:7,10 | 68:1 |
| 101:11,20 | 23:19,20 25:18 | 98:3 | 152:12,12 153:2,5 | easiest 31:12 |
| documentation | 43:19,22,23 44:7 | Dr 2:1,9,18 3:8,12 | 153:12,16,20 | east 152:21 153:24 |
| 9:18 86:7 | 44:11,16,24 46:3 | 3:21 4:20 5:6,6 | 154:10,24 155:5 | 154:1,11 156:5,6 |
| documenting 87:22 | 46:22 48:4 50:1 | 12:1 21:19 23:1 | 155:11,13 156:1 | 156:11,23 158:20 |
| documents 102:3,7 | 51:2 85:5 86:4 | 23:11 29:6 30:12 | 156:19,22 158:9 | 158:21,25 159:4 |
| 102:17 104:1,2,6 | 94:6 108:17 124:5 | 32:18,18,21 33:17 | 158:12,16,17 | eastern 159:20 |
| 104:19,21 | 124:11,15,17,24 | 41:6,11,25,25 | 159:2 160:8,21 | easy 84:15 |
| doing 13:15 17:8 | 124:25 126:21 | 42:5 44:19 45:4 | 161:6,18 163:2 | eat 149:9 |

| | | | | |
|--|--|---|--|--|
| ECRR 67:6,16 68:3 72:23 108:13 109:5 112:20 117:8 161:15 | 127:25 128:1,9,13 129:16 137:4 138:4 144:25 151:25 162:11 163:15 165:1 | employment 115:9 employs 92:18 enable 102:4 enables 131:2 Encyclopedia 67:4 ended 156:11 159:10,20,22 endorsement 47:16 ends 165:14 energy 118:13,21 engage 72:18 75:1 89:15 91:11 94:2 123:14 135:25 engaged 74:13 92:5 97:15 108:21 engagement 74:18 74:25 engaging 93:2 English 92:4 161:20 enhance 62:21 enhanced 44:25 46:22 enormous 129:7 140:13 enormously 140:19 enriched 103:15 ensure 6:5 105:23 entered 63:11 entertain 145:16 enthusiasm 77:25 entia 164:18 entire 68:2 entirely 53:23 115:12 119:13 126:1 135:1 159:25 entirety 170:2 entitlement 16:18 entrained 152:15 Environment 119:5 environmental 66:23 67:3 81:15 91:19 150:20 | 151:8 envisage 167:24 EPA 150:20 epidemiological 41:3 44:11 45:16 45:21 48:4 51:1,8 51:9 58:3,12 73:23 79:11 88:24 88:25 89:1,4 96:19 120:7 123:10,22 132:5 133:12 epidemiologist 29:12 30:16 31:7 31:8 32:7 epidemiologists 42:7,22 epidemiology 29:19 30:8,13 31:25 32:24 35:17 41:6 42:3,12,23 43:3 44:8,20 45:10,20 46:4,6 46:18,21 47:3,21 81:15 91:19 140:23 epilation 91:3 113:4 126:10,16 127:21 equal 71:12 equally 78:14 99:4 equation 45:12 equatorial 152:18 159:2 equivalent 68:1 equivalently 130:1 Ernest 117:20 err 16:25 error 151:22 163:15 especially 38:7 114:4 146:12 160:7 essence 95:10 116:14 136:21 | essential 4:9 essentially 31:5 98:19 103:14 120:3 125:17 133:16 165:21 establish 12:19 14:18 44:3 54:3 established 12:19 51:22 58:3 123:14 137:13 establishes 10:9 49:22 establishing 95:1 Establishment 102:6 estimate 42:11 50:23 139:6 estimated 50:22 estimates 25:15,20 45:19 estoppel 133:22 et 11:20 22:25 23:3 23:3,5 27:14 48:9 119:8 Europe 108:8 European 71:5 112:17 151:19 evaluate 96:1 131:24 133:23 evaluation 25:11 25:12 132:7 evaluations 74:24 even-handedness 29:18 evening 83:19 84:21 event 167:15 eventually 35:6 151:2 everybody 10:24 41:25 138:11 159:24 163:5 169:13 evidence 2:18 3:11 3:23 6:11 14:16 |
|--|--|---|--|--|

| | | | | |
|--|---|---|---|--|
| 14:19 17:10,11,15 17:18 18:16 20:24 23:5 26:4,20 28:20 29:12 31:4 31:5 32:22 33:18 33:22,24 35:4,11 35:12,14 36:4 41:1,25,25 42:15 44:19 47:12 48:11 50:19,25 51:13 60:4 61:9 63:19 66:9 68:4,17,21 69:6,8 70:22 71:24 72:4 74:2,4 74:10,14,23 75:9 77:11 78:14,15,20 79:11,20 80:23,25 81:2 83:4,6 85:24 88:23 91:5,20,24 92:25 93:25 95:2 96:1,4,5,12,17 98:23 99:22 101:11,20 105:5 105:18,21,24 106:4,9 108:19,20 108:22 109:23 110:15 111:17,17 112:18,20 113:4 113:14 114:8,20 114:21 115:18 118:7 120:7 121:17 122:13 123:22 124:13,22 124:22 125:11 126:15 131:3,4,19 131:20,22 133:2 133:12,23 138:22 141:7,19 142:8,9 143:3,4,20 144:24 146:12 148:9 149:23 154:21 156:9 161:13 162:8,21 164:10 164:23 165:5 168:3 | evidencing 73:23 evident 79:10 evidential 14:1 evidentially 132:1 ex 98:14 121:22 ex-Soviet 108:9 exactly 14:10 15:3 15:6 85:22 90:23 examination 43:18 examine 91:10 120:15 examined 60:6 example 33:16 35:11 38:13 43:20 44:14 47:19 50:2 51:4 52:18,23 62:5 63:3,24 68:18 73:23 75:4 84:24 120:10 123:19 124:7 127:5 144:21,25 examples 106:8 exasperated 86:6 exceeded 59:22 87:25 exception 15:21 excess 50:8,11,18 77:25 124:14,18 140:2 145:5 exchange 4:5 67:24 75:15 exchanges 79:11 exclude 47:12 48:5 48:8 53:11 excluded 8:9 25:17 47:6 147:25 exercise 72:20 88:2 exhibit 22:20 exist 44:17 75:12 97:16 102:7 104:22 162:25 existed 160:17 existence 60:21 123:1 exists 27:17 28:6 | EXP 168:21 expansion 55:23 57:11 expect 80:23 85:22 87:13 89:10 120:25 expected 77:15 85:15 89:15 expecting 104:16 expensive 3:16 experience 29:21 29:23 57:5 58:2 experienced 57:20 experiences 113:19 experimental 22:21 23:6 65:17 experiments 115:1 expert 17:18 60:4 77:16,18 78:1,6 78:18 82:24 84:16 85:1,14,16 87:14 88:24 89:14 91:20 92:1,13,21 93:11 96:4 112:2 114:12 115:12 116:17 129:5 131:1,1 142:7,13 154:16 154:17 expertise 29:14,17 29:19,25 30:1,6,8 30:21 31:8 32:3,8 60:9 64:18,21 67:5 77:20 82:14 83:1 87:23 88:1 88:10,13 142:11 142:14 experts 10:17 26:24 31:17 59:25 60:14 60:17,25 61:11 64:5,20 71:22 72:13,22 74:19 75:3,6,8,9 77:15 77:15,22 82:23 84:14 93:5,10 94:2 95:10 96:9 | 96:12,16,17 97:20 99:10 105:13 106:7 108:25 111:4 112:7,19 119:25 120:1,1 121:13 122:23 130:18,20 131:15 133:2,14 141:12 143:2 144:23 163:24 164:10 experts' 60:22 74:13 explain 68:16 70:9 71:5 155:9 explained 3:13 42:6 47:16 68:22 94:8 108:16 138:1 explaining 105:14 137:3 explains 69:8 129:15 156:15,16 explanation 9:13 9:14 164:20,21 explicitly 92:1 95:8 explode 126:19 128:24 exploded 144:20 149:1 explore 134:10 explosion 153:6 exposed 8:6,11,17 8:23 9:4,19,22 10:4,10,19 22:19 23:18,20 34:12 39:11 50:20 51:1 51:4 52:20,24,25 53:18 54:3 57:21 76:4 85:10,25 86:3,14,25 122:14 128:7,14,15,20 130:13 144:5 149:24 exposition 161:18 exposure 9:6,16 10:24 12:18 13:8 | 14:6 23:4,23 24:3 29:23 30:2 31:14 36:5,7,9,19 37:5 44:24 48:7 49:20 50:13 51:21 53:2 53:8,17 79:12 85:4 90:10 95:18 106:12 124:5,23 129:16,20 134:23 136:24 137:5 138:4 144:23 146:16,23 148:1 148:19 149:8,13 159:14 160:7,20 162:9 163:16 169:20 exposures 9:12 49:8 105:15 149:15 151:16 164:1 expressed 33:16 62:1 85:6 extensive 86:24 extent 6:19 135:16 external 125:21,22 136:20 137:7 140:1,4,14 extra 22:15 39:9 59:9 63:25 extract 79:23 extraordinary 91:18 extrapolation 23:7 23:24 extremely 72:4 84:18 93:5 103:18 103:19 130:1 160:2 eyes 125:25 |
| F | | | | |
| face 7:4 90:15,17 faced 38:9 fact 14:5 15:9 27:5 32:21 36:1 40:25 | | | | |

| | | | | |
|--|--|---|--|--|
| 41:3 57:24 74:25 76:16,18 79:9 80:25 92:16,19 94:16,20 95:20 96:13 111:25 114:18 115:4,6 116:7,10 117:9,24 118:2,25 119:3 122:7 125:19,21 126:6 130:17 132:22 136:11 140:11,13,18 142:1 143:5 144:8 145:22 149:21 158:18 159:12 165:14 170:2 factor 23:8 118:6 152:13 159:14 factors 63:2 facts 62:14,18,20 83:18 84:21 94:24 95:10 98:1,3 115:10,16 119:15 119:17 fail 16:6 failed 1:15 failing 26:21 84:25 fails 147:17 failure 15:17 17:17 78:6 fair 71:12 fairly 66:16 102:15 112:23 faith 165:7 fall 90:10 102:9 fallen 144:12 falling 142:4 155:19 156:5 159:1 fallout 65:4,10 85:25 88:7 122:15 143:25 152:17 154:14 155:17,22 falls 40:24 false 34:9 163:25 | familiar 66:21 85:7 90:1 family 24:18 fanciful 10:16 17:11 46:20 141:19,20,20,22 141:24 142:1,6,10 142:15,18 143:5 146:12 far 1:7 7:19 8:13 10:1 20:10 28:18 35:18 36:24 46:14 47:7 100:2 110:4 112:10 115:21 130:7 far-fetched 62:6 63:7 fault 82:14 faulty 49:12 91:24 91:25 126:2 favour 17:2 favourable 163:11 Federation 86:25 87:5 feeding 140:6 feel 58:23 78:17 133:13 feeling 112:14 feet 153:10 156:3 156:10 fellow 66:20 felt 88:18,20 161:11 Feuerhake 64:22 64:25 65:2 69:13 71:17 73:25 99:13 108:14 110:24 111:4 122:19 143:1 Feuerhake's 70:8 107:3,19,22 fewer 77:3 field 66:1,22 75:7 160:24 168:21 fighter 167:8 | figure 10:14 86:22 126:21 139:1 153:17,18 155:5 156:8,15,16,18,18 156:21,24 157:6 157:20 158:19 figures 53:2 71:14 136:18 file 57:13 files 168:12 fillets 109:4 film 137:14,15 final 40:11 47:24 60:20 100:14,16 100:24 106:5 166:1 finally 9:15 40:10 69:9 86:11 96:18 98:4,6 160:17,24 170:7 find 4:25 5:5 10:22 11:18 13:3 24:9 53:1,7 55:15,25 57:3 66:14,15 75:5,7,10 79:14 86:21 88:8,17 90:11 104:19 148:20 finding 13:17 34:20 79:7 94:18 97:2 145:7 findings 15:9,9,10 15:10 43:25 45:18 45:21 71:4 77:5 finds 113:22,24 fine 89:21 167:9 finish 12:4,5 100:5 101:3 120:22 143:18 158:7 166:15,19 finished 39:23 100:8 101:2 166:12 finishes 160:10 finishing 100:7 | fire 30:18 firm 2:19 73:12 first 1:10 3:25 12:12,16 15:16,21 18:21 55:25 58:25 59:8 68:5 99:5,16 101:10,22 102:11 103:1,2 113:3 117:19 122:3 130:24 132:22 142:3,5,23 147:24 150:2 153:3,21 160:13,20 161:25 163:23 169:25 firstly 132:19 144:10 161:25 fish 149:10 fissioning 128:25 fit 122:21 five 133:2,6 flagged 125:8 flashing 138:13 flaw 10:23 134:6 flaws 96:6,7 flew 154:5,12 flicking 56:16 flowing 159:4 flows 159:3 focus 109:18 focused 27:1 focuses 6:15 focusing 49:12 fold 150:21 follow 16:11 40:22 100:21 134:20 follow-up 43:16 44:5 followed 58:19 following 86:14,23 102:10 107:25 109:16 162:8 follows 8:2 17:25 147:18 foot 133:16 footnote 57:14,14 | force 72:5 foremost 68:5 forgivable 87:12 forgive 6:9 forgot 59:10 forgotten 54:14 89:24 form 26:24 47:5 61:25 63:20 83:21 139:23 140:23 format 101:5 former 63:4 formulae 88:11 forth 125:20 127:6 133:14 149:10 forthright 2:4 3:16 forward 23:13 33:3 60:16 61:4 62:4 73:6 94:24 95:5,8 95:16 96:17 98:1 98:2 99:2 134:17 143:4 Foskett 56:9 found 12:25 49:8 62:5 64:15 70:4 71:1 95:2 137:21 138:5 146:7 foundation 13:2 14:1 126:13 founded 72:25 founding 99:18 four 2:7 121:12 Fourthly 8:5 frankly 104:21 119:15 French 137:18 145:4 frequency 75:19 Friday 78:11 167:2 friend 9:18 10:6 23:1 26:21 28:1 29:8 30:3 32:20 33:2 35:24 40:7 friend's 38:14 39:3 40:2 52:11 |
|--|--|---|--|--|

| | | | | |
|---|--|--|---|--|
| friendly 111:10 | generic 74:9 | 26:1 28:18 29:8 | 137:11 139:16 | growing 98:22 |
| friends 68:1 122:8 164:5 | genetic 81:19 107:6 107:24 139:8 | 30:23 31:22 32:12 | 140:9 142:2 | guidance 16:11 17:4 28:3 53:22 |
| frolic 31:9 | 162:6,8 | 33:14 35:1,21 | 143:11 145:15,20 | Gulf 79:14 81:19 146:7 |
| front 12:21 125:24 | Genie 118:3 | 36:14 37:24 40:2 | 147:4 154:19,22 | guy 136:16 137:15 |
| FTT 12:15 98:15 170:3 | genomic 27:17 | 41:7 42:14 43:7 | 154:25 157:23 | |
| Fukushima 85:24 124:8 165:1 | genotoxic 144:25 | 48:24 49:19 50:2 | 158:3,4,7 165:8 | H |
| fulfil 99:17 141:18 | genotoxicity 164:3 | 52:10 54:2 57:13 | 165:12 167:6,7,25 | Haar 1:3,5,24 2:22 2:24 3:1,6 6:9,17 |
| fully 9:11 | genuine 82:1 142:7 142:22 | 61:18,22 62:11 | 168:10,18 169:22 | 7:6,10 8:2,23 10:9 10:14 11:2,14,25 |
| function 118:11 | geographical 90:12 | 64:17,24 75:14,25 | good 19:19 28:24 | 12:12 14:2,9 |
| fund 97:6 | geographically 90:11 | 81:5 84:21 90:13 | 30:21 57:7 78:21 | 17:24 18:6,8,10 |
| fundamentally 35:23 | getting 36:23 47:23 67:17 143:11 | 90:25 94:12 99:10 | 79:5 106:22 112:3 | 18:25 19:2,4,13 |
| funded 57:18 97:14 97:18 | 145:8 149:9 | 101:10 105:18 | 123:8 136:3 | 19:16,19 20:21 |
| further 7:24 29:1 33:19 52:10 54:11 | 166:14 | 107:11,13 109:5 | 145:22,23,25 | 21:3,6,9 22:1,3,9 |
| 55:4,11 58:15 | gist 102:9,16 | 112:10 115:16 | 146:4 148:20 | 27:10 28:8,15,18 |
| 96:19 97:12,13,17 | give 4:5 7:2 14:18 38:13 52:15 58:24 | 116:20 117:18,23 | Government 5:21 113:15 | 29:11 30:11,19,24 |
| 97:18,19 104:15 | 61:10,12,13 63:2 | 121:1 123:10 | 113:15 | 31:10,13,24 32:11 |
| 111:24 115:16 | 78:25 80:23 81:8 | 125:4,8 130:10 | gram 136:16,18 | 32:14,16 33:14 |
| 117:18 127:16 | 96:23 108:22 | 134:3 137:15 | graph 91:3 | 35:10,18,21 36:23 |
| 134:3 135:13 | 122:9 133:11 | 138:2 139:17 | Grapple 34:13 | 37:2,8,13,16,22 |
| 165:15 170:11 | 134:19 136:1,2 | 140:17 141:18 | 127:12 152:24 | 37:25 38:2 39:9 |
| future 20:2 62:16 72:6 | 145:9 169:10 | 146:5 151:11 | 153:2 156:2 | 39:18,20,23 40:15 |
| | given 3:11 4:1 16:11 17:4 65:24 | 152:25 155:11 | 158:23 | 40:17,20 41:11,13 |
| G | 77:12 82:3 84:21 | 156:1 161:15 | grateful 1:19 7:6 7:10 102:14 141:8 | 41:18,21,23 43:10 |
| gain 166:5 | 86:7,22 91:10,21 | 162:17,20,24 170:20 | gray 85:8 | 43:14 45:25 46:5 |
| Galileo 162:17 | 92:9 93:6 96:1 | God 162:19 | grays 44:16 | 46:11 47:8,11,14 |
| gamma 85:11,19 113:7 126:19 | 100:16 104:19 | goes 13:5 14:22,24 15:12 16:16 23:15 | great 20:18 35:23 87:25 145:7 | 48:14,23 49:6,15 |
| 127:2,14,21 128:2 | 113:16,19 123:5 | 24:20 51:7 68:7 | greater 24:5 27:15 58:5 63:6 73:24 | 50:1,5,16 51:12 |
| 128:3 140:11 | 142:10 | 90:6 94:22 113:23 | 74:4 79:11 | 51:17,19 52:10 |
| gaping 10:22 | gives 10:23 66:15 80:24 131:24 | 117:10,18,19 | greatest 16:12 27:20 92:12 | 55:22 56:24 57:1 |
| gate 141:16,21,24 142:24 146:10 | 153:24 | 122:17 125:4 | ground 110:7 | 58:9 59:17 61:24 |
| general 51:13 69:1 75:20 76:17,21 | giving 41:3 49:13 66:9 91:20 142:8 | 126:20 129:9 | group 7:17 10:3 18:3 26:24 58:19 | 68:8 72:18 74:21 |
| 77:4 79:19 141:6 | 154:23 | Gofman 118:20,20 | 67:22 72:23 76:4 | 89:8 90:5,6 92:11 |
| generally 22:13 58:22 69:6 73:7 | glass 28:7 141:8 | going 7:8 14:9 18:23 21:10,11 | 76:4,9,16 92:21 | 92:13 126:4 167:1 167:7 169:21 |
| 76:25 | Glasstone 129:4 | 25:24 26:2,9 29:3 | 92:23 111:7,13 | 170:6 171:2 |
| | go 5:12,25 7:24 9:25 16:5 18:20 | 29:15 31:20 52:20 | 112:18,20,21 | Haar's 31:2 87:24 |
| | 18:21 21:21 24:10 | 54:3,19 64:19 | 113:1 114:22,24 | hair 90:9,12 149:15 149:18,19,25 |
| | | 78:8 81:7 82:9 | 115:8 117:8 | half 23:4 24:1 135:5 |
| | | 88:10,11 89:20 | 142:17,21 151:15 | Halfway 35:24 |
| | | 100:2 101:15 | groups 44:5 118:18 128:4 145:18 | |
| | | 104:14 106:25 | | |
| | | 117:7,16 118:16 | | |
| | | 120:16 131:23 | | |

| | | | | |
|---|---|---|---|--|
| Hallard 29:16,25 30:6 31:14 87:20 102:14 144:7,9,18 147:11,13,22 148:8 149:11,14 150:2 151:3 152:2 152:6 158:18 159:11 160:3,6,16 | 93:4,17,23 97:7 97:14 147:20 164:15 Haylock's 41:25,25 44:19 93:1 141:3 hazard 103:15,15 129:21 148:2 hazards 38:6 Head 121:13 heading 34:3 headline 130:14 health 5:8 20:5,9 50:9,17 57:19,19 65:20 73:24 74:4 84:17 85:16,21 89:2 105:15 110:19 118:23 121:7 129:16 healthier 76:21 77:1 healthy 76:24 147:8 hear 31:15 39:22 heard 2:5 56:19 68:8 133:2 hearing 11:12 12:8 55:14 103:22 109:12 hearings 101:22 146:14 164:11 heart 68:7 heavily 140:23 heavy 137:1,2 heights 157:24 158:13 held 7:16 123:21 help 42:3 46:7,7,12 47:3 61:22 165:12 helpful 2:7 88:18 106:25 115:22 helpfully 166:7 helps 31:1 134:25 Heppinstall 4:15 4:22,24 5:3,5,11 5:18,23 14:24 | 18:10 21:12 22:3 26:1 31:1 32:2,4,7 56:5,15,20 64:20 69:12,25 103:23 148:7,14 154:16 156:13 157:8,10 157:14,18 158:3,6 166:17,20,22,24 167:1,6,10,17,25 168:7,9,11,19,21 168:24 169:1,6,8 169:12 170:14,16 170:20 Heppinstall's 13:23 heralded 29:2 hereditary 19:24 Hey 137:15 high 23:7,20,24 42:17 44:13 54:12 121:7 124:25 130:1,7 135:19 136:6,7,9 137:6,9 137:22 138:3,9,15 138:16,17 139:3 139:15 140:19,21 144:2 higher 76:5 128:17 135:10 highest 16:25 34:11 34:18,21,24 50:23 highlight 24:18 highly 22:23 80:21 132:6 150:1 Hiroshima 74:6 143:23,24 144:1 hit 38:22 HL 15:13 36:6,18 37:4 62:2 hoc 74:14 Hoffmann 94:15 Hogan 2:17 3:7,12 129:25 170:4 Hogans 2:25 138:21 hold 45:5 | hole 50:7 homework 110:11 hominem 106:15 131:14 homines 18:3 honour 158:10 hook 159:22 Hooper 137:24 hope 29:15 55:15 56:3 57:3,7 87:8 119:22 166:4 hopefully 5:23 44:6 49:25 89:25 horses 135:9 hot 17:20,21 hour 143:14 158:7 housekeeping 55:23 57:1 Howard 64:22 66:13 74:12 133:11 HPA 5:18 HPA's 147:4 huge 124:7 human 20:5 50:9 50:17 51:24 135:3 humans 19:25 24:3 28:7 hundreds 120:7 163:24 hypocentre 113:6 126:17 136:23 hypotheses 14:1 48:1 71:20 93:19 93:21 98:8 hypothesis 13:13 13:18 20:13,24 28:11 48:7,18 49:18 55:8 69:7 79:7,8 80:12 98:20,23 99:2,7 110:17 113:14 132:2 hypothesis-formi... 110:16 | hypothesis-gener... 81:4 96:10 hypothesis-raising 97:8 hypothetical 46:23 <hr/> I i.e 60:23 80:22 95:23 139:6 ICRP 27:13 64:7 67:17 68:5 70:3 71:18,23,25 72:14 74:6 77:24 80:24 89:3,16 91:23 93:12,24 94:1,3,5 95:12,23 97:20 99:9,15 105:14 106:10 107:23 117:10,23 118:4 120:2,12 121:21 121:23 122:2,12 122:17,20 123:6 125:7 128:5,6,18 130:4 136:8,15,23 143:23 144:13 147:17 151:22 160:14 161:10 163:20,25 164:25 idea 61:3 76:25 104:8 106:22 143:25 146:23 158:3 ideas 67:24 68:9 74:19 82:12 identified 5:15 109:22 120:14 identifying 6:8 ignore 37:20 ignored 35:5 122:24 125:10 149:12 ignores 13:11 ignoring 13:19 15:11 27:5 123:15 ii 95:4 |
|---|---|---|---|--|

| | | | | |
|---|--|--|--|---|
| Ikarian 17:17,21 61:1 | 150:15 160:16 164:1 | individuals 50:19 51:1 | Institute 57:18 65:12 | interpreter 92:5 |
| ill-health 38:7 122:13 | included 51:10 86:10 | induced 25:9 | institution 66:7 | interrupted 84:3 |
| illness 39:15 | includes 18:4 24:13 36:15 38:5 91:2 | induces 20:8 | instructed 106:7,8 | intervened 76:6 |
| illustrate 63:8 | including 26:5 38:6 121:13 123:4 | inducted 161:19 | instructions 105:11 | intestine 44:15 |
| imagine 104:8 119:16 | inclusion 151:4,7 | industry 76:23,25 118:4,11,12 145:4 | insufficient 13:1,6 165:20 | introduce 45:6 |
| imagined 116:7 | inconceivable 92:14 | infect 22:7 | integrity 88:4 | invalidate 77:5 96:8 |
| immediate 126:11 126:18 127:19,20 127:22 | incorporated 68:24 | infected 22:7 | intemperate 114:3 114:4,5 | inverse 126:20 |
| immediately 3:10 21:11 | incorrect 72:24 73:16 78:2 105:11 106:11 164:14 | infinite 117:4,5,5 | intend 105:18 | investigate 55:5 104:16 |
| impermissible 15:23 | increase 22:17 58:4 62:23 63:17 108:9 108:11 124:8,9,21 124:22 143:6 150:11 | influences 66:24 67:3 | intended 131:13 | investigation 24:17 27:24 97:14 104:15 |
| implicitly 93:10 | increased 43:15 44:10 51:2,5 109:16 122:13 162:6 | inform 52:8 | intention 12:6 31:1 31:2 | investment 97:19 |
| implied 20:10 67:6 | increases 45:15 108:15 113:4 124:4 150:7 | information 42:10 44:7 71:3,10 88:17 97:1 101:25 102:4 158:5 | interest 25:14 43:4 58:1 89:2 113:17 117:22 119:3 | invisible 122:25 |
| implies 22:22 23:22 23:25 59:14 | increasing 25:17 118:5 | Inge 99:13 | interested 68:12 | invited 67:2 121:14 131:17 |
| imply 67:25 | increasingly 68:24 | ingestion 135:22 | interesting 83:23 113:14 | involve 29:19 |
| importance 3:7 111:25 | independent 50:25 63:1,16,20 108:4 108:24 109:23 111:17 114:18 | inhalation 64:1 149:24 | interim 99:5 | involved 8:18 10:24 69:4 118:17 148:22 |
| important 19:22 34:2 40:12,13,21 41:24 43:2 44:18 47:23 49:3 53:25 54:10 58:24 103:11,18,19 104:12 106:9 136:11 137:8,25 163:6 | index 102:20 103:23 167:12,13 168:5,12,15 | inhale 138:18 | interjection 76:14 | involves 85:4 |
| importantly 138:6 | indicate 14:7 44:14 77:18 81:7 125:1 | inhaled 136:16,18 | intermediate 155:19 | ionising 7:23 8:4,6 8:18,24 9:7 14:6 34:11 50:20 57:21 63:25 79:13 95:18 |
| impossible 115:11 | indicating 84:5 | initial 126:22 128:15 | internal 64:8 69:20 72:1 73:24 74:4 79:12 94:6 95:15 105:15 106:12 122:4 129:17 130:13 134:22 136:13 137:5 144:5 146:24 151:15,22 162:9 163:16 164:1 | ions 64:12 |
| impression 77:8 123:3 | indication 29:22 42:16 96:14 | innocent 115:13 | international 70:12 121:11 | Irena 137:18 |
| inability 44:10 | individual 28:23 85:12 169:19 | inputs 147:15,24 | Internet 1:14 122:9 | Irina 145:3 |
| inaccurate 28:5 | | inquisition 162:16 162:16 | interplay 35:10 | Irish 159:15,17 |
| inadequate 103:9 | | inquisitorial 6:19 | interpret 163:12 | irradiate 139:25 |
| inaudible 48:5 167:19 | | insecure 84:24 122:4 147:21 | interpretation 114:21,23,25 115:9,16 154:17 163:10,15 | irradiated 24:25,25 152:20 |
| incidence 51:6 | | insert 168:12 | international 70:12 121:11 | irradiation 22:23 |
| incidentally 145:6 | | insights 20:8 | interpreted 163:12 | irreducible 45:13 |
| include 88:15 144:14 149:13 | | insofar 29:13 31:20 52:16 74:13 | interpretations 114:19 | irrelevant 41:19 145:24 |
| | | instability 27:17 74:9 | | irrevocable 133:22 |
| | | installations 71:7 | | irritated 165:11 |
| | | instance 124:13 163:8 164:23 | | IRSN 27:14 |
| | | instances 162:5 163:11 | | Island 8:12 9:17,23 10:5,25 38:15,20 39:7 51:12 102:13 127:12 134:24 144:20 148:5,11 |
| | | instigated 78:13 | | |

| | | | | |
|--|---|---|---|---|
| 148:13,23 149:2,5 149:20 153:7 155:19,21 156:5,7 156:12 157:5,17 158:25 159:5,9,21 isolation 62:15 63:17 isotope 83:15 84:9 isotopes 84:4 issue 5:23 16:17,23 40:24 44:8 48:22 50:10 55:7 59:8 61:4,17,18 62:19 68:7 72:11 73:18 73:19 77:7,14,16 86:12 94:11 97:10 99:14 101:11,19 105:19 113:2,3 117:7 118:1 134:13,21 141:6 142:11,23 143:20 146:14,19 147:1 152:7 161:12 165:15 166:8 issues 12:1 58:21 67:1,25 73:22 89:7 90:18 96:18 100:18,23 101:8,8 105:2 106:24 108:22 114:13 136:5 142:12 144:10 items 141:17 | Johnston's 159:7 joint 67:17,19 journal 113:8 judge 94:17 102:11 130:25 141:15 169:6 judges 71:14 judgment 62:9 jumping 142:3 June 1:1 147:2 170:25 jury 94:17 Justice 1:4,23 2:21 2:23,25 3:3 4:14 4:18,23 5:2,4,10 5:15,22,24 6:14 6:22 7:1,7 8:1,22 10:8,12 11:1,13 11:23 12:10,21 13:20,22 14:3 15:18 17:23 18:5 18:7,9,23 19:1,3 19:12,14,18 20:17 20:22 21:5,7,25 22:2,8 27:9 28:4 28:14,17 29:10 30:5,16,20 31:19 31:25 32:5,9,13 32:15 33:6 35:9 35:16,20 36:16,25 37:7,11,14,20,23 38:1 39:5,11,19 39:21 40:14,16,19 41:8,12,17,20,22 43:9,13 45:5 46:1 46:10,16 47:10,13 47:22 48:15 49:1 49:11,17 50:4,15 51:8,16,18 52:9 55:17 56:8,13,16 56:23,25 58:8,17 59:3,6 60:6,8 61:5 61:21,23 62:7,10 62:17 65:7,16 66:19 67:8,14,20 | 69:17,21,24 70:1 70:14 72:16,22 78:25 79:3 80:9 80:14,18 81:11,13 89:22 90:22,24 91:1,5,12,16 94:12 97:25 98:10 98:11 99:12,24 100:4,6,18,25 101:13,18 102:11 102:24 103:4,8,13 104:3,8 106:18,22 107:5,8,11,13,21 109:1,10,13,18 110:1,6,10,20 111:2,8,15,21 112:8,14,22 113:9 113:13 114:1,8 115:17,20,24 116:1,4,12,18,22 117:2,4,12 119:7 119:22 120:13,19 121:25 123:3 130:14 131:22 132:10,17 133:18 134:4,10,14,25 138:19 139:1,10 139:19,23 140:8 140:22 141:2,9 143:8,12 145:14 145:20 146:1 152:9,11 153:1,4 153:11,13,19 154:9,15,18,25 155:4,9,12,25 157:3,9,13,16 158:1,5,7,11,15 160:19 161:4,17 163:1 165:6,12,17 165:23 166:11,13 166:18,21,23,25 167:4,9,15,18 168:4,8,10,17,20 168:23,25 169:5,7 169:10 170:13,15 | 170:18,22 <hr/> K <hr/> Kaldor 32:24,25 33:4,16 82:15 Karl 102:21 117:24 keep 12:15 31:19 53:2 54:17,17 104:7 168:4 Kennedy 168:20,21 kept 28:2 kicked 118:15,24 kilo-becquerels 87:7 kilometre 159:17 kilometres 126:17 127:9,16,17,24,24 127:24 128:9,10 136:22 155:20 kilotons 127:12 kind 18:20 57:12 71:12 74:15 112:4 114:10 126:9 130:21 147:13 kinds 106:11 126:23 knew 126:25 128:12 knocking 67:14 knot 152:19 159:3 159:9 know 6:1 23:11 35:16,18 46:4 47:2 49:4 58:19 70:17 78:23 81:2 81:3 82:18 85:22 97:2 103:4 111:14 113:9,11 115:24 115:25 116:24 119:6 135:9 140:16 141:23 142:12 144:23 145:19 148:24 149:12 154:15,16 158:6 165:6 170:9 | knowledge 25:8,17 70:18,25 86:19 known 68:15 76:20 76:24 82:23 85:6 89:5 129:3 knows 76:15 83:17 102:2 Kuhn 68:12,25 <hr/> L <hr/> laboratories 27:18 28:6,16 lack 60:10 laid 2:11,13 97:25 98:14 141:15 161:21 landed 159:7 language 120:11 121:1,6 large 24:2 44:5 50:25 73:20 80:22 81:21 82:8 94:4 97:9,18 118:12 119:14 120:10 121:6 123:25 124:21 125:21 130:9,11 144:24 150:4 largely 22:15 43:21 larger 43:16 76:10 81:5 129:21 late 99:16 161:22 law 38:21 94:19 126:20 151:6 163:9,11 lawful 110:17 lawyer 134:2 lay 23:21 166:6 laying 100:22 lays 161:18 lead 63:6 81:5 110:18 leading 37:21 leads 112:11 144:17 |
|--|---|---|---|---|

| | | | | |
|----------------------------|----------------------------|-----------------------------|---------------------------|----------------------------|
| learn 53:3 | 42:2 49:21 50:14 | list 35:15 51:9 95:4 | 152:5,23 153:5 | 55:12 91:9 97:19 |
| learned 9:18 10:6 | 52:16,17 53:1,10 | 105:20 150:19 | 156:14 158:19 | 108:12 110:15 |
| 26:21 28:1 29:8 | 53:16,19 54:8,18 | listed 101:9 121:18 | 162:17 | 115:25 117:9 |
| 30:2 32:20 33:2 | 71:11 88:7 90:9 | listen 112:6 | looked 73:21 88:19 | 120:20 121:15 |
| 35:24 38:13 39:3 | 130:2 139:2,5 | lit 105:8 | 114:25 126:16 | 160:13 164:2 |
| 40:2,7 52:11 | 140:19,21 155:19 | literally 120:7 | 158:1 | lots 108:3,3,3 |
| learning 14:4 | 157:18 | literature 60:15 | looking 13:24 | 149:19 162:5,5 |
| leave 12:10 29:6 | levels 10:24 28:21 | 108:24 112:1 | 20:19 23:12 24:7 | loud 46:8 |
| 40:10 71:9 124:9 | 53:12 54:11 71:12 | 121:2 125:25 | 42:8 53:16 78:21 | Lovells 2:17 3:7,12 |
| 139:12,13 147:10 | 87:5 135:11 | 133:10 145:9 | 79:4,5,6 81:25 | 129:25 170:4 |
| 163:4 165:16 | 137:22 139:10 | litigation 27:3 68:2 | 114:24 115:3 | low 20:4 22:24,25 |
| leaves 6:17 74:17 | 147:6 154:8 162:6 | little 23:17 38:14 | 136:8 153:13,16 | 23:7,18,22 25:18 |
| led 17:10,15 117:14 | lever 168:13 | 47:25 56:21 62:11 | 153:17 162:18 | 25:18 27:15 40:21 |
| 119:7 | libbing 37:1 | 70:9 77:14 95:4 | looks 4:24 170:9 | 40:23 41:5,8,23 |
| leeway 106:23 | library 104:10 | 129:14 152:4 | Lord 1:5 11:6 12:3 | 43:5,23 44:7,11 |
| left 1:5 8:10 47:15 | 167:12,14 | 165:10 | 19:17 40:10 55:10 | 44:24 46:3,10,11 |
| 48:12 63:10 84:6 | life 38:6 71:16 | live 30:9 87:4 | 55:22 62:9 76:6 | 46:22 48:4,25 |
| 88:14 147:25 | lifetime 51:3 | lived 108:18 | 94:15 100:5 | 50:1 58:11 64:14 |
| left-hand 22:1 65:9 | light 19:20 36:16 | living 86:24 159:23 | 101:25 103:7,10 | 72:1 73:24 94:6 |
| 154:4 | 133:18 | LNT 27:16 42:1 | 104:17,23 106:21 | 95:14 124:6,11,17 |
| legal 13:24 14:13 | lights 138:13 | loaded 113:10,11 | 107:1 109:9,25 | 124:24 125:5,13 |
| 17:20 94:16 | liked 83:24 | local 144:15,15 | 110:5,22 111:3 | 125:15,23 135:8 |
| legible 57:4 | likelihood 62:16,22 | logic 10:23 11:2 | 114:16 115:25 | 135:11,21,21 |
| length 11:8 24:5,10 | 62:23 63:6,18 | 161:22 162:12 | 116:24 120:18,25 | 136:6,7,10,23 |
| 41:14 48:25 82:4 | 95:17 163:14 | logical 9:24 10:1 | 123:18 132:8 | 137:5,10,12,12 |
| 116:2 | limb 22:5 | 90:7 132:12,24 | 134:12 141:5 | 139:10,15 157:18 |
| lengthy 11:13 | limit 34:15 35:2 | logically 8:3 17:9 | 143:17 145:16 | 163:2 164:13,17 |
| 43:10 89:20,21 | 42:6 90:12 120:13 | long 35:15 114:20 | 147:5 153:17 | lower 43:19 49:8 |
| lens 69:5 | limitations 43:24 | 118:16 128:14 | 155:5 156:13 | 75:19 76:4 147:6 |
| Lesvos 151:18 | limited 31:16 95:21 | 157:11,21 166:18 | 158:9 161:7 164:7 | LSS 89:5,7,12 90:2 |
| let's 10:12 26:1 | 98:20 99:8 152:13 | 169:18 | 165:15 166:9,17 | 91:25 99:14 |
| 36:16 47:2 48:10 | Lindahl 12:1 32:18 | longer 43:16 44:5 | 166:20,22 168:11 | 125:16 143:22,23 |
| 124:9 126:16 | 112:22 | 47:25 55:14 79:23 | Lordship 6:21 | lucky 119:4 |
| 127:16 128:8 | line 10:22 48:11 | 45:2 48:6 54:19 | 96:25 100:21 | lunchtime 59:4 |
| 136:24,25 151:2 | 69:19 79:2,25 | 59:15 61:18 64:17 | 101:6 102:1 | lung 23:18,22 24:2 |
| 152:5,23 158:11 | 88:9,16 89:24 | 65:8,25 73:3 | 105:22 119:18 | lymphocytic |
| letter 102:10 | 157:4 | 77:14 79:1,18,24 | 158:12 166:7 | 132:14 133:1 |
| leukaemia 39:15 | linear 23:7 42:18 | 83:22 89:19 90:18 | lorry 38:15,21,23 | lymphoma 137:19 |
| 45:16,24 46:22 | 42:19 43:21,22 | 96:20 98:6 107:17 | 38:24 | 137:22 |
| 66:22 71:6 123:24 | lines 7:12 82:16 | 108:2 113:24 | lose 90:9 | |
| 124:1,15,18 | 137:11 | 121:1 126:3 | losing 90:12 | <hr/> M <hr/> |
| 132:14 133:1 | link 45:17 50:16 | 127:18,19 128:11 | loss 131:11 | M17 20:19 |
| 137:19,22 145:5 | 51:22 | 137:10 138:9 | lost 103:9 107:7 | M25 20:20 |
| level 10:19 12:18 | links 50:8 | 142:16 143:4 | 137:9 | magical 57:5 |
| 16:20,23 28:22 | lip 27:4 | | lot 14:22 25:22 | main 49:15 105:20 |

| | | | | |
|--|--|---|--|--|
| 121:17 151:13 153:9,25 156:3,9 158:19 169:15 mainstream 72:14 maintain 19:25 maintained 84:20 maintaining 87:16 maintenance 69:3 major 24:24 68:3 92:11 129:24 147:24 163:14 164:7 majority 51:24 70:20 133:8 maker 61:25 114:12 making 15:23 71:18 82:24 90:14 92:12,17 104:17 106:1 112:22 118:13 136:17 138:20 158:15,16 165:7 malformation 140:20 143:7 162:7 malformations 79:12 107:25 108:10,16 109:16 man 88:3 92:23 managed 91:6 manager 65:15 Manhattan 118:22 118:24 manifest 165:2 mankind 52:22 manner 74:15 77:12 122:24 Manson 59:12 map 153:2 maps 129:14,14 march 123:16 mark 8:15 marked 56:6,10,11 marks 72:10 | massive 108:23 mast 37:24 master 155:24 match 76:19 material 6:3 20:25 21:1 43:11 60:17 70:22 104:11 109:6 120:19,21 129:21 132:7 144:11 149:4,24 152:16,20 154:18 159:19,20 materials 87:1 104:20 mathematical 30:12 126:4,9 mathematics 120:4 matter 3:20 34:4 38:22 39:16 42:20 117:22 matters 16:3 38:23 77:20 113:18 140:25 Meacher 119:5 mean 10:14,19 30:20,24 31:19 44:12 49:7,11,23 71:9 99:13 103:4 106:22 111:14 112:5 119:15,20 119:24 121:3 126:15 136:17 137:25 139:1,11 139:12 141:14 143:12 145:17 150:9 151:5 154:18 158:12 165:23,25 means 8:16 14:25 39:5 49:23 80:7,8 152:23 165:6 meant 13:2 71:9,9 measurable 127:15 measure 98:16 154:6 | measured 50:11,18 127:1 measurements 102:1 135:20 137:14 155:15 measuring 9:10 mechanisms 22:17 68:25 74:8 129:4 mechanistic 20:8 43:1 47:20 51:22 52:4,8 55:6 mechanistically 45:3 median 50:21 medical 14:8 30:14 30:16 47:6 52:18 65:11 97:2 135:14 medicine 65:12 66:18 medium 42:17 meeting 102:21,22 121:10 megatonnage 149:4 megatons 127:13 MELODI 164:4 member 76:22 88:23 112:25 142:17,21 members 57:2 114:22 145:18 166:10 membership 67:10 memory 48:20 64:23 mentality 123:13 mentioned 145:3 mentioning 2:9 mere 12:25 13:7,15 14:5 16:19 98:20 merely 95:25 96:9 131:14,18 merit 60:23 71:19 met 14:20 145:6 157:24 metal 137:1,2 | meterological 157:22 method 88:6,8 119:10 120:5 149:8 160:25 161:2,7,19 methodology 88:25 89:7 92:9 108:5 123:6 164:12 methods 44:11 45:16 metre 87:7 metres 127:9 Metzer 3:4 mFISH 2:15 3:16 5:12,13,16,16,19 6:4,7,12 7:4,14 48:21 49:7,13,19 Michael 119:5 microbiology 46:12 microsieverts 139:8 mid 117:17 midday 59:1 middle 38:21 62:11 153:14 military 145:2 Mill 161:3,5,6,21 Miller 23:3 145:1,1 milligrays 58:5 million 85:25 86:3 86:9,9,15,24 87:4 87:10,11 millisievert 136:17 millisieverts 10:20 41:9,15 45:19 46:4 50:22 58:5,6 130:8,9,12 135:13 136:20 137:16,23 138:10,24 139:2 140:4 151:3,10,10 151:18,24 Mills' 161:25 mind 9:16 12:15 28:2 39:22 77:9 | 143:17 168:5 mindset 37:18 72:8 mine 122:8 168:13 miner 23:25 miners 23:20 146:7 minimum 12:18 44:3 45:13 53:7 149:2 151:22,25 163:20 Minister 119:5 Ministry 56:10 minor 62:14 63:17 155:16 minority 119:8 121:4,18 minute 153:12 minutes 55:18 59:3 143:13 154:20 misleading 16:12 43:25 77:8 misreading 39:3 missed 104:11 135:19 misses 160:13 missing 74:19 109:6 144:10 152:5 159:25 160:19 170:17 mistake 73:19 84:16 85:20 87:13 87:15 mistaken 71:24 mistakes 83:8 84:14 misunderstand 94:10 mix 2:8 Mm 140:8 mobile 6:5 mode 169:12 model 18:2,14 21:16 23:2 26:18 27:16 64:7,9 67:18 68:15,19 72:14,21,23 73:5 |
|--|--|---|--|--|

| | | | | |
|--|--|---|---|---|
| 73:12 74:6 77:24 89:3,16 91:23 92:18 93:1,8,12 93:13,15,24 94:1 94:6,9 95:12,23 96:2,6 97:21,24 98:25 99:9,15 105:14 106:10 107:23 117:10,23 119:1 122:4,25 123:6,7,12,21 125:16,17,17 128:5,5 143:22,23 143:23 147:17 149:12 158:18 163:20,25 164:25 modelling 120:5 models 25:10 68:16 96:13 120:5 modify 24:21 moist 129:8 moles 148:4,15,18 148:21,24 moment 5:25 6:9 13:22 21:24 28:8 43:6 48:10 77:7 93:21 134:25 155:12 169:10 moments 6:22 money 117:5 164:3 months 89:13 Morgan 102:21,22 117:24 118:2,14 morning 1:18 45:9 53:25 78:11 168:1 170:21 mortality 51:3,6 Mothersill 2:13 18:4,12 20:11,19 21:14,19 22:4,10 24:13 26:5,8,16 27:7,12,18 28:13 28:20 45:2,3 47:5 47:11 48:16 74:10 151:21 169:22 | Mothersill's 35:12 48:6 motivated 67:11 mounting 72:4 move 11:3 14:10 31:16 40:14 87:20 119:9 145:14 156:23 moved 154:1,11 158:20 movement 157:5 moves 29:5 135:14 moving 36:25 157:13,14 158:20 multicellular 20:7 multiple 44:2 multiplicanda 164:19 multiplied 149:3 multitude 20:6 mutations 138:22 139:8 mystery 169:3 | necessary 12:18 16:3 53:8,15 97:13 101:17 necessitatem 164:19 need 6:18 7:24 9:25 12:15 31:22 33:1 47:4 52:10 53:12 53:13 54:1,21 55:4,5,5 76:9 84:12 87:8 90:8 97:3 101:16 112:15 131:15 136:3 140:13 142:5 147:5 168:22 170:7 needed 97:17 needing 54:17 needs 25:22 76:15 167:16 neglect 71:4,5 negligence 27:2 negotiate 92:7 Neither 95:5 net 131:10 networks 82:25 neutral 82:13 89:14 neutrality 72:11 77:16 78:6 Nevada 127:15 never 16:3 120:11 120:22 129:15 131:10 nevertheless 25:16 36:6,18 37:4 42:11 115:15 135:22 new 10:3 18:11 20:11,23 21:13 27:13,16 28:5 68:9,19 69:6,8 92:22 98:7,19,23 98:25 99:2 124:14 124:19 130:3 140:15 146:13,15 | 150:5 168:15 Newtonian 68:18 nexus 45:23 48:5 Nicholls 62:9 63:22 Nicholson 129:5 night 1:6 3:14 5:15 74:20 105:7 Nobel 66:11 92:24 noise 46:8 non 164:18 non-fanciful 61:8 non-ICRP 120:2 non-irradiated 24:23 25:1 non-legal 57:2 non-paradigm 26:15 non-radioactive 83:15,20 non-targeted 18:12 20:1 21:14 25:14 26:16 non-targeted' 24:4 non-trivial 61:8 normal 95:6 north 159:23 northern 86:10 155:21 note 18:24 31:19 32:17 40:5 59:23 78:9 83:2 noted 30:9 166:15 notice 4:1 noticed 11:13 Notter 96:21 novelty 169:21 NRPB 45:14,14 70:4 71:19,23 nuclear 8:12 9:6 29:24 30:1,2 52:23 54:5 65:12 65:15 71:6 76:23 76:25 118:4,10,11 123:24 124:1 125:20 137:10,18 | 137:20 145:4 nuclides 65:14 144:16 number 1:25 3:23 22:21 24:16 26:4 29:5 43:16 58:21 66:23 67:22 86:5 86:7,9 89:24 95:4 97:9 109:19 119:14 120:10 121:6 123:4,25 149:14 163:11,12 numbering 25:4 43:12 numbers 19:15 93:6 110:20 126:13,14 164:13 numerous 78:4 96:16 99:11 |
| O | | | | |
| o'clock 100:1 166:21,22 170:22 objective 77:19 124:22 162:8 observable 48:13 48:14 observation 7:3,9 73:2 observations 123:22 observed 20:9 22:20 24:1 43:17 observing 125:11 obsolete 105:11 obtain 101:25 102:4 obtained 102:10,19 102:25 136:21 obtaining 104:1,4,5 obvious 9:8 149:18 obviously 58:12 140:22 142:17 Occam's 164:18 occasion 43:12 | | | | |

| | | | | |
|--|--|--|---|---|
| 71:16 occasionally 78:2 occasions 73:9 96:16 103:21 123:4 occupational 52:18 76:19 occurred 80:7 occurrences 122:13 occurring 121:8 occurs 68:25 ocean 159:3 Ockham 161:20 offer 28:20 offhand 74:15,22 77:12 122:24 Office 157:25 official 124:3 offshore 9:17 oh 3:3 18:9 56:25 90:5 136:15 147:3 153:16 165:18 170:14 okay 48:15 51:18 59:4 60:11 66:20 91:17 110:6 111:22 147:10 154:25 165:17 167:23 168:5 170:22 old 18:15 23:1 26:18 68:9 omitted 147:24 149:13,14 once 8:20 32:13 42:22 oncogenic 23:2,8 one's 167:16 168:4 ones 55:15 79:17 102:18 127:11 150:16 ongoing 21:9 58:10 onward 123:16 onwards 33:11 79:15,25 88:9,16 | open 8:10 9:9 open-minded 82:10 operate 22:16 operates 94:19 operating 95:11 opinion 23:11 32:6 54:7 61:7 70:13 77:19 83:12 opinions 59:25 61:13 109:24 opponents' 36:2 opposed 139:6 141:22 opposite 16:9 opposition 144:10 oppositional 116:21 oral 40:18 167:20 orally 45:9 order 12:19 42:8 71:14 87:9 90:9 98:4 135:16 140:2 140:14 141:18 organ 25:10,19 organisation 67:7,9 67:12 organs 25:19 original 1:12,12 3:9 3:9 52:2 69:10 106:5 113:1,2 127:1 originally 102:25 126:22 149:14 161:19 164:16 originated 52:3 ought 89:9 outcome 35:16 outdated 6:13 outer 90:11 outset 134:1,11 outside 5:25 29:16 38:21 88:10,13 132:3 overall 16:2 19:20 62:18 160:12 | overcome 34:6 overconfident 54:21 overgenerous 133:20 overlooked 105:24 152:6 overridden 56:8 overrule 75:8 overthrow 68:20 overthrows 69:9 overturn 80:24 overview 14:15 owing 43:25 Oxford 121:10,10 161:20 <hr/> P P 80:1,2,6,8,16 pace 39:12 page 2:2 11:17,22 12:2,13 18:1,8 19:7,14 20:19 21:22,25 24:11,12 24:13 25:3 26:2 27:8,10 29:2,8 31:17 32:12 34:1 34:2 35:21 40:3 43:11 50:6 56:17 57:13,14 61:24 62:11 65:1,5,24 65:25 66:17 69:19 69:20 70:14 75:14 75:25 79:2,15,25 81:18 82:16 83:10 83:21 84:7 85:2 86:1,12,22 88:9 88:16 89:19,23 93:17 94:13,14,22 94:23 95:3 98:10 103:12 147:3 152:12 161:16 pages 49:9 150:4,4 paid-for 5:21 painting 123:17 | pancreatic 83:5 132:14,19,23 134:16,18,20 135:2 paper 1:7,12,13,15 1:21 8:8 11:22,25 55:12 56:3,6 76:18 81:14,17,19 82:4 89:12 92:7 92:15,17 107:6,16 107:19,19,22 109:3,19 112:10 112:11 113:2,9,12 113:21 114:6 119:17 122:18 128:21 139:4,5 145:10 167:17 papers 1:8,9 3:18 4:7 47:18 52:6,7 54:19 56:22 65:21 66:23 79:16 99:11 108:3 109:2,8,10 109:11,14,15,20 109:21 110:6,9,10 110:15,21 111:12 111:17,19 120:25 121:7,15 122:22 123:25 133:9 137:24 143:6 163:13 paradigm 18:11,15 18:16 20:12 21:13 26:18,19 27:16,23 28:6 68:9,18,20 68:22,24 69:2,4,5 69:10,11 72:5,7 72:15 97:10,12 98:19,23 paradigm' 27:13 paradigms 68:8,11 paragraph 4:17 11:18 12:2,13,23 14:21 15:18 16:5 18:6,8 19:5 21:22 21:23,25 24:14,20 | 25:5,6,6 26:7 27:8 27:9,10,11 28:2,5 29:8 31:17 32:12 32:16 33:11,15 34:4 35:25 40:6 43:14 45:10,22 61:24 62:10 94:13 94:22 95:3 98:9 98:14 paragraphs 4:16 14:10 156:14 parents 108:17 Paris 145:6 parity 170:5 Parker 29:9,11 30:14 31:21,22,25 35:16 46:19 57:15 82:15 102:9,16 Parker's 31:4 35:14 45:11 part 5:16 18:6 24:2 26:7 35:2 40:22 41:19 46:17 54:13 69:4 73:20 89:1 89:13 92:20,23 94:5 100:14 111:6 111:13 138:21 139:4 141:5 145:15 154:6 156:8 159:3 164:6 parte 98:15 particle 23:23 66:1 particles 23:5 85:5 106:12 129:10 138:5 140:6,11 144:15 160:5 particular 20:3 39:25 44:10 45:12 50:21 51:23 53:10 68:17 76:16 83:1 83:22 89:1 97:10 115:10,15 122:20 127:10 142:1 164:23 particularly 4:17 |
|--|--|--|---|---|

| | | | | |
|--|---|---|--|--|
| 20:5 43:19 59:13 90:3 136:13 particulars 165:9 particulates 138:18 156:4,11 158:21 158:24 parties 98:13 parties' 170:2 partly 88:1 parts 17:9,10 149:20 pass 105:7 passage 47:17 passages 13:4 42:25 53:24 115:20 passed 89:6 passes 16:21 passing 50:2 83:2 154:2 Pathologists 66:21 pathology 66:21 pathway 160:20 pathways 64:6 patience 166:9 patients 44:13 pause 32:14 56:25 69:18 81:8 107:7 143:19,21 155:12 pay 20:3 paying 27:4 Pearce 45:15 124:13 peer 60:14 65:21 99:11 106:9 112:1 120:8 121:6 125:25 133:10 145:9 pension 38:17 39:1 132:15 133:15 134:19 pensioner 17:2 pensions 151:7 penultimate 93:9 98:14 | people 8:17 10:3 27:22 52:24,25 54:12 74:5 85:1 86:24 87:4 90:8 90:11 108:12 111:11,12 113:25 115:7 118:17 119:2 121:20 122:7 124:15,17 127:25 128:7,13 128:20 136:22 137:19 138:18 141:23 149:19,20 149:25 159:23 people's 137:13 149:18 perceived 78:16 perfectly 113:16,20 performing 44:1 period 68:20 98:22 99:5 108:6 156:6 159:1 person 26:12,13 71:15 92:6 114:18 115:14 117:19 118:21 personal 47:14 113:18 134:25 personally 33:6 75:10 93:2 123:3 personnel 76:21 82:12 persons 23:18,20 67:11 persuade 68:4 persuaded 48:2 PhD 67:1 83:17 142:23 PHE 27:14 Phelps 1:7,13,15,16 1:17,21 2:2 11:21 56:2,3,5,17 phenomenon 27:25 48:13,14 159:13 162:3,4,10 | philosopher 161:20 philosophical 161:24 philosophy 58:22 163:18 phones 6:5 photoelectron 74:11 physical 83:18 physicist 65:11 92:20 physicists 92:25 physics 65:3,9,18 65:20 66:1,4,6,12 68:19 pick 1:5 59:1 picked 1:24 2:25 63:9,12 115:21 picks 129:10 picture 21:9 123:17 155:16 piece 13:24 96:1 105:18 pieces 91:24 125:11 141:7 164:10 pile 51:15 ping 131:1,1,8,8 141:6 pinged 131:9 Pittsburgh 117:21 pivotal 146:14 place 9:13 122:10 138:12 placed 127:3 places 1:25 5:20 plan 153:13 154:22 157:3 plants 149:9 platform 129:25 plausible 48:17 72:4 98:24 play 24:2 36:22 41:15 43:4 plead 35:6 165:8 pleaded 4:1 | please 6:5,6 18:20 18:24 21:21 34:1 45:7 57:13 69:17 120:20 138:2 plenty 73:9 plutonium 159:14 160:5 pm 100:10,12 155:1,3 170:23 point 4:1,14 6:14 6:20 8:4 9:15,21 11:15,16 16:15,25 17:1,23 20:13 29:16 30:6,22,22 35:21,22,23 36:11 37:9,10 38:1,2,4 38:14 39:24 40:3 40:17 42:1,12,25 44:20 46:6,21 47:24 49:15 50:14 52:19 55:8,23 57:1 60:10 71:17 75:11,18 78:5,7 78:20 90:14 92:11 93:9,12 98:24 104:5,6,17,22,25 105:24 108:11 109:25 110:13,18 111:3,15,20 113:25 114:2,15 116:18 122:17 123:18 128:7 129:20 130:9,20 130:20 131:12 133:25 136:4 137:8 140:5 141:11,13 143:9 145:19 147:12 148:16 154:2,21 154:22 158:6,16 160:10,17,20 163:1,7,13 164:7 pointed 17:19 29:1 74:10 96:7 106:20 110:14 118:3 | 143:25 146:6,22 pointers 51:10 pointing 74:23 points 34:2 55:23 58:21 59:2 78:4 78:13 116:2,5 158:15 166:3 politically 67:11 pong 131:1,2,8,15 141:6 poor 147:22 pops 147:16 population 20:5 75:21 76:10,12,14 76:15,17,22 77:1 77:4 81:14 86:8 86:13 87:9,11 89:5 147:7 population-based 81:20 populations 79:21 posed 34:15 35:3 position 14:12 88:1 91:18 97:23 115:15 116:11 124:11 125:23 133:19 134:3 156:23 170:10 positively 47:3 posits 27:14 possession 6:3 possibilities 14:17 15:11 34:25 35:8 61:19 62:4,6,20 62:25 63:15,16,19 63:21 64:13 72:16 94:4 95:2,9,21,22 98:3 163:22 possibility 6:17 9:22 10:2 12:25 13:2,7,8,12,15 26:23 45:23 46:13 46:22 47:1,5 49:22 73:8 96:15 125:12 142:20,20 |
|--|---|---|--|--|

| | | | | |
|---|---|--|---|--|
| 163:14,23 possible 34:11,18 34:21,24 35:13,14 35:19 48:1 63:8,9 63:10,11,12,13 64:7,9,11 73:9,10 87:10 124:24 144:22 147:14 151:17 possibly 28:1 42:18 86:15 113:6 122:4 131:5 posters 67:12 postulated 68:25 potential 5:19 43:25 96:6 134:11 potentially 38:8 68:21 96:5 148:2 power 46:10,11 52:23 54:5 162:14 PowerPoint 129:15 practical 52:15 53:15 praeter 164:19 preceded 68:20 precisely 69:1 72:7 98:1 precision 43:15,24 predicated 95:22 predictability 123:6 predicted 27:15 155:20 predicting 105:15 predictions 120:4 predominantly 152:17 preempts 97:24 preface 40:20 prefer 60:4 82:11 preferred 97:21 premise 72:20 prepared 1:10 87:23 91:2 155:6 presence 103:16 | 104:20 present 14:3 25:8 46:3 49:21 52:2 54:1 55:15 71:10 101:6 116:4 presentation 58:25 presentations 154:7 presented 97:1 112:1 113:3 121:15 134:7 144:23 presently 6:3 53:12 press 67:13 68:14 pressed 86:11 96:13 pressing 12:16,20 pressure 118:4 presumably 80:19 129:18 pretty 138:20 143:18 prevent 118:5 previous 2:18 11:11 12:15 89:9 101:22 102:11 130:21 132:22 principally 144:11 principle 151:18 163:8 principles 163:17 prior 17:9 35:5 124:23 prism 122:20,20 125:10 privileged 4:7 56:12 Prize 66:12 92:24 probabilities 10:10 27:3 44:21 93:25 95:7,13 probability 13:8 15:1,16 16:7 37:19 46:15 64:14 probably 9:19 | 58:25 84:12 85:7 100:5 101:17 116:25 117:19 143:8,15 145:11 149:3 probative 48:4 problem 81:22 112:9 113:23,24 115:4 135:8 144:13 problems 68:5 92:3 96:7,7 99:14 107:23 132:12 procedure 77:17 169:5 procedures 164:14 proceedings 2:19 2:21,22 3:9,10,15 20:16 56:11 58:20 104:14 proceeds 68:10 process 24:2 49:2 60:20 97:24 98:5 104:9 116:21 132:7 164:4,4 processes 22:16 produce 86:21 88:20 126:19 produced 88:18 127:6 148:5 152:2 153:2,22 166:6 produces 118:12 producing 3:18 production 148:22 149:8 professional 66:1 professor 1:11,22 2:4,13,15 3:10 4:2 4:12,25 6:11 7:3 18:4,12 20:11,19 21:14,19 22:4,10 24:13 26:5,8,16 27:7,12,18 28:13 28:20 29:9,11 30:14 31:4 32:24 | 32:25 33:4,16 35:12,14 40:25 41:1 45:2,3,11 47:11 48:6 49:5,6 56:2 57:15 64:25 65:2,17,24 66:3,5 66:7,8,10,13 69:13 70:2,8 71:17 73:25 74:10 74:12 78:8,10 79:16 82:13 83:7 84:24 85:14,19,24 87:15,17 89:11 92:4,8,12,15 96:20 107:3,19,22 108:13 110:24 111:4 112:24 113:17 117:20 118:19 122:18 124:7 126:1,2,6 127:17 128:24 129:13 133:11 137:1,17,24 138:5 140:18 142:7,16 142:20 143:1,1,24 145:1,1 147:20 151:21 169:22 professors 64:21 82:15 profile 54:1 progress 32:9,11 58:13 progressively 156:6 159:1 project 29:22 57:18 57:23 81:23 118:22,24 164:4 prolong 47:22 promise 158:9 promote 67:20 promoting 72:24 proof 58:22 59:13 60:9 93:10 94:11 95:11 proper 74:24 | properly 9:11 17:16 138:2 proportion 87:8 159:6,19 proportional 163:10 proposed 23:1 proposition 17:7 52:11,23 97:3 103:5,8 114:11 116:12 propositions 8:13 45:12 111:18 120:15 131:24 propounded 18:11 21:13 26:15 prospect 100:7 protection 5:8 105:12 150:20 151:8 protocols 92:22 protracted 22:18 protraction 22:13 22:15 prove 36:4,6,8,18 37:4,8 54:11 proved 94:16 96:18 proves 53:17 provide 20:7 43:3 44:7 50:19 96:14 115:23 150:16 provided 1:16 166:1,2 provides 83:4 providing 77:19 provisional 135:1 publish 145:13 published 47:18 60:14 65:21 66:22 66:23 67:3 68:13 71:1 85:21 92:7 126:11 145:8 punch 50:7 purely 30:12 purpose 41:8 53:4 |
|---|---|--|---|--|

| | | | | | |
|--|---|---|---|--|--|
| 53:14 68:2,3 105:10,25 170:6 purposes 42:20 43:6 52:18 push 33:4 157:20 pushing 117:12 put 4:5 5:7 7:11 8:25 9:3,24 11:4 11:10 13:4 15:6 23:12 25:24 40:16 41:11,15 46:5 48:10 55:8,12 59:11,16 69:13,17 73:6 79:25 84:10 88:2 89:24 96:17 99:2 103:23 104:24 109:25 111:15 122:8 125:19 126:23 131:16 133:17 142:24 148:10 150:7,17 152:1,25 155:7 156:8 165:8 165:21 168:6 puts 129:14 putting 33:3 105:25 124:25 135:17 | 148:25 149:4 quantum 15:1,5,15 16:4,6 question 4:9 8:15 9:9,16 10:6 11:5 11:19 17:9,25 21:7 38:17 46:17 46:24 49:24,25 51:14 59:21 64:21 67:15 68:21 72:10 80:6,11 81:19 82:5 83:12 84:10 85:3 89:25 90:1,5 90:7,16,20 110:11 132:25 133:21 142:5,14 146:11 146:19 147:2 150:10 152:1 questionable 163:20 165:3 questionnaire 81:24 questionnaire-ba... 81:23 questions 24:16 25:22 28:10,11 33:1 45:6 55:11 75:16,21 89:7,10 90:16 141:4 quite 4:19 11:13 16:9 36:23 58:20 67:25 73:1 75:8 79:10 86:6 89:20 89:20 101:2,15 103:4 105:7 113:10 114:1 115:13 116:16,22 119:12,16 120:20 122:3,12 126:1,5 127:10,13,18 128:22 129:3 131:11 133:17 148:20 149:18 154:10 157:21 quote 62:12 78:24 | 82:15 89:20 94:14 96:23 quoted 62:10 69:22 quoting 78:22 | <hr/> R <hr/> R 98:14 Rabbitt 140:16,22 radar 47:21 Radford 118:19 radiation 7:23 8:4 8:6,11,18,24 9:4,7 9:20 10:4 14:6 18:17 19:23,25 20:7,8 22:14,19 24:17,22 25:14 26:20 28:22 34:12 39:12 42:2,18 44:24 48:7 49:20 50:13,20 51:2,21 52:16,17,20,21 53:3,19 54:4,13 54:18 57:21 63:25 65:19,19 66:2 72:2 73:25 74:5 79:13 84:1,17 85:1,4,10,13,16 89:2,12 91:19 94:7 95:18 105:12 112:17 113:7 118:23 121:13 124:5,23 126:11 126:12,18,19 127:2,2,5,14,19 127:20,21 128:1,2 128:3,9,15 129:17 135:2,9,11 137:7 140:1,4,12 146:8 151:19,23 162:9 radiation-associa... 113:5 radiation-induced 38:8 radio 154:8 radio-iodine 86:14 | radioactive 65:4,10 65:14 83:10,13,14 84:5,18 87:1,6 103:15 104:20 134:23 152:14 155:17 radioactivity 138:16 144:5 154:6,11,12,13 157:1,20 radiobiologist 48:18 radiobiology 32:18 32:21 radiogenic 39:14 83:5 132:19 133:4 133:7,12 144:17 radiogenicity 132:25 169:24 radiological 154:3 radionuclides 122:5 129:19 136:13 137:6 146:24 radiotherapy 44:13 radius 153:22 radon 23:19,21 24:3 rain 74:5 128:16,16 128:20,22 129:13 rainout 129:6 144:1 raise 13:1,7 15:2 67:5 78:13 97:10 97:11 98:21 99:3 117:20 132:20 133:7 134:13 raised 3:20,21 11:5 12:1 25:23 28:10 28:11 35:22 37:9 40:3 58:21 61:20 77:10 99:4,13 101:8 134:1 142:11 143:24 147:1 152:7 160:8 | raises 24:16 33:1 61:9 96:18 105:3 146:17 raising 8:15 10:1 12:25 13:8 61:12 range 20:6 23:21 43:22 51:2,5 95:22 rate 23:22 32:23 rates 23:8 25:18 126:16 ratio 23:17,21 149:4,5 rational 9:13 raw 55:7 154:18 Rayner 75:15,16 147:1 razor 164:18 re-examination 148:7,11 re-opened 3:23 re-visit 40:8 reach 34:20 44:21 reached 99:6,6 reactor 65:15 read 13:22,23 31:25 37:3 45:8 45:13 59:14 62:8 66:19 74:15 82:3 82:5,9 86:18 89:21 91:1,4,5,8 109:3,7 115:25 116:8 121:25 122:6 reading 33:9 45:11 56:7,14 75:17 81:17 167:20 ready 170:20 real 27:25 33:3 34:5 53:15 54:23 67:9 74:18 110:18 123:23 124:9,10 125:11 126:10,13 159:12 168:3 realised 131:13 |
| <hr/> Q <hr/> quadratic 42:19 43:22 qualification 42:21 47:9 qualifications 30:14 66:16 qualified 26:24 66:18 quality 5:12 24:16 quantification 16:20 quantify 144:8 quantities 64:4 149:1 quantity 85:6 120:24 144:19 | | | | | |

| | | | | |
|--|---|--|--|--|
| <p>reality 38:8 82:24 really 61:1 71:5 74:15 80:22 87:10 90:18 91:14 99:20 114:15 116:16 117:21 119:17 125:3 126:4,8 137:16,23 138:10 139:13 143:8 154:14 reason 7:9 34:13 39:5 40:13,21 77:6 120:21 128:12 133:25 141:23 reasonable 8:17 10:2,23 13:1,7,9 13:13,18 14:18 15:2 16:21 25:9 36:4 37:5,12,19 37:21 47:1 59:19 61:9 62:5 63:18 64:15 95:2 97:11 97:11 98:7,16,22 99:3,4,18 132:20 133:7 reasonably 85:22 89:14 reasoning 13:19,24 14:22 reasons 7:7,24 17:12 34:21 61:10 61:12,14 117:10 164:22 recall 15:7 32:25 77:7 170:8 received 63:25 64:2 64:3 78:12 108:18 132:20 134:21 136:19 152:13 recognised 3:17 10:16 23:11 54:15 recognising 54:10 recognition 33:15 33:17</p> | <p>recollecting 148:10 recollection 49:11 49:12 recommends 20:2 reconcile 24:15 reconstruction 5:13 record 9:1 18:19 recorded 12:24 15:18 32:13 116:15 155:15 156:24 rectum 44:15 red 48:11 138:13 153:14 154:2 reduce 60:21 reduced 71:11 127:5 reduction 22:14 Reefer 17:17,22 61:1 refer 101:16 105:21 120:16 160:23 168:10,18 reference 1:6,24 11:4 18:14 24:13 25:25 26:13 35:6 57:24 62:1 68:11 75:9 83:10,21 88:15 93:17 96:22 107:7 145:10,12 references 55:4 79:1 101:2 107:16 107:18 108:2 referred 3:11 4:7 10:7,17 51:12 52:6 86:20 113:12 120:14 121:6 130:25 132:4 146:20 160:22 164:5 referring 26:6 57:15 120:24 refers 22:5 98:18 143:5</p> | <p>reflected 20:25 21:4 reflection 14:5 58:14 refresh 64:23 refusal 75:1 refuse 123:19 refused 91:11 105:1 refusing 123:14 refute 105:5 Regan 128:24 regard 52:10 60:17 60:25 78:14 91:21 115:11 117:7 160:12 regarded 60:19 regarding 105:19 Regardless 89:11 regards 13:15 region 86:10 159:17 regretfully 17:14 reiterates 95:3 reject 22:10 rejected 12:22 13:17 15:4 16:14 20:12 22:9 34:9 61:15 69:8 rejection 61:11,13 relate 78:14 related 50:11 84:1 84:2 100:23 137:24 146:23 162:3,11 relates 62:24 75:13 85:17 103:16 138:6 relating 18:12 21:14 58:21 64:17 142:13 relation 2:15 7:12 7:14 27:2 29:23 31:17 32:18 35:10 relationship 125:15</p> | <p>relationships 43:19 relative 102:17 147:7 relatively 4:12 68:17 release 102:3 releases 67:13 relevance 51:20 73:15 98:7 relevant 33:23 47:1 50:10 59:18 60:14 62:17 77:18 80:21 100:23 106:9 119:12 144:3 146:3 154:14 reliability 4:9 6:7 7:3 reliable 14:19 17:10 18:16,16 26:19,20 36:4 84:22 95:1 140:23 reliance 4:25 162:14 relied 31:10,10 64:7 relies 9:19 32:17 89:17 107:20 rely 5:5 31:3,24 47:5,11 111:11 116:9 132:5 165:21 relying 31:22 remained 123:7 remains 18:15 24:22 26:18 64:7 132:1 remark 19:10 remarks 4:12 19:14 61:21 78:19 remember 2:1 52:14 58:2 112:22 167:11 remembering 7:15 8:13 remind 1:25</p> | <p>reminded 165:18 remit 93:6 removes 55:1 repair 22:16 repeat 62:2 106:21 repeated 83:16 84:20 86:9 repeatedly 82:22 repeating 5:11 repetition 34:8 106:25 replace 93:16 replication 20:4 reply 105:1 167:2 170:6 report 2:1,2 4:10 7:9 19:6,11 20:17 21:1,4,8,10,20 24:6 25:16 28:9 35:7 43:7 48:20 49:9,16 50:2 57:17,22 73:18 75:17,18 87:2 91:1 92:1,5 113:1 113:2 117:14 119:8 120:16 121:5,5,19 123:5 141:3 150:2,17 151:1,13,14 156:14,16,17 157:7 160:9 161:15 reports 20:18 74:1 74:3,7,13 78:5 89:11 94:2 105:16 115:6 120:8,11,14 150:3,15 representation 3:2 representative 76:10,15 102:5 represents 52:12 reproduce 141:2 reputed 48:18 require 12:20 19:23</p> |
|--|---|--|--|--|

| | | | | |
|----------------------------|-----------------------------|----------------------------|---------------------------|----------------------------|
| required 34:22 | responsibility 15:15 | riding 135:9 | 109:16 112:17 | runs 38:15 |
| requirement 35:5 | responsible 32:5 | right 3:6 5:4,18 | 118:5 119:1 122:4 | Russian 86:11,25 |
| requires 16:18 | 92:21 155:22 | 6:14 8:2,14 10:21 | 122:25 125:17,17 | 87:5 120:11,17 |
| 94:16 | rest 12:10 168:21 | 12:11 14:13 18:9 | 128:4,5 151:19 | 121:1,6,14 |
| requiring 97:19 | restricted 43:23 | 25:4,5 28:24 | 160:14 | Russian-speaking |
| research 20:2 | result 22:15 25:13 | 30:16,19 33:6,14 | risks 23:18,22 | 121:12 |
| 24:12 27:19,22 | 38:18 70:24 79:13 | 36:24,25 37:7,20 | 34:14 35:2 38:8 | Russians 121:12 |
| 33:19 46:12 54:11 | 80:21,22,22 115:8 | 39:2,19 41:20 | 44:12,16 51:6 | |
| 55:5 58:11 65:13 | 118:13 152:16 | 46:16 48:3 51:18 | 72:1 | S |
| 65:15,18 66:24 | 162:18 | 52:9 56:13 57:7 | road 38:21 | safe 52:16,17 53:1 |
| 67:22 70:23 92:19 | resulted 77:8 | 60:19 69:2 70:2 | robust 11:18 93:16 | 54:8,16,18 94:6 |
| 107:4 126:13 | resulting 43:16 | 73:12 74:16 76:7 | rock 37:21 152:2 | safety 53:22 123:20 |
| 164:3 | results 22:14 24:15 | 80:18 87:17 97:22 | 161:23 | Sage 167:2,6,7 |
| researchers 71:21 | 32:6 50:16 58:11 | 99:24 100:25 | role 6:19 24:24 | sailors 7:17 9:2,17 |
| 108:4 | 75:22 125:1,4,5,6 | 101:18 107:1,5,11 | 36:7,9,19,22 37:6 | sake 10:12 41:9 |
| residential 23:19 | 136:21 145:8 | 107:13,14 109:13 | 37:12 77:21 114:9 | 135:12 |
| residual 46:20 | 147:18 150:8 | 110:1 111:2 | 116:4 | samples 2:7 11:5 |
| 134:23 155:17 | 155:15 | 117:11,16,23 | room 94:18 | 11:16,19 |
| resigned 117:25 | resurgence 25:13 | 118:22 130:10,15 | Rosenblatts 2:20 | satisfied 95:1 |
| 118:14,19 | retained 170:9 | 134:9 143:11 | 2:23 3:5 101:25 | satisfy 62:15 |
| resist 146:5 | retaliation 167:5 | 146:1,4 151:11 | 103:1 | saturation 22:24 |
| resolve 44:8 | retired 118:14 | 152:11 153:12,20 | Roth 140:17,22 | save 116:2 |
| resources 117:4 | 122:2 | 154:18 155:4 | 2:23 3:5 101:25 | saw 28:8 43:1 46:1 |
| respect 16:13 27:20 | retrospective | 156:1 158:16 | 103:1 | 102:20 129:23 |
| 35:24 59:23,25 | 139:20 | 162:19 166:13 | round 1:17 20:24 | Sawada 64:22 |
| 61:1,2,10 72:10 | return 61:4 147:1 | 168:25 169:10 | 37:14 53:6,17 | 65:24 66:8 89:11 |
| 92:13 95:11 | returned 83:19 | right-hand 21:22 | 54:25 | 92:12 112:24,25 |
| 106:20 109:1 | revealed 41:2 | ring 167:8 | route 4:3 41:22 | 113:17 126:1,6 |
| respected 23:12,13 | reverse 59:17 | rise 10:23 14:18 | 152:5 | 127:17,23 128:21 |
| respects 88:5 | review 109:19,22 | 154:25 167:10 | routes 144:11 | 129:13 130:10 |
| respond 64:19 | 110:1 112:1 | rising 6:21 | Rowland 1:11 2:4 | 136:21 138:5 |
| 130:17 | 125:25 133:10 | risk 13:6 15:1 16:4 | 5:1,9 6:12 11:25 | 142:7,16,20 143:1 |
| responded 97:7 | 145:9,10 147:4 | 16:19,20 18:14,17 | 33:10,12 50:12,16 | 143:24 |
| 106:3 130:20 | reviewed 60:14 | 19:23 21:16 25:10 | 50:19 75:5 124:20 | Sawada's 92:4,8,15 |
| respondent 105:1,4 | 65:21 70:3 99:11 | 25:12,15,19 26:17 | 139:19,24 | 126:2 130:10 |
| response 1:11,12 | 106:9 120:8 121:7 | 26:20 27:15 34:3 | Rowland's 1:10,22 | 143:20 |
| 1:22 3:16 5:9 | reviewing 21:2 | 44:4,9,10,25,25 | 56:2 | Sawant 23:3 |
| 22:23 24:24 39:15 | 109:19 | 44:25 46:22 48:8 | Royal 66:20 | saying 3:16 7:25 |
| 43:18 70:8 78:16 | revised 106:5 150:5 | 51:3 53:12 54:1 | rubbish 96:10 | 15:9 16:23 20:10 |
| 112:4 131:3,4,5,5 | 166:1 | 58:4,6 64:7,9 | rude 11:7 | 20:12 21:4 22:3,9 |
| 131:5,6,9 133:20 | revision 53:13,13 | 65:19 70:3 71:14 | rule 6:11 54:3 | 26:3 27:21 38:11 |
| 133:24 135:3 | revisited 54:17 | 72:14 91:23 92:18 | 60:13 94:16 | 39:9 40:20 42:14 |
| 155:7 | Revolutions 68:13 | 93:1,8,12 94:5 | 131:18 | 46:2 50:14 53:9 |
| responses 20:4,7 | rework 36:16 | 95:12,23 99:9,15 | ruled 60:5 | 53:17 54:1,4,7 |
| 24:18,22 81:24 | | 105:14 107:23 | rules 17:18 77:17 | 60:25 80:20 91:11 |
| | | | run 63:8 96:3 | |
| | | | running 138:12 | |

| | | | | |
|--|---|---|---|---|
| 108:19 111:11 114:3 116:16 125:3 134:17 135:18,25 137:4,4 137:17 139:7 159:2,6 says 18:10 21:12 22:11 27:11 31:18 32:16,23,25 35:19 35:25 53:2 57:15 61:24 62:12,13 65:8 66:15 71:13 80:2,13,14 81:11 82:2 86:1 87:3 93:18 95:4 98:12 103:11,12,14 110:25 118:7 124:8 147:3,25 152:12 154:3 155:14 158:23 162:19 163:7 SB 168:8 SB1 61:22 64:24 65:6 66:13 SB1/110 94:14 SB1/2.10 152:8,10 SB10/163 161:3 SB11 2:1 50:3,4,5 SB13 152:24 SB13/37 155:11 SB13/40B 152:25 SB18 168:7,15,15 SB19 11:16 170:4 SB21 18:21,25 25:24 43:8 SB22 5:8 57:24 87:3 103:24 SB22/11 102:23 SB24 56:1 SB6/89 107:10 SBs 104:10 scale 50:25 97:7,9 scans 52:25 54:5 57:21 58:8,9 sceptical 81:17 | scepticism 83:17 Schmitz 64:22,25 65:2 69:13 70:8 71:17 73:25 99:13 107:3,19,22 108:13 110:24 111:4 122:18 143:1 science 42:12,23 43:2,6 44:23 46:12 47:6 49:21 58:22 64:18 67:24 68:10,15 70:18,19 71:19 72:5 98:8 119:10,14 145:22 145:23 146:1 161:11 162:12,12 162:14 163:18 sciences 43:4 121:14 scientific 10:15 14:12 22:9 23:14 26:9,14 42:21 55:1 59:24 60:3 60:13,15,19 61:7 64:18 67:22 68:4 68:13 69:14 70:5 70:12 72:8 73:5 74:19,24 83:1 89:12 93:2,14 94:9 95:10 98:19 99:21 101:7 108:24 109:23 111:18 113:2,7 115:12 119:10,15 119:17 121:22 122:2,6 123:16 133:9,14 160:25 161:2,7,19 163:13 scientifically 18:15 26:19 60:1 72:25 92:6 scientist 78:21 79:5 82:10 85:20 92:13 114:18,20 134:2 | 142:22 scientists 5:18 54:15 67:23 68:6 69:4 70:20,21 72:23 106:17 108:21 131:20 132:3 145:17 151:21 161:8 163:24 score 95:5 Scout's 158:9 screaming 138:12 scrupulous 87:21 Scylla 37:24 se 114:9 sea 88:5 129:8 144:12 152:17,21 155:20 159:8,15 159:17,17,24 sea-to-land 64:2 144:11 152:6 158:17 159:11,16 160:3,10,18 seashore 144:13 seawater 152:15 second 4:4 10:7 16:6 35:2 46:16 57:1 104:25 113:15 138:21 142:4,18 150:3 secondly 7:21 132:19 149:14 160:14 secret 102:8 Secretary 1:15,20 2:11 3:19 8:25 9:3 12:8,16 13:14 13:19 14:11 15:8 17:19 19:9 27:1 33:10,24 35:5 37:17 53:6 54:14 67:6 101:21 102:3 106:3 107:9 111:6 121:23 122:2,6 131:13 132:12,15 | 132:18 142:11 147:12 154:7 section 11:17 19:5 21:20 25:2 26:3 45:10 155:13 sections 78:23 secure 96:19 150:13 see 2:3 6:1 25:5 26:1 28:18 29:17 30:20 31:9 33:2,7 33:10 40:9 48:9 50:12 53:5 65:25 76:2 80:23 83:24 84:10 107:18 108:2 112:5,25 114:6 122:10,19 123:2,19,19,21,23 124:14,19,19,20 128:11 131:2 132:11 136:5 139:18 143:16 152:23 153:5,8,20 154:1,10 157:19 158:21 159:21 167:21 seeing 115:10 seek 4:6 5:17 45:6 68:3 seeking 26:12 33:4 seeks 27:13 seen 11:25 15:25 56:21 68:23 79:17 88:11 96:3 115:18 117:24 122:22 157:3 seeping 144:16 select 114:21 selected 147:6 selection 114:20 124:19 selections 104:11 selective 109:4 self-consistent 155:16 | self-induced 129:6 self-reporting 140:24 self-selection 140:24 Sellafield 5:20 29:22 159:15 160:4 senior 118:21 sense 3:2 36:21 67:10,16 75:12 91:9 113:18 119:19 123:13 sent 168:11,15 sentence 13:24 14:3 18:10 21:12 26:6 30:17 37:2 57:15 separate 63:1,20 101:15 separately 49:17 64:16 sequences 100:23 serious 84:16 92:17 107:23 seriously 23:24 72:1 118:10 service 16:24 27:4 38:17,24 59:21 76:21 79:14 81:16 95:19 services 92:4 set 3:9 14:19 31:20 35:6 84:4 106:4 114:19 140:12 150:13 152:17 161:24 sets 150:5 setting 15:22 92:21 110:12 120:22 shabbily 165:3 Shackletons 154:5 154:12,13 157:1 share 67:16,19,23 shared 146:16 she'll 58:25 |
|--|---|---|---|---|

| | | | | |
|--------------------------------------|---|----------------------------------|---------------------------|----------------------------|
| shielding 127:4 | sieverts 85:6,8 | skewed 78:15 | 110:8,19 116:20 | 139:15 144:7 |
| shift 68:19 69:11 72:5 | signalling 105:9 | slight 57:11 | 118:16 120:3,6 | 147:21 164:10 |
| ship 105:8 | signed 151:20 | slightest 77:4 | 121:19 122:23 | SSD's 59:13 60:25 |
| ships 74:20 105:7,8 138:11 | significance 44:2 | slightly 77:3,12 79:23 | 130:4 138:1 | 64:5,19 77:22 |
| shop 63:10,11 | significant 58:4 70:12 113:23 | slips 84:15 | 159:21,22 | 78:6 92:1 93:5,10 |
| short 6:24 48:20 | 124:21 144:22 | sloppy 38:14 | sorts 56:6 127:3 | 94:2 95:10 106:7 |
| 55:20 59:10 79:17 | 145:5 148:2,19 | small 2:6 43:25 | sought 82:22 110:3 | 107:2 124:11 |
| 100:11 152:12 | 149:13 155:23 | 44:15,17 63:16 | sound 70:4 123:8 | 152:3 |
| 155:2 | 160:2 | 78:22 79:21 80:20 | 150:12 | St 121:10 |
| short-circuit 4:15 | significantly 121:7 137:21 149:21 | 80:20 96:25 97:7 | sounds 90:7 | stable 68:17 83:12 |
| short-staffed 101:3 | 150:7 | 97:9 108:17 | source 8:11 | 83:14,20,25 84:6 |
| shortcut 134:11 | silently 105:9 | 127:10,13 137:16 | sources 108:1 | 84:9,11 |
| shortly 1:20 | silly 87:13 | 137:23 138:4 | south 152:18 153:6 | stage 10:7 40:18 |
| shot 131:16 133:16 | similar 31:13 32:3 | 162:9 | 155:18,21 | 61:25 62:3 99:5,6 |
| shoulders 147:22 | 45:24 126:25 | Smith 100:15 | southern 153:7 | 104:14 |
| show 9:4 18:18 | similarities 35:15 | 144:20 149:15,16 | space 47:4,4 | stand 46:2,24 152:3 |
| 22:4 47:5 51:5 | similarly 88:14 | Smith's 134:20 | Spanish 162:16 | 166:4 |
| 53:9 104:20 | 147:21 | sneered 28:15 | speak 14:4 | standard 47:1 |
| 109:15 123:25 | simple 74:25 | snip 149:16,16 | speaking 101:4,7 | 58:22 59:13,18,18 |
| 137:11,24 | 116:16 126:5,15 | soldier 147:8 | specialists 52:13 | 60:9 61:16 70:18 |
| showed 14:21 | 162:12 | solely 43:23 | speciality 41:4 | 70:19 93:10,22 |
| 79:20 106:10 | simplistic 120:5 | solicitor 59:12 | specific 25:19 | 94:11 95:6,11 |
| 108:6 113:12 | simply 3:25 6:4 | solicitors 2:17,19 | 105:2 | standards 30:4 |
| 118:7 121:7 127:8 | 13:2 28:16 29:2 | solid 39:15 153:14 | specifically 18:11 | standing 38:16,19 |
| 129:15 | 30:17 39:2 41:3 | solids 152:15 | 21:13 26:15 60:5 | 38:20 |
| showing 156:22,24 | 44:25 48:8 59:16 | somebody 23:13 | spend 67:14 | stands 45:22 |
| 157:4,5 | 60:24 72:19 73:18 | 82:17,18,20 | spin-off 165:11 | start 57:4 78:8 |
| shown 54:20 55:4 | 76:13 80:13 81:9 | 113:22 165:7 | SPO 16:8 | 153:6 166:21,22 |
| 120:7 144:25 | 84:5 93:3 97:21 | somewhat 82:9 | spread 153:25 | started 55:9 118:25 |
| shows 9:19 30:15 | 121:16 122:24 | 87:17 160:5 | spread-out 153:10 | 119:3 126:14,14 |
| 81:4 113:22 126:1 | 123:15 139:6 | soon 99:7 136:7 | Springer 67:4 | 127:18 |
| 128:21 145:5 | single 28:21 | sophisticated 74:8 | spurious 140:10 | starting 24:11 42:1 |
| sick 58:20 | siren 37:20 | 147:13 | square 87:7 126:20 | 52:19 78:9 142:2 |
| side 33:4,24 65:9 | sit 100:6 | sorry 1:16 4:18 | 154:3 | 147:12 |
| 78:9 91:21,22 | site 101:12 155:24 | 19:12,13,16 27:10 | SSD 15:16 17:14 | starts 29:9 69:19 |
| 95:5 120:6 121:21 | sites 102:1 104:20 | 32:14 47:22 49:23 | 32:17 60:18 64:8 | 75:25 113:13 |
| 121:21 124:10 | 106:13 123:24 | 64:24 65:5 78:10 | 69:22 72:13 75:3 | state 1:15,20 2:11 |
| 131:3,4 154:4 | 124:1 144:3,4 | 78:17 80:4 86:18 | 82:22 89:9 93:11 | 3:19 8:25 9:3 |
| sides 33:23 72:12 | sits 147:22 | 89:24 91:15,16,17 | 96:4 97:20 105:13 | 12:16 13:14,19 |
| 105:6 157:16 | situation 74:17 | 96:21 103:10 | 106:14 111:23 | 14:3,11 19:9 25:8 |
| Sienkiewicz 40:1,4 | sizes 42:8 | 107:1 109:10 | 112:16 115:23 | 35:5 37:17 43:6 |
| sievert 85:11,17 | skeleton 169:16 | 146:5 153:17,18 | 119:25 120:1 | 54:14 67:6 83:19 |
| 135:5,5 | 170:8,16 | 164:6 | 122:23 124:16 | 101:21 102:3 |
| | | sort 57:6 74:16 | 126:6 130:6,17,19 | 106:3 111:6 |
| | | | 133:16 138:8 | 131:13 132:15,18 |

| | | | | |
|---|--|--|---|--|
| 142:11 154:7 State's 12:8 15:8 17:19 27:1 33:10 33:24 53:6 107:9 132:12 147:12 stated 83:8 84:6 112:19 122:2 151:15 statement 13:11 28:5 69:23 86:11 100:19 103:19 105:2 106:5,6 114:12 130:18 142:18 149:16,17 165:22,23,25 166:1 statements 94:7 96:4 states 116:19,25 122:5 133:3 145:2 151:6 162:1 stationed 149:22 stations 52:24 54:6 statistical 43:15,24 44:2 46:7 164:14 statistically 51:5 80:21 statistician 46:9 91:18 statistics 89:17 108:6 steams 105:9 stem 155:18 156:25 157:10,13,14,19 step 8:20 9:25 10:1 stepping 21:24 142:3 146:10 steps 8:21 9:24 10:21 50:17 Sternglass 117:20 stone 142:3 146:10 stones 142:2 stop 42:13 stopping 23:10 36:8 142:2 | stops 42:23 straight 137:11 straightforward 102:15 strategy 106:14 stray 78:18 strayed 77:24 stress 17:8 stressful 84:15 Stretch 129:5 157:24 strike 134:4 strip 139:19 strong 112:23 113:18 114:1 stronger 9:20 strongly 110:25 strontium 144:16 struck 38:23,24 54:24 93:4 Structure 68:13 Stuart 161:3,5,6,21 Stubbs 102:11 130:24 students 66:9 studied 7:17 8:3,5 137:19 153:11 studies 2:6 24:18 29:20 43:17 44:13 51:1 73:6,23 76:23 79:19,20 80:5 81:1 89:1,4,4 96:8,10,19 97:8,8 97:9 99:15 123:10 123:11 125:9,20 125:21,22 139:25 140:16 146:21 163:13 study 2:3,6 7:13 20:3 33:1,5 51:8 66:2 68:15 75:5 77:5 79:21 80:1,3 80:15,20,21 81:4 81:4,6,14,21 82:7 83:4,22 90:2 | 91:25 96:21,24 97:6,13,13,17,18 97:19 98:21 99:8 124:13,20 126:1,2 138:7 145:4 146:25 164:16 studying 76:16 stuff 37:23 115:25 168:4 sub-micrometre 156:4,10 158:24 subject 8:3 subjectively 147:14 subjects 103:13 subliminally 37:18 submission 15:24 16:10 31:6 33:7 34:4 41:9 47:9 100:14,16 109:18 111:16,21 135:8 136:11,12 139:14 145:22 160:12 162:23 166:12 169:15 submissions 1:3 4:16 10:18 11:9 11:11 12:4,8,11 13:3,23 17:25 26:2,7 27:4 29:15 31:3 32:1 33:21 35:4 39:4 40:2,8 40:11,15,18 41:13 45:8 55:11,13 57:10,13 58:16 59:7,10 89:13 100:13 106:18 165:13,14 166:14 167:21 168:2,24 169:15,20,23 170:3,4 171:2,4,5 submit 4:8 41:24 72:13 77:22 99:17 103:18 144:3 159:25 163:23 164:25 | submits 17:14 submitted 34:22 102:18 103:1 109:12 128:21 133:10 subsequent 21:7 147:19 substance 149:7 substantial 64:4 substantially 25:15 succeed 34:6 suction 129:8 sudden 108:9,11 suffered 7:18 106:12 140:19 suffering 54:12 127:25 128:13 suffice 62:15 sufficient 15:2 16:20 34:23 38:12 39:13,13 53:19 132:20 134:19,21 134:22 sufficiently 57:4 93:16 109:21 138:17 suggest 7:4 46:21 49:9 62:24 72:3 75:4 84:22 92:25 110:25 162:10 suggested 45:15 82:14 86:8 101:6 105:23 115:5 121:4 166:8 suggesting 16:3 28:15 54:2 126:8 130:22 suggestion 11:6,7 100:21 109:2 165:9 suggests 146:9 suitable 80:11 sum 85:9,11 summarise 33:22 49:24 | summarised 43:7 47:9 summary 170:10 sunt 164:18 supervised 66:10 66:25 supplementing 104:12 support 33:12 45:23 47:18 49:13 59:16 109:5 110:2 111:18 123:11 125:7 131:24 132:3,6,6 145:23 155:16 supporting 20:25 49:18 supportive 132:1 supports 45:20 71:25 suppose 135:17 supposed 162:3,10 supposition 116:9 suppress 71:9 suppression 113:14 Supreme 40:4 sure 13:14 30:5 34:23 37:15 57:8 59:19 60:11 76:9 81:25 119:15 121:3 143:18 148:7 153:11 160:8 surely 113:12 134:19 surprising 77:2 82:10 84:25 surveillance 20:1 survey 81:20,23 154:3 157:1 surveyed 73:25 surveys 155:16 surviving 56:9 survivors 43:20 44:6 51:4,13 |
|---|--|--|---|--|

| | | | | |
|---|---|---|---|---|
| 125:18 suspect 164:13 sweeping 19:9 swept 165:1 swimming 159:24 sympathise 119:18 system 24:1 94:19 105:12 116:25 161:21 systems 22:21 23:6 | 81:14 84:4 92:16 108:7 117:15 119:20 121:16 148:8 takes 30:23 88:25 93:9 95:5 151:22 talk 76:1 119:5 talked 161:6 talking 96:20 117:25 127:11,13 138:3 149:6 158:22 161:10 169:14 talks 98:12 target 120:23 143:14 166:24 task 59:23 61:6 119:20 120:22 taught 92:24 team 146:18,21 teams 88:24 tease 46:24 47:24 technique 2:16 3:17 5:21 6:4,8,13 7:5 49:7,13 techniques 108:5 technologically 126:3 tediously 145:19 telescope 162:18 tell 1:7 37:2 42:16 42:22 44:23,25 45:2 53:11 80:12 102:12 127:4 158:15 162:21 telling 20:23 80:3 109:7 162:17 tells 128:24 ten 55:18 154:20 164:25 170:22 ten-fold 151:17,23 tend 61:11 63:21 83:2 tended 123:11 tendency 82:11 | 83:7 96:1 ter 1:3,5,24 2:22,24 3:1,6 6:9,17 7:6 7:10 8:2,23 10:9 10:14 11:2,14,25 12:12 14:2,9 17:24 18:6,8,10 18:25 19:2,4,13 19:16,19 20:21 21:3,6,9 22:1,3,9 27:10 28:8,15,18 29:11 30:11,19,24 31:2,10,13,24 32:11,14,16 33:14 35:10,18,21 36:23 37:2,8,13,16,22 37:25 38:2 39:9 39:18,20,23 40:15 40:17,20 41:11,13 41:18,21,23 43:10 43:14 45:25 46:5 46:11 47:8,11,14 48:14,23 49:6,15 50:1,5,16 51:12 51:17,19 52:10 55:22 56:24 57:1 58:9 59:17 61:24 68:8 72:18 74:21 87:24 89:8 90:5,6 92:11,13 126:4 167:1,7 169:21 170:6 171:2 terms 1:13 2:4 72:22 88:12 96:2 101:2 123:12 136:6 137:13 152:24 terrible 44:22 terribly 17:21 150:12 territories 121:8 territory 44:22 45:20 46:11 135:24 test 7:16 8:14,19 | 14:13 15:11 20:16 27:21 28:19,25 34:9 36:5,10,24 37:19 39:2 79:7 80:12 94:25 98:13 98:18 101:12 102:1 106:13 129:23 133:6 141:12,15 144:3,4 163:21 164:2 test-related 9:7 tested 76:20 testified 93:11 testing 102:14 110:7 tests 8:12 29:24 30:1,2 34:14 38:10 44:2 48:9 148:5,12,14,23 text 91:13 thank 1:23 5:24 55:17 56:13 58:16 99:24 100:9 143:17 166:9,11 166:14 167:16 168:5 170:22 theoretical 28:21 120:4 theories 69:14 82:12 161:24 theory 8:5 23:12 26:11,14 27:15 47:15 96:2 130:14 162:19,22 thesis 18:2 65:3,9 thing 57:6,11 84:11 103:11 116:17 118:16 119:12 122:3,11 134:15 140:15 things 3:14 56:5 63:13 67:14 75:24 76:2 90:13 98:8 104:11 111:1 115:4,10 119:11 | 122:3,16,16 164:20 168:1 169:13 170:19 think 1:9 5:25 6:1,2 7:19 11:2,6,17 31:2 36:23 37:2 38:1 45:7 46:5 47:22 49:4 51:17 55:25 58:25 66:19 70:17,23 73:3,5 73:14,19 74:16 75:12,16 82:6,7 84:12,13 85:7,15 86:17 90:17 91:2 92:22 99:16 100:2 100:5,6,7 106:18 106:22,24 110:13 111:3,10 112:15 114:4,15 116:4,9 116:10,12 119:7 123:18 124:15 131:23 134:4 135:24 136:3,4 137:8 139:13,14 143:8,21 145:21 147:2 154:6,19 157:4 158:1,13 159:13 166:2,18 166:19 167:4,6,10 168:11,14,19,22 thinking 6:21 thinks 81:9,12 third 150:3 163:7 thirdly 8:2 160:15 Thomas 2:15 3:10 4:12 40:25 68:12 78:8,10 79:16 81:9 82:13 83:7 85:14,19,24 87:15 87:17 89:6 96:20 124:7 137:1 140:18 147:20 Thomas' 4:2,25 6:11 7:3 41:1 Thomas's 84:24 |
| T | | | | |
| tab 2:2 18:22 19:3 19:4,7,13 21:21 24:8,10 43:10 50:3,5 56:1,1,2,3 57:25 61:22 64:24 65:6,23 66:13 87:3 152:9 157:7 table 2:12,14 84:8 91:2 100:18 101:4 101:5,9 105:20,23 106:1 150:17,17 166:5 170:8 tables 84:4 take 10:12 12:7 13:25 14:13 15:21 16:2 33:12,21 34:1,18 36:1 54:25 55:17 57:12 59:1 60:16 71:14 78:23 79:8 81:3 89:22 99:25 102:23 103:11 107:2,8,15 112:12 121:24 143:13 147:4 151:2,5,9 151:18,24 152:7,9 152:24 154:19 158:12 161:2 162:15 taken 1:21 11:20 13:4 14:23 48:19 62:15,22 63:2 72:17 74:24 80:25 | | | | |

| | | | | |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| thorough 11:14 | 158:20 160:8 | transcripts 57:3,9 | 126:7 130:22 | turns 131:25 |
| thought 35:20 | 165:20 | 73:3 78:22 105:21 | 131:2,17 137:25 | 147:15 |
| 48:20 81:9 117:13 | times 73:5 80:8 | transfer 64:2 | 139:14 142:5 | two 39:21 48:1 |
| 122:11 134:13 | 150:22 | 144:11 152:6 | 146:11 148:4,6 | 50:10,17 56:5 |
| 145:16 160:19 | tiny 149:1 | 158:17 159:11,16 | 154:2,5 161:14 | 57:2 66:9 75:24 |
| 170:18 | tip 153:7 | 160:4,10,18 | 166:4,10 169:5,25 | 76:2 82:21 90:13 |
| Thoughtful 74:18 | tissue 44:15 | transformation | Tribunal's 4:11 | 92:24 100:1 105:6 |
| thoughts 45:5 | title 56:17 113:10 | 23:3,8 | 16:8,10 39:25 | 106:23 109:2 |
| 135:1 | 113:11,11 | translation 91:7 | 40:5 60:9 64:23 | 111:19 115:3 |
| three 133:2 167:13 | today 12:6 | translocations | 71:22 | 122:3,16 135:9 |
| 170:11 | told 26:22 66:8 | 75:19 140:3 | tricks 165:4 | 141:17 145:17 |
| threefold 124:22 | 86:16 102:5 | transported 152:22 | tried 1:14 126:7,21 | 153:5,16,21 |
| 140:2 | 117:15 118:8 | 155:18 156:5 | tritium 118:1,6,12 | 156:18 163:22 |
| threshold 12:20 | 124:7,23 145:11 | 158:25 159:8,10 | trivial 46:21 62:14 | 167:25 |
| 13:10 16:21 34:5 | 148:3 162:25 | traps 75:11 | tropical 129:7 | type 85:4 123:13 |
| 34:8,10 42:1 | 164:15 | travel 45:7 | tropopause 157:12 | types 24:17 85:10 |
| 59:14,21 | tomorrow 166:16 | travelling 156:11 | trouble 92:16 | 85:13 |
| thresholds 44:9 | 166:19 167:24 | trawl 116:5 | troublesome 69:6 | |
| throw 26:3,8 | 168:10,18,19 | treated 87:18 165:3 | true 36:3 62:22,23 | U |
| 136:24 164:2 | 170:22 | tree 46:2 | 64:1,3,9,11 70:19 | U-234 103:17 |
| throwaway 4:12 | tonight 166:15 | trend 54:18 | 70:21,24 73:8,11 | UK 57:19 |
| 5:1 | tons 102:12 144:21 | trends 43:22 | 80:6 90:16 93:3 | Ukraine 86:10,25 |
| thrust 21:3 28:12 | top 19:16 21:22 | Tribunal 2:22,23 | 94:1 96:2,3 | 87:5 |
| 41:24 | 25:4,4 34:2 65:25 | 3:25 4:4 6:18,20 | 110:23 | Ulster 66:25 |
| thumpingly 35:23 | topic 104:14 106:18 | 10:7,21 11:11 | truly 140:21 | Ultimately 20:6 |
| 37:10 38:3 | topics 101:13 | 12:3,14,20,24 | truth 71:13 81:3 | unable 88:6 |
| Thursday 170:25 | total 17:3 148:25 | 13:20 14:15,25 | 117:1 163:9 | unarguable 8:14 |
| thyroid 124:8 | totally 4:8 17:12 | 15:4,4,7,7,14,24 | try 4:15 36:16 42:8 | unaware 77:6 |
| tidy 169:10 | 41:18 96:8 | 16:12,14,17,22 | 53:21 54:21 92:2 | unbiased 77:19 |
| Tier 98:9 101:22,22 | touched 103:13 | 17:5,8,15 20:23 | 100:8,20 115:2 | 115:12 116:17 |
| 102:11 103:1,2 | toxic 103:16 | 26:22 27:5,6 28:3 | 120:19 136:3 | uncertain 160:15 |
| 115:6 130:24 | toxicity 137:2 | 28:25 32:17 33:18 | 141:2 156:13 | uncertainties 150:3 |
| 131:18 132:22 | 144:18 | 34:9,17 36:1 | 158:5 | 150:9,15,19,25 |
| 153:3 169:25 | track 105:10 | 37:18 40:1,6 | trying 30:17 37:1 | 160:16 |
| time 11:24 20:24 | tracking 9:5 | 55:13 57:2 58:14 | 37:14,17 40:7 | uncertainty 150:22 |
| 22:15 31:16 45:22 | trail 112:11 | 59:19,24,25 60:13 | 45:17 49:24 52:14 | 151:4,8,12,16 |
| 51:17 55:12 57:17 | trained 60:2 92:6 | 60:16 61:6 72:3,6 | 52:15 53:5 54:23 | uncontroversial |
| 66:10 67:14 68:18 | trajectories 153:19 | 74:17 75:2,5 77:9 | 55:3 71:7 75:12 | 39:8 |
| 69:9 79:18 82:3 | 155:6 | 85:7 92:3 95:8 | tumour 51:25 52:3 | underestimate 23:8 |
| 92:16 93:12 99:10 | trajectory 153:9,25 | 97:25 100:15 | turn 4:15 12:12 | underestimated |
| 101:24 102:13 | 156:25 158:19 | 105:25 107:16 | 53:21 54:25 65:23 | 23:24 72:1 |
| 104:22 117:5,13 | transcript 42:15 | 108:20 111:25 | 66:13 69:15 88:22 | underground |
| 118:16 131:6 | 69:15 75:14 78:4 | 112:2,4,5 115:19 | 132:9 156:18 | 23:20 |
| 143:16,19 144:20 | 79:15 89:19 96:22 | 115:22 117:22 | turned 6:5 | underlining 56:12 |
| 145:21 157:21 | 115:18,23 122:7 | 119:18 120:9 | turning 53:17 | underlying 44:12 |

| | | | | |
|---------------------------|---------------------------|--------------------------|-----------------------------|---------------------------|
| undermine 82:22 | 115:14 | 129:1,2,17 130:13 | 113:25 115:1 | 24:12,24,25 48:9 |
| undermines 74:6 | unobjectionable | 135:22 136:14,16 | 117:10 118:17 | vivo 22:22 25:1,3 |
| undermining 96:5 | 39:10 | 136:19 137:1,20 | 122:14 126:23 | 25:10,18 28:9,12 |
| 99:15 | unpack 135:16 | 138:4,18 140:6,11 | 129:3,18 142:12 | voice 41:3 |
| understand 2:6 6:2 | unpacked 39:21 | 144:1,6,16,18,19 | 144:14 148:23 | voices 37:20 |
| 9:2,12 30:7 32:1 | unreliability 78:5 | 144:24 145:5 | 155:15 166:6 | volatility 104:1,7 |
| 41:24 48:12 56:16 | unreliable 7:5 | 146:7,9,16 164:3 | varying 86:3 | |
| 88:8 90:19,22 | 17:11 26:4 87:18 | uranium-234 | Vaskess 155:25 | W |
| 91:12,14 92:2,15 | unrepresentative | 117:25 | 157:2 | Wahab 6:12 7:12 |
| 103:20 104:13 | 79:22 | urge 15:13 137:25 | vast 156:2 158:22 | 124:20 139:19,24 |
| 111:24 112:13 | unsafe 64:8,10,12 | urine 11:5,16,19 | 159:7 | 146:18,21,25 |
| 113:16 116:13 | 95:14 105:12 | use 70:25 71:2 | vehement 1:13 | 164:15 |
| 131:11 133:18,25 | UNSCLEAR 18:14 | 83:23 88:6 93:13 | velocity 88:6 | Wahab/Rowland |
| 141:14 151:6 | 18:19 19:6 22:11 | 110:2 143:15 | 152:18 | 4:10 7:9 33:1,5 |
| 156:8 | 24:5 27:14 28:9 | 145:21 150:22 | verbal 94:7 | 40:23 41:14 130:6 |
| understandable | 43:7 47:17 48:19 | 151:12 | versus 120:2 | 138:7,20 |
| 113:20 | 52:6,11,14,15 | useful 43:18 69:2 | vessels 8:24 9:2,20 | wait 153:12 |
| understanding | 53:4,14 54:6,22 | 79:20 | veteran 81:16 82:8 | waiting 33:8 |
| 20:6 28:19 41:8 | 55:3 71:18,23 | uses 26:1 52:21 | 124:12 | Wakeford 23:17 |
| 61:16 76:5 84:25 | 86:7 | 160:14 | veterans 76:20 | wall 127:6 |
| 88:12 100:24 | unsound 123:8 | usurp 27:13 | 81:20,21 124:14 | want 11:3 12:7 |
| 138:19 161:8 | unsurmountable | UT 60:6 94:13 | 124:19 129:24 | 18:24 25:25 39:23 |
| understood 85:16 | 34:10 | 168:23 | 130:3 140:16 | 40:10,17 61:18 |
| 92:11 109:1 | untoward 128:13 | UT's 15:18 | 144:5 146:8,13,16 | 63:2 64:17 69:15 |
| 111:16 135:6 | untrue 84:13 | uterus 44:15 | 165:2 | 70:17 75:11 77:14 |
| understudy 58:18 | unusable 105:14 | | video 122:8 | 78:9,11,23,25 |
| undertake 46:25 | unusual 129:16 | V | videoed 122:9 | 79:24 81:2 82:5 |
| undetected 44:1 | 130:1 | v 98:14 | view 6:20 7:2,16 | 89:19,21,22 94:12 |
| undoubtedly 3:21 | up-to-date 168:2 | vain 33:15,17 | 9:21 16:2 19:21 | 98:6 101:10 107:8 |
| 49:15 | updated 57:8 | Valentin 121:23 | 20:14 26:25 35:19 | 107:11,15 109:5 |
| unfair 4:8 160:9 | upper 12:24 15:4,7 | 122:1 | 46:20 52:12 67:17 | 122:10 130:16 |
| unfamiliar 89:18 | 15:7 16:11,14 | valid 97:24 128:6 | 67:19,20,23 71:24 | 132:11 146:25 |
| Unfortunately 56:9 | 17:4 26:22 27:5,6 | validate 81:24 | 72:24 94:24 95:25 | 152:9 160:24 |
| unhelpful 33:25 | 28:3 34:9,15 35:2 | validity 61:15 | views 23:13 32:22 | 161:4 163:5 164:8 |
| uniform 38:16 | 39:25 40:1,6 98:9 | 77:23 96:5 97:12 | 33:16 52:8 60:23 | wanted 2:12 58:15 |
| Union 108:9 | 101:22 115:5,19 | 115:3 | 61:15,25 74:23 | 99:20 104:22 |
| United 116:19,25 | 131:18 153:24 | valuable 100:21 | 83:1 141:7 | 116:25 148:16 |
| 120:12 133:3 | upset 78:10 | 161:12 | vigorously 83:8 | 167:5 |
| 145:2 | upwards 54:19 | value 60:24 73:6 | VII 25:16 | wants 12:3 |
| units 85:20 | uranium 64:10,12 | 79:19 80:1,3,6,8 | virtually 51:25 | war 16:24 27:2 |
| universally 73:14 | 74:11 83:9,13,14 | 80:16 95:13,15,24 | visible 117:17 | 38:16,17,24 39:1 |
| University 65:18 | 83:15,21,24,25 | 96:11 98:2 | visited 149:20 | 79:14 81:20 |
| 66:4,6,11,24 | 84:4,6,11 94:7 | values 61:4 94:20 | vital 19:8 | 113:15 146:7 |
| 68:14 117:21 | 102:12 103:15 | 95:16 | vitality 20:15 44:18 | warned 89:9 |
| unknown 38:6 | 106:12 128:22 | various 102:2 | vitro 22:21 23:4 | warning 77:11 |

| | | | | |
|---------------------------|---------------------------|----------------------------|---------------------------|----------------------------|
| warnings 56:7 | 154:19 170:20 | William 161:20 | workers 76:25 | 113:7,9 118:2 |
| washed 152:19 | we've 2:5 39:21 | Williams 132:22 | 125:20 137:11,18 | 150:15 |
| wasn't 2:25 4:1 | 48:3,3 49:2 51:12 | 155:8 | 137:20,21 145:6 | |
| 41:4 108:12 | 55:12 68:8 91:6 | willing 71:7 | 146:8 | X |
| 138:15,16 148:11 | 101:1 102:9 109:7 | wind 156:24 | working 57:17,23 | X 49:2 63:9 136:1 |
| 148:13 149:24 | 121:18 122:22 | 158:13 | 57:23 | 171:1 |
| watch 63:9 | 133:2 134:7,8 | winds 153:24 | works 69:2 145:2 | x-raying 71:10 |
| water 141:8,9 | 146:6 166:14 | 155:19 157:18,23 | 162:13 168:14 | |
| way 1:17 7:12 11:4 | 167:23 | winning 92:24 | world 22:9 52:15 | Y |
| 11:10 12:14 14:10 | weapon 53:23 | wisdom 14:5 | 54:23 71:1 113:15 | Y 49:2 63:9,10 |
| 15:23 16:13 18:18 | Weapons 102:6 | wise 145:14 | 122:19 136:9 | 127:12 136:2 |
| 29:3 30:13 31:12 | Wednesday 1:1 | wish 14:11 46:2 | worry 112:8,14 | 152:24 153:2 |
| 37:14 41:16 46:5 | week 12:4 89:9 | 59:15 | worrying 6:19 | 156:2 158:23 |
| 49:7,13 53:6 55:8 | 167:12 | wished 33:19 | worst 96:10 | year 132:14 152:19 |
| 63:22 70:24 74:16 | weeks 156:6 159:1 | withdraw 165:9,10 | worth 5:11 82:9 | years 54:16 119:20 |
| 79:7,8 82:12 86:6 | 159:8 170:11 | withdrawal 31:13 | worthless 17:11,16 | 164:25 |
| 94:25 100:22 | weigh 98:4 | withdrawn 31:5,11 | 105:16 141:19,20 | yelling 138:12 |
| 111:5 112:5 | weighing 60:20 | witness 30:8 77:12 | 141:21,22,24 | yesterday 2:10 3:11 |
| 113:20 114:24 | weight 7:8 62:18 | 84:15,23 87:18,21 | 142:1,6,10,15,19 | 7:24 10:17 11:5 |
| 115:10 116:22 | 77:13 150:6 152:1 | 96:4 105:17 116:6 | 146:12 | 12:5 13:13,21 |
| 119:21 121:3 | welcome 135:17 | witnesses 18:3 26:4 | worthwhile 82:6 | 14:21 16:15 17:13 |
| 123:1 124:25 | went 13:13 29:16 | 29:6 30:9 33:13 | worthy 27:24 | 17:19 26:10 29:2 |
| 126:15 127:4 | 70:9 76:8 104:9 | 60:18 72:12 74:22 | 104:15 | 36:17 39:24 59:11 |
| 128:14 130:21,24 | 118:21 137:18 | 78:6 93:11 105:4 | wouldn't 4:6 70:16 | 72:18 87:24 |
| 135:15 136:8 | 150:5 | 106:16,16 109:5 | 140:12 | young 57:20 58:3 |
| 137:3 141:14 | weren't 9:19 17:20 | witnessing 72:6 | write 130:8 145:10 | |
| 142:2 145:2,20 | 17:21 138:14,15 | won 27:2 | writes 118:8 161:6 | Z |
| 152:12 157:20 | west 152:17 154:12 | wonder 148:6 | writing 57:17 | Z 63:11,12 |
| 161:10,11 168:14 | 155:18,18,21 | wondering 169:13 | written 12:10,11 | Zaire 96:20 |
| ways 3:23 22:4 | 157:5 159:4 | word 19:22 67:10 | 28:2 45:8 59:12 | zeal 78:1 |
| 50:11 115:3 161:8 | whack 140:4 | words 70:19 71:2 | 92:5 94:2 115:7 | Zealand 124:14,19 |
| we'll 6:15,22 13:3 | whatnot 140:10 | 114:1 119:9 129:6 | 120:11 153:9 | 130:3 140:15 |
| 29:17 30:23 33:2 | whatsoever 41:2 | 136:15 140:1 | 169:3,8 | 146:13,15 |
| 40:9 46:25 55:17 | 60:23 61:15 73:15 | 141:20 142:15 | wrong 28:4 30:20 | Zealanders 10:4 |
| 57:4,8 99:25 | 79:19 84:19 85:18 | 159:4 162:4,15 | 30:22 36:10 53:24 | zero 13:6,8,9 60:24 |
| 100:8 107:13 | whilst 27:4 29:19 | work 31:7 48:3 | 60:25 61:3 67:17 | 61:5 96:11 |
| 112:9 120:22 | 29:21 45:6 146:25 | 58:10,13 60:13 | 67:25 71:21 75:8 | |
| 135:12 143:13 | 154:11 155:13 | 82:19 88:15 | 76:13 80:13 81:10 | 0 |
| 154:19 167:21,21 | white 153:14 | 106:10 117:9,9 | 87:16 91:23 95:14 | 0 94:20 95:5,15 |
| we're 42:21 48:12 | wholly 15:23 16:12 | 119:21 130:25 | 109:2 114:9 | 98:2 |
| 52:19 53:5,12 | 72:24 | 138:23 145:1 | 122:12 125:6 | 0001 80:1,7 |
| 112:8 120:15 | wide 43:22 | 160:4 | 147:18 162:19 | |
| 124:23 127:11,13 | widely 85:21 | worked 142:22 | 163:20,25 164:12 | 1 |
| 137:2,4,17 138:3 | wife's 149:16 | 145:3 | 164:23 | 1 2:2 50:3,5 61:5 |
| 149:5 153:16 | Wikeley 130:25 | worker 76:24 | wrote 102:10 113:3 | 66:17 94:20 95:5 |
| | | | | 95:13,24 98:2 |

| | | | | |
|---------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| 136:16,17,18 | 137 43:11 | 2(1) 50:18 | 33 24:12,13 94:23 | 56 56:1,2 |
| 152:19 156:15,18 | 14 18:6,7,8 26:7 | 2.00 100:12 | 34 95:3 | 57 19:7,14 56:1,3 |
| 156:21 159:3,9,16 | 86:1 | 2.1 64:25 65:6 | 35 17:20 25:3 72:11 | 58 89:19,23 |
| 171:2 | 1400 138:10 140:4 | 2.4 66:13 | 77:17 | 589 43:14 |
| 1,000 136:20 | 147 85:2 | 2.6 64:24,24 65:23 | 36 40:3 | 59 171:4 |
| 1,400 130:8,11 | 15 31:17 32:12 59:3 | 20 65:21 98:9 | 37 61:24 87:6 109:8 | 5A 168:19 |
| 1,500 148:4,18,24 | 83:3 125:9 127:12 | 143:13 | 157:7 | |
| 1.6 156:14,15 | 137:23 148:19 | 2001 20:19 | 38 151:3,9 | 6 |
| 1.7 156:14,16 | 149:3 | 2002 99:12 | 39 79:15 | 6 17:6 27:8,10 88:9 |
| 10 85:25 86:3,9,15 | 15,000 81:15 | 2004 121:11 | | 91:2 126:17 |
| 87:10 98:10 118:6 | 150 50:22 51:5 | 2006 19:6 24:6 | 4 | 127:24 128:9 |
| 125:9 128:10,25 | 158 45:11 | 2007 113:7 | 4 2:2 14:10,13,14 | 136:22 |
| 148:19 149:2 | 16 27:10 34:1,2 | 2008-2010 145:4 | 23:21 49:9 50:6 | 60 23:9 58:6 |
| 166:21,22 169:1 | 57:25 65:1,5 | 2010 145:6 | 78:14 79:2 82:16 | 60s 117:11,12,17,19 |
| 10,000 80:8 | 69:19 | 2014 132:16 133:15 | 83:10 85:1 86:1 | 117:23 123:14 |
| 10.00 1:2 170:25 | 160 83:10 | 2016 1:1 170:25 | 101:13 127:17 | 68 31:17 32:12,16 |
| 10.10 6:23 | 17 27:11 35:21 | 21 83:21 | 4.05 170:23 | |
| 10.12 6:25 | 86:12 | 21/30 19:1 | 4.30 100:8 166:23 | 7 |
| 100 10:10 41:9,15 | 170 10:13,19 150:4 | 210 40:6 | 4.45 100:2,3 | 7 29:2 57:13,14 |
| 45:19 46:4 125:9 | 18 65:24 90:24 | 22 9:1 | 400 10:11 | 79:2 82:16 88:15 |
| 135:12 139:2 | 143:5 168:8 | 23 24:11 84:7 87:3 | 41 141:12,15 | 127:24 136:22 |
| 155:20 171:5 | 19 65:25 90:24 | 132:16 147:2 | 163:21 164:2 | 70 20:19 24:14 |
| 100-fold 122:5 | 1945 51:4 | 23.13 12:2 | 41(1) 14:20 | 700 130:8 |
| 101 14:21 15:18 | 1962 68:14 | 24 56:23,25 | 41(5) 94:25 | 70s 118:15 |
| 103 4:17,21 5:5 | 1963 65:11 | 25 119:20 | 43 16:18 79:25 | 73 24:14 99:16 |
| 61:24 | 1966 65:3,8,11 66:3 | 250 150:4 | 431 50:23 | 74 34:4 |
| 104 4:16,24 | 1970 66:18 | 28.19 11:18 | 45 133:5 | 77 35:25 |
| 107 86:22 88:16 | 1973 65:17 117:16 | 29 1:1 | 47 81:18 | 78 25:6 |
| 108 88:9 | 132:2 | | 48 81:18 | |
| 10T 23:4 24:1 | 1986 86:23 | 3 | | 8 |
| 11 82:16 101:14 | 1990 66:3 | 3 12:13,23 69:16 | 5 | 8 89:19,23 93:17 |
| 11.28 55:19 | 1990s 119:4,4 | 79:2 86:9 127:9 | 5 14:11,13 15:12 | 102:12 127:24 |
| 11.40 55:18,21 | 1991 66:5 | 127:13,16 150:22 | 18:1,8 26:2 49:9 | 136:22 144:21 |
| 110 61:22 | 1995 66:5,6 | 159:16 161:15 | 51:5 61:25 78:14 | 150:20 |
| 112 93:17 | 1997 118:2,14 | 3,000 23:9 127:9 | 78:15 79:15,24 | 80 11:22 12:2 |
| 119 79:2 | 19th 161:22 | 151:18,24 | 83:21 86:24 87:4 | 80s 99:16,16 |
| 12 57:14 125:9 | | 3.28 155:1 | 87:11 137:16 | 84 62:10 94:13 |
| 12.45 100:10 | 2 | 3.40 155:3 | 150:20 | 109:10 |
| 120 69:19,20 | 2 12:13 23:21 41:22 | 30 21:21 43:10 | 5.3 155:13 | 86 94:22 |
| 121 70:14 | 50:24 88:9,16 | 170:25 | 5.6-fold 124:14,18 | 87 95:3 |
| 122 82:16 | 135:11 150:22 | 30,000 81:20 | 50 58:5,5 | 88 147:3 |
| 127 21:22,25 | 153:17,18 155:5 | 300 151:10 | 50,000 153:10 | 89 75:14 |
| 13 29:8 79:25 | 156:8,16,18,24 | 32 18:22 19:2,3,4,7 | 55 29:8 | |
| 152:12 | 157:6,20 158:19 | 19:13 24:8,10 | 55,000 156:3,10 | 9 |
| 133 45:10 | 159:16 | 62:11 94:13 | 557 21:22 22:1,11 | 9 75:14 147:2 |
| | | | | 161:16 169:1 |

| | | | | |
|--|--|--|--|--|
| <p>90 75:25 129:1 144:16 90s 117:13 92 11:17 96 4:16,24 33:11,15</p> | | | | |
|--|--|--|--|--|