

DR BUSBY: My daughter, Cecilia, is an understudy, as you know, for Group Captain Ades who has followed these proceedings quite closely from his sick bed and has raised a number of points about issues relating to standard of proof and philosophy and science generally, which in the context of the current appeals we feel to be important, so I would like to give my daughter the first presentation here. Probably I think maybe she'll take us to midday and then I can pick up on the actual points.

MR JUSTICE BLAKE: That's 15 minutes, yes?

DR BUSBY: If that's okay. Until lunchtime, yes, until the next break.

MR JUSTICE BLAKE: Yes.

Closing submissions by MS BUSBY

MS BUSBY: Just the first issue is that we do have a couple of extra bits which were appendices to our closing submissions. They are very short. We just forgot to put them in yesterday. It is a document which was written for us by a solicitor, Mr Manson, on the standard of proof and particularly the SSD's argument that that implies a threshold. I won't read it out but it's there for you to look at if you wish. (Handed) Simply put, we support the arguments that Mr ter Haar has made that it's the reverse criminal standard that's the relevant standard. That is that the Tribunal must be sure beyond reasonable doubt that the appellants' cancers were not contributed to by their Army service and it's not a question of a threshold which must be exceeded.

In this respect, we note that the task before the Tribunal is not to adjudicate the different scientific opinions. The Tribunal, with respect, are not experts

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in the area even if some of them may be scientifically trained. To adjudicate the scientific debate is to in effect prefer the evidence of one expert over another, something very specifically ruled out in the decision of Mr Justice Charles in the UT which has been examined in some depth.

MR JUSTICE BLAKE: That's because of the nature of the standard of proof rather than the Tribunal's expertise or lack of it. We have that point.

MS BUSBY: Okay, sure, yes. So we would also argue that it's not for the Tribunal to disregard or rule out the scientific work of relevant experts published in the accepted peer reviewed scientific literature. The Tribunal may take forward the criticisms of other experts with regard to this material, or the arguments of the SSD that certain witnesses are not regarded by the scientific consensus as right, and consider whether, in the final weighing up process, these arguments reduce the existence of doubt. But it's not for them to decide that those experts' views have no merit whatsoever, i.e. that they can be afforded a value of zero, simply on the basis that the SSD's experts regard them as wrong. And I am saying that not really with respect to the Ikarian Reefer arguments that were made but just with respect to the idea that they've been criticised for being wrong. I'll return to the issue of carrying forward values of 1 or zero as discussed by Mr Justice Charles.

But the task of the Tribunal, it seems to us, is to say: is there a body of scientific opinion, based on what appears to be non-fanciful and non-trivial evidence, that raises reasonable doubt of attribution? In this respect they must give reasons for their rejection of any arguments or experts that tend towards the raising of doubt. They must not only give reasons for their rejection of these opinions but must give reasons as to why they are absolutely certain that those views can be rejected as having no validity whatsoever. So that is our understanding of the standard at issue.

I just want to go on to look at an issue about the combination of possibilities because this has been raised also. Mr Justice Charles made remarks in his decision and it might help to go to it. It's SB1, tab 110.

MR JUSTICE BLAKE: Yes.

MR TER HAAR: Page 37. It's paragraph 103. He says: "At stage 5 the decision maker will form views that

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can be expressed by reference to the circumstances. I repeat that, as was accepted by the HL appellants, at that stage it may be that the decision will be that the combined effects of the possibilities

carried forward do not found a reasonable doubt because for example the combination of those possibilities is too far-fetched."

MR JUSTICE BLAKE: Yes.

MS BUSBY: We would argue that that has to be read in conjunction with the judgment by Lord Nicholls, also quoted by Justice Charles in paragraph 84, and this is in the middle of page 32, just to go back a little bit. Just at the end of that quote, just above where it says "In Re B Children", he says: "Facts which are minor or even trivial if considered in isolation when taken together may suffice to satisfy the court of the likelihood of future harm."

MR JUSTICE BLAKE: "The court will attach to all relevant facts the appropriate weight when coming to an overall conclusion on the crucial issue."

MS BUSBY: Yes. So some facts or possibilities may in combination appear to diminish rather than enhance the likelihood of a case being true. But some taken together may increase the likelihood that it is true.

And we would suggest that the difference relates to whether or not the possibilities advanced are dependent on each other or are completely independent and separate factors to be taken into consideration. I want to give you an example of both. In the former case, the combination of them, that is in the case where they are dependent on each other, the combination does indeed lead to a greater likelihood that the case advanced is too far-fetched. To illustrate, the argument might run: it is possible that X dropped his watch. It is then possible that Y picked it up. It is then possible that Y left it in a shop.

It is then possible that Z entered the shop. It is then possible that Z picked it up by accident. We might say that for all these possible things to happen in combination is very unlikely. However, in the case where the possibilities are independent of each other, many small possibilities which may be minor in isolation together increase the likelihood that there may be reasonable doubt. And most of the possibilities advanced by our evidence are of such an independent form. They are separate possibilities, not dependent on each other, which tend rather to accumulate in the way that Nicholls describes above.

So we argue, for example, that our appellants may have received an extra dose of ionising radiation from

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inhalation. Even if that were not true they may have received a dose from sea-to-land transfer, and even if that were not true, they may have received a dose from substantial quantities of carbon-14, not considered by the SSD's experts.

And even if none of those pathways are accepted it remains possible that the ICRP risk model relied on by the SSD is unsafe for internal emitters. And even if that is not true, it is possible that the risk model is unsafe for uranium nanoparticles.

Even if that were not true, it is still possible that it is unsafe for uranium ions bound to DNA. Such possibilities, even if they are themselves considered to be of low probability, are in combination we would argue more likely to found a reasonable doubt than each one separately.

So I want to go on to look at arguments relating to the nature of science and scientific expertise.

We are not going to respond directly to the SSD's allegations about our experts, but since Mr Heppinstall has called into question the expertise of Professors Schmitz Feuerhake, Sawada and Howard, I would just like to refresh the Tribunal's memory of their CVs.

So if we can go to SB1, tab 2.6. Sorry, not 2.6, .1, Professor Schmitz Feuerhake and her CV is at page 16.

Professor Schmitz Feuerhake took her doctorate degree in physics in 1966. Her thesis was the dosimetry of radioactive fallout. Sorry, you haven't got there yet. It's page 16 of SB1, tab 2.1.

MR JUSTICE BLAKE: Yes.

MS BUSBY: So if you just look at where it says "1966" on the left-hand side: doctor degree in physics, thesis was about the dosimetry of radioactive fallout. From 1966 to 1963 she was a physicist at the Medical Academy of Hanover in the Institute of Nuclear Medicine and she carried out research on dosimetry and diagnostic applications of radioactive nuclides. She was also the manager of a nuclear research reactor.

MR JUSTICE BLAKE: Yes.

MS BUSBY: Since 1973 she was Professor of Experimental Physics at the University of Bremen and her research was in the area of radiation dosimetry, radiation risk and health physics. She has published over 20 peer reviewed papers in those areas.

If you can turn now to tab 2.6, which is Professor Sawada, and his CV is given on page 18. If you look up at page 19 at the top you'll see that his

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professional field is elementary particle physics and the study of radiation effects. He was from 1966 to 1990 the Associate Professor in the Department of Physics at Nagoya University. From 1991 to 1995 he was Professor of the Department of Physics at Nagoya University and since 1995 he has been Emeritus Professor in that institution.

Professor Sawada actually told us while he was here giving evidence that two of the students that he had supervised during his time as Professor at Nagoya University have very recently been awarded the Nobel Prize in physics.

If we turn to Professor Howard, that's SB1, tab 2.4, and he doesn't actually -- I couldn't find his CV. It says it's attached but I couldn't find it, but he gives a fairly detailed breakdown of his qualifications on page 1:

"I qualified in medicine in 1970."

MR JUSTICE BLAKE: I think we can read that.

MS BUSBY: Okay. He is a fellow of the Royal College of Pathologists. He is familiar with the pathology of leukaemia. He has published in the field. He has published a number of papers on cancer and environmental influences. He has done research at the University of Ulster into the effects of nanoparticles and supervised a PhD on those issues. He has been invited to contribute a chapter on cancer and environmental influences published in the Springer Encyclopedia of Bioinformatics.

I raise these CVs, this expertise, because the Secretary of State has implied that ECRR is a campaigning organisation.

MR JUSTICE BLAKE: Yes.

MS BUSBY: It is not a campaigning organisation in any real sense of that word. There is no membership available for politically motivated persons. There is no organisation of campaigns. There are no posters, there are no press releases.

MR JUSTICE BLAKE: Don't spend your time knocking things which are not critical to the argument. The question is: is the ECRR campaigning in the sense that they share a joint view that ICRP is getting it wrong and they have a better model?

MS BUSBY: Of course. Of course they share a joint view.

MR JUSTICE BLAKE: But it's a campaign to promote that view.

MS BUSBY: It's more -- I would say that this is a scientific research group. It is a number of scientists who share a view. They have come together to discuss the science, to exchange ideas and debate the issues. It is quite wrong to imply either that they are

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somehow the equivalent of Friends of the Earth or that their entire purpose is to bring litigation. This is not the major purpose of the ECRR. It is to seek to persuade the scientific community of the evidence of problems with the ICRP. They are first and foremost scientists, I would argue.

And this goes to the heart of the issue about paradigms. We've already heard from Mr ter Haar about ideas of an old or a new paradigm. Science proceeds by the elaboration of what have been called paradigms, and the reference is, if you are interested, to Thomas Kuhn in a book called *The Structure of Scientific Revolutions* published by the University of Chicago Press in 1962. It's a very, very well known model in the study of science. He argues that models which appear to explain all the available evidence in a particular area are relatively stable over time. An example of a paradigm would be Newtonian physics before the shift to Einstein's new model. The overthrow of a paradigm is preceded by a period when contrary evidence potentially calls into question the basis of the paradigm is effectively explained away or dismissed, or seen as an anomaly or sometimes incorporated into the paradigm through increasingly complex, postulated mechanisms. This occurs, Kuhn argues, precisely because there is a general consensus that the paradigm is right, it's useful, it works, and there is a commitment to the maintenance of that paradigm on the part of scientists involved in the area. It is through the lens of the paradigm itself that this troublesome new evidence is generally analysed.

And often an alternative hypothesis which better explains the new evidence will be rejected for some

considerable time before it finally overthrows the original paradigm and we have what has been called a paradigm shift.

Now Mr Heppinstall, in cross-examining Professor Schmitz Feuerhake, put it to her that her theories were not accepted by the scientific authorities and I want to turn to the transcript which would be Day 3 --

MR JUSTICE BLAKE: Just let me put something away, please.(Pause) Yes.

MS BUSBY: Page 120 and it starts at line 16. So that's internal page 120.

MR JUSTICE BLAKE: Yes.

MS BUSBY: It's actually been quoted by the SSD in their closing statement.

MR JUSTICE BLAKE: Yes.

MS BUSBY: So it's Mr Heppinstall.

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MR JUSTICE BLAKE: Yes.

MS BUSBY: "So it's right, isn't it, Professor, that EEC and its risk analysis has been reviewed by both ICRP, CERRIE and the NRPB and it has been found to have no sound scientific basis."

She answered:

"Yes. So what?"

Professor Schmitz Feuerhake's response was admittedly a little blunt but she went on to explain, and she is asked: "That criticism, do you not accept, is being made by a very significant body of international scientific opinion."

MR JUSTICE BLAKE: Yes. Her answer is over the page, 121.

MS BUSBY: Yes:

"We wouldn't be here if we agreed with this criticism and what you want to know, I think, is who defines the standard of knowledge of science and is it true that such words define the standard of science, because they are a majority in between the scientists? Or is it not true that all scientists have to draw their conclusions from the same material of evidence and research? This is -- I think it's consensus that this should be the way to come to the true result, and what we criticise is we use the same basis of knowledge. What was published in the world was what was found and our argument, it's said these words did not use the whole body of information which is available because they neglect perhaps the findings after Chernobyl, they neglect, they cannot really explain why in European countries everywhere there is leukaemia near nuclear installations and they are not willing, they are trying to depress [and we later had a discussion of what she meant; she didn't mean suppress, she meant leave out] the information that diagnostic x-raying at the present level is harmful and should be reduced. So what we demand only is a kind of fair debate on equal levels and not that there is a board who says what is the truth and what judges have to take for the risk figures in order to decide if this person has been damaged by this occasion or damaged by his life."

So the point that Professor Schmitz Feuerhake is making is of course the ICRP and UNSCEAR and BEIR and the NRPB assert that her science has no merit. That they do not accept her hypotheses does not make her wrong. She believes, as do many other researchers and experts that we have brought to the Tribunal's attention, that the ICRP, UNSCEAR and the NRPB are mistaken in this view and that the available evidence supports the contention that the ICRP and others have

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seriously underestimated the risks of low dose internal radiation.

And we would suggest to the Tribunal that it's extremely plausible that the mounting evidence will force a paradigm shift in this area of science in the future. What the Tribunal is witnessing in this court case is precisely arguments between one paradigm and another, between one scientific culture or mindset and another.

And in this respect there are question marks over the whole issue of CPR 35 and the neutrality of witnesses on both sides.

We would submit that the experts called by the SSD are committed to the ICRP risk model, to the mainstream paradigm. It's clear that despite the direction from Justice Charles that all the possibilities should be taken into account and discussed they have not been asked, as Mr ter Haar made clear yesterday, to engage with alternatives; they have simply been asked to carry out a narrow assessment exercise based on the premise that their model is correct.

MR JUSTICE BLAKE: Well, many of the experts in terms said that the model that the ECRR group of scientists was promoting was in their view wholly incorrect, not scientifically founded. So that's more than a disagreement with it, it's quite a caustic observation.

MS BUSBY: I think if you look through the transcripts that what they actually said was it was not accepted as the scientific model. I think at times they said that some of the studies that were put forward were of no value but on the whole they generally accepted that there was a possibility that these might be true. There were plenty of occasions where they said "Yes, it's possible that this is an effect; yes, it's possible that that might be true."

They were very firm that their model was the right one, was the accepted one, was the consensus one, but I don't think that's the case that they all universally dismissed it as of no relevance whatsoever or completely incorrect.

And perhaps they would have said that in their report had they addressed the issue. They simply didn't address the issue and we think that that's a mistake. They should have done. It's a large part of our case that they were asked to look at all the available issues.

So, for example, epidemiological studies evidencing the greater health effects of low dose internal radiation surveyed by Professor Schmitz Feuerhake were

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not discussed in their reports. They may have been discussed in evidence but they were not discussed in the reports.

Evidence of the greater health effects of internal radiation from black rain deposition for people at Hiroshima, which undermines the ICRP model, was not discussed in the reports.

The elucidation of sophisticated mechanisms in cell biology, bystander effects and generic instability pointed to by Professor Mothersill, and evidence for the photoelectron effect of uranium brought by Professor Howard were not considered or critiqued in the experts' reports. Insofar as it's been engaged with in evidence before the court it has been in an ad hoc and offhand manner, a kind of "I haven't really read this but I don't think it's right" sort of way.

That leaves the Tribunal in a difficult situation. Thoughtful critique and a real engagement with the scientific ideas of our experts is missing. It's a case of ships in the night. And there's a danger, we would argue, as Mr ter Haar has also alluded to, that the offhand, dismissive comments of the witnesses in their evidence and their pointing to consensus views that back up those evaluations may be taken as proper scientific engagement when in fact they came closer to a simple refusal to engage at all.

We would argue that it's not for the Tribunal to adjudicate between our experts and those of the SSD. We would suggest, for example, that it is not for the Tribunal to decide if they find the Rowland study convincing or not. There are very many eminent experts in the field who find it convincing, and it would be quite wrong for them to overrule such experts by reference to other experts whose evidence they may personally find more convincing.

And I just want to point to a couple of traps that I think exist for those trying to make sense of this debate, and so one of them relates to the -- if we can go to the transcript from Day 9 at page 89. It's an exchange between Dr Rayner and Dr Haylock. Dr Rayner asked some questions which arose I think out of reading Dr Brenner's report. No, it's not. It's a report on Dr Brenner, but it makes the point that there was a lower frequency of translocations in the cohort in the control cohort compared with the general population. She asked a few questions about what effect that might have on the results. And Dr Haylock has said: "When you compare the two things ..." And if we go to page 90 this is where he starts to

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talk about it: "If you compare the two things and you see a difference, that might well be because the control group is lower and not because the exposed group is higher. That's my understanding."

My Lord intervened: "Right." And he went on to say: "So you need to make sure that your control group is representative of some larger population." And you answered: "The background population?" But Dr Haylock is simply wrong to say "yes" to the interjection "The background population?" As he well knows, the control population needs to be representative of the particular group you are studying and may in fact be rather different to the general population. And in fact the paper makes clear that the controls were very carefully chosen to match the age and occupational background of the veterans tested. It's well known that service personnel are in general a healthier cohort than an average member

of the population. This is acknowledged in many studies of the nuclear industry. It's known there as "the healthy worker effect", the idea that workers in the nuclear industry are generally healthier than the background population. So it's not actually surprising that the control might have had slightly fewer abnormalities than the general population. This doesn't in the slightest bit invalidate the findings of the study. Yet Dr Haylock for some reason was either unaware of this issue or didn't recall it at that moment and a rather misleading impression might have resulted in the mind of the Tribunal. So there is a danger that has already been raised and we would concur in warning against it that evidence given in a slightly offhand manner in the witness box may seem to have more weight than it should. So I want to look a little bit at the issue of experts and what experts can be expected to do, in effect the issue of expert neutrality. Court Procedure Rules 35 have been accepted as relevant and they indicate that an expert should assist the court by providing an objective, unbiased opinion on matters within their expertise and should not assume the role of an advocate.

We would submit that the SSD's experts have all acted in effect as advocates for the validity of the ICRP model, and so in doing they have strayed, through what we might call an excess of enthusiasm and

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campaigning zeal, into areas in which they were expert and have occasionally made incorrect assertions from the same desire to make their case. There are numerous points in the transcript and reports where we might point to the unreliability and the failure of neutrality of the SSD's expert witnesses and I shall just point to a few. I am going to start with Professor Thomas, and I just want to note in starting that we on this side are very sorry indeed that Professor Thomas was upset on Friday morning, and we want to just make clear that the e-mail she received was not about this case nor instigated by us. But many of the points I raise in regard to her evidence relate equally to Day 4 and Day 5 and if her evidence on Day 5 was skewed by her emotional response to what she perceived as an attack then we are sorry for it and we still feel that she allowed herself to stray into areas she was not expert in and to make some contentious remarks. She made a point early in her evidence to the effect that a good scientist is always looking for doubt. Now I'm quoting from transcripts but they are small sections. I don't know if you want me to take you to them before I quote.

MR JUSTICE BLAKE: Well, if you want to give me thereferences we can look them up.

MS BUSBY: So Day 4, page 119, line 3 to 7.

MR JUSTICE BLAKE: Yes.

MS BUSBY: "I would agree you are always looking for doubt. If you are a good scientist you are always looking for doubt, you are always looking for the alternative hypothesis, and finding a way to test so that you can take a hypothesis way." However, her attitude to doubt was in fact very much to dismiss it, and that was quite evident in the exchanges over the epidemiological evidence for greater congenital malformations from exposure to internal ionising radiation, both after Chernobyl and as a result of service in the Gulf War. You'll find those in the transcript from Day 5 from page 39 onwards. Professor Thomas, although many of the papers were ones she had not seen before and had only had a short time to look through, was emphatic in her claims that the studies were of no value whatsoever. In general she claimed that the studies showed no useful evidence because the study populations were too small and therefore could be unrepresentative. So there's a slightly longer extract which you might want to look at, if you like, which is Day 5, and that's page 43, line 13 onwards. Dr Busby put to her that the

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P value for this study is .0001. "Answer: I don't care what it says about the P value, I'm telling you the study is badly designed, and I'm sorry, you shouldn't be drawing conclusions from badly designed studies. "Question: Is it true to say that a P value of .0001 means it couldn't have occurred by chance except in one in 10,000 times? Is that what a P value means?"

MR JUSTICE BLAKE: The answer is yes.

MS BUSBY: Yes.

"Question: But if the design is not suitable to test your hypothesis it doesn't tell you anything."

"It's wrong," she simply says.

MR JUSTICE BLAKE: Well, she says: "You won't be able to cure a badly-designed study by applying a P value."

MS BUSBY: No.

MR JUSTICE BLAKE: That's right -- if it is badly designed you, presumably, dispute that it was badly designed.

MS BUSBY: Well, she's saying it's a small study. A small study with a very highly statistically relevant result, i.e. a very large result, a result you would really not expect to see, may not give you enough evidence to overturn the whole of ICRP, but it certainly gives you some evidence. In fact, Dr Haylock, later on, taken to these same studies, said that, yes, these are not, you know, this is not evidence that you would want to, you know -- you would absolutely take as the truth, but it's a hypothesis-generating study, it's a study that shows an effect which might lead you to go and do a larger study. It would indicate to you that something is going on. It would be something that might give you pause for thought. But not Dr Thomas, who simply thinks it's wrong.

MR JUSTICE BLAKE: She says "badly designed".

MS BUSBY: Yes. She thinks.

MR JUSTICE BLAKE: Yes.

MS BUSBY: Taken to a paper where the study population was 15 15,000, carried out by the Environmental Epidemiology Service of the US Department of Veteran Affairs, she was still sceptical, even without reading the paper. This is the same day, page 47 to 48. "Question: A paper about genetic effects in Gulf War veterans, a population-based survey of 30,000 veterans, would that be a large enough study?" "Answer: "Yes, but there's a problem with this. This is a survey, a questionnaire-based project. Again, unless you validate the responses in the questionnaire, it's difficult to be sure that what you are looking at

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is genuine." And she says: "Answer: "You haven't given me time to read this paper at length.

"Question: Do you want to read it now or not?" "Answer: No, I don't think it's worthwhile."

I think that to assume that a study carried out by the US Department of Veteran Affairs on such a large cohort, to be not even worth going to read, is somewhat surprising for an open-minded scientist. Again, displaying a tendency to prefer certain ideas, theories or personnel over others in a way that could be said not to be neutral, Professor Thomas suggested that although she couldn't fault the expertise of professors Parker and Kaldor, and this quote is from Day 4, page 122, lines 7 to 11:

"Answer: I would actually choose somebody else. I would choose Elisabeth Cardis, somebody who I know very well and I'm aware of all her work. So yes, I would defer to somebody like Elisabeth Cardis rather than the two you cited."

Now, the SSD has repeatedly sought to undermine our experts on the basis that they are known associates, yet here is their own expert making clear that, in reality, informal networks of colleagues coalesce around particular areas of expertise and scientific views and tend to defer to each other. We might note in passing that this is the same Elisabeth Cardis whose 15 countries study provides some evidence for our contention that pancreatic cancer is radiogenic. In addition to a combative approach to the evidence Professor Thomas also displayed a tendency to make mistakes and defend them vigorously. She stated during her cross-examination that natural uranium was not radioactive. The reference is Day 4, page 160. She was asked. "Question: So are you of the opinion that stable uranium is not radioactive?" "Answer: Stable uranium is not radioactive, it is the non-radioactive isotope of uranium." She repeated this assertion, and despite clear scepticism from Dr Busby, whom she knows to have a PhD in physical chemistry, she didn't check her facts that evening but returned the next day to state even more emphatically that there was a stable non-radioactive form of uranium. The reference is Day 5, page 21. She comments of a particular study she's asked to look at: "Answer: It's interesting that they use depleted uranium. I would have liked to see a control where they used stable uranium and then you could have a handle on

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whether it was related to the radiation or whether it was related..." And she is interrupted.

Taken to a set of decay tables of uranium isotopes indicating that all of them were radioactive she simply stated that they had left out stable uranium. This is page 23:

"Answer: You don't have decay table where there is a stable isotope because it does not decay.

"Question: I see. But actually may I put it to you that there is no such thing as stable uranium?"

"Answer: I think you probably need to check because I think that is untrue."

Experts can of course make mistakes, and being in the witness box is stressful, slips are easy to make; but this is a very serious mistake for an expert in the health effects of radiation to make about the nature of an extremely common radioactive element. It's also one she appeared to have no doubt about whatsoever, and despite the repeated challenges still maintained, even given an evening to go and check her facts. This is not, we would suggest, the behaviour of a reliable witness.

Another example is Professor Thomas's insecure understanding of dosimetry, another surprising failing in an expert on radiation effects in people.

So Dr Busby asks her: "Question: Of course if the dose is from an element or from a type of radiation exposure that involves alpha particles you would agree that the doses calculated are expressed in a quantity known as sieverts." I think the Tribunal is probably familiar with the conversion from gray to sieverts. "Answer: No, that's when you sum all the different types of radiation together. So if you are exposed to both alpha and gamma and beta the sievert is the sum of the individual components of dose which come from those different types of radiation. That's the definition."

Now, Professor Thomas may not be an expert dosimetrist, but I think it might be expected of an expert in radiation and health that they understood the concept of sievert, which relates only to alpha emission and has nothing whatsoever to do with adding it to beta and gamma. Perhaps we can allow Professor Thomas the mistake in dose units, but as a scientist who has published widely on the health effects of Chernobyl we might reasonably expect her to know exactly how many children were affected by the disaster. In discussing the evidence from Fukushima Professor Thomas asserted that 10 million children were exposed to fallout from

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Chernobyl. This is Day 4, page 14. She says: "Answer: For a comparison, in the areas around Chernobyl, 10 million children were exposed to varying doses."

When the number was challenged she continued to assert in a quite an exasperated way that this was the number given in UNSCEAR documentation. When it was suggested that the whole population of Belarus was only 3 million she repeated that this number of 10 million included northern Ukraine and the Bryansk region of Russian. Finally pressed she made an emphatic statement on the issue, and this is page 17:

"DR BUSBY: Do you agree that the population of children exposed to radio-iodine following the Chernobyl accident cannot possibly be anywhere near the 10 million that you have just told us?"

"Answer: No, I absolutely do not, and I think you should read that document. I'm sorry, that is common knowledge."

The document referred to is not in the bundle, but if I were able to produce it you would find that at page 107 the figure is given. Following the 1986 accident at Chernobyl about 5 million people living in Belarus and in extensive areas of Ukraine and the Russian Federation were exposed to radioactive materials. The WHO report on Chernobyl, which we do have in the bundle at SB22, tab 23, says:

"Currently about 5 million people live in areas of Belarus, the Russian Federation and Ukraine, with levels of radioactive caesium deposition more than 37 kilo-becquerels per square metre."

I hope we don't need to debate the proportion of children in the population in order to conclude that it really isn't possible to have 10 million children in a population of 5 million.

This could be said to be just another forgivable, silly mistake, albeit not perhaps one you'd expect of an expert in this area. But it's not just that Professor Thomas made a mistake, it's the combination of being wrong while maintaining with absolute certainty that she's right that makes Professor Thomas a somewhat unreliable witness whose assertions should be treated with some caution.

Mr Hallard, to move to him, was an altogether more cautious witness, and one who was scrupulous in documenting how he had come to his conclusions and where he was prepared to concede expertise to others. But it's clear from Mr ter Haar's arguments yesterday that there were a great many areas where he exceeded his

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expertise, partly because of the very difficult position he had been put in by the nature of the exercise he had been asked to carry out. There's no doubt he was a man of integrity, attempting to do his best; but it's also clear that in some respects he was at sea. He admitted to being unable to use deposition velocity as a method to calculate the level of fallout in the air as he didn't understand the method. That you will find on Day 9, page 108, line 2 onwards.



"Answer: You are going outside my expertise, I'm afraid. Going in that direction, I've seen the formulae and I've got a broad understanding, but in terms of how it's used I'm afraid that's outside my expertise." He similarly left out carbon-14 because he couldn't work out how to include it. The reference is Day 7, page 107, line 2, onwards.

"Answer: I couldn't find any information which I felt was helpful enough. I haven't produced any assessment of the dose based on carbon-14. I looked at it and just felt that I couldn't produce an assessment of the dose."

If we turn to Dr Haylock, he is, as was made clear in evidence, a biostatistician. He's a member of epidemiological teams but not an expert in epidemiological methodology. But he certainly takes part in epidemiological studies; he has a particular interest in the health effects of radiation. He accepts the ICRP model, which is based on the Japanese A bomb studies, that is on epidemiological studies of the affected population known as the LSS. Since Dr Thomas had in effect passed on all the issues to do with questions about the LSS methodology to Dr Haylock when cross-examined by Mr ter Haar the previous week, the SSD ought perhaps to have warned Dr Haylock that he might expect questions in this area. Regardless of that, the reports of Professor Sawada and his scientific paper on the LSS and radiation dosimetry have been part of the BS submissions for some months. Dr Haylock might reasonably, as a neutral expert, have been expected to engage with his arguments since they are crucial to a criticism of the ICRP model on which he relies for his statistics. Yet Dr Haylock was apparently unfamiliar with the argument, and the transcript is Day 8, page 58. You might want to look at it, it's quite lengthy. The quote is going to be quite lengthy, but if you don't want it read out, that's fine.

MR JUSTICE BLAKE: Do you want to take me there now?

MS BUSBY: It's Day 8, page 58. I'm sorry, I've forgotten to put the line number, but hopefully -- it's the question from yourself:

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"Question: Are you familiar with the comment on the LSS study?"

"Answer: Not particularly, no, I'm not, I'm afraid."

Oh, it's a question from Mr ter Haar. And Mr ter Haar goes on:

"Question: Certainly it sounds logical, doesn't it? If people have been assuming on the one hand you need a certain level of dose in order to lose your hair and, on the other hand, there's a fall off in exposure geographically and you find that people at the outer end of that geographical limit are also losing their hair, the two things don't seem to go together. That's the point he's making.

"Answer: On the face of. "Question: If true, it does cause some questions? "Answer: On the face of it, yes, but I think often you have to look deeper into these issues to really understand them."

Well, maybe you do, the question is perhaps why didn't he?

MR JUSTICE BLAKE: Couldn't understand it.

MS BUSBY: Yes, exactly, and I am coming to that.

MR JUSTICE BLAKE: 18 and 19.

MS BUSBY: You go on to say: "MR JUSTICE BLAKE: Have you read the report that he prepared for us which I think includes at table 6 the epilation graph?"

"Answer: No, I haven't read it in detail.

"MR JUSTICE BLAKE: And have you read the evidence that we've managed to get out with some difficulty in translation?

"Answer: Well, I read what I could of it but it didn't all make a lot of sense to me, I'm afraid."

And even given a break to examine it in detail he refused to engage saying it was too complicated --

MR JUSTICE BLAKE: No, he said he couldn't understand the text.

MS BUSBY: Still didn't really understand it. Yes, yes, yes. Well, I'm sorry --

MR JUSTICE BLAKE: You are sorry what?

MS BUSBY: That is -- okay, I'm not sorry, I'll just say -- this is an extraordinary position for a statistician in the area of environmental radiation epidemiology. Not only that but one giving expert evidence in a case where regard must be given to the arguments of the other side, and where one of the central arguments of the other side is that the ICRP risk model is wrong. One of the central pieces of evidence for that is faulty dosimetry in the LSS study, and that faulty dosimetry is

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explicitly addressed in a report that the SSD's expert has not even bothered to try and understand.

I am aware that the Tribunal had problems with Professor Sawada's English, even after the services of an interpreter had been engaged, but his written report is not difficult for a scientifically trained person to negotiate. And it is accompanied by a published paper which is even clearer as to Professor Sawada's methodology and his arguments. Even given the difficulties of communication it is clear that Mr ter Haar understood the major point that Professor Sawada was making and, with the greatest respect to Mr ter Haar, he is not an expert scientist. It is inconceivable that Dr Haylock would not have been able to understand Professor Sawada's paper if he had taken the time and trouble to do so. The fact that he did not, despite this paper making some serious criticisms of the risk model he employs every day, despite the fact that it is based on careful research by an eminent physicist -- one who has himself been part of the expert group who were responsible for setting up the new dosimetry protocols, the DSO2, which I think he did say he was part of that group -- and a man who I've already said has taught two Nobel Prize winning physicists is, we would suggest, evidence that Dr Haylock's confidence in his risk model is not based on personally engaging with the scientific debate but on simply accepting the consensus as true.

In this we would argue that Dr Haylock struck very much, as all the SSD's experts, to an extremely narrow remit of applying the numbers given and doing the calculations they were asked to on the basis of the currently accepted risk model. This takes me to my penultimate point about the standard of proof implicitly used by the SSD's experts.

The expert witnesses who testified for the SSD have time and again made the point that the ICRP risk model is the one they use because it is the accepted model of the scientific community. They say there is no other accepted model, there is nothing else that is based -- that is considered sufficiently robust to replace it.

So Haylock on Day 8, and the reference is page 112, says: "Answer: There may be other hypotheses, but they have not demonstrated they are better than what we already have at the moment, they are still hypotheses." It's clear that the standard applied here by Mr Haylock is whether there is anything that is better than the ICRP model. Whether, on the balance of probabilities, taking into account all the evidence,

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there is a model that is more true than the ICRP. The SSD's experts didn't engage in their written reports with any alternative to the ICRP, despite being directed to consider all the possibilities, and despite a large part of the appellants' case being that the ICRP risk model may not be safe for low doses of internal radiation and for uranium. In their verbal statements they explained that they had not done so because no alternative model is accepted by the scientific consensus. This is to misunderstand the nature of the standard of proof at issue in this case. I want to go back to Justice Charles's decision in the UT at paragraph 84, which is page 32, and it's back to SB1/110. At the bottom of that page there's a quote from Lord Hoffmann: "If a legal rule requires a fact to be proved ... a judge or jury must decide whether or not it happened. There is no room for a finding that it might have happened. The law operates a binary system in which the only values are 0 and 1. The fact either happened or it did not."

But he goes on in paragraph 86 and the next page, page 33, to say: "In my view an approach of carrying forward facts in that way does not apply to the Article 41(5) test because it is satisfied by establishing on reliable evidence possibilities that found a reasonable doubt."

He reiterates this on page 34 at paragraph 87 where he says, number (ii) in his little list, is: "Neither side takes forward a score of 1 or 0 based on the normal civil standard (balance of probabilities)."

The Tribunal should carry forward and explicitly consider possibilities that are not necessarily accepted as facts. The SSD's scientific experts are in essence operating a civil standard of proof with respect to the ICRP risk model. They have, on the balance of probabilities, assigned it a value of 1 and assigned to the alternative that it may be wrong or unsafe for low dose internal emitters a value of 0. They have then carried forward these values into their consideration of the likelihood that our appellants' cancers were caused by their exposure to ionising radiation during their service.

We would argue that they have not in fact considered all the possibilities but have considered a limited range of possibilities predicated on the assumption that the ICRP risk model is correct, i.e. that it carries a value of 1, rather than the acknowledgement that it is merely the consensus view.

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This tendency to evaluate a given piece of evidence, or theory, or model, in terms of a binary true or not true distinction, can be seen to run through all of the expert witness statements of the SSD and their evidence in court. Evidence potentially undermining the validity of the model is criticised, and potential flaws and problems are pointed out; but those flaws or problems do not necessarily totally invalidate those studies. Yet, for the experts, they are categorised merely as hypothesis-generating studies or, at worst, as rubbish. They are, in effect, accorded a value of zero, allowing the experts to assert that there is no evidence for the alternative models. Despite the fact that, if pressed, they will allow, they provide some indication or a possibility. We have numerous occasions on which the experts have admitted that the evidence put forward by our experts raises issues which might be finally proved or disproved by further more secure epidemiological studies. So if we look at Professor Thomas talking about the Zaire Notter study -- and I'm very sorry but I haven't got the reference here to the transcript, I've just got the quote, but I will give that to you afterwards -- but it was a discussion in which she said the study was too small. Your Lordship said: "If you were presented with information of such a medical finding and you were curious to know more about whether the proposition was correct, what would you need to do?" And she answered: "You'd fund a bigger study."

Dr Haylock has responded to those small scale studies as hypothesis-raising studies. So if a large number of small scale studies all raise a the same issue with a particular paradigm it is reasonable to consider that they raise a reasonable doubt about the validity of that paradigm, and further study may be necessary, and indeed further study has been funded for the DoReMi investigation that Dr Haylock has himself engaged in. Yet in this context, where doubts clearly exist and are acknowledged, where further study might be needed, where further study has indeed been funded, a very large further study requiring an awful lot of investment, the SSD and his experts continue to claim that the ICRP model, as the best available, is simply to be preferred as right.

We would argue that this position that it is the only valid model preempts the decision-making process of the Tribunal as laid out by Justice Charles, which is  
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precisely not to carry forward any facts as if they had a binary value of 1 or 0., but to carry forward the possibilities and doubts that attend these facts in order to finally weigh them up at the end of the process.

I just want finally very briefly to look at the relevance of reasonable doubt in the context of new hypotheses in science, because it is one of the things that was argued in the Upper Tier. At paragraph 20 of Justice Charles's decision, which would be page 10 –

MR JUSTICE BLAKE: Yes.

MS BUSBY: -- he talks about the Edwards case and says:

"... it was accepted by all parties that the test laid down in the penultimate paragraph of R v DSS ex parte Edwards is the basis on which the FTT should [measure reasonable doubt]."

This is the context.

This test refers to the development of what is essentially a new paradigm in a scientific area, a development from a mere hypothesis based on a limited study which might not be considered to raise a reasonable doubt, through a period when the growing evidence for this new hypothesis or paradigm is causing it to become more plausible to a point when it becomes accepted as the new model. The Edwards discussion makes it clear that at the very beginning of this new hypothesis being put forward it cannot raise reasonable doubt. But it makes it equally clear that reasonable doubt is raised in the interim period after this first stage and well before the consensus stage is reached.

Arguably, it is reached as soon as the hypothesis ceases to be based on only one limited study.

The criticisms of the ICRP risk model advanced by our experts go back some considerable time and are based on numerous peer reviewed papers.

MR JUSTICE BLAKE: Before 2002?

MS BUSBY: Yes. I mean, Inge Schmitz Feuerhake raised the issue of the problems with the LSS dosimetry in A bomb studies and the undermining of the ICRP risk model in the 80s, late 80s, I think. 73 was the first. We would submit that these more than fulfil the criteria for founding a reasonable doubt based on the Edwards decision.

So that's really the end of what I wanted to say, and it's for Dr Busby to elucidate the scientific arguments and that body of evidence that I have alluded to.

MR JUSTICE BLAKE: Right, well thank you very much. We might as well take a break now. We'll continue at

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two o'clock.

How far do you think you are going to get by 4.45?

DR BUSBY: By 4.45?

MR JUSTICE BLAKE: Yes.

DR BUSBY: I think probably I'll finish by then, my Lord.

MR JUSTICE BLAKE: I don't think we should sit beyond that.

If you think there's a prospect of finishing by then, if you haven't finished by 4.30, we'll try and do that. Thank you.

(12.45 pm)

(The short adjournment)

(2.00 pm)

Closing submissions by DR BUSBY

DR BUSBY: This is the final submission now on the part of the appellants Battersby and Smith. The Tribunal will have been given our final submission document which was handed up.

MR JUSTICE BLAKE: This is the table of issues for closing statement?

DR BUSBY: Yes. It was an attempt that we made to try and follow the valuable suggestion your Lordship made about laying out the cases in a way that appeared to be related to sequences of issues which were relevant to the final understanding of the case.

MR JUSTICE BLAKE: Right.

Closing Submission by Dr Christopher Busby is in another file.