Thursday, 23 June 2016
(10.00 am)
(The hearing was delayed)
(10.10 am)
MR HEPPINSTALL: Hopefully the finalised index of SB22 is on your desk.
MR JUSTICE BLAKE: Thank you very much. I'll check that in due course.
Any other housekeeping matters? No, thank you.
Yes, let's continue then.
DR RICHARD HAYLOCK (continued)
Cross-examination by DR BUSBY (continued)
DR BUSBY: Good morning, Dr Haylock.
A. Good morning.
Q. Last night you perhaps were able to look at some of the papers that were put in. But what I'd like to do first thing this morning, especially since the Tribunal is particularly interested in your response to the issue, we could maybe go to the Wahab and Rowland study, SB7/123.
This, as you know, I expect -- first of all, you have looked at this one now?
A. I have, yes.
Q. Yes. Whilst I realise that you may think it's not in your area of expertise because it's not strictly

an epidemiological study, or you could argue it's not strictly an epidemiological study, or some might say it is, I wonder first of all if I could ask you if you agree with the Health Protection Agency that it does appear to show a significant excess, a threefold excess of chromosome aberrations in these New Zealand veterans who were --
A. It does appear so. However, I have some reservations about the statistical methodology used to derive that significant difference between the two.
Q. Could you say what those reservations are?
A. Yes. Partly due to the -- it's partly due to the type of data we have in this study. It seems to me that the point you are mentioning refers to table 3 in this report, where you are comparing the mean for the veterans' group versus the mean for the control group.
However, if you look at the figure above --
Q. Sorry, are we in the actual published report?
A. Sorry, page --
MR JUSTICE BLAKE: 83.
A. -- 83.
MR JUSTICE BLAKE: Yes, so that's the short table, the small table?
A. Yes.
MR JUSTICE BLAKE: Page 83.

A. So here we are comparing the means in the two groups and generating confidence intervals based upon the assumption that these data are symmetrically, normally distributed. But it's clear from the figure above that that isn't the case. We have quite a skewed distribution with a long tail, so although I've obviously not been able to do any calculations of my own I would question whether those confidence intervals are really representative of the true variants of the two distributions of the two sets of data. They are conditional on the fact that the distributions are normal, and they're not.
Q. I think I --
A. How far they differ from what I would do is not possible for me to say, given that I haven't had the data. But the further -- the more skewed a distribution is, the more inappropriate this sort of comparison is.
However, they also do do a comparison of the individual data, something called a Wilcoxon two sample rank sum test.
The idea of this particular type of test is it doesn't -- it doesn't depend upon the distribution of the -- the underlying distribution of the data. What it does is essentially say: if you ranked all the values in order then you would expect, if there's no difference

between the two, for them to occur essentially in a random order. You wouldn't expect to have all the controls, the -- yes, the controls followed by the veterans; you'd expect them to be randomly distributed up the list of -- up the -- if you put them in size order, there would be no pattern to it.
That says there is a difference and I think that's the statistical test upon which this difference is shown.
However, as I said, it does not take into account the underlying variability in the two sets of data.
I would say a parametric test based on a Poisson distribution or similar would possibly be better.
Again, I can't say whether it would give a different result unless I have the opportunity to do it, but it's -- one of the things about summarising this sort of data is that, as done in the table and at the bottom of the columns of data -- and throughout the paper the authors refer to the numbers of aberrations per thousand cells -- is what you're losing is the individual variability between the individuals within each group.
Obviously if there's lots of variability within individuals in a group, when you are comparing that group to another group, that's more of a difficult comparison. Lots of variability makes comparing two

groups difficult and --
MR JUSTICE BLAKE: Variability in what, sorry?
A. If you are trying to say "Is this group different from this group?" both groups vary within each other a lot.
MR JUSTICE BLAKE: In terms of their experiences, in terms of their biological findings?
A. In terms of the numbers of chromosomes we see, the chromosome aberrations we see out of the number of cells.
Perhaps I could illustrate my point by another paper that we have in the bundle. Is that possible?
MR JUSTICE BLAKE: Yes. The?
A. SB22, the Tawn paper. Number 22, I think it is.
MR JUSTICE BLAKE: SB22, tab?
A. 22, I presume, yes. "Chromosome aberrations determined by FISH in radiation workers from the Sellafield nuclear facility".
MR JUSTICE BLAKE: Right.
A. If you look on page 300 -- or is it 200? 300. At the top you see two graphs, one in which in the top graph the data are grouped data. In the lower panel you're seeing the individual data and seeing essentially the variability of the individual responses which you don't see in the upper figure. So the upper figure gives the impression that everything looks brilliant and they're

all nice and close, but it's hiding the underlying variability. So if you're comparing two groups which are also similarly variable, then by summing them you lose the within person -- sorry, within group, between person variability.
MR JUSTICE BLAKE: All right. Let's see if I am following this.
A. I am sorry. These are complicated --
MR JUSTICE BLAKE: I'm sorry, I'm probably not up to speed with you.
But you are saying that if you are going to make a comparison between your cohort and your control group --
A. Mm.
MR JUSTICE BLAKE: -- you need to take into account the chromosomal differences --
A. You need to take into account the individual variability and response between individuals within the group.
MR JUSTICE BLAKE: Within each of the cohort and the control?
A. Yes.
MR JUSTICE BLAKE: Or internal to the cohort and the control?
A. Internal to the cohort and the control.
MR JUSTICE BLAKE: Right. And you will say an example of

that being done is figure 1 in Tawn at tab 22 or simply --
A. I'm trying to illustrate the point that when you group data, or as in the case of the Rowland people where you are just simply summing, you see a single value, whereas that belies the underlying variability between individuals, which the lower panel of the B(?) in the Tawn paper shows that --
MR JUSTICE BLAKE: And there's no equivalent in the Wahab paper?
A. There isn't.
MR JUSTICE BLAKE: So they haven't acknowledged the underlying variability?
A. That is what I understand from the statistics that they say, yes.
MR JUSTICE BLAKE: Well, we've got that answer. Does that complete your concerns about the methodology or did you have other concerns about the methodology?
A. I think that completes my concerns, my Lord.
MR JUSTICE BLAKE: Right, thank you.
DR BUSBY: Thank you.
As I understand it, you say that there is an effect, but the confidence intervals may not be correct because it's not a normal distribution, but the effect is shown by the non-parametric test that they used?

A. Yes. However, if you did do a different test I would want to see -- a test that I would say might be more appropriate, I would like to see the P value of that. But on the face of it I would say it does show a difference.
Q. Well, whilst we are there perhaps -- and keep your Tawn paper there because we are going to come to that -- if we can go to SB22/24?
MR JUSTICE BLAKE: 24.
DR BUSBY: Yes. It's comments on the New Zealand nuclear test veteran study.
A. I haven't got that, my Lord.
MR JUSTICE BLAKE: Is it not in your tab 22? I'm afraid you'll have to -- the witness' bundle just doesn't seem to have been loaded.
MR HEPPINSTALL: I thought I had done it.
MR JUSTICE BLAKE: Tab 22?
DR BUSBY: Tab 24, my Lord.
MR JUSTICE BLAKE: Sorry, tab 24 of bundle SB22?
DR BUSBY: Yes. (Handed)
MR JUSTICE BLAKE: We've never been able to get this working right, but there we are.
A. I have it.
MR JUSTICE BLAKE: Right. When you've finished with it if you slot it into tab 24 then we'll know where it is.

Yes?
DR BUSBY: If I could just take you to -- first of all, this is a report by your own outfit, the Radiation Protection Division of the Health Protection Agency. Yes?
And if I can take you to the second page at the top. These pages are not numbered but at the top of the second page at the bottom of the first paragraph the Health Protection Agency, unsurprisingly, agrees with you that the non-parametric test -- the Wilcoxon test -- was appropriate for the data and that "the P value indicates a highly statistical difference between the numbers of stable translocations and controls".
Would you agree with that?
A. Mm-hm.
Q. Then --
MR JUSTICE BLAKE: Is that the same point you have been making?
A. Yes, I believe so.
MR JUSTICE BLAKE: You weren't involved in writing this paper?
A. I was not.
MR JUSTICE BLAKE: No.
DR BUSBY: Then there's another paragraph just immediately below that, where they use their own approach based on T statistics. I think you probably disagree with the T

statistics approach, but anyway, they say:
"The probability of observing the number of stable translocations is extremely small, 2 times 10 to the minus 10. Thus there is a very small probability that the observed difference between the veteran and control data is due to chance."
Would you agree with that?
A. That's what I says. I agree that's what it says.
Q. Sure, but do you agree with it?
A. Well, the T test is a test that is -- it actually is dependent on the fact that the data are normally distributed. As the data get further away from the normal distribution, the T test becomes less appropriate.
However, if the test is as significant as that I think it probably would still show a difference.
Q. Right. So if we just go to the back page where it says "Conclusions", and they say:
"We concur with the authors that the results from this study indicate a statistically significant threefold increase in stable translocations for veterans compared to controls and that it is possible to ascribe the increase in stable translocation to radiation exposure."
Would you agree with that?

A. That's what it says. I wouldn't necessarily agree with that statement because I've not had the opportunity to --
Q. But this is the Health Protection Agency --
A. It is, though it's not me.
Q. -- Radiation Protection Division.
Okay --
MR JUSTICE BLAKE: When you say you wouldn't agree with it is that because you just don't know?
A. Yes.
MR JUSTICE BLAKE: You are not saying you positively disagree with it; you just don't have the data?
A. No.
MR JUSTICE BLAKE: In a sense you can only comment upon one aspect of the statistical method?
A. Yes, I believe it's open to challenge and that there might be other more appropriate statistics, and if those gave different values then I think I would want to question the results of the study. If they gave similar values then I would say no, I think that's probably okay.
MR JUSTICE BLAKE: Right. Of course, some of this material depends in any event upon biological examination that you are not going to comment upon?
A. Yes. All I was thinking about was the methodology used

to analyse the data, my Lord.
MR JUSTICE BLAKE: And although the Agency, the authors of this paper, seem to think that you can use the T statistics, you're not so sure about that?
A. I'm not so sure about that, my Lord.
MR JUSTICE BLAKE: Yes. Otherwise, is this Wahab and Rowland study an epidemiological study, or does it rely upon epidemiological methods?
A. I would say it relies upon epidemiological data and it applies statistical methods. The problem with all these sorts of studies is: have you applied appropriate statistical methods? If you apply different methods would you get different results? It's not always absolutely clear that for a particular sort of data you should apply one method or another method.
As I said, some of the statistical tests we use depend on the distribution of the data. If you put them in size order, do you get a nice symmetric bell curve shape or do you get something else?
If you get something else, then that can affect the reliability of the test. But it depends how far away you are getting from normal. If it's a bit far away -- if it's a very skewed distribution then possibly the statistics are not valid. If it's just a little bit different, well, it may not be perfect but it may be the

best test we have available. It's not always a straightforward: this test applies to this data or this test doesn't, unfortunately.
MR JUSTICE BLAKE: All right.
A. Sorry.
MR JUSTICE BLAKE: Okay. Yes.
DR BUSBY: Dr Haylock, I think we need to nail this point. You agree that the non-parametric test -- you agree with the Health Protection Agency that the Wilcoxon test does not rely upon any sort of distribution?
A. It doesn't.
Q. Therefore, whatever it finds, whatever P value it gives is a valid solution to the question, a valid answer to the question: could it have occurred by chance?
A. Yes.
Q. And you agree that it couldn't have occurred by chance?
A. As interpreted in the results of that test.
Q. Thank you.
Well, whilst you took us to the Tawn paper and since it's out in front of us could we just go to the Tawn paper?
If I could take you to the introduction which is on the first page, that's page 296 -- yes?
A. (Nodded assent)
Q. About a third of the way down -- yes, a third of the way

down it says, it writes:
"Translocations are stable aberrations that persist through cell division, and their presence in peripheral blood lymphocytes is maintained because descendants of irradiated bone marrow stem cells carrying translocations survive and appear in the circulating blood."
One of the questions that was being raised -- there have been a number of questions raised about the credibility of this important study, and one of them is that, as Professor, I think Thomas said: how is it that these veterans could still be manifesting chromosome -- this translocation evidence such a long time after their exposure, 50 years?
But would you agree that this paper largely answers that question by saying that these translocations are stable and could have lasted a long time?
A. I'm not sure that's an epidemiological question that I could answer.
Q. Well, you could say it's not within your --
A. To my knowledge --
Q. -- expertise.
A. -- that is the case, yes, but I'm not an expert on translocations and whether they do remain stable or not.
MR JUSTICE BLAKE: You are being asked to comment upon the

statement "Translocations are stable aberrations which persist through cell division" and that's a biological issue rather than an epidemiological one?
A. I believe so, yes.
MR JUSTICE BLAKE: All right.
DR BUSBY: Just in case you may be able to help us with another statement made by these researchers, if we could go to the top of page 297, where it says:
"Thus, for protracted low-LET exposure, translocation frequencies should increase with cumulative dose and provide a good measure of total dose."
Are you able to comment on that?
A. Not really, no, I'm afraid.
MR JUSTICE BLAKE: That's a dosimetry question rather than a statistical analysis of dosimetry?
A. Yes.
DR BUSBY: Did you know about this paper? You've obviously seen this paper before.
A. Yes, I've seen it before.
Q. And it has to do with radiation workers at Sellafield?
A. It does, yes.
Q. Are you able to tell us whether the radiation workers at Sellafield are exposed to internal radionuclides?
A. Some are, yes.

Q. Thank you. I think that's all we need to do with that one.
MR JUSTICE BLAKE: As far as the statistical method of this paper is concerned, you don't have any comments?
A. No, it appears to be fine.
MR JUSTICE BLAKE: It's a fine statistical method. Insofar as you can comment on that --
A. Insofar as I can comment overnight and --
MR JUSTICE BLAKE: Yes, okay.
DR BUSBY: Could we go back to Rowland now, SB7/123, and we want to go to table 15, page 34. So this is the Massey University larger paper that has the data in it. You can see the actual data points here. The ones that you were concerned about.
Now, again I'm not sure whether you can help us here but I am going to ask you anyway. It's been suggested that the range -- you can see if you look across it says "participant" and then it puts "dose", column 4 it says "dose". Sorry, page number 34, this is, table 15.
A. Mm-hm.
MR JUSTICE BLAKE: Sorry, page 34?
DR BUSBY: Yes. These are the results, the individual results.
A. Right.
MR JUSTICE BLAKE: You've got to the right --

A. I have the table, my Lord.
MR JUSTICE BLAKE: Yes, good.
DR BUSBY: Now, if you look at dose in gray, in column 4, you can see that some of these doses are very large and some of these doses are zero?
A. Mm-hm.
Q. It's been suggested that this in itself attacks questions of credibility of the paper because it's hard to see -- and we're talking about distributions now -- how it is that you could have such an odd distribution, with lots of people with absolutely no dose whatever and some people with -- I mean, in one case there's a dose of 1.2 gray indicated. This is on about --
MR JUSTICE BLAKE: Well, I think we can see the range. Yes. Up to 1.4, I believe. Yes, what is the question?
DR BUSBY: I just wanted to ask you if you agreed with that, that it seemed unlikely that there would be such a wide range of doses, or maybe you are not able to comment on that?
A. It's a difficult question for me to comment on, I'm afraid. No, I'm afraid I'm not going to comment on it, not without having a chance to look at it more carefully.
Q. I mean, would it help if I pointed out that where it writes "dose in gray", that's not really the dose at

all, that's the dose that they assumed on the basis of the chromosome --
MR JUSTICE BLAKE: You've to use this witness for what he can inform us about. Please don't --
A. Could I make a comment that I think that we have a single value of dose here. This is a point estimate. What we don't have associated with this is a measure of the uncertainty on those doses either, so that would have been very helpful to interpret them. Are the big doses more uncertain than the little doses? That would be useful. I would suggest that's more likely to be the case but I don't know that.
DR BUSBY: Well, that's quite a good answer. I mean, in fact the zero doses don't mean zero dose, according to the paper here, if you look at page --
MR JUSTICE BLAKE: Please don't make a statement. Ask a question, Dr Busby, please.
DR BUSBY: Right, can we go to SB22/21, then.
This was back to Tawn, I think. No, Hristova, which I think we asked you to look at overnight.
A. You did.
Q. If we just look at the -- all we need to do here, because this is not your area -- this is specifically in response to your point that you just made. If you look at the abstract towards the bottom it says:

"When compared with the control group ..."
These are nuclear workers again:
"... workers with accumulated doses up to 100 millisieverts showed no increase in genome translocation frequency, whereas workers with accumulated doses from 101 to 200 millisieverts showed a statistically significant doubling."
So what they are saying is -- well, do you agree that what they are saying is they don't see anything, so in this case it would be the same sort of distribution, you'd get 0, 0, 0, 0 and then suddenly you'd see something?
A. I think their conclusions here are a little challenging in that the group they are talking about, the less than 100 millisievert group, contains only six people. So I think that maybe if you chose a different six people you'd get a different answer.
Q. I'm sure that would be true but the ones they did choose they got 0 is the point, and that doesn't necessarily mean that they didn't get 100 millisieverts, they could have got 50 or 60 or 70 or 80. It wasn't really 0, that's my point. It would just be an assumption of 0 because they didn't see anything.
Well, all right --
A. I am not confident in making comments on the conclusions

of the studies when they are based on such few numbers. It's a poor comparison, I'm afraid.
Q. Yes. Well, yes, thank you.
So I think really we can't go any further with this Rowland thing, but the Tribunal was interested in any help that you could give with regard to that study and you've been very helpful, especially on the Wilcoxon point.
MR JUSTICE BLAKE: Come on, let's move on, please.
DR BUSBY: Yes, how are we doing? 10.35.
Right, I would like to take you to your calculation F. This is your paper, SB2/21, I think. Sorry, it's 2.21.
MR JUSTICE BLAKE: Yes.
DR BUSBY: At the end of your report you comment on Battersby -- this is our appellant, Don Battersby -- and the probability of causation for CLL.
A. Yes.
Q. I think you write there something like:
"There was no risk model that I could use to calculate a probability of causation for Battersby."
A. Not one that I would want to rely upon.
Q. Yes, right.
Do you know the risk model of the Center for Disease Control, called NIOSH-IREP, the American system for

calculating the probability of causation?
A. I do know that system, yes.
Q. Would you agree that that's commonly used in the United States for calculating the probability of causation in the case of a nuclear workers or people related to radiation?
A. In relation to compensation, I believe.
Q. Yes. In fact, it's kind of legally accepted that the results of that would be authoritative and acceptable for legal purposes?
A. Maybe but --
Q. Are you aware that the United States system, the Center for Disease Control system, has accepted that CLL is a radiogenic disease?
A. I disagree with that statement. I don't believe they have, no.
Q. Its in the Federal Register. Do we need to go to it?
A. The evidence is there is not -- I can't remember what the terminology was now, but it was not that there was zero evidence but there was no -- I can't remember the terminology, sorry.
Q. So you are saying that the Federal Government has not accepted that CLL is a radiogenic disease?
A. Correct.
Q. Well, there's not much more I can say that about

unless --
MR JUSTICE BLAKE: I suppose implicit in this line of questioning was: do you think that NIOSH would provide a suitable risk model for the relationship between radiation exposure and CLL?
A. No, they don't. The model they use, from my research, indicates that it's a model which is based upon putting all the cancers together that they do not provide separate risk models for. So it's not a specific model for CLL, it is just using the general model that you get if you put all the cancer types that you don't have a separate model for together. So I didn't consider this represented a viable and suitable model.
DR BUSBY: Dr Haylock, have you ever gone and actually looked at the NIOSH-IREP model?
A. Yes.
Q. On the Internet, do you agree you can find a list of cancers on which you can click on a specific cancer?
A. It lists -- it divides cancers up into whether they were group 1, where they have an individual model, or group 2, where the risk is derived from a general model and CLL appears to fall into group 2 and it's derived from this overall grouping of cancers that are not separately done in group 1.
Q. So if you were to go to the NIOSH-IREP model and you

were to put in CLL and you were to put in Mr Busby's dose, what would pop out at the end?
A. Sorry?
Q. It would do the calculation and it would produce a probability of causation?
A. It would, but that is for the purposes of the compensation scheme. That's not what I was asked to do. I was asked to select an appropriate risk model and I decided that there was not an appropriate risk model because the NIOSH model is not based on epidemiological evidence of CLL.
MR JUSTICE BLAKE: So as I understand your answer, NIOSH for its own purposes and its own scheme puts CLL into group 2 cancers.
A. Yes, with many other cancers.
MR JUSTICE BLAKE: With other cancers?
A. Where there is not specific evidence --
MR JUSTICE BLAKE: Hang on, and then it gives a risk assessment for group 2 cancers generally, it hasn't done an epidemiological study on CLL specifically?
A. Definitely not.
MR JUSTICE BLAKE: So it just includes CLL in group 2 cancers and you didn't think that's appropriate --
A. No, absolutely not.
MR JUSTICE BLAKE: -- for the issues that we are facing?

A. Definitely not, particularly given the fact that there is no other evidence that CLL can be caused by radiation exposure from large epidemiological studies.
DR BUSBY: Dr Haylock, why do you think that the NIOSH organisation, agency, decided in 2012 that CLL was a radiogenic cancer?
A. I don't know, but I don't believe it was based on good quality epidemiological evidence.
Q. So this is you against NIOSH-IREP, is that fair to say?
A. NIOSH don't -- I could not find that they have published the reasons why they decided to compensate for that disease. It doesn't appear to be publicly available.
Q. It wasn't given to you by the defence?
A. I've looked on the NIOSH-IREP site and all it says is that it's listed in this second group and this decision was made, it changed from being absolutely zero risk to -- to not a zero risk but not a specific risk model type of calculation. So I don't believe it was done on the basis of epidemiological evidence.
Q. So you're not aware of quite a large report that was actually provided by the Secretary of State which covered -- which was a report by the NIOSH on this exact issue?
A. I was not provided with that report.
Q. Well, we're a bit short of time so we can't go any

further with that one.
I would like to ask you now about pancreatic cancer. Do you believe pancreatic cancer is radiogenic? Are you able to help us with that?
A. I can, I think, and I don't believe it's radiogenic.
Q. Again, the NIOSH-IREP system would enable you to provide a positive probability of causation?
A. That's system is used by the Americans for their purposes. I was asked as my expert opinion did I think that and would I want to do a probability of causation calculation, and my expert opinion was no, I wouldn't.
Q. When you produce a probability of causation, you use the equation excess relative risk over 1 plus excess relative risk, is that correct?
A. Yes.
Q. What does the "1" stand for?
A. It's the underlying risk.
Q. The underlying risk where?
A. The other risk in relation to the disease.
Q. But the underlying risk in what? In the national population?
A. Yes.
Q. So where would you get that number from?
A. Well, if you are doing simply a relative risk calculation it doesn't feature in it; if you are doing

an absolute risk calculation then it will do, yes.
Q. It has to do --
A. You get it from the population from which you draw the individual, ideally.
Q. But the national population is not the population you draw the individual from. You draw it from a soldier population, is that not right?
A. If you had such a population.
Q. So if the soldier population was more healthy than the national population by, say, 20 per cent then it might be more appropriate to put, instead of 1 on the denominator to put 0.8, would that be correct?
A. No, because the idea is to look within the population, was there an effect of radiation?
Q. Which population?
A. The population from which the person is drawn.
Q. Which is what population I'm asking you?
MR JUSTICE BLAKE: Is that the UK population of people of a certain age or --
A. It depends what group you are talking about. Are you talking about the whole -- are you interested in risk in relation to the whole population or are you interested in risk in relation to just soldiers?
DR BUSBY: We're interested in risk in relation to people who have been exposed to radiation because this is

particularly a probability of causation regarding radiation, so the ERR that you are talking about is the excess relative risk per unit dose in the population that you have been exposed to.
MR JUSTICE BLAKE: That's the question now. Please, what's the answer?
A. Sorry, can you ask again?
MR JUSTICE BLAKE: I think it's suggested that it's wrong to use 1 as the underlying risk in the national population.
A. No, I disagree. Sorry.
DR BUSBY: We're a bit short of time now, so I think there's only room for a couple more points but to go to this question of pancreatic cancer --
A. Yes.
Q. -- perhaps we could go to the big Cardis study, the 2005 study that we looked at yesterday, which is SB6/68.
If I could take you to table 1 --
A. Mm-hm.
Q. -- which is on page 308.
A. Yes.
Q. If we go down that you can see at some point -- in fact I think unfortunately this is printed on both sides so we're going to have to be a bit tricksy here.
A. Confusing.
Q. You can see there's a table for all of these nuclear

workers and it gives 272 cases of pancreatic cancer?
A. Yes.
Q. And you see observed and expected?
A. Yes.
Q. But that's not what I'm interested in, and in order to determine which -- because we are going to go over the page now, so we are going to count up from the bottom and go 20, so if we go up 20.
MR JUSTICE BLAKE: This is page 399 you are on?
DR BUSBY: 399. We want to go up 20 numbers, in order to get to the point, in order to get to where it says "ERR per sievert" which is three columns from the right.
A. 2.10?
Q. That's right.
Would you agree the excess relative risk per sievert in this population is 2.1 per sievert?
A. Uh-huh.
Q. So if you fed that into a probability of causation, you'd have whatever your dose was that Mr Hallard provided you, multiplied by 2.1, divided by 1, plus whatever that was. That's how you do it, isn't it?
A. That is how you do it, yes.
Q. That would give you a positive answer, wouldn't it?
A. Could I point out --
Q. Could you answer the question?

MR JUSTICE BLAKE: Hang on.
A. Yes, it would give you a --
Q. And a positive answer means -- sorry.
MR JUSTICE BLAKE: He wanted to add something to his answer.
A. I wanted to add that that excess risk is not -- if you look at the confidence interval next to it, that confidence interval has a lower bound which is negative, implying that the data does not support that that excess risk is statistically significantly different from no risk.
DR BUSBY: That may be true but then that may be true due to the fact that pancreatic cancer has a very low probability anyway and there are only 272 cases in this population, column 1, is that correct?
A. It might well do, yes. Yes, certainly.
Could I also make another point --
MR JUSTICE BLAKE: Please.
A. -- if you don't mind, that one of the issues with doing this sort of study is that when you do lots and lots of tests to look for effects on many, many diseases, then by the nature of the statistical tests we do you tend to see random occurrences happening about 1 in 20 times if we use a P value of 0.05 to indicate the statistical significance. So for every 20 tests you might expect one test to come out significant by random chance.

So in this situation here we're doing quite a few different tests. So I think we have to be clear that when a test like -- when a test is shown as significant then we have to make sure that that has a -- in order to accept it as a hypothesis-testing study, that there was a prior hypothesis that this might have happened. Otherwise it would be only considered as hypothesis-generating because of the chances of it occurring at random.
So we do see in some of these studies incidences of significant P values and we have to take that into account. But in this case we wouldn't say there was any evidence from this study that pancreatic cancer was raised with radiation.
MR JUSTICE BLAKE: Because of the P value?
A. Because of the P value, and because the lower bound of the confidence interval goes below -- shows the excess could be zero.
DR BUSBY: Well, thank you. I'm glad that you went to the question of probability tests, because we can ask you to do one. I think on May 18 we floated a few questions across, which I hope you got. One of them was to estimate the probability that four veterans would develop pancreatic cancer and die of it in a population of 13 appellants.

This is a simple binomial calculation, but did you do it?
A. In a population of 13 appellants?
Q. Yes. We did point this out to you in the question that we sent through. Maybe you didn't get those questions?
A. I did get them, but I didn't interpret it in that way, I'm sorry. I didn't understand your question to mean exactly that specific point.
Q. Well, let me put it this way. Say we had -- the individual probability of dying of pancreatic cancer is known, it's about 4 per cent.
A. I did some other calculations as well, because you'd asked about this question, and I looked at a population of people. I assumed a person who was born in 1939 and who was known to be alive in 1959, because they had to be, say, 20 years old at the test and followed through until that person was aged 70 and looked at: what will be the probability for a typical person in the UK population with that age, with that birth date and known to be alive at a certain time? And it came out as half a per cent. So I would expect if you had a group of people with that profile you would expect half a per cent of them to die of pancreatic cancer by the time they got to the age of 70.
DR BUSBY: Right, so in other words --

MR JUSTICE BLAKE: I'm losing this rapidly.
In tab 2.22 I thought you were giving answers to questions. There are other questions that you've also been asked, are there? Because I don't see this question.
MR HEPPINSTALL: I don't want to intrude on the cross-examination but it may be worth looking at the point that's being made itself in the amended statement of case, which is SB1/1.2A, page 49. Then you can see the context.
So Dr Busby has raised this issue.
MR JUSTICE BLAKE: In the statement of case, not in the questions?
MR HEPPINSTALL: No, he then, to be fair, on 18 May sent some questions.
MR JUSTICE BLAKE: Some further questions?
MR HEPPINSTALL: He said he was going to tell our witnesses what questions he was going to ask in cross-examination.
MR JUSTICE BLAKE: We haven't had an answer to this question before now.
MR HEPPINSTALL: No, not a written answer. At least you'll see the --
MR JUSTICE BLAKE: Then I'd better --
MR HEPPINSTALL: All right. That gives you the question, anyway.

MR JUSTICE BLAKE: Well, do you understand the question? You were asked a question outside the questions, I think.
A. Yes.
MR JUSTICE BLAKE: Right.
A. The question Dr Busby posed was not what I interpreted from what he wrote down.
MR JUSTICE BLAKE: Since we're taking the answer raw, as opposed to looking at something you've already done, can you just repeat what calculation you have done and then we'll see where we go from there.
A. Okay. So in order to -- what I thought I was doing for Dr Busby, I assumed a person who or a population of people born in 1939 that were known to be alive in 1959, i.e. they had reached the age of 20.
MR JUSTICE BLAKE: In 1939, alive in 1959.
A. Then I followed them through until they reached the age of 70 and said: of that group how many would we expect to die of pancreatic cancer based upon England and Wales national rates?
MR JUSTICE BLAKE: Yes.
A. I found half a per cent.
DR BUSBY: That was part of what I asked you to do.
MR JUSTICE BLAKE: Right.
DR BUSBY: But the main thing I was asking you to do was to

calculate the probability that four of those people would end up in this Tribunal out of 13 -- cancer --
A. I couldn't do that because we don't have the information to do that.
Q. Well, of course, it's a simple binomial calculation, isn't it? It's like how many people -- if you throw a dice so many times, what's the probability of getting 6, six times out of 13 throws? Or not a 6 in this case, a 0.5 per cent?
A. Your question doesn't make sense because what you are saying does not apply to the whole population of test veterans. You're asking a question about people who you already know about, not people -- not more widely. It's not a sensible question to ask, I'm afraid.
MR JUSTICE BLAKE: Is there any statistical significance on the question of linkage between the fact that -- the age data you've given us are Battersby data, date of birth, date of cancer, date of exposure, right? You have come up with half a per cent risk of such a person developing a cancer.
We're told that Mr Battersby did develop a cancer -- such a cancer -- and we're also told that in this appeal of 13 other veterans of different ages, et cetera, four have developed pancreatic cancer.
Any comment upon that?

A. Yes, that I think that the fact that Dr Busby knows about these pancreatic cancers is because these people are part of his Test Veterans' Association. I was looking at: what is the probability of these things occurring by normal -- by causes other than radiation or other than being in the test, amongst the whole group of veterans? So what I did was apply that half a per cent to the population of test veterans, and we have 20,000 test veterans, so half a per cent of 20,000, assuming they were all the same as Mr Battersby, and that would give you a number of 100. So I would say in the test veterans cohort you might expect on the basis of national rates to see about 100 pancreatic cancers, and up to -- of the cohort that we have at Public Health England at the last analysis they were 77. That was done in 1998 so I might expect there to be a few more now.
So the fact that Dr Busby knows about four --
MR JUSTICE BLAKE: Four.
A. -- doesn't seem remotely unusual to me, particularly seeing as he is representing people who are part of an organisation who might have concerns that diseases are caused by the test. I don't believe that's remotely unusual at all.
DR BUSBY: Well, let me put it another way. Actually maybe

I can see we're not going to get very far with this but I am just going to put it once more to you because you haven't really done what I asked you to do.
A. It was not a sensible thing you were asking for.
MR JUSTICE BLAKE: Anyway --
DR BUSBY: For whatever reason.
MR JUSTICE BLAKE: -- put the last question because I think he may have done, but there we are.
DR BUSBY: Okay, well, in that case let's just go to SB7/113. This is the last question.
MR JUSTICE BLAKE: Yes. This is the mortality experience of A bomb survivors?
DR BUSBY: That's correct, my Lord. This is the 1973 annual report from the Atomic Bomb Casualty Commission.
A. I have it.
Q. Can I take you to page 6 of that report?
MR JUSTICE BLAKE: Right.
DR BUSBY: Now this report is interesting because it was one of the first reports that said what it's saying --
MR JUSTICE BLAKE: Which paragraph do you want to take us to?
DR BUSBY: We're looking at "comparison group".
MR JUSTICE BLAKE: Do you see that, about in the middle of the page?
A. I have it.

DR BUSBY: It says:
"In order to ascertain the effects of radiation exposure, it is necessary to compare the mortality experience of a population exposed to ionising radiation with a comparison or control population."
Would you agree with that as a sort of general epidemiological statement?
A. It's one way. I don't believe it's the only way or even the best way.
Q. Right:
"For this purpose a group of people who were not present in the cities was included in the sample."
Would that have seemed a reasonable thing to do?
A. It depends what question you want to answer.
Q. I think the question -- you know the question they want to answer. Perhaps you could tell us the question they want to answer?
A. Well, if you are saying if you want to compare that group with the group who were exposed to the bombs and compare their health, then --
Q. I asked you what the question was that they wanted to answer.
MR JUSTICE BLAKE: Well --
DR BUSBY: Could you answer that question?
MR JUSTICE BLAKE: Well, do you know what question was being

posed by the authors of this study? And therefore I think you are then being asked as to whether what they said they were doing by way of a comparison group was an appropriate --
A. I think they are trying to compare and see if the health of the people who were exposed to the bombs is significantly worse than that of the group that wasn't in the city at the time of the bomb.
DR BUSBY: Well, could you agree --
MR JUSTICE BLAKE: If that's the purpose, then is what they have done -- I think you are being asked to comment upon the methodology.
A. I believe there was an issue with this in that when it was looked at the not in city group --
DR BUSBY: We haven't got a lot of time.
MR JUSTICE BLAKE: Sorry, what's the question? Ask the question.
DR BUSBY: I have asked him the question, my Lord.
MR JUSTICE BLAKE: Do it again because I don't think --
DR BUSBY: What was the purpose of this study?
MR JUSTICE BLAKE: Well, he has told you the answer.
DR BUSBY: In that case we can move on.
MR JUSTICE BLAKE: Right.
DR BUSBY: We are going to go to the bottom of this page now.

MR JUSTICE BLAKE: Low mortality?
DR BUSBY: It says:
"The low mortality for the not in city group would have the effect of exaggerating the difference in mortality between the heavily exposed population and the control group."
A. Right.
Q. This is what they are saying. I ask you to accept that that's what they are saying, really, because we are going to go on to the killer point over the page.
A. I agree that's the point they wanted to make.
Q. Yes, right. Can we go to the next page, 7, top of the page now?
A. Mm-hm.
Q. "The use of the low dose survivors as a comparison group is endorsed by the Subcommittee on Somatic Effects of the Advisory Committee on the Biological Effects of Ionising Radiations. It was felt that 'some relatively small contaminations on the side of dosimetry is potentially less disturbing than the known large differences that mark the NIC group with respect to occupation, social class, and perhaps other factors'."
Does that seem reasonable to you?
A. It does.
Q. So can we go back to page 6 now, right at the bottom,

and see what they are talking about. So going back to that last paragraph, where they say:
"Although the tables include comparisons between early and late entrants and between the not in city and exposed populations, the discussions will be confined mostly to the comparison between the mortality of a low dose group and the more heavily exposed population groups."
What does that mean?
A. As I understand it, it means that they are not using the not in city group as an appropriate comparison group but doing essentially a within comparison, where you're looking at people who were, they think, lowly exposed at the time of the bomb versus people who are more highly exposed to see if there's a difference in that exposure.
Q. Thank you. So they threw out their control group, is that correct?
A. Yes.
DR BUSBY: Yes. That's all. No further questions.
MR JUSTICE BLAKE: Thank you very much.
MR HEPPINSTALL: Were we planning to have the break at this moment?
MR JUSTICE BLAKE: We were planning to have a break a little later but can we just pause a moment. Do you just want to sit down for a second? Would it be helpful if we

just asked a couple of questions before you re-examine?
MR HEPPINSTALL: It was helpful last time, my Lord.
MR JUSTICE BLAKE: I'm not sure that it -- I mean in that order rather than --
MR HEPPINSTALL: It shortened my re-examination because we had the same questions.
Questions from the Tribunal
MR JUSTICE BLAKE: Well, it was simply on your reading list last night, and I'm sorry, you had an interesting evening. We asked you to look also at the Schmitz Feuerhake paper.
A. Indeed.
MR JUSTICE BLAKE: Do you have any comments on that paper as an epidemiologist or biostatistician?
A. The paper is not in a sense a study in itself. It appears to be a review of other studies, and as such I did not have access to many of those papers.
I confined myself to looking at the ones relating to the matter at hand which was about the -- relating to table 2, where we're talking about congenital malformations.
MR JUSTICE BLAKE: Yes.
A. So, as I say, it appears to be a review but it's not a review in the sense that I would have understood it and would have done myself, where you would look at the

studies and give a -- dare I say try and give a balanced view as to the plus points and the negative points.
Looking at this, Dr Busby appears to have picked out points from the studies which support his argument, but doesn't seem to take into account any of the issues with these studies as to whether those points are valid or not.
MR JUSTICE BLAKE: So it's a review in selecting material from previous studies --
A. He appears to be selecting material from previous studies that support his point of view.
MR JUSTICE BLAKE: Rather than --
A. Rather than what I would consider an epidemiological review, where you critically review the quality of the studies along with the results they show. Because I think you can't separate the two; the results and the review of the quality of the study go hand-in-hand.
MR JUSTICE BLAKE: Yes.
A. Some of the studies relate to his own work as well, I note.
MR JUSTICE BLAKE: Right.
A. So I mean I tried to look at one or two of the papers and, well, that's -- my view was that he was selecting information that was supporting his cause --
MR JUSTICE BLAKE: I think there's a number of authors, yes.

The authors were selecting information.
A. I mean he refers to many, many studies here, my Lord, and it's not possible --
MR JUSTICE BLAKE: No, no.
A. -- to have gone through all of them and looked at them --
MR JUSTICE BLAKE: I think you have given us that --
A. It would not -- I don't think it would -- in the kind of journal I would want to publish I don't think it would be seen as a fair and balanced review of the studies.
MR JUSTICE BLAKE: Yes.
Thank you. I think that was the topic which I'd identified on my notes. But you are going to be asked som questions in re-examination by Mr Heppinstall.
Re-examination by MR HEPPINSTALL
MR HEPPINSTALL: You were very recently asked questions about the NIOSH --
A. Yes.
Q. -- judgment, as it were, on chronic lymphatic leukaemia.
Could you take a up SB22 and have a look at tab 8, please.
A. I don't have anything --
Q. Nothing in tab 8. (Handed)
This is taken from the Federal Register of the United States Government. You can see that at the first

page, second column, it starts:
"Discussion on the guidelines for determining probability of causation under the Energy Employees Occupational Illness Act."
If you turn over the page, there are page numbers, very large, to 15,269, so that's about three pages in, and on the second column there's section B:
"NIOSH reconsideration of CLL."
MR JUSTICE BLAKE: Are you there? Do you have that?
A. Yes.
MR JUSTICE BLAKE: Well done.
A. I was trying to recall this earlier, my Lord.
MR JUSTICE BLAKE: Right, here we have it.
MR HEPPINSTALL: And can you just tell us, do you know what NIOSH is?
A. National Institute of Occupational Health?
Q. But is it a US Government advisory body?
A. Yes, it is. Sorry.
Q. And if we just look at this first sentence it says:
"In the original technical documentation for NIOSH-IREP, the discussion of the rationale for excluding CLL from consideration under the relevant legislation stated that this decision would be revisited as new scientific information became available."
So were you aware that in 2011 there was

a reconsideration of the exclusion of CLL?
A. Yes, I was.
Q. And, as can be read by anybody reading it, there's various activities, public meetings, consultations, et cetera, and we can see on that third column, about halfway down, can you see the bit that starts "The consensus among the panelists was ..."?
MR JUSTICE BLAKE: After footnote 10.
MR HEPPINSTALL: Thank you. Do you see that?
A. Yes I have it.
Q. "The consensus among the panelists was that the current scientific evidence was inconclusive with respect to CLL's association with ionising radiation. Additional research was required to definitively answer this question."
Do you see that?
A. I do.
Q. Going on, they say:
"Subsequent to the July meeting, five additional subject matter experts, unaffiliated with NIOSH, were asked by NIOSH's Division of Compensation Analysis and Support to provide their individual judgments as to whether the evidence of an association or lack thereof between radiation exposure and the risk of developing CLL is sufficient to continue to regard CLL as

a non-radiogenic cancer and continue to exclude it ..."
Essentially from the scheme. Were you aware of that review?
A. Yes, I was.
Q. Then if we go over the page they give us the results from the five reviewers, so 15270, first column, second paragraph --
MR JUSTICE BLAKE: "The experts chosen ..."
MR HEPPINSTALL: "The experts chosen for this review were selected by NIOSH based on their past experience in the area of radiation and epidemiology with the goal of obtaining a diverse range of perspectives on the matter. Each of the five experts ...(Reading to the words)... scientific opinion about the weight of the evidence. The full text of those opinions are available in the docket for this rule making."
Then it goes through, do you see, what each reviewer said?
A. I see, yes.
Q. So:
"One reviewer concluded that the available evidence is insufficient to rule out an association between ionising radiation and CLL."
Do you recall that?
A. Mm-hm.

Q. "A second reviewer found no evidence on epidemiological grounds to support the contention that CLL is induced by radiation."
Do you see that?
A. Yes.
Q. There's then a quote and also it says:
"The reviewer did comment, however, that CLL remains one of the most controversial issues in radiation epidemiology."
Do you have anything to say about that?
A. Controversial, I'm -- I'm not really convinced about that. All the large studies that we see so far in general have very, very few occurrences of CLL and really there is no evidence that I know of of epidemiological studies that support the assertion that CLL can be caused by radiation.
Q. If we go to the next column we can find the third reviewer. We just looked at the first two, so if you look at the second paragraph, column 2:
"A third reviewer concluded that in fact the scientific evidence pertaining to the molecular mechanisms of CLL induction weighs heavily towards the conclusion that CCL is similar to other ...(Reading to the words)... to a malignant transformation of a cell. The weight of this scientific evidence is in support of

the conclusion that the somatic mutations that contribute to the genesis of CLL can be produced by ionising radiation."
Well, I don't need to summarise it because the conclusion comes next:
"Scientific evidence does not provide a sufficient basis for regarding CLL as non-radiogenic."
So the third reviewer was in favour?
A. But not apparently for epidemiological reasons.
Q. What reasons is that third reviewer giving, or what type of reasons?
A. Biological reasoning.
Q. Then we get the conclusion of the fourth reviewer:
"My expert opinion supports including CLL as a radiogenic cancer and against the continuing, and it seems to me arbitrary, practice of exclusion."
So we know the conclusion of the fourth reviewer, but I don't think we know on what basis, looking at this.
A. Yes.
Q. Then the fifth reviewer found that the body of scientific evidence indicates that CLL is not caused by exposure to ionising radiation at any level of dose.
Do you see that?
A. Yes.

Q. Then we have the summary from NIOSH in the third column, second paragraph:
"In sum, of the five reviewers, three offered their support for the consideration of CLL as radiogenic for the purposes of potential compensation."
Then they give a summary of that.
Then I think the rest is dealing with the risk model.
But if we move on to 15271, we get the agency's judgment in the second paragraph of the third column, which starts "Finally, in the Agency's judgment ..." Do you see that?
A. I do.
Q. "Finally, in the Agency's judgment including CLL as a potentially compensable cancer would be in keeping with the already established Federal policy."
Then it says:
"With respect to the radiogenicity of CLL the Agency finds the evidence of radiogenicity offered by epidemiological studies to be non-determinative ..."
Do you agree with that?
A. Yes.
Q. "... but no longer believes that it is possible to state that the probability of causation equals zero."
Are you aware that the legal test for inclusion or

exclusion is that the risk has to be above zero?
A. Yes, I am.
Q. Then it goes on to say:
"NIOSH has waived the non-determinative epidemiological evidence. The mechanistic argument of CLL causation, similarities between CLL and other compensated cancers, the classification of CLL and the treatment of CLL is potentially compensable radiogenic cancer by veterans agency, and finds sufficient evidence to include CLL as a compensable cancer under the legislation, thus allow claimants with CLL to be eligible for dose reconstruction."
You're aware of that decision?
A. Mm-hm.
Q. So the decision is you are allowed to be eligible for dose reconstruction.
Then as I think you answered in cross-examination the next stage then is to develop a risk model?
A. Mm-hm.
Q. If you turn over the page to page 15272, the middle column there, the second column is discussing a draft report which is about developing that risk model for CLL. Do you see that?
A. Yes.
Q. And you can see in the second paragraph:

"The CLL risk model was quantitatively tested by calculating probability of causation results ..."
Is that the same sort of thing that you have done for the Tribunal?
A. I believe so.
Q. "... for males between 20 and 40 years of age hypothetically exposed to 1 sievert [so 1000 millisieverts] of high energy gamma radiation."
Then we see the results:
"Although the evaluations were restricted to exposure for males, the same results for females ..."
Et cetera.
"The results of these evaluations indicate that the probability of causation exceeds 50 per cent only at the 99 percentile, and then only for time since exposure greater than 15 years for men initially exposed to age 20."
Now, is that a finding that surprises you or doesn't surprise you?
A. It doesn't surprise me in that the 99th percentile is a very high point.
Q. But the fact that the doubling of the risk to the 50 per cent threshold is only crossed at 1 sievert, does that surprise you?
A. I'd say that seems quite low.

Q. Maybe read the next sentence:
"Doses higher than 1 sievert will be required to produce 99th percentile values of probability of causation that equal or exceed a value of 50 per cent for older ages at time of exposure, at time of diagnosis."
Do you agree with that?
A. Yes.
MR JUSTICE BLAKE: 1 sievert is quite a high dose?
A. Yes, that's a lot.
MR JUSTICE BLAKE: We're talking about millisieverts?
A. Yes.
MR JUSTICE BLAKE: I just wanted to clarify from all that quotation you agreed at 15271:
"The Agency finds the evidence of radiogenicity offered by epidemiology studies to be non-determinative."
That means what? That there is no evidence from epidemiology that CLL is caused by radiation?
A. Yes, the number of CLL cases we see in big epidemiological studies is really, really small. So in a sense --
MR JUSTICE BLAKE: Epidemiology can't assist or it rules out?
A. In a sense it's -- well, in a way it's providing some

reassurance that despite receiving radiation we're not seeing in fact a high occurrence of these diseases. In the lifespan study I believe in the latest analysis of leukaemia incidence there were only 12 cases that were used so there's such a tiny number that it's -- you know, it doesn't provide any useful information in a sense.

MR JUSTICE BLAKE: Right. So that's what "non-determinative" means?

A. Yes.

MR JUSTICE BLAKE: Epidemiological studies can provide no useful information?

A. I presume it means on the balance of all the evidence that they can't say it's absolutely zero. I mean, we do see 12 cases. Those 12 cases could have been caused by radiation but it's certainly not within the -- epidemiology couldn't say that. The number of cases is just so so tiny.

MR JUSTICE BLAKE: All right. If that completes that topic --

MR HEPPINSTALL: On that topic, yes.

MR JUSTICE BLAKE: -- it probably is time now for a break. So what are we now? Come back at 25 to.

(11.24 am)

(A short break)

(11.35 am)

MR HEPPINSTALL: SB17/11, please. You were asked questions by my learned friend Mr ter Haar in respect of the UK NRPB epidemiological studies into UK test veterans.

This, I think, is a paper that you are familiar with?

A. I am.

Q. If you look at the fifth named author, I think that's you, isn't it?

A. Yes, it is.

Q. Is the fourth named author Sir Richard Doll who we were discussing during your cross-examination?

A. Indeed, yes.

Q. And if we just turn over the page, you gave a figure of 20,000 test veterans and we see there, over the page, a table which gives a total of 21,357 participants.

There's a difference between involvements and participants. Perhaps you could tell us why that is?

A. There were inclusion criteria in terms of what these people -- whether they were eligible to be included in the study. There were a pool of people who were potentially eligible and we selected from those. That describes the difference.

Q. For the Tribunal's interest, we are here concerned with

Operations Grapple X, Y and Z and we see those, do we not, on the left-hand side with numbers given for numbers of participants by service on the right-hand side?

A. Mm-hm. Yes.

Q. Above that, Mr Battersby was at Operation Buffalo. Do we get the same data there as well? The fourth one down.

A. Yes, just about.

Q. Now, I just want to turn to section 3 of this paper at page 221. Actually, it's just the facing page, which discusses non-UK nuclear weapons test studies, the studies into other countries' veterans. If we turn over the page, about halfway down it says:

"An early study examined the health of Australian participants."

Do you see that?

A. Yes.

Q. Then the last couple of sentences in that paragraph:

"More recently, a cohort study of mortality and cancer incidence in Australian participants in the UK nuclear weapons tests in Australia has been set up. This cohort study is being overseen by an independent scientific advisory committee."

Is that the study that we know as Carter?

A. I don't know, to be honest.

Q. Ah, very well.

A. Sorry.

Q. Okay. In the next paragraph we see the US five series study, so is it also the case that the United States Government carried out an epidemiological study?

A. Yes, a large one.

Q. Then over the next page in the next paragraph it says "For the New Zealand study ..."

Is it also right that a study of the New Zealand test veterans was carried out?

A. Yes.

MR JUSTICE BLAKE: That's not the Wahab study, or is it?

A. I don't think so, no.

MR HEPPINSTALL: Can we just leave that open but if you just turn to SB22/4.

MR JUSTICE BLAKE: What should be in SB22/4?

MR HEPPINSTALL: The follow-up of New Zealand participants in British atmospheric nuclear weapons tests in the Pacific.

A. No.

MR JUSTICE BLAKE: SB22 needs a lot of work, but it might be that it's --

MR HEPPINSTALL: I think the copies were handed up during the cross-examination of Professor Schmitz Feuerhake.

We've been to it before.
MR JUSTICE BLAKE: Yes, it rings a bell.
MR HEPPINSTALL: Well, we will put in that tab the Pearce paper but luckily the results are summarised in the one we are looking at, so if you go back to the NRPB paper, we see it says:
"The all-causes ..."
Can you help me with SMR?
A. Standardised mortality rate.
Q. You did that without looking. It's at page 223, top of the page. It says:
"For the New Zealand study, the all-causes SMR ..."
Do you see that?
A. Yes.
Q. Yes.
"... was 114:
A. Yes, 114.
Q. "The all-causes SMR in the control group was 108."
A. Yes.
Q. "The relative risk was reported as 1.1, not significantly different from 1. For all cancers the SMRs in participants and controls were 164 respectively with the relative risk again not significantly different from 1."
Then if we look at the next paragraph do you agree

multiple myeloma in test participants relative to controls."
Do you recall that?
A. Yes.
Q. Then it says over the page:
"However, this seemed to be more a consequence of low levels in the controls rather than of elevated levels in test participants."
Can you just explain that to us, please?
A. Yes. The difference was caused by lower than expected incidence of the disease in the control group compared to the overall population than the -- that being true in the veterans. So the difference -- there was a difference but it's due to low levels in the controls, not due to high levels in the participants.
Q. Then if we turn over the page to page 238 and the next substantive paragraph that starts "The second and third analyses ...", do you see that?
A. Yes.
Q. That says:
"... have provided no convincing evidence of excess multiple myeloma amongst test participants. This increases the likelihood that chance was responsible for the difference seen in the first analysis between the rates of multiple myeloma in test participants and the

with this:
"Neither the studies of US nor New Zealand test participants provide compelling evidence that test participation has influenced the induction of cancer generally."
A. Yes, that's clear from this evidence.
Q. Then if we turn to the summary of the conclusions which is at page 237 and we look at the second paragraph there, "Three epidemiological analyses", do you see that? Section 6, "Summary".
A. Yes.
Q. Then the second paragraph:
"Three epidemiological analyses of mortality and cancer incidence in UK participants in the UK atmospheric weapons testing programme have been published over a 15 year period. A consistent finding has been the so-called 'healthy soldier effect', that mortality from broad causes of death is generally below that in the general population, but similar to that in a matched series of controls."
Do you agree that that's the general conclusion?
A. Yes, correct.
Q. It goes on to say that:
"The first [study] produced a striking excess of leukaemia (excluding chronic lymphatic leukaemia) and of

controls."
So does that mean or does that not mean that the excess was not replicated in the second and third studies?
A. It mean it was not replicated. I agree, yes.
Q. It goes on to say:
"In the case of leukaemia, however, there is some evidence for a persistent risk."
So was that replicated?
A. The controls became more like the cases, i.e. there was a rate increase but it was still raised. The difference was still higher in the --
Q. Sorry, you finish.
A. There was still more -- there was still more leukaemia in the veterans than in the controls although the difference decreased.
Q. Now, you were asked, or criticisms were put to you about the NRPB studies, and do we see in the next paragraph the authors, which of course include you, concede that the study only includes about 85 per cent of men meeting the definition of test participant?
A. Yes. This issue was so long as it was a representative 85 per cent.
Q. We see:
"The investigators were very alert to this risk when

the cohort was being assembled and indications were that any bias was small."

Can you help us as to how they came to that conclusion?

A. No, I'm afraid not, due to that was done before I was involved in this.

MR JUSTICE BLAKE: This is the Parker criticism of 540 missing veterans or something like that?

A. No, I think that related to the difference between the first and second analysis. I think this is referring to how the cohort was set up originally, in the first place, and that was --

MR JUSTICE BLAKE: Only 85 per cent.

A. -- long before i was involved in this. Yes. Once the cohort had been defined, that was it.

MR JUSTICE BLAKE: Obviously you have to go into (inaudible) now to reach some testing conclusion that, excluding 15 per cent, didn't significantly distort --

A. In 85 per cent of a population is a very large sample, though, so ...

MR HEPPINSTALL: When you say "very large sample", what do you mean? Compared to other epidemiological studies?

A. Yes.

Q. Now, immediately stop me if I'm going beyond your expertise, but the next paragraph says:

"If the recorded radiation exposures of participants in the UK atmospheric tests were correct the collective dose to participants was about 17 man sieverts."

A. I have no personal knowledge of that.

Q. Right.

MR JUSTICE BLAKE: What's a man -- sievert for man?

A. Effectively adding up all the --

MR JUSTICE BLAKE: All the sieverts?

A. -- so one man receiving 1 sievert is 1 man sievert, so two men receiving half a sievert is still 1 man sievert. It's a collective -- a term of collective dose.

MR HEPPINSTALL: Can you help us with the next sentence:

"If there were established radiation risk factors, this implies that about one radiation-induced cancer would be expected in the whole group of test participants."

A. Yes. So you're applying the risk models that we have and saying, given that model is true, how many of the deaths we see might be due to radiation. The estimate here is one.

Q. The next sentence:

"Where would be no chance of detecting this against the rather high natural death rate."

Can you help us with that?

A. Sorry, can you point that out to me?

Q. The next sentence:

"There would be no chance of detect in this against the rather high natural death rate."

Then it quotes from table 3, I think. Perhaps we'll look at table 3. Page 227.

A. Table 3. So the excess is such a small excess in comparison to the number of deaths we see that there's no chance of seeing it in a statistical way. It's only -- you are only seeing it by using the risk model and interpreting the deaths we see in relation to the risk model. We couldn't see -- we are unlikely to see a difference between the case and controls in that respect.

Q. If you turn back to page 238, the final sentence, please, in that paragraph.

"However, if radiation exposures were much larger, or if participants were exposed to some other risk factor, then a detectable effect might arise."

Do you see that?

A. No, I'm not --

Q. It's the last sentence --

MR JUSTICE BLAKE: Back to 238.

MR HEPPINSTALL: The third paragraph on page 238.

A. Ah, yes.

Q. Yes. So we just looked at "there would be no chance of

detecting this against the rather natural high death rate", and then it says:

"However, if radiation exposures were much larger or if participants were exposed to some other risk factor then a detectable effect might arise."

A. Yes, because you would see a larger difference between the observed cases amongst the test participants than the controls.

Q. If there was some other --

A. If there was some other --

Q. -- if there's some other agent at play, whether it be radiation or any other agent.

A. Yes.

Q. Thank you.

Can you take SB5 now, please. This might seem like a odd exercise but I do want to pin down what the studies actually are, because there's been a lot of mention of INWORKS, the National Registry, 15 countries.

A. Yes.

Q. There are various things in the papers that, to those who are not expert, might think that they were the INWORKS study but they're not, or they may not be.

So if we look at SB5/47 first.

A. Yes.

Q. Now, again, I think you are mentioned as an author, or

you were named as an author of this paper. But can you just help us with what this paper is, please?

A. So we had the 15 countries study which looked at occupational radiation exposure in a range of 15 countries. This work takes the data from three of those countries, so the UK, France and the USA. The cohorts that they provided in this 15 country study, it takes those and adds extra follow-up to them.

So in the 15 country studies the UK contributed the second analysis to the national radiation workers. In this analysis we're looking at the third analysis of that cohort.

So this is a -- although it has slightly fewer participants compared to the 15 country study it has more statistical power because it has more person years follow-up and more deaths.

Q. Now, that was published online on 22 June 2015, I think, in The Lancet.

A. Yes.

Q. But then if you turn to tab 53, this was another paper on INWORKS published on 9 September 2015, but is it telling us something different or something else or updating?

A. This one refers to solid cancer, whereas the other paper refers to leukaemia.

Q. Right. So in terms of INWORKS the Tribunal have tab 47, which is leukaemia, and then tab 53, which is all(?) solid cancer.

A. The two papers are complimentary, they use the same dataset but looking at different causes of death.

Q. Is it right that it's this paper -- and we can see this under "what this study adds" -- is that you found a similar result to that set out in the LSS?

A. Yes.

Q. Now, can we just look at the NRRW, which hopefully is at tab 48. Again, you are an author.

A. Uh-huh.

Q. As I understand it -- well, can you tell us just what this study offers in terms of results and analysis?

A. So this study is the third analysis of the National Registry for Radiation Workers. It looked at 179,000 workers and examined their cancer mortality and cancer incidence in this group.

Q. Now, finally, there's the 15 country study. If you could turn to tab 50. That came before the INWORKS.

A. Yes, it's a predecessor, essentially.

Q. Yes. But several witnesses, including yourself, have alluded to some problem.

A. Yes.

Q. If you turn to tab 54, does this paper assist us with

that problem?

A. Yes, yes. There was an issue with the difference we saw in the 15 country study when we excluded the Canadian data which led us to believe that there might be an issue with the Canadian data. This paper confirms that fact.

Q. Now, you were asked a series of questions about the line of "best fit" and "LNT", if I can put it that way.

Can you take up SB2/2.18, which is Professor Thomas's report. Do you have SB2 there?

A. Mm-hm.

Q. Can you turn, please, to paragraph 1.14, page 4.

A. Mm-hm.

MR JUSTICE BLAKE: 1.4?

MR HEPPINSTALL: 2.8, tab 2.18.

MR JUSTICE BLAKE: I have the tab.

MR HEPPINSTALL: 1.14, page 4.

MR JUSTICE BLAKE: 1.14. Yes.

MR HEPPINSTALL: Professor Thomas, on the opposite page, page 5, has presented a diagram. Can you see that?

A. Yes.

Q. You were asked questions about the low dose range. Do you recall that from your cross-examination?

A. I do.

Q. There are lots of dots on this. But is it right that

the blue dot is the LSS, the Japanese study?

A. Yes.

Q. The orange dots are the NRRW that we were just looking at?

A. Yes.

Q. I think the green dots are the Teca(?) study that we've discussed during the proceedings.

Red stands for Chernobyl.

Blue is Yangjiang, which is an area of high natural background radiation in China; is that right?

A. I believe so.

Q. Then brown is the BNFL worker study; is that right?

A. Yes.

Q. So can you just help us, here we have excess relative risk and dose, and can you help us -- do you know what the dots are representing on this plan?

A. The dots are representing the excess relative risk in various groups, where the groups are -- you are grouping workers according to dose they received, looking at the excess relative risk in those groups relative to baseline or to zero exposure.

Q. The magnification of the lower dose range that is described here, does this help us in any way analyse the low dose range?

A. I think it illustrates the fact that most of the data we

have are in the low dose range there, and that there is quite a bit of variability in it. So it is quite difficult to use just that data to generate a dose response relationship, which is why you can see that the LSS is higher up and that -- will use that to extrapolate downwards.

Q. Well, let's look at the choice of the line. If we look at SB17/4, please. Now, my tab is rather confusing because I have this paper twice, but the first version is incomplete, but there should there be a paper entitled "Cancer risks attributable to low doses of ionising radiation, assessing what we really know". Do you see that?

A. Mm-hm.

Q. The first author is Professor Brenner?

A. Yes.

Q. The second, Sir Richard Doll. And some other authors who we are familiar with.

If we turn over the page or pages to page 13764, which is about four pages in, there are some graphs --

MR JUSTICE BLAKE: I have nothing in that tab.

MR HEPPINSTALL: Nothing in tab 4 at all?

MR JUSTICE BLAKE: Some of us have half of it, some of us have none of it.

DR RAYNER: I do not have that page, it's blank.

difference between them. But I can't actually read it, I'm afraid its too small.

MR TER HAAR: I think Dr Haylock is at a disadvantage, as is everybody, because of where this article stops. Because the vital comparison which is being carried out is exactly what has been omitted from the photocopying. So if you looked at the bottom of that page, line A, is the linear dose response, that's curve A, as it says on that page. The article, I believe -- I do not have a full copy of it -- goes on to say what the arguments are for B, C, D and E. So it's vital we have a full copy of this.

MR JUSTICE BLAKE: We seem to have -- and I don't know what's happened here -- but we have a data problem.

MR TER HAAR: We do have a data problem, but I have some reservations of re-examination of something which --

MR JUSTICE BLAKE: Who has the full article?

MR HEPPINSTALL: I have the full article.

MR JUSTICE BLAKE: Can you give it to the witness?

MR HEPPINSTALL: I can, yes. Yes. Well --

MR JUSTICE BLAKE: Is it --?

MR HEPPINSTALL: There's some marking.

MR JUSTICE BLAKE: You've seen the full article?

MR TER HAAR: No, I can see -- I understand the exercise that is going on and I can see how vital what has been

MR HEPPINSTALL: You haven't got page ... right.

MR JUSTICE BLAKE: It looks like it's another misplaced Brenner.

MR HEPPINSTALL: Well, do a --

MR JUSTICE BLAKE: I have written in the index.

MR HEPPINSTALL: Do you have 13763? Do you have that? There's a -- yes. So let's try it with that. So 13763, there's a figure 3.

A. Mm-hm.

Q. You may just want to pause to look at what figure 3 is, a schematic representation of different possible extrapolations of measured radiation risk down to very low doses.

A. Mm-hm.

Q. They are different curves, lines, et cetera.

A. Yes.

Q. Is this -- well, could you explain what the authors are trying to do?

A. The authors are trying to illustrate the fact that you can fit various different dose responses to this low dose region where there is not so much information. I can't actually read what it says, but my assumption would be that they are comparing the various alternatives to the linear dose response. My guess is they're assuming that you can't actually detect any

left out would be to understanding the article, as I think Dr Rayner has also read ahead and seen where it's going.

MR HEPPINSTALL: Do you have the summary at page 13765?

DR RAYNER: It stops after 13763.

MR HEPPINSTALL: Without the punch line it's pretty difficult.

MR JUSTICE BLAKE: Right. Does someone have a clean copy of the full article? Can we go to another topic and if we can -- is it in the library somewhere?

MR HEPPINSTALL: It should be. Let me just give you -- are we in tab 4? E2, tab 3. Yes. Is that a full copy?

MR JUSTICE BLAKE: Is it possible we can run off some photocopies? Do you have access to photocopying facilities in this building?

THE CLERK: I can run off photocopies.

MR JUSTICE BLAKE: You could. Thank you very much.

THE CLERK: How many copies do you need?

MR JUSTICE BLAKE: Can we do six, please. Then that will be a cost benefit reward ratio.

MR HEPPINSTALL: Right, we are just going to park --

MR JUSTICE BLAKE: Can we park that?

MR HEPPINSTALL: -- there's a series of questions and we'll park them.

So you were asked questions about the RERF

dosimetry. Again, I just want to try and assist -- or for you to try and assist the Tribunal -- by identifying things in the bundle. So SB 5/55, please. I think this is one of the papers that you asked to be in the bundle.

A. Did I?

Q. Yes. We see that it's chapter 13, DSO2. Is that the dosimetry system 2002 you are referring to?

A. Yes, this is the latest one that we have for the Japanese bomb data.

MR JUSTICE BLAKE: So this is still current?

A. This is the current one, yes.

MR JUSTICE BLAKE: Right. So issued in 2002?

MR HEPPINSTALL: We see in the introduction dosimetry system 2002 is not a completely new system, but rather is a revision of the dosimetry system, 1986. Is that right?

A. Yes, absolutely.

Q. "Unlike previous attempts at quantifying dose values for individual survivors, DS86 and DSO2 are wholly computational rather than empirical."

Can you help us with that, please?

A. We don't have actual measurements of the doses of the bomb survivors, what we have are computations made on the basis of the information gathered from the survivors five years or more after they were involved in the

explosions. And on the basis of other information and mathematical modelling from other sources. I believe primarily from other tests.

Q. It goes on to say:

"The computational process by which dose values are determined in these systems is modular."

Then it says:

"Comprised with three independent elements, starting with the propagation of the radiation leakage from the weapon through air to produce the radiation field of ...(Reading to the words)... through and around structures and terrain to produce a shielded radiation field and the culminating with transmission into the body to compute mean radiation of fields and doses into individual organs."

Now, I know you're not a dosimetry expert, but is that your understanding of the three components?

A. Absolutely, yes.

Q. Then there's another document on the dosimetry system at tab 58 that I think we looked at last week.

A. Mm-hm.

Q. This is entitled "Radiation doses from residual radioactivity". Do you understand what the RERF is referring to by way of "residual radioactivity"?

A. I believe so.

Q. And what is that, please?

A. That it's related to fallout from the bombs.

Q. Does this chapter deal with their treatment of that topic?

A. Yes.

Q. Can you take up SB7, please, 124. You were shown the Zaire paper.

There were questions about -- well, I think there was an exchange between you and Dr Busby about whether or how the controls were dealt with. So can you look at "subjects and methods" which is on the second page.

There is a question about whether they've been -- well, it was your response, you didn't know whether they had been controlled for radon or not.

A. Oh yes.

Q. If you can't help us don't worry, but when I look at "subject and methods" it says:

"The 75 miners were compared to a control group of 31 individuals with no exposure or history in mining who live in Namibia more than 12 miles from the pit."

Can you see that? It's about halfway down, there's a line above "no virus infections".

A. Yes.

Q. Then it says:

"The miners were age-matched with the controls."

So if you briefly explain that to us?

A. The controls were chosen to be of a very similar to the cases.

Q. Then it says:

"The background radiation dose, excluding the radon progeny from locations of the controls averages 1.6 millisieverts per year."

Now, I don't know whether you can help us with that.

A. I think they just mean that that is the normal background that somebody living in that area would be exposed to.

Q. Do you see anything here that shows that there was control for radon exposure in the mine?

A. No.

Q. Thank you.

MR JUSTICE BLAKE: So excluding the radon progeny simply means making radon out of the background? No. What is "radon progeny"?

A. When you are exposed to radon it's the radioactive decay -- the elements that radon decays into that give you an exposure, when it refers to the "progeny".

MR JUSTICE BLAKE: Those elements of progeny like the (inaudible). Okay, got it. But that's not doing the control on radon.

A. It appears that it is not taken into account, no. The

1.6 excludes that, certainly.
MR HEPPINSTALL: You were also taken to the Areneta study which is at tab 93. If you go to the conclusion, which is page 259, conclusions split over two columns. If we look at the second column, I think it's the penultimate sentence of the paper:
"We did not, however, have the ability to determine if the excess was caused by inherited, environmental or synergistic factors or was due to chance."
Do you know what the authors are trying to convey -- you haven't quite found it. So page 259.
MR JUSTICE BLAKE: If you go back, the very last page of the tab is the references. Opposite that, I think you have it there, "conclusions", just above the text "acknowledgement".
A. Oh, right.
MR HEPPINSTALL: "We did not, however, have the ability to determine if the excess was caused by inherited, environmental or synergistic factors or was due to chance."
MR JUSTICE BLAKE: Do you have that sentence? you are still looking for it.
A. No, I'm just trying to get my head around that.
DEFENCE: You are just orientating yourself.
A. Yes. I think it means that they didn't have the ability

to see -- to determine if it was due to other environmental factors or other things, rather than the -- rather than the fact that the veterans were at the Gulf War.
MR HEPPINSTALL: Thank you. You were also taken to Kang, which is at 98. Turn to page 509 of Kang. The page numbers are in the top-right hand corner. Do you have page 509?
A. Yes.
Q. Second column, about halfway down, there's something starts "A third limitation of the study"?
A. Yes.
Q. It says:
"A third limitation of the study is that we were unable to evaluate specific defects which may be each logically different because of the dearth of documentary information regarding specific exposures of particular veterans and the lack of knowledge on the human ...(Reading to the words)... which exposures might be associated with which outcomes."
Can you assist us with that?
A. I'm not familiar with this paper, I must admit.
Q. Okay.
A. As I understand it, it means it's difficult to say which of a number of causes, potential causes, might have been

the -- might cause the effect.
Q. Thank you. Just bear with me a moment, please. Right, let's attempt to go back to Professor Brenner.
MR JUSTICE BLAKE: Now, have we completed SB7 or are we going to make another visit back there?
MR HEPPINSTALL: No, my Lord, that's the end of SB7.
MR JUSTICE BLAKE: Let's put that away.
MR HEPPINSTALL: So I just need to go back to Brenner, SB17. SB17/4. We were looking at figure 3 where they were trying to -- well, they were experimenting with the lines -- oh, hang on.
A. I don't believe I have a copy.
Q. No one gave one to you. (Handed) Can you read the text now?
A. Just about.
Q. Do you want to have a read of that text under figure 3. (Pause)
A. Okay.
Q. Right. Then we can see, I think, underneath figure 3, there's different descriptions of those lines curved. So we see, for example, that immediately under that figure it says:
"Extrapolation of observed risk to low doses."
Do you see that?
A. Yes.

Q. Then there's another heading in bold, smaller:
"Linear dose response relations (curve A)."
Do you see that?
A. Mm-hm.
Q. Then, if you go over the page, it follows the pattern of looking at the other curve, so the next heading is:
"Scenarios in which an assumption of linearity underestimates low dose risks, downwardly curving dose effect relations."
Which is curve B.
Do you see that?
A. Yes.
Q. Then finally, over the page, we get towards the end, we have:
"Scenarios in which an assumption of linearity overestimates low dose risk thresholds and hormetic responses."
Which were curves D and E; yes?
A. Yes.
Q. Then we have curve C, the upwardly curving dose effect relations, on the next column.
A. Yes.
Q. Then, in the summary, we get the conclusion, which I think is in the second paragraph of the summary, which starts "At present we cannot be sure". Can you see

that?
A. Yes.
Q. "At present we cannot be sure of the appropriate dose response relation to use for risk estimation at very low doses."
Do you agree with that?
A. Yes.
Q. "Mechanistic arguments exist for suggesting that a linear extrapolation of risk to very low doses are appropriate, but testing such arguments at very low doses is not easy."
Do you agree with that?
A. Indeed.
Q. "However, the alternate models shown in figure 3, although applicable for some endpoints, are less credible than the linear model as a generic descriptor of radiation carcinogenesis at low doses and low dose rates."
Do you agree with that?
A. I do.
Q. Now, if we move to --
MR JUSTICE BLAKE: That continued at the final paragraph of that summary as well.
MR HEPPINSTALL: Yes.
MR JUSTICE BLAKE: Have you had a chance to read that?

A. Not the final paragraph, no.
MR JUSTICE BLAKE: "In summary, given our current state of knowledge, the most reasonable assumption is that the cancer risks from low doses of x or y rays decreased linearly with decreasing dose."
A. Yes.

MR JUSTICE BLAKE: "In the light of the evidence for downwardly curving dose responses this linear assumption is not necessarily the most conservative approach as sometimes has been suggested and it is likely that the result is an underestimate of some radiation and an overestimate of others."
A. Yes, absolutely.
MR JUSTICE BLAKE: Okay.
MR HEPPINSTALL: So are you indicating you agree with that?
A. I am.
Q. Now, when you were being cross-examined you made quite a lot of reference to the ICRP document?
A. Mm-hm.
Q. 103.
A. Yes.
Q. Which we have in the bundle, SB3/2. Therefore, I think it's important that you are given an opportunity to point out to the Tribunal what you are referring to.

You have your paper copy and I have my paper copy but its in SB3/2.
A description of the Commission is actually given on that -- well, yes, so if you go in the inside front cover of your book, that's the first page that the Tribunal have.
A. Yes.
Q. And it describes the International Commission on Radiological Protection as:
"The primary body in protection against ionising radiation, a registered charity and is thus an independent non-Governmental organisation created by the 1928 International Congress of Radiology to advance for the public benefit the science of radiological protection."
Is that your understanding?
A. It is.
Q. Right. So first of all I'd like to go to page 195, please. You can see that there's a section starting "The possibility of non-linear low dose responses for cancer risk".
A. Yes.
Q. Paragraph A173.
A. Yes.
Q. And you are far more familiar with this than I am, but

paragraphs A173 through A176, do they consider whether the LNT model is the best model?
A. Yes, they consider that in relation to the other hypothesised models that Dr Busby has mentioned.
Q. And indeed do they do that by mentioning the CERRIE Committee 2004?
A. Yes, which was set up specifically to examine those models.
Q. And if we look at A176, do we get their conclusion?
A. Yes.
Q. "The Commission agrees with the general view expressed by the majority of trade members that none of the proposals on the gross underestimation of risk that were considered have a sound scientific basis and that some are demonstrably flawed."
A. Yes.
Q. Thank you.
Now, you talked about the DDREF --
A. Yes.
Q. -- when we were looking at how you calculated your probability of causation. Now, that's discussed at pages 52 to 53 of this document.
So if we look at paragraph 70 on page 52 it says:
"A dose and dose rate effectiveness factor ..."
That's what DDREF stands for, is it?

A. Yes.
Q. "... has been used by UNSCEAR ..."
UNSCEAR is the United Nations body?
A. It is the Scientific Committee on the Effects of Atomic Radiation.
Q. "... to project cancer risks determined at high doses and high dose rates to risks that would apply at low doses and low dose rates."
So is that what you were describing to the Tribunal?
A. Yes.
Q. "In general, cancer risk at these low doses and low dose rates is judged from a combination of epidemiological animal and cellular data to reduce by the value of the factor ascribed to DDREF."
It says:
"In its 1990 recommendations the Commission made the broad judgment that a DDREF of 2 should be applied for the general purposes of radiological protection."
Then if you turn over to paragraph 73, page 53, after a review of the evidence, do we find the conclusion there of the Commission that they find no compelling reason to change those 1990 recommendations for a DDREF of 2?
A. Yes.
Q. Thank you.

Now, you were asked questions about developing research which these recommendations of the ICRP had touched upon. I think they're called transfer of risk between populations. So if we turn to page 187 at paragraph 8135, do we find a summary of those innovations that you were describing?
A. Yes.
Q. Now, you did give an answer about those but as we're looking at the paper can you help us with a summary of what those innovations are, insofar as it's possible do so?
A. I'll try again. So the idea is that within a particular population it doesn't matter whether we use an excess relative risk or an excess absolute risk model, with the same underlying rate of disease we have the same risk in either model. The problem that occurs is if you want to predict risk in a different population where the underlying rate of a disease differs from that in which you derive the model. Because if you use an absolute risk model, when you transfer the risk over you predict the same risk per unit exposure irrespective of what the baseline is. Whereas if you have a relative risk model then if you transfer it -- if you transfer across to a population where, say, the baseline was half, then the excess you would predict in that new base in that new population would also be half.
You would end up with potentially different results of what you would predict in your new population according to whether you had a relative or absolute risk model to transfer the risk, if the baseline rates are different.
Now in the case of the probability of causation calculations I was asked to do for bladder cancer there is a difference in the risk between the Japanese or Eastern population and in the Western population. So therefore this was particularly appropriate to use because this ICRP says this is the most appropriate way of dealing with this issue about having different results according to which of the models you use, and the ICRP says at the moment the best thing to do is to average the risks you get from the two models and that is your most appropriate answer.
Q. Now, there's a rival blue booklet to ICRP. There's the 2010 ECRR paper which for us is in SB10/163, although it is not entirely necessary for you to turn it up.
You've read those recommendations as I understand it?
A. I have.
Q. And did you find in that publication anything which would allow you to carry out an alternative set of

probabilities of causation?
A. No.
Q. Do you want to say what were you looking for and what didn't you find?
A. I was looking for an appropriate risk model. All I found were suggestions of factors that the ICRP model estimates could be multiplied by to get the alternative estimates, but these factors didn't appear to be based upon any sort of evidence that I considered reliable and therefore I didn't find anything useful.
MR HEPPINSTALL: My Lord, I have no further questions. That is the Secretary of State's case.
Further questions from the Tribunal
MR JUSTICE BLAKE: Right, thank you. We have another topic we would like to --
MR HEPPINSTALL: With Dr Haylock?
MR JUSTICE BLAKE: Yes.
DR RAYNER: Before you put the bundles away, if you could get out SB12, please, and it's tab 18. I apologise because you haven't seen this. This a commentary by Dr Darroudi, some of which we covered this morning and I won't ask you about the biology --
A. I know the man. He is a biologist.
DR RAYNER: Absolutely. I was just interested to hear some of your views about some of the methodological issues he

has and again going back to the Wahab paper. For example, if you read down here, it's the seventh paragraph which starts "In addition ..." and he is critiquing Dr Brenner's critique of the Wahab paper if that makes sense.

"In addition, Dr Brenner does not comment on the lower frequency, approximately 1.5 fold lower, of translocations in the unexposed cohorts reported, which is lower in comparison to the existing data in the literature."

Yes?

A. Yes.

DR RAYNER: So what effect will that have if you are comparing a cohort with a lower incidence on the eventual results?

Do you want time to read it again?

A. I want to compose my answer. I think if you ... (Pause)

DR RAYNER: So it is a little bit like what you were asked before about: if there is a lower background of incidence of something, what does that do to the eventual figure?

A. Yes, if you are comparing an exposed group with the control group and you see a difference, the question is: is that difference because one group is raised or one group is lower? This is suggesting that in the

circumstances the control group is lower than would be expected from other studies. Therefore, when 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 of it.

MR JUSTICE BLAKE: Right.

A. So you need to make sure that your control group is representative of some larger population --

MR JUSTICE BLAKE: The background population.

A. Yes, if it's not, if for example it's lower, you don't know when you compare to your exposed population why the difference occurs. Is it because the exposed has higher frequency or is it because the control has lower frequency? Is there some way you inadvertently selected the control group that it was not representative? So, for example, might they have been younger? I think we understand that these things are related to age. So in other studies we have had age matching. So it's slightly difficult to comment more than that I think.

MR JUSTICE BLAKE: Yes.

DR RAYNER: The other criticism arises in the second paragraph at the end. So it says "inconsistencies in cell culturing times".

I'm not going to ask you about that.

"... inaccurate calibration curves ... and the inconsistencies in the use of partial (FISH) for generating the dose response curve and whole (mFISH) genome labelling for veterans and unexposed group."

Do you have that?

A. Sorry.

DR RAYNER: It's the second paragraph on the first page.

A. Okay.

DR RAYNER: It's four lines up and it starts --

A. "... the inconsistencies ..."?

DR RAYNER: Yes, it says:

"For that reason it would appear that Dr Brenner has not examined the technical flaws in the Wahab/Rowland work as set out in my first report ... eg the inconsistencies in cell culturing times, inaccurate calibration curves generated for both dicentrics and translocation, and the inconsistencies in the use of partial (FISH) for generating the dose response curve and whole (mFISH) genome labelling for veterans and unexposed group."

Is that something that you had picked up when you read that paper?

A. No, that's a bit too technical biological for me, I'm afraid.

DR RAYNER: Thank you.

MR JUSTICE BLAKE: That's biological and not statistical?

A. I was only looking at the statistical aspects, I'm afraid.

MR JUSTICE BLAKE: Yes, fair enough.

Yes, the only other topic that we had briefly raised with this witness during Mr ter Haar's cross-examination was about the NRPB studies 1 and 2 and Professor Parker's criticism of why they had taken out -- why there was a change of the cohort between 1 and 2.

Now I don't know because I'm not familiar with all the material at first instance. Was that addressed somewhere else in the papers or is it just an unknown unknown?

MR HEPPINSTALL: No. We looked at a paper earlier about the NRPB studies and you'll notice that's part 2 of 2. There's a part 1 of 2 which addresses all of the practical problems and the assemblage of the cohort. That's in the library and I can give you the reference.

MR JUSTICE BLAKE: We don't need this witness to go back and do that.

MR HEPPINSTALL: I think he wasn't there at the time.

MR JUSTICE BLAKE: He can't give any personal evidence about it, but since he's employed in the institution --

MR HEPPINSTALL: Well, I could try and show him the paper

but it would be fruitless.
MR JUSTICE BLAKE: If you have it, he would only be producing something if we were asking him to do some archival research rather than --
A. If I researched it beforehand, my Lord, I could have given you an answer.
MR JUSTICE BLAKE: Since we are about to say goodbye to him, if there's any assistance that we can legitimately derive from him but it's not another impossible theoretical --
MR HEPPINSTALL: No, I'm just --
MR JUSTICE BLAKE: No, but if it's somewhere else and it's there then we don't need to go to him.
MR HEPPINSTALL: No, it's definitely there. It's just a question of finding it. But we have part 1 of that series. We also have all three long reports but they're in the library and we've been deliberately been using the summaries.
MR JUSTICE BLAKE: No, I don't want to sound like a glutton for punishment but it was just trying to clarify whether there's anything more that we can get. In which case I think that we've really exhausted you, no doubt, and exhausted what we can ask you. So that completes your evidence. Thank you very much for coming.
(The witness withdrew)

Housekeeping
MR HEPPINSTALL: I can give you the reference. It's E2, tab 2, "Epidemiological studies of UK test veterans. 1: general description."
MR JUSTICE BLAKE: That explains why they did what they did.
MR HEPPINSTALL: Yes, that goes to all the various problems and issues.
MR TER HAAR: My Lord, can I raise a matter which I was going to raise later which arises out of my learned friend's reference just there, which is this.
MR JUSTICE BLAKE: Can we let the witness go?
MR TER HAAR: Certainly.
MR JUSTICE BLAKE: Thank you.
Let's give him a moment to pack up and then we can do it. Don't worry. (Pause)
Right.
MR TER HAAR: My Lord, it's this. It may be best illustrated if I could ask you to take up bundle SB1 at tab 1.1. This is the document which we put in pursuant to an order of Mr Justice Charles, headed "Possibilities/certainties relied upon by the appellants".
MR JUSTICE BLAKE: Yes.
MR TER HAAR: You will see if you go to numbered page 5, the start of various schedules which give a large number of

references.
MR JUSTICE BLAKE: Yes.
MR TER HAAR: My intention is -- because these are actually all still FTT references -- to get this amended so that you will have SB references. And we're also going to put in a table references to the transcript of this hearing which we hope will be helpful to show the cross-relation and cross-reference there.
I think, but I haven't checked, that almost every one of these FTT references is now in an SB bundle. I think there may be one or two which aren't. I am wondering whether it would be more convenient for the Tribunal to have perhaps a bundle SB23, so that you don't have to go back to the library and just have fresh copies. I am not suggesting we go back to yet more material. That's not what I am suggesting. It is just so that you don't have to go to the library when looking for these references.
But it's whatever is convenient to the Tribunal is what I have in mind.
MR JUSTICE BLAKE: Yes, right. (Pause).
I think your suggestion is one that we would welcome, i.e. an SB23 with abstracts from the library, rather than instructions to go searching in the library, not least because there's three of us and there's one

library.
MR TER HAAR: I hope it's not much but it occurred to me as Mr Heppinstall was referring to the NRPB, again rather than you having to go back to that if you can have it so you actually know the SBs carry everything that you are going to want to look at.
MR JUSTICE BLAKE: Well, that would be more helpful because SBs, (a) we have various volumes and (b) they are more transportable and accessible. So yes, thank you.
Do you have some housekeeping issues?
MR HEPPINSTALL: I was only going to mention one thing that occurred to me and it was just as we were looking at that report from Dr Darroudi. In the almost ancient history of these proceedings there was a direction that most of the expert reports before Mr Justice Foskett in the civil case were admitted into evidence before the first First Tier Tribunal, which is why you will see some of the language in those reports is inapt for this Tribunal but apt for the High Court. So if you were wondering about some of those reports, firstly their date which is sometimes inexplicably a long time ago, and (2) the language used in those reports, that explains that.
MR JUSTICE BLAKE: Right. I think we all understood some of the archaeology of the case, that it was Foskett, then

FTT, then UT, then us, and we have scatterings of information from all. But it doesn't -- I mean, that particular document, although it's referring to other documents as well, that was before the FTT.
MR HEPPINSTALL: Before the FTT and then previously before Mr Justice Foskett which explains some of the strange language and dates.
MR JUSTICE BLAKE: All right. Well, there we are. We will shortly, then, rise and we will come back for submissions on Tuesday.
MR TER HAAR: Yes.
MR JUSTICE BLAKE: I had expressed the observation that we would be assisted by a schedule of the following, although I appreciate that the Hogan Lovell appellants say there's a lot in that document to which Mr ter Haar has just taken me. But I've noted the following.
If we had in a succinct form -- and I stress succinct -- a schedule of appellant, pathway -- I put dosimetry, which is any comment applicable -- you can't do it, it's right, it's wrong, it's plus or minus -- medical condition, causation doubts and references and it may be the latter can tie in that schedule.
Those columns in a sense act as a sort of index for us to overview everything that we are going to have to make sure we look at, the object being that we don't

miss something in the volume of material.
So it's not a direction, it's a suggestion.
MR TER HAAR: My Lord, I always like to do what the Tribunal wants if I can, but I think there are practical difficulties from my point of view. You may have noticed that Mr Sage hasn't been here today and yesterday as he has already gone away to start trying to put on paper as much as we can of our submissions because we think that would be of assistance to the Tribunal on Tuesday. We think it might save time and writing.
MR JUSTICE BLAKE: I'm sure that's right, yes. Anything in writing at least we have a record of and we can put it away and file. But bear in mind that notes towards pleadings or skeleton arguments are themselves forming quite an interesting volume of material.
MR TER HAAR: But the problem is, and in a sense it is one reason I raised this a couple of days ago as to exactly what the Tribunal had in mind was in order to try and find time to achieve what it was, and I do think that from our point of view, although the document I've just taken the Tribunal to is lengthy, it does actually answer each and every one of those headings.
MR JUSTICE BLAKE: Well, I can imagine that you were going to say that.

MR TER HAAR: Hence the word "succinct".
MR JUSTICE BLAKE: It made no sense to me when I first saw it because, as you appreciate, I haven't had and I didn't have in 2015 any of the material and I couldn't understand anything about it.
MR TER HAAR: Of course not.
MR JUSTICE BLAKE: I may understand a little bit more about it now. It's a suggestion. If there's any adaptation to ensure that each of those things are looked at, so be it. It may be -- heaven knows how we're going to structure our thinking because we won't start thinking until we've heard all the submissions, but of course one has provisional ideas as to how we might structure our thinking but those topics, pathway, dosimetry, condition and causation issues seem at least to be a potentially helpful set of questions that we could look at.
MR TER HAAR: We will look at it. It may well be what we can do is in a relatively short form do it by reference to this lengthy document, but anyway let us think about that.
MR JUSTICE BLAKE: Yes. See schedule, see appellants' case, whatever it is, yes.
MR TER HAAR: We, of course, have every interest in our case being as transparent and lucid to the Tribunal as it possibly can be.

MR JUSTICE BLAKE: It's generally speaking a good idea.
MR TER HAAR: Yes.
MR JUSTICE BLAKE: But obviously there's always a danger of us getting too far ahead of structuring what's happening, but at the same time if we say nothing you may be missing an opportunity to help us.
MR TER HAAR: I totally understand. Thank you.
MR JUSTICE BLAKE: Right, and we think that if we start on the Tuesday with the opportunity for reflection and refinement over the next two-and-a-half days that we will complete the process by Friday?
MR HEPPINSTALL: Yes, I would have thought earlier, my Lord.
MR JUSTICE BLAKE: You can have a time estimate amongst yourselves of how much you will take.
MR HEPPINSTALL: Can I just touch on order because I've assumed the normal civil order of first in, last out in this Tribunal before and found myself surprised, but that would be again my proposition, that I go first as long as that is acceptable to everybody else.
MR JUSTICE BLAKE: I see. That's where you want to go?
MR HEPPINSTALL: Well, it's the normal civil order and it makes sense to me in this case. Although in this Tribunal I've done it the other way round every time I've been to this Tribunal. That's why I'm raising it.
MR JUSTICE BLAKE: Is this a contentious topic?

MR TER HAAR: Its not contentious. Again our response really is whatever the Tribunal will find of greatest assistance.

What I do think is that there is a danger, certainly as between Mr Heppinstall and myself, that if I go first he will answer and I might well want to sweep up, if he goes first and I go second, he might want to sweep up, because I think one of the dramatic differences between us is that there is still a difference of approach. We will be saying that the Secretary of State has not really taken on board the approach directed by the Upper Tribunal. That may right or wrong but that will be our submission.

So what I would ask is that in a sense -- I'll discuss it with Mr Heppinstall and Professor Busby -- we ought to allow a timetable which at least gives maybe half an hour or three-quarters of an hour of sweep-up response to whoever is the person who otherwise would not have a response.

MR JUSTICE BLAKE: Certainly the idea that I threw out about this schedule -- I don't mean to get obsessed by that at all -- is simply that by the close of the proceedings, at least, we have everyone connected with each other's core submissions. So we're not just missing each other by saying: "Well, look, he hasn't dealt with our case at

all and therefore he's responded to a case which was not the case we're making" and then we're not getting that engagement in closing.

MR TER HAAR: That's exactly the concern. At previous interlocutory hearings you heard complaints, which may or may not be well-founded but it's certainly our position and Dr Busby's that the Secretary of State has not addressed full on the proper approach and what we've been saying. It may be in those circumstances -- I will talk to Mr Heppinstall -- that actually it might be best for him to hear my criticisms first and then to respond in that way.

MR JUSTICE BLAKE: In the back of my mind I thought that might be appropriate. But I think, look, unless my colleagues have any firm views on this, I think you can talk to each other for a bit now and decide what we are going to do. If it turns out that he goes first and then you go next, I do think there may need to be a reply of some sort so we can make sure that we have the best out of all of you. Yes?

MR TER HAAR: I totally understand the Tribunal's concern that there shouldn't be unfinished business at the end of this.

MR JUSTICE BLAKE: Yes, yes. I've got to know what the Secretary of State says in response to your points.

MR TER HAAR: So I'll talk to Mr Heppinstall now about it.

MR JUSTICE BLAKE: Yes, right. I think if you can do that and if you can just amongst yourselves in order to accommodate the Tuesday, Wednesday, Thursday, Friday, which is not bad, four days, comfortably to enable that process to happen, you give yourselves --

MR TER HAAR: My personal position is, as I think I indicated to the Tribunal, that I won't be here on Friday but Mr Sage can be.

MR JUSTICE BLAKE: Yes, right. Yes, I think you have.

MR TER HAAR: We won't be unrepresented on the Friday.

MR JUSTICE BLAKE: No. Well, yes, I think we'll allow you to debate it amongst yourselves. I hope you don't need a direction for the debate.

MR TER HAAR: I don't get that tone from the conversation.

MR HEPPINSTALL: I think we'll be fine, I hope.

MR JUSTICE BLAKE: And what we really want is that sense that we have by the end of the process at least achieved all that engagement.

MR HEPPINSTALL: Yes.

MR JUSTICE BLAKE: Right, thank you. Thank you all for keeping within our time limits.

MR TER HAAR: Will it be 10.30 or 10 o'clock on Tuesday?

MR JUSTICE BLAKE: I think probably 10.30. Unless there's an alarm about timing, I think 10.30. Listening to

submissions, probably 10.30 to 4.15 would be sort of normal working hours. Yes. If it looks like we're running into time difficulties we can review that but 10.30 would be better for submissions since we don't have the witnesses to accommodate so much.

Right. Thank you. See you next week.

(12.56 pm)

(The court adjourned until 10.30 am on Tuesday, 26 July 2016)