

IN THE HIGH COURT OF JUSTICE  
QUEEN'S BENCH DIVISION

1990 R No 860  
1989 H No 3689

ROYAL COURTS OF JUSTICE  
 THE STRAND  
 LONDON

Tuesday 10th November 1992

Before

THE HON. MR JUSTICE FRENCH

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ELIZABETH REAY

Suing on her own behalf and as  
Mother and Administratrix of the  
Estate of DOROTHY REAY (deceased)  
and as Widow and Administratrix of the Estate  
of GEORGE REAY (deceased) (Plaintiff)

V.

BRITISH NUCLEAR FUELS plc (Defendants)

AND

VIVIEN JANE HOPE (Plaintiff)

V.

BRITISH NUCLEAR FUELS plc (Defendants)

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APPEARANCES:

For the Plaintiffs:

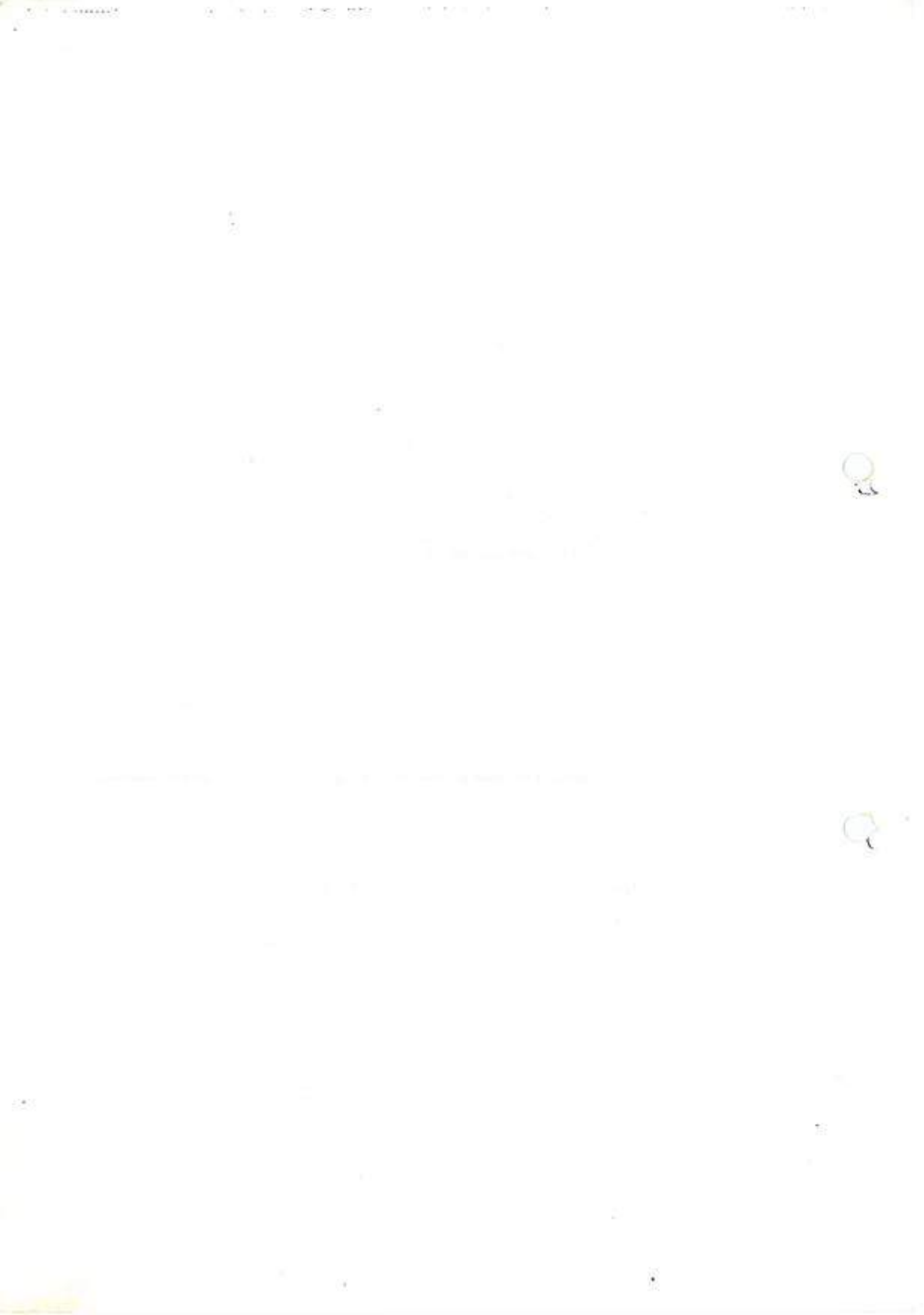
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 MR B F J LANGSTAFF  
 MR G S READ and MISS T GILL  
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For the Defendants:

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From the Notes of J L HARPHAM LIMITED  
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SEVENTH DAY'S PROCEEDINGSTUESDAY, 10TH NOVEMBER, 1992STEPHEN RICHARD JONES RecalledCross-Examined by MR. HYTNER (Continued)

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- Q. Prof. Jones, before we carry on with the cross-examination, there are two matters really left over from yesterday, if I may just revert to them. The first relates to your part in the process of setting up SEAM and writing your report and linking in with the documents. An examination of the transcript has led us to believe that there may be a conflict between certain answers you gave yesterday and what I want to do is simply clarify the position. When did it first occur to you - when - that you needed documents relating to the pre-1964 stack discharges?
- A. I am afraid, Mr. Hytner, I cannot be precise. I think the answer I gave yesterday was somewhere between September 1991 and, of course, March 1992. Certainly by March 1992 I had the information.
- Q. That is because the documents were found in the exercise initiated by the affidavit of Mr. Day in late September, whether you know that or not. Did you know that?
- A. No. Certainly I may have known at the time, but in my present state of recollection I cannot put the calendar together. However, it was certainly in my mind for quite some time and certainly I was well aware that the pre-1964 discharges, as in the addendum, were based on a projection. I am afraid that is the best answer I can give.
- Q. You see, what I have to put to you, in all fairness to everybody, is that, if you had thought that there were documents in existence relating to the pre-1964 stack releases, you would have sought them when you began your exercise because they were necessary for your exercise?
- A. They were only necessary, Mr. Hytner, when we had the SEAM model in such a state that we could actually begin to run it with some sets of discharges, and that was certainly towards the late summer or autumn of 1991.
- Q. You see, I appreciate you are not a solicitor and you would not have any idea of what solicitors do, but you would know that it would cause some hard work to be done by your employers if you sought old documents. You would have known that, would you not?
- A. Yes, of course.
- Q. We know, and as you must have known at the time, that your first report originally was due to be exchanged with the Plaintiffs on the 1st December, 1991 and what I put to you, Prof. Jones, and I must do this in fairness for you to answer it because I shall make comments later on



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it, is that it is inconceivable that, if you had actually thought about these documents before they turned up on discovery in the early spring of 1992, you would have sought them well before the autumn of 1991?

A. It may be, Mr. Hytner, that I made enquiries of the people engaged in the discovery exercise and, indeed, others as to whether such documents existed and, if so, where they may be. I am sorry I cannot now be more precise. It is certainly a matter of fact that I was under a great deal of pressure, in fact, during the whole of 1991, but particularly towards the end, to complete the construction of SEAM, complete the validation and produce a report. I am afraid I have not kept a log or diary of exactly what I did when during that period and so I cannot answer your question with any confidence or precision.

Q. Then I follow it up with the next question, which I asked yesterday but I have to follow it up in view of your last answers. When did you first become suspicious that the discharge figures which were then definitive in Howorth and Eggleton might be wrong?

A. I think perhaps I should venture some explanation of the way I have approached the problem of plutonium deposition around the site because my attention is focused largely on the deposition very close to the site, which is large, and that deposition is, as I indicated yesterday, not that much affected by the discharges from the B204 stack, however large or small they may be. I point out to you that Howorth and Eggleton managed to account for the near site plutonium deposition reasonably well with a much lower discharge figure from the B204 stack than I now suggest. So, in my mind, the way I approached the problem - and I stress it was a different way from that which Dr. Day approached the problem - I was not thinking in terms of the environmental data that there was any great evidence for very much higher discharges from B204 stack at all, simply because I had focused in on the measured plutonium deposition within a few kilometres of the site as being what I thought was the problem that most required explanation.

So, to my mind, the introduction of the high stack discharges was a question of establishing that the log books existed and establishing that the other supporting documents existed and gave some confidence in what was in the log books, and those were derived from the discharge measurements, not from the environmental data, although one has, of course, to check that such a large increase in discharge is consistent with the environmental data at locations further from the site, which I think the various reports that have been in establish that it is.

So I did not approach the 204 stack discharge issue as a matter which was central to the explanation of plutonium deposition around the site for those reasons.

Q. I have put my case to you and I do not think I need pursue that answer any longer.

A. Thank you.



Q. Now I want to turn to the discrepancy between the authorisation figures and your own figures. Have you done the exercise that we asked you to do yesterday?

A. I have, Mr. Hytner, and I have a document which I would like to circulate, if I may.

Q. By all means, but can I attempt to short-circuit a long cross-examination by seeing if we can agree in principle? Is one of the differences, or the basic difference, between the two estimates that you have added into your figures alpha emissions which are not plutonium?

A. I have added into my figures, as is quite clearly explained in my report, the figures which are estimated as the discharge from approved places, total alpha. That is, as described in my report, the discharges thought to originate largely from the B30 pond surface. Those are described in the authorisation submission in, I believe, Table 1.5 as approved places. For the purposes of assessment, those are assumed to be plutonium alpha.

Q. MR. JUSTICE FRENCH: Sorry, forgive me. I have not got anything like all that?

A. Maybe it would help, Mr. Hytner, if I did circulate the document because it is all set out there.

MR. HYTNER: Certainly. (Produced and circulated)

Q. MR. JUSTICE FRENCH: Including the answer you have just given?

A. Including the answer I have just given, my Lord.

MR. JUSTICE FRENCH: What is this? D2, or shall we make it a further annex to Prof. Jones? D2:

Q. I do not find the answer you have just given set out, at least as part of the legend. It may be it is a table?

A. I think it is effectively in one of the footnotes, my Lord, but perhaps if I explain what the table is. This is an amendment to the table which is the third page of the bundle that Mr. Hytner presented to me yesterday with the same title. I realise, looking at this, that I may have presumed authorship of the data in that report. I have attributed that to Dr. Day and, if that is not correct, I apologise for presuming.

Essentially, I have set out the same figures under the same headings as in Mr. Hytner's document 3a and I show that, on the first set of figures for the authorisation application, Table 1, original, the figures in that table are, indeed, correctly extracted from the authorisation and do add up to the total shown, which I have shown as the total (Day), hence my presumed authorship.

What I then show is that there are additional discharges of alpha activity assessed as originating from approved places. These are the discharges which are



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assessed by reference to air sampling at the site perimeter and which are described in my report, as the first footnote says, in Chapter 5, pages 8-10 and Annex 5D, page 1. Those discharges are assumed for the purposes of the assessment of the discharge to be plutonium alpha and the figure that I have described as the correct total is, therefore, the original total with those discharges from approved places added. It is stated in my report that the relevant table in my report, 5D-4b, does include those assessed discharges from the Magnox ponds, although they are not called discharges from approved places.

Q. Report 5D-4b, did you say?

A. That is the table, my Lord. The explanation of what is included in Table 5D-4b is, I believe, Annex 5D, page 1.

The second set of numbers on the sheet I have presented are the figures for the amended authorisation application, set out in exactly the same way, noting that the figures for the discharges from approved places are not altered in the amended authorisation but are, of course, still there, and that leads to a further set of totals. The original totals, as set out in the document presented by Mr. Hytner, the discharges from approved places, which are the same for each year as in the original case, and what I describe as the "correct total".

The final set of figures are the figures from my report, from the high stacks, Table 5D-3b, as indicated, and the low stacks, Table 5D-4b, which, as I have explained, include the discharges from the Magnox ponds or approved places, and I arrive at a total.

The final two columns are the percentage increase as originally evaluated in Mr. Hytner's document plus what I consider is the correct percentage increase, based on a comparison of my total with the corrected total for the amended application, and that, I think, was certainly the basis of the difference between us on these figures which you pointed to yesterday.

I also make the point that these total figures for discharge are of limited significance in assessing the deposition particularly close to the site, simply because they combine the discharges from high stacks and the discharges from ground level sources, and discharges from those two sources have very different dispersion and deposition behaviour. So really, if you want to address the issue of deposition close to the site, you need to assess those two sources separately. However, I have lumped them together purely for the purpose of comparing the totals, as was done in this document.

Q. MR. HYTNER: It looks as though there is not much between us because, on a careful reading of one of the



paragraphs in your report, it became apparent last night that perhaps you had added in the approved places. Can I make this absolutely clear to you, Prof. Jones, so that again you do not feel trapped and you know what the objective of my questions is. I am concerned with the best estimate of the unaccounted for plutonium within a 20 km radius of Sellafield. That is, plutonium that did not come from the high stacks or low stacks and did not come from the Magnox pond or uranium oxide. That is, plutonium for which you cannot account. Do you understand that?

A. I understand that and I would emphasise the qualification I made yesterday, which is that doing that integration over 20 km introduces a number of uncertainties because of the difficulty of accounting for the more diffuse sources such as sea to land transfer.

Q. Yes?

A. So I would simply point out that, whatever you might arrive at by way of argument in relation to an integral over 20 km, I am likely to find significant objections to.

Q. You would find significant objections because, of course, any alteration in your own figures would have a much greater effect if the deposition is spread over 20 km than if it were, for the reasons you gave yesterday, confined to 5 km?

A. Well, Mr. Hytner, I have indicated my objection and I am satisfied that you proceed with your line of cross-examination and we will see where it takes us.

Q. Now that you know what I am after, we can perhaps take this shortly. What is on the ground is plutonium. That has been measured, has it not?

A. That is correct.

Q. Alpha emitters other than plutonium are not included in the measurement of plutonium. That is correct, is it not?

A. That is correct, yes.

MR. JUSTICE FRENCH: Just a moment. Alpha emitters other than plutonium are not measured, did you say?

MR. HYTNER: On the ground with the plutonium. For all I know, my Lord, they may be, but they are not part of this measurement.

MR. JUSTICE FRENCH: Yes.

Q. MR. HYTNER: The figures you have given for high and low stack releases includes releases from "approved places", which themselves include non-plutonium alpha. Is that correct?

A. That is correct. However, the figures are arrived at, as I have described, by considering the results of air



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sampling at the site perimeter and doing some calculations based on modelling to arrive at an estimate of the release. Because that is done, there are specific figures obtained for plutonium and americium as a component or contributor to those emissions and it is a matter of fact that the alpha figure recorded for approved places is mostly plutonium.

- Q. Prof. Jones, the blunt fact is this, that if the Court is looking to see how much unaccounted for plutonium there is on the ground, the accurate figure to look for is the amended authorisation figure plus a little bit of plutonium, or whatever proportion of plutonium is the plutonium share of the approved places release?
- A. That would be strictly the most accurate and correct way of deriving it, Mr. Hytner. I would say two things. First of all, in my Table 5D-4b, for earlier years, there are figures given for americium emitted from low stacks, which represent just such an apportionment between plutonium and americium in the Magnox ponds release.

Secondly, over the course of history of the plant, the contribution to deposition from these approved places releases is relatively small and, therefore, whether or not you make the correction you suggest, I consider that you would arrive at very much the same figure.

- Q. You say small. In 1988 the approved places was 130 mega Bq as opposed to a total of 290. I am sorry, you put the Day figures. In relation to a total of 471 and 420?
- A. Indeed, that is the situation in the later years. The point that I am making is that, of course, in the earlier years, and you are considering a total historical perspective, the sum total of the emissions from the approved places is rather small relative to the sum total of the emissions from the higher stacks.

- Q. Is this correct, that if my Lord is seeking to know how much unaccounted for plutonium there is within a 20 km radius, your figures have got to be uplifted, first of all, to take account of your cautious, as you call it, SEF application and, secondly, for the amount of non-plutonium alpha that was measured from the approved places?
- A. In principle, that is correct.
- Q. That is right?
- A. Yes. Whether that would make any great difference to the figures is something which I might beg to differ upon.

- Q. In relation to 5 km, I now understand from my instructions that your principle is not altogether wrong. In relation to 20 km, the pro rata increase would be much greater, would it not?
- A. It would, indeed, and I have indicated to you my objections to using the figures for 20 km. I doubt that this is a matter we can solve by cross-examination.



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- A Q. I am relieved to hear that! Nor would it now be possible, however skilled I were at calculating figures on my feet - nor would it be possible in cross-examination to arrive at a precise calculation of the amount of excess plutonium on the ground, would it?
- A. Indeed, even calculating the integral to 20 km from measurements, as Dr. Day has indicated in his reports, is fraught with some uncertainty because of the uncertainty in the measured value at the greater distances.
- B Q. So there must, at the end of the day, remain a very considerable uncertainty as to how much above 66 GBq of unaccounted for plutonium there is on the ground within 20 km?
- A. I would qualify that to say how much, if anything, above 66 GBq. I could produce an assessment which came to a lower figure based on integration. Uncertainty works both ways.
- C Q. Prof. Jones, my understanding of your evidence yesterday was that, in arriving at your figure of 66 GBq, you had applied to stack discharges pre-1964 the SEF of 8, when you felt that that was really rather high. Is that correct?
- A. That is correct, although again I emphasise that since the SEF of 8 is that which is measured for B204 stack and since B204 stack dominates the total historical discharge and the discharge in the earlier years, while there might be a degree of caution in that, it is not a very large one.
- D Q. There is no way in which, on your approach, you could ever suggest that the excess plutonium was lower than 66 GBq?
- E A. I have pointed out that in my fourth report I carry out an exercise based on integration and that does, indeed, suggest that calculating the deposition by that method could produce a lower value. I have also explained in my fourth report that the reason for that difference is that my original method, which was not based on integration, places most emphasis on explaining the plutonium deposition levels close to the site, whereas, of course, the integration method, as we know, places more emphasis on explaining the deposition levels further away. So the two methods do not necessarily give the same answer.
- F Q. Leaving aside what has been put to you, that your figure of 66 should be uplifted because of your cautious SEFs and now the non-plutonium alpha from the approved places, can I go to other matters which might affect the figure?
- G A. By all means.
- H Q. The next are radon daughters. Radon is a naturally found gas, is it not?
- A. It is.



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Q. It is radioactive. Is that right?  
A. It is, indeed.

A Q. As it decays, it decays into isotopes that are familiarly known as radon daughters?  
A. That is correct.

Q. Though all I am doing by using that jargon is to indicate subsequent isotopes in the decay chain. It is an alpha emitter. Is that right?  
B A. Certain of the radon daughters are, yes, and it is the radon daughters that really matter.

Q. Yes. When you get the filter papers which have sucked the discharging air out and you find on your filter paper alpha, that may be either from plutonium or the radon daughters?  
A. It may, indeed.

C Q. If you assume that all the alpha on your filter is plutonium and make no allowance for the radon daughters, you will end up with a figure for plutonium discharge that is too high, will you not?  
A. You will, yes.

D Q. You have made a number of observations about radon daughters in your report. You have made specifically a comment that radon daughters did not dominate the discharges. Is that correct?  
A. That is correct. That is perhaps qualified in my report as something of a judgment that I have made but, nonetheless, a judgment that I have made on the basis of quantitative data.

E Q. I do not dispute that. Many of these things are matters of judgment, where somebody can be right or wrong. Is that correct?  
A. Correct.

Q. But, in your final calculations, you make no allowance for radon daughters in the stack releases, do you?  
F A. That is correct.

Q. When you say that radon daughters or anything does not dominate, the normal implication or inference to be drawn is that you do not regard that as being the majority?  
A. That is correct.

G Q. But it also implies a very substantial minority, does it not?  
A. It certainly can do. If you would like me to expand on the way I have reached that judgment, the measured concentrations of alpha activity.....

H Q. MR. JUSTICE FRENCH: Can I ask you to pause there? I think the question is a linguistic one. If something does not dominate, if that be the expression used?  
A. Yes.

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Q. Then, so proceeds the question, it means that it is a significant part of the total but does not dominate. Is that right?

A. Thank you, my Lord.

Q. Is that how you use it?

A. That is how I would use it and I was about to venture and attempt to put some quantification on that.

Q. Yes. Now, having established how it is used linguistically, then, of course, proceed as you wish?

A. The information I have considered in relation to this question are some of the log books which show experimental sampling campaigns on the B204 stack, when it is clear that determinations were made based both on the initial measurement by Health Physics Department and subsequent measurements made in the analytical laboratories and, in a few cases, a specific analysis of the stack sample for plutonium. That is one source of data and another source of data is general experience backed up with some specific measurements on the B204 stack system, as it is today, as to what sort of concentrations you would expect to arise purely from radon daughters in terms of the count.

Those considerations would lead me to believe that the proportion of the discharge accounted for by radon daughters would be somewhere around 20 per cent of the total, maybe at most, but certainly of that order. So, in saying radon does not dominate, I have been having in mind something of the order of an 80/20 split, as a matter of judgment, not as a precise figure.

Q. MR. HYTNER: So we have to reduce your figure for high stack releases by 20 per cent to allow for the radon daughters?

A. That is certainly possible, yes.

Q. Which would increase the plutonium excess, the unaccounted for plutonium, within 20 km by 20 per cent?

A. Depending on what value you placed on that evaluation, yes.

Q. Yes.

A. And also, I might add, depending on what deposition behaviour you assume for the plutonium released. I note that Dr. Day, in his third report, assumed a variable deposition behaviour so as best to explain the deposition at greater distances and, if one took that approach, it simply would not matter, within reason, what the amount released was. One would simply vary the deposition behaviour to explain the deposition at greater distances. I simply note that as an approach that has been used by Dr. Day in one of his reports.

Q. Whilst anything is possible, there is a strong probability, is there not, that, for all the factors that I have put to you, the amount of excess plutonium within 20 km would be far larger than 66 GBq?



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A. I am sure you could put some numbers together based on such an integration which would produce that result, but whether I would accept it as a reasonable interpretation is another matter. I do not believe I would. I draw again to your attention the fact that in my original evaluation, using the methodology that I, first of all, used, without reference to integration over any radius at all, I started with an incomplete set of B204 discharges, which, from memory, had a cumulative discharge about a factor of 2 less than the final figure and, on that basis, I reached a figure of 74 GBq.

Using the full set of discharges, which I now present in my report, and doing the re-evaluation, I get 66 GBq. I, therefore, point out that, using my original method of evaluation, the answer for the excess plutonium simply is not very sensitive to the level of emission from B204 stack and, if we were to venture into a discussion on how one might arrive at it by integration, I would wish to look at the data exceedingly carefully because I know it is not a straight forward exercise.

Q. Too much uncertainty in measuring all these factors. Would that be right?

A. Indeed, together with uncertainty about what the deposition behaviour of the released material actually was.

Q. Whatever the excess, whether it remains at 66 or whether my Lord decides that it is more than 66, where do you say it comes from?

A. The additional releases I have taken to represent the sum total of a number of releases which are referred to in the Addendum but the quantification of which in the Addendum was not really performed on very reliable or very complete deposition data. The ones specifically mentioned in the Addendum are the release from the surfaces of the pile ponds and the releases from the early plutonium production facilities at North Group.

Q. MR. JUSTICE FRENCH: I want to make sure what you mean by the latter?

A. My Lord, as you will know the Sellafield site originally was a site set up specifically to produce plutonium for ....

Q. Are you talking of the two piles?

A. From the two piles, yes.

Q. Thank you. I understand that. I did not understand the other description.

A. And the facilities that I am referring to are a little way north of the piles on the site and are the facilities where the final purified plutonium solutions were converted into plutonium metal. There were indeed other facilities on the site much closer to the reprocessing plant and the piles which also handle separated plutonium



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A and which one would assume would be candidates for releases. To those in terms of a ground or an effect on local deposition I would add the 1961 event in the Calder cooling towers which resulted in plutonium reaching the cooling tower basin. It resulted in a release in droplets through the top of the cooling tower but also it resulted in a release through blow-out of spray and droplets from the cooling tower base. So without going into those in any detail there are a whole range of either identified plutonium releases or potential areas for releases which were not subject to monitoring, and I have ascribed the excess essentially to the sum total of all of those.

Q. MR. HYTNER: Where do we find in your first report a clear statement as to where you believe these releases originated from?

A. I think the statement simply enumerates most of those possibilities that I have suggested, Mr. Hytner. On Annex 10C, page 2, part way down the page, under the heading, "Spatial Distribution of Deposited Activity", the second paragraph of that sub-section on spatial distribution of deposited activity says very much what I have now said in Court.

Q. Could you read it out for us?

A. It says:

"There are a multiplicity of possible sources for the emission of plutonium and/or americium at low effective height. Relevant sources for plutonium are the Magnox ponds at building B30; the piles pond at building B29; the original plutonium finishing facilities at North Group; the Calder cooling towers (as a consequence of the 1961 plutonium evaporator leakage) and a variety of plants in the chemical processing areas."

Q. Those are the possible places they could have come from. Have you any idea where this did come from?

A. No, I cannot be specific. I am quite sure that the re-suspension from the piles ponds will have made a contribution. From the deposition data and particularly the data that is taken closer to the relevant Calder cooling towers, it is apparent that had at least a local effect, but beyond that I do not have the data to be specific about what the relative magnitude of each of those sources was at all.

Q. I am grateful for that answer because as you know further particulars were sought of your report by correspondence. You were aware of that, of course?

A. Of course, yes.

Q. And the answer was that it is all in your report. In particular, as you know, the proposed mechanisms were sought and again we were told that everything was in your



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report. Can you now assist on this? Are you seriously suggesting that a substantial proportion of this 66 GBq came from the pile ponds in re-suspension?

A. I am unable to put a figure on how big a proportion came from the pile ponds. I would remind you that the evaluation that was done for the R171 Addendum arrived at a cumulative figure for discharge from the pile ponds of - the figure escapes me as to whether it was 50 GBq or 70 GBq but certainly a sizeable amount, simply by reference to the relative concentrations of plutonium as measured in the pile pond water compared with the B30 pond.

Q. I am instructed that the figure was 37 GBq.

A. That sounds about right.

Q. If indeed it came from the pile ponds can you propose a mechanism?

A. A general possible mechanism is described in my report. It is a known and understood mechanism whereby radionuclides which are attached to particulates in particular are in much greater concentrations in a very narrow layer at the surface of a body of water due basically I understand to electrostatic effects, and therefore anything which disturbs that surface or gives rise to the potential for re-suspension will release a much greater proportion of the radionuclides that are so enriched and will release a much greater proportion of the radionuclides than you might expect by comparison with measurements made on the bulk water in the pond. So that is an established mechanism which does work. I have to say I make no particular claim for the extent to which it does actually work at the pile pond. I find it very hard at this remove, not knowing what the precise conditions in the pond were, to evaluate that, but it is simply in there as one of the candidates, together with the other sources that I have enumerated, remembering that certainly in relation to the plutonium facilities at North Group it is quite clear from the documents that plutonium was handled in those facilities in much lower standards of containment than would now be the case, so they are equally highly plausible sources for an additional release.

Q. Not highly plausible sources for a considerable release for the reasons that I think you will have known I gave in opening this case, that if it was a considerable release the droplets, the aerosol, would have been not only visible but would have been noticeable because of the effect rather like thin rain or mist?

A. I do not accept that is the case. That is certainly not relevant to a release from the plutonium finishing facilities where I do not think anybody is contending the material would be released in droplets, nor am I aware of the numerical evaluation on which that particular statement was based.



- A Q. Prof. Jones, if considerable quantities of plutonium in suspension had come from the pile ponds it would have been a very low level release, would it not?
- A. It would have been a release, as for all these cases that I have assumed, with an effective height of about 10 metres, yes.
- B Q. You could not get a much lower effective height because of the position of the pile ponds?
- A. I agree, it certainly would be a near ground level source.
- C Q. In those circumstances if an alpha emitting aerosol were being emitted or released from the pile ponds you would have expected, would you not, that the health physics monitors would have picked that up pretty quickly?
- D A. That would depend entirely on what the expected concentrations of radionuclides in air caused by this release were. As part of my work on the case one of the other sources of data which I have been very interested to seek has been early records for alpha in air sampling on the site. I have sought those records and seen them. These suffer from the same defect potentially as the stack sampling in relation to radon but in relation to environmental samples, since the quantities of plutonium which you are looking for are much, much smaller, by several orders of magnitude, the radon problem is much more serious.

E The air sampling data which I have seen for the site, because if you like the level of detection imposed upon that due to radon and other factors is high relative to the quantities I am looking for, all I can say about the air samplers on site are that they are consistent with the sort of release scenario that I suggest. In other words, the required levels of air activity on the site, to be consistent with the release that I propose, could have existed because those levels are not high by the standards for occupational monitoring which were being pursued at the time.

- F Q. MR. JUSTICE FRENCH: How high was pond level above ground or how low was it below ground, or was it at ground level?
- A. You mean the surface of the pond, my Lord?
- G Q. Yes.
- A. The pond is a concrete structure which is built above ground so the pond surface would be elevated above the local ground level.
- Q. By how much?
- A. I do not know the dimension, I am afraid.
- Q. A matter of inches, feet, yards?
- H A. Feet to yards probably, my Lord. The release height of 10 metres I have assumed, I have stressed is an effective



A release height based on experiments that we have done at various points around the site which indicate that if you release material at ground level the additional turbulence around the buildings results in a dispersion which is better characterised by a release to an effective height of 10 metres than an effective height of zero. That is why for consistency I have treated all these additional releases as resulted from 10 metres. It does not necessarily bear any direct physical relationship to the particular circumstances of the pond, my Lord.

- B
- Q. MR. HYTNER: Are you saying that the 37 GBq in the Addendum were an accurate figure for the pile pond releases up to that date?
- A. No, of course I am not because that figure was arrived at as I have described, simply by extrapolating based on pond water concentrations, so by definition it cannot be a very accurate figure. What I am saying and what I am sure I point out elsewhere in my report is that the figure I arrive at based on the consideration of the deposition measurements is a better measure of the cumulative emission from all of these sources than has previously been available, and I still hold to that view. I simply quoted the figure of 37 GBq, which you kindly reminded me of, as an indication that the previous assessments suggested that the piles ponds could indeed be a source of activity of about that magnitude, and I rely on it for no more than that.
- C
- D
- Q. When you consider the improbabilities of 66 or more giga Becquerels coming from the sources that you have suggested, would you like to reconsider the matter and look at the most obvious candidate, which is uranium oxide?
- E
- A. You say it is the most likely candidate. Indeed, quite early on in my consideration it did occur to me as to whether the plutonium could be explained by uranium oxide. The reason why I did not pursue that was as I have explained at some length in my second and third, and indeed fourth reports, that if the plutonium deposited near the site, particularly for the samples taken closest to the site where we are looking at levels of up to 20,000 Bq per square metre of plutonium, if that all originated from uranium oxide then one can calculate on various bases how much caesium should also be deposited there, and measurements show that the level of caesium which is deposited there is far less than the quantity you arrive at if you assume that the plutonium came from uranium oxide. That is the basic reason why I do not believe that the uranium oxide can explain this plutonium deposition.
- F
- G
- H
- Q. I promised I was only going to ask one challenging question about uranium oxide, that was it and I leave it, save to say this, that I understand at the end of the day you are telling my Lord that the probability is that 20



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is too high and that the best estimate is somewhere below 20 but above 15?

A. That would be the figure that I arrived at from the fission product deposition, that is correct, and that I think is the best basis for the assessment.

Q. That is below 20 but above 15?

A. That is correct.

Q. In addition to all the matters that I have put to you which I have suggested increases the amount of excess plutonium above 66 GBq, there is the next problem. The whole of the figures that you have given for discharges are based on a computer model, the SEAM model?

A. The discharges, with respect, are for the most part not based on the SEAM model. The discharges for the most part are based on being related in some way to measurements of the discharge. Those discharges which are related to the SEAM model are essentially the figure for excess plutonium which we have just discussed at length, since that is arrived at by putting into the SEAM model to account for the deposition near the site, but I think that is probably the only instance where the discharge depends on the model.

Q. The 3,400 GBq depends on the model, does it not?

A. No, not at all, not in the slightest. That derives by the route that I have described from the results of the stack sampling and the application of the SEFs to those results. It does not derive from the SEAM model at all.

Q. Because the one thing about a model is that it can never be relied on to give the precise figure. Models are only reliable to within a factor of 2, are they not, the best models?

A. That would be a good general interpretation. However, the extent to which the SEAM model has been validated against environmental measurements might possibly give a little more confidence than that. It might indeed suggest that in some areas, while the model figure might be uncertain, it is likely to be higher than the true value. That generally is the cast that I would put upon the results of the SEAM model in terms of levels of radionuclides in the environment and intakes to people. I stress that as far as the discharges are concerned with, I think, the single exception that I have quoted, those are based on discharge measurements not on the model.

MR. HYTNER: I now want to turn to another topic, and that is the relationship between BNFL and NRPB. My Lord, in view of one total misconception which will emerge in relation to Dr. Dickinson's statement of what the Plaintiffs have been saying in certain regards and in view of Mr. Rokison's opening speech, my Lord, what I have done for the sake of total safety is to have typed out what precisely we are saying about the relationship

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so that there can be no mistake whatever and it cannot be misinterpreted. My Lord, if I hand a copy to your Lordship and a copy for my learned friends (handed).

MR. JUSTICE FRENCH: Mr. Hytner, so we do not lose sight of this document ....

MR. HYTNER: P3, my Lord.

MR. JUSTICE FRENCH: I was wondering whether a better solution might not be to make it an appendix to your opening?

MR. HYTNER: My Lord, I am very happy to do that.

MR. JUSTICE FRENCH: Then certainly I shall know exactly where it is at any given time. Shall we call it "Opening, Appendix 1"?

MR. HYTNER: Yes, my Lord. The reason I have done this is that the phrase I used in the opening was that it was not suggested that NRPB and BNFL were commercially in bed with each other, but that they were close friends. My Lord, I appreciate that is a phrase that can be misinterpreted and that is why it is carefully particularised:

Q. Can we just read it through, because what I want to do, Prof. Jones, it may be that you will agree some of these statements, in which case we need not go to any documents, because I do not want a long cross-examination. It starts off, as you see:

"There is no suggestion that NRPB have acted improperly or in breach of their statutory function, which is advisory rather than that of an enforcement agency or watchdog."

What is said, and this is what we are alleging is that:

"... the nature of the statutory function and the position of BNFL in the nuclear industry have led to the development of a close relationship which resulted in the following:

(a) the development of personal relationships between personnel in the two bodies."

Would you agree or disagree with that?

A. If you replace "professional" by "personal", I would agree with it.

MR. JUSTICE FRENCH: I think you mean "personal" by "professional", don't you?

A. Yes, sorry, if you replace "personal" by "professional", my Lord.



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Q. MR. HYTNER: It led to you being on first name terms. Many of you in BNFL and many of them in NRPB would write to each other using your first names?

A. I think that is a matter of common courtesy when it is somebody who you deal with frequently.

Q. When you know them?

A. Yes, on a professional basis. I cannot speak for others in BNFL but I can be quite clear about myself, that I do not have what I would describe as a personal friendship with anybody in NRPB.

Q. You are quite right to be careful in particularising that. I was not suggested that people visited each other's houses or went out for dinner with each other or went to the theatre with each other, but you wrote to each other on first name terms, you telephoned each other on first name terms, something, a relationship which did not, for example, replicate itself with COMARE or the Ministry?

A. I have certainly on occasion corresponded with inspectors in the authorising department on first name terms on exactly the same basis. I would not take that to imply that there is a personal relationship between me and anybody in HMIP, or indeed that there is anything unprofessional about it.

Q. Let us go on:

"(b) a willingness on the part of NRPB to remove from draft reports material which might have been of interest to the public but embarrassing to BNFL."

Would you agree with that?

A. I do not think I would. I am sure you are about to present me with a specific example so I will perhaps wait for you to do so.

Q. Without having a specific example put to you, you would not agree with that?

A. No, not in the way it is cast. Certainly on occasion I have commented on reports which NRPB are about to publish and I have made various comments. I have never found that NRPB are willing to remove something from a report purely because it is embarrassing to BNFL. They are willing to remove something from a report if it is not justified or accurate but not purely on the basis that it is embarrassing to BNFL.

Q. Could you look at page 172 in P1? This only goes back as far as 1987 so presumably you were at Sellafield then, were you?

A. That is correct, I was at Sellafield at the time.

Q. Do you remember the ....

A. I remember this issue in this letter quite well. Indeed, the results that are here discussed are of some importance.

Q. It is your letter?

A. It is my letter, yes.

Q. 31st July, 1987, to Dr. Stather of the NRPB, and it relates to a draft report from a man called Popplewell.

A. That is correct.

Q. Is it Dr. Popplewell?

A. Yes, Dr. Don Popplewell.

Q. "Dear John

May I thank you again for the opportunity to comment on the draft paper by Dr. Popplewell concerning plutonium levels in autopsy tissue samples. I gave you some comments by telephone immediately before I left on leave, and as you requested I am now setting these down in writing."

You make a number of comments which I do not think we need bother with, on page 172, and then at page 173, (iv):

"I believe there is evidence from environmental data (although only based on Pu 238/Pu 239 + 240 data) which would suggest that exposures to low burn-up material would be consistent with exposures to Sellafield discharges, particularly atmospheric discharges, in the 1950s."

I am sorry, I should have read (ii):

"The isotopic data are a clear demonstration that the tissue burdens are not dominated by material currently present in the marine environment near Sellafield. Equally, I believe that it can readily be demonstrated that the isotopic composition is clearly different from current discharges from the site, both liquid and aerial."

Then you go on:

"In view of (ii) above I must object to the reference to the Sellafield site as an "obvious source of low burn-up material". Equally, the final sentence seems to me to be unnecessary speculation when the relationship between the NRPB and ourselves should be such that you can establish precisely what processing methods apply to various parts of our plant, and what discharges result. Moreover I suspect that these references may be seized upon, quite unnecessarily, by the press as evidence that some undeclared process was being carried out at Sellafield, resulting in previously undeclared discharges which are the source of significant radiation exposure of the public."



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May I therefore suggest the following:-

i The paper be modified to deal with the references I mention, while reporting the data factually.

ii The paper should contain estimates of CEDE and red bone marrow dose, and comparison where appropriate with R171.

iii Matters relating to the significance of the isotopic ratios in indicating sources of exposure should be fully discussed in a separate paper, ideally published in parallel, which draws on all available discharge and environmental data. I would like to see this as a genuine cooperative exercise between NRPB and BNFL and to be a joint publication."

Then I think Dr. Stather, copy to you, writes to Mr. Mummery on 1st July, 1987, and then in due course the report was published. Can we look at the draft that you objected to?

MR. ROKISON: That came first.

MR. HYTNER: I am so, sorry, you are quite right, I should have read that first, my Lord:

Q. Would you now look at the draft at 176, the end of the second paragraph:

"The low values of the ratio suggested that the plutonium was from a source produced by only a short-term reactor irradiation process. Subsequently all three subjects were identified as having been employed at Sellafield Works, an obvious source of low burn-up plutonium."

That is plainly a reference, is it not, to the fact that when these deceased persons absorbed their plutonium they were working at Sellafield, which was then an "obvious source of low burn-up plutonium"?

A. Yes, I have no difficulty with that comment in the paper.

Q. You asked for that to come out.

A. Perhaps before we go through the report, I clearly have in mind, because I remember this letter very well, the problem that I had with the Popplewell paper, and the problem that I had was simply this, as I read it I perhaps read into it, and maybe read into it unnecessarily, but certainly I read into it an implication from the paper that there were discharges of low burn-up plutonium from Sellafield which were still going on at the present day and which represented some undeclared activity. That is what I read into the report and that is simply not correct. I have no problem whatever with the statement that the plutonium in the tissues of these people is attributable to the Sellafield



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site, and indeed that it probably relates to atmospheric discharges in the early years, and that was certainly the intended tenor of my comment. Whether we can establish that from what is in these documents I am not quite clear but certainly that is what my problem was.

Q. Can we look at page 178?

A. And I do not believe as finally modified that the paper really was that substantially changed but you may wish to seek to establish the opposite.

Q. Would you look at the last sentence, to which you also took exception, of the report, on page 178:

"With regard to the ex-worker cases, low burn-up plutonium again seems to be the main source of contamination, suggesting that there may be different processing methods for the low burn-up fuel compared with the high burn-up fuel, and it is the former process which leads to worker contamination, and indeed to intakes by the neighbouring populace."

That was a paper written, of course, not for the tabloid newspapers but to be published in a scientific journal for other scientists to read?

A. That is correct. Maybe I was over-sensitive but I stress that the implication I had read into it, which is rather exemplified by that last sentence, was not an objection to the fact that the low burn-up plutonium originated from Sellafield, or that the tissue burdens of these people could have originated from Sellafield, but the implication that there was something funny going on with the treatment of low burn-up fuel now, and it was that something funny that was going on which was leading to exposures now, which is simply not the case. What I had said further to NRPB in my letter was, if you think that is the case then the relationship between us should be that you could come and find out, and let's carry out some measurements. That I do not think is either unprofessional or indicates that I am trying to brush something under the carpet.

Q. I have got to be careful of what I am putting to you, Prof. Jones. I am not suggesting that you were dishonourably or dishonestly trying to suppress something. What I am suggesting is that in a perfectly proper scientific paper a scientist made two observations which you found, as you say now through perhaps over-sensitivity, might be embarrassing for BNFL and so you asked for those parts to be deleted?

A. I would add further to that, it might be embarrassing to BNFL and also in my considered opinion wrong, and I would only ever write such a letter if it met both of those criteria.

Q. Plainly the statements were not wrong, were they? Sellafield, when these men died or when these men worked at Sellafield, was an obvious source of low burn-up plutonium?



A. Through exposure in the early days of the plant, that is quite correct, and similarly as we have seen in this case, it is an obvious source of low burn-up plutonium in terms of the releases from the plant during the early period of operation, but it is not a source, an obvious source, of low burn-up plutonium now such that that material is dominating the exposure now of the local populace, and it was that, that was my problem with the paper as clearly as I can express it.

Q. All I am putting to you is this, that something written in a scientific paper which through over-sensitivity you wanted deleted, even though the precise statements were correct, were deleted in the final paper, weren't they?

A. Subject to checking exactly what was deleted from the final paper and exactly what was not, that may well be the case.

Q. My recollection is that the phrase, "an obvious source of low burn-up plutonium" was wholly deleted and the part which you wanted deleted from the final sentence was also deleted - part of the sentence remained in and part of the sentence ....

MR. JUSTICE FRENCH: If that is wrong it will be pointed out soon enough.

MR. HYTNER: It will be pointed out, my Lord, yes, rather than go to the documents.

THE WITNESS: But again I would hold that the paper as presented did not try to suggest that the material in the Seascale cases came from anywhere other than Sellafield.

Q. MR. HYTNER: You see, Prof. Jones, if you had received a reply to your letter, "Dear Stephen", "Dear Prof. Jones, I have read your comments. Sellafield was at the time an obvious source of low burn-up plutonium and it is low burn-up fuel which leads to worker contamination and indeed to intakes by the neighbouring populace, both those statements are correct, we are not prepared to alter them", you could not have complained, could you?

A. No. I might still, if I felt strongly about it, have attempted to persuade the correspondent that it would certainly be accurate to say that about historic operations and historic discharges but it would not be accurate to say it about operations now, and I am quite happy with the paper, indeed I would have been quite happy with the speculative conclusion, that this suggests that the major intakes of plutonium by the local populace were due to early discharges from the plant, quite possibly discharges to atmosphere.

Q. May I make the position again absolutely clear so that it is not suggested later that I have put something unfair



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about BNFL and NRPB? I do not express a personal opinion because I am Counsel and it is not my business to do so but some perfectly respectable people might well believe that it is legitimate to head off wild speculations in the tabloid press which might be unfair. I am not putting to you as something that is improper your request to Dr. Stather or Dr. Stather's acquiescence, do you follow? No impropriety on either side is being suggested. What I am putting to you is that if you had not been on close and friendly terms with NRPB you might well have got a negative answer to your request?

A. That is quite possible. I would also add that whatever the amendments to the paper might have been it really detracts in no way whatever from the factual content of the paper, nor do I consider the amendment by NRPB was anything other than sensible and professional. I would never suggest that they try to sweep something under the carpet, despite it being technically correct, simply because it is embarrassing to BNFL, nor would I expect them to acquiesce to that to the point where I would never even ask.

Q. "C. A willingness on the part of NRPB to make positive suggestions on presentation to assist BNFL in public relations exercises". That is again something that they have done, is it not, made suggestions as to how to present a paper so that it will look good from a public relations point of view?

A. Mr. Hytner, I cannot recall an example, but I am sure you can.

Q. Perhaps we had better look at page 36. I think it starts at page 32. This is John Stather of NRPB speaking, it is said, to Roger Clarke also of NRPB. This is a memorandum from Mr. Coulston to Dr. Anderson dated some time in 1986 but the date is obscured:

"John Stather has spoken to Roger Clarke and got agreement for me to see this paper and make general comments but not to produce ..... transcript".

This is a very badly copied document. This is a COMARE report, and here is Mr. Coulston going through the report. At page 35, half-way down, there is the comment:

"The conclusions cover approximately one page and are roughly as follows. They have seen fit to address the questions of 'public concern'. Firstly there is new information on previously unreported discharges from the Sellafield site for any plausible reassessment of these discharges affect the estimates of risk in the Black Report, and secondly is it possible that there have been other undisclosed discharges of radioactivity of the environment".

On page 36, half-way down:



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"Finally John (Stather) has done a brief resume of some of the main points which he indicated to me verbally and allowed me to see a brief comment that he had written to Roger Clarke. The following points are perhaps of particular interest to us.

1. He believes that we would want to make the point that where informational potential discharges was limited he made a pessimistic assumption.

2. NRPB believe that based on the information they have available that more than 95% of the dose from radionuclides have been accounted for. The statement I have quoted that the doses from the Sellafield discharges have increased by 30% is incorrect, that the doses of course depend upon where ..... The only general statement that could be made is that the risks from leukaemia from Sellafield discharges have increased by 60%. John also notes that for ..... the dose from Sellafield discharge rate of 20 years has doubled."

Then there is something else which is impossible to understand because of the blanks. Over the page on page 37, the final paragraph:

"The general message would appear to be, and I believe John thought this, that conclusions are along the lines of don't worry too much about the facts lists determine what it is that we want to determine".

Again that is grammatical garbage and ---

A. Could you refer me to where that is?

Q. That is the last paragraph of page 37. It is suggested to me that "lists" should be "let's". This has all the hallmarks, Professor Jones, as I am sure you will appreciate, of something which has been taped and given to a typist?

A. It does indeed look rather like the first draft of something typed from dictation.

Q. Yes, typed from a tape. So it may be "... don't worry about the facts, let's determine what it is that we want to determine". There it is, you have Dr. Stather, again not improperly, not doing anything dishonest, but he is a wholly separate body, he is the Government body for radiological protection, making suggestions as to how something can be presented to look rather better for BNFL, do you follow?

A. No, I think in all that you went through I only saw one point where you could suggest that there was a positive suggestion being made to BNFL that things be presented in a certain way. Reading through it quickly, the rest of it, the vast bulk of it, read to me simply as Coulston having had prior sight of a paper through Stather.



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Q. You are quite right.

A. Which was certainly of interest to BNFL and which BNFL would very clearly, if it was a paper that was likely to give rise to an awful lot of media queries, as COMARE papers do, it is obviously helpful for BNFL to have had prior sight of it, but that is all I read into that.

Q. You are quite right, and there is one notable absence in this list of matters that I am putting to you and that is that NRPB showed BNFL draft reports and invited their comments, because that is not an indication and is not suggested as an indication of a closer relationship. That is what you would expect them to do, is it not?

A. In the case of a paper emanating from COMARE, I would not expect NRPB to ask us for comments. On occasion, it certainly might be the case that we would get sight of a draft shortly prior to publication on the basis that we might need to know what is it, to think about how we wish to respond either technically or in terms of a public response. That, I think, is quite a proper exercise. It seems to me, although doubtless you will want to put it to Dr. Stather, that the vast bulk of what is in that rather garbled memorandum is very much along those lines.

Q. I have not disputed your analysis of this document. On the whole it is simply a commentary by Mr. Coulston on what the document says, but it records Dr. Stather making his presentational suggestions. The next thing that is on this is, "A willingness on the part of NRPB on occasions to accept data at their face value without critical review". Do you agree with that?

A. I would imagine that you are making this point on the basis of our discussion yesterday regarding Dibben and Howells and the uranium oxide story.

Q. I am actually making it on the basis of what you say yourself in Chapter 5 page 8 of your first report.

A. Which relates to that same matter. In that case, in hindsight, that was clearly wrong. I would simply say that at cursory examination the Dibben and Howells reports looked very thorough, and if one was not setting out to do a detailed review of each and every bit of information which was supplied, which it seems to me in constructing R171 was clearly not being done, that one could be forgiven for not going through the paper in detail and making critical review of it; but in so far as you have established on my testimony - and Dr. Stather may confirm or reject that - that that was the case in regard to Dibben and Howells, then that stands. I don't regard that as particular evidence of anything unprofessional.

Q. Going on, "A willingness on the part of NRPB on at least one occasion to collaborate with BNFL to refute a suggestion that data provided by the latter and accepted by NRPB were wrong". The occasion I refer to I have



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already put to you yesterday and we do not need to look at the document again. It was over Dr. Jakeman?

A. Yes, I think I said to you then that since the suggestion that you made referred to interactions between Dr. Clarke and somebody else in BNFL, either Mr. Mummery or Dr. Anderson, that was something I didn't really feel I could comment on. It didn't seem to me that there was any great collaboration to refute Jakeman. In fact, as you know, that particular sequence of events turned out very positively, but you may wish to discuss it again with Dr. Stather, I have no doubt.

Q. "It led also to BNFL being encouraged to bring persuasive pressure on NRPB to alter reports to assist BNFL in relation to presentation". That certainly happened on many occasions, did it not?

A. In what particular regard is BNFL encouraged to do that?

Q. One plain example is the one that I have just given in relation to Popplewell, because Popplewell was two-sided; it was you making the request in quite firm terms before it was acceded to?

MR. ROKISON: My learned friend has not referred to the document which gave rise to that communication, which was of course a letter inviting BNFL's comments.

MR. HYTNER: Of course it invited comment.

Q. What I am suggesting to you is that you were encouraged by the general relationship between yourselves and NRPB to put pretty strong requests for something to be altered?

A. Yes, I did, because it was a matter that I felt strongly about. I repeat that first of all I would have been astounded if NRPB took that into account, if my point did not have technical validity, so that I would never try to insist that NRPB seek to do something purely to assist presentation. If there wasn't some good scientific reason why that should be done, I would be astounded if NRPB accepted any such suggestion from me, and indeed so astounded that I don't think I would ever try to make the request. I don't think it would be proper.

Q. The last on the list is not a matter for you at all, it is a matter for Dr. Stather, but for the sake of completeness I will read it out, though I do not expect you to comment on it. "The refusal by NRPB to provide assistance to the Plaintiffs on issues relating to dose". Can we now leave the NRPB? I hope I have now made that clear. I just want to revert finally - and this is the last topic I shall come to - to a comment that was made yesterday by you in answer to a question from Mr. Rokison, namely that this was the best monitored site in the United Kingdom. Do you recall that?

A. I do.



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A Q. One reason that it is the best monitored site in the United Kingdom is that it is unique in the level of discharges particularly of plutonium but also of other radionuclides into the atmosphere and into the environment generally?

A. That is correct.

B Q. Just so that this can be illustrated, could you look at the document that was put in yesterday which you looked at, which was the peak which my Lord indicated looked rather like a Tolkein castle? If I can find my own document, it will help. You were slightly puzzled yesterday because it took you by surprise in the witness-box when I asked whether it was accurate. The figures along the bottom left are tens of kilometres?

A. Yes, I have now deduced that.

C Q. Of course, if I can alter the metaphor to make it rather easier for me, if we call the top of the peak the top of the witch's hat, that is immediately above Sellafield?

A. That is correct.

Q. Seascale is well within, as it were, the hat and is some way from the brim?

A. I would not accept that as an account which gives the correct impression.

D Q. It is well within the peak, is it not? It is well within that castle?

A. Looking at the diagram - and you may correct me if I am wrong - looking towards the Dark Tower as my Lord described it, I conclude that Seascale is actually round to the back of it, hidden by the base of the tower itself and really rather near the bottom.

E Q. But within it?

F A. Yes. I think it may assist, because I thought you would be wishing to make a point of how Seascale stands in relation to the deposition of plutonium, if we could turn to the document that I put in this morning, where the data are presented in a different way and one which I think is more helpful in terms of seeing what the level of deposition at Seascale is compared with the position of the Dark Tower or the witch's hat, and that is the final sheet on that, a graph entitled "Measured plutonium alpha deposition as a function of distance from Sellafield". That shows the measured deposition data on which both Dr. Day and I have relied at various times.

G Q. MR. JUSTICE FRENCH: I am sorry, what document are you going to?

A. My Lord, this was the document that I circulated this morning.

Q. P2?

H A. That is correct, and it is the final page of that, my Lord.



Q. With the green bubbles on it?

A. With the green bubbles, that is correct. This is a graphical presentation of the data of a kind that both Dr. Day and myself have made before. All of the relevant measurements of plutonium deposition that have been made close to Sellafield are plotted out simply as a function of distance from the site or from the source of emission. As the red arrow indicates, Seascale is approximately three kilometres from the site; that indicates roughly where Seascale is. The four solid green dots are specific deposition measurements in Seascale that are referred to - I should say in or near Seascale, since one of the measurements was made a little way back from the village - in Chapter 12 of my report. I think that that particular graph is a little more helpful in seeing where Seascale sits in relation to the Dark Tower, than the contour diagram which is actually quite hard to follow. I think in answer to your question, Mr. Hytner, I would accept the graph I have provided as the best factual description I can give of the relation between the deposition at Seascale and deposition nearer to the site.

Q. Can one sum that up by saying that you would put Seascale as being under the brim and near the perimeter of the brim?

A. That is correct, my Lord. I think that would be reasonable, if we were working on the witch's hat analogy.

Q. MR. HYTNER: Finally, again to illustrate the point that Sellafield was unique and therefore required this massive monitoring, would you look at the second document where the peak is, but it is the second document?

Perhaps you could assist the court, because sometimes these diagrams are easier to follow than figures - have you got a ruler with you?

A. I do not, Mr. Hytner.

Q. I am sure somebody can provide you with one. Perhaps you could also be given a red pen which would assist for clarity. (Handed) That is, my Lord will recall, a bar chart showing in the black parts of the column, the black bars, the emissions reported to NRPB, and the open bars are those corrected emissions, emissions calculated by you. Do you think you could just put your ruler across those bars at the level of what are now the permitted discharge limits just to see to what extent the historic discharges exceeded those limits?

MR. ROKISON: The present limits?

Q. MR. HYTNER: The present limits.

A. You will need to remind me, Mr. Hytner, what the present limits are, and no doubt that can be checked.

Q. You should not bowl googlies at me, Professor Jones! Five GBq per annum, approximately.



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A. Is that the total discharge from the site or the discharge limit for high stacks, or exactly what?

Q. All sources including approved places, are my instructions?

A. Of course, that line is only going to be about a twentieth of the way up the first division, so it is not going to come up very far, is it? I do not know whether you wish me to do it accurately or rather to guess. I would guess somewhere around there. (Indicating) I have no dispute with you that discharges in the early years would be well in excess of the current authorised limit.

Q. I want to make it clear, because this question may be misunderstood by the public, that of course it is not suggested for a moment that BNFL in those years were breaching a discharge limit, because of course there were no discharge limits imposed on them?

A. That is right, nor does it necessarily imply that the radiation exposure to the public was greater than the standards either now in force or perhaps then in force, because that is a matter that you would have to evaluate by reference to the level of discharge.

Q. That is a matter which no doubt will be discussed in due course?

A. Yes.

MR. HYTNER: My Lord, if I may make that P3, I have finished my cross-examination. There is just one thing which may assist your Lordship and it is this: this originates from my own total inability to grapple with some of these mathematical symbols. My Lord, I have had typed out two sheets which simply explain in what I call English words the mathematical symbols. I know that they are something to the same effect from Dr. Hilton-Smith, but I thought this was actually fuller and neater, if your Lordship would like a copy.

MR. JUSTICE FRENCH: Yes, any help is welcome.

MR. HYTNER: Thank you very much, Professor Jones.

MR. JUSTICE FRENCH: Mr. Rokison, I have one or two matters that I would like to seek Professor Jones's help on. Would you rather I did that before you re-examine or after?

MR. ROKISON: Yes, that would be very convenient. I have only got a couple of questions, my Lord, but that would certainly be very convenient.

MR. JUSTICE FRENCH: Thank you.

By MR. JUSTICE FRENCH:

Q. In a sense, I think this is following one of Mr. Hytner's lines of enquiry. Could you go first please to your first report, Chapter 5 page 10?



A. Yes, I have it, my Lord.

Q. You are dealing at the foot of that page with releases of aerial effluent resulting from accidents and plant abnormalities. You say, "The foregoing relates to discharges occurring on a routine or substantially continuous basis. In addition, a number of significant discharges have occurred over the years due to abnormal plant conditions or accidents. Such discharges often occur over a relatively short period ranging from less than an hour to a few weeks"

A. That is right.

Q. The document upon which you drew your red line is a document which sets out in graphic form emissions reported - what does "fro" mean?

A. I beg your pardon, my Lord?

Q. Have you now got the document?

A. Yes.

Q. Could you read the title, "Emissions reported fro NRPB"?

A. I presume it means from or within.

Q. Is it not more likely to be "to"?

MR. ROKISON: I think it should be "for", my Lord.

Q. MR. JUSTICE FRENCH: It is "for", is it?

A. Yes, so those were the figures first produced for the NRPB, yes.

Q. Then it has 1986, so presumably this is a 1986 document which has been corrected by you in 1992, is that right?

A. Yes, I presume the figures that are here set out are in the first set of tables in my annex 5D, in which I give the discharges --- no, I beg your pardon, that cannot be right because I never give the discharges as reported for R171. In the first tables of my annex 5D, I get the discharges as reported to NRPB for R171 addendum and, as reported, those only go up to 1982 I think, but of course it is not obvious that the black or filled bars presented on this actually go past 1982, because they become relatively small. I therefore conclude that the black or filled bars must be figures that the Plaintiffs or Dr. Day have extracted straight from the report R171. The open bars must then be the sum of the relevant figures in my later tables, 5D3 and 5D4. That, I presume, is the origin of the data.

Q. Going back to the paragraph that we were looking at, it says "Such discharges often occur over a relatively short period." Are we to suppose, looking at page 2 on which you drew your red line, that all the discharges are there or are we to suppose that when you get a long unfilled bar, if I can put it like that, that must be the aggregate over a year, must it not?



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A. Yes, it is indeed. I think I can answer that point from the graph. Certainly the figures for discharge in my table include where appropriate the short term emissions aggregated into the year, although for the purpose of the model due allowance has been made for the fact that in fact they only occurred over a much shorter time. In the figure that you see, if you look at the black filled bars, you will see that the black filled bar for 1961 is much higher than the other bars that surround it. That is because that higher black filled bar for 1961 takes specific account of the second of the incidents that I have listed in Chapter 5 page 10, that is the failure of the plutonium evaporator. This is strictly a discharge record for plutonium. I think the only other significant short term release would have been the one in 1979 from the effluent treatment plant, which again I think is aggregated into my annual figure; it may or may not be aggregated into the original NRPB figure in black. I am not quite clear about that. Certainly you can see the effects in 1961 of the failure of the plutonium evaporator.

Q. You say that such discharges often occur over a relatively short period ranging less than an hour to a few weeks. Can you help me as to why an abnormal discharge should go on for a matter of weeks?

A. In the case of the particular incident there that I refer to, which I think is probably the only example in that list of the matter of the failure of the plutonium evaporator, the sequence involved in that incident was that plutonium leaked from a process vessel into cooling coils or water within cooling coils which was cooling the vessel. That cooling water was routed, in order to lose its heat, through the basin of the Calder cooling towers, something which would be regarded as an extremely unusual arrangement in the current day and not one which would be accepted at all, but that is the way the plant was set out at that time. As a consequence of the plutonium getting into the cooling water, it then got into the cooling tower basin which had quite a high volume and the question then, as I understand or from my recollection of reading the reports, was how to dispose of the material which was in the cooling tower basin. Until the water in the cooling tower basin could be exchanged and turned over, there was a continuing release of plutonium in the spray, and since it took some time - and I can't recall now the exact means used to empty the basin but it could only be done over a period of time - while that was being done, then the release continued. So in general terms, an accidental or an abnormal release can continue for just as long as the necessary remedial action takes, and in the case of the plutonium evaporator the remedial action took a little while.

Q. A matter of weeks?

A. Yes.



Q. Do you know how many weeks?

A. Not off the top of my head, my Lord.

Q. The information is available?

A. We could provide the information if you wish.

Q. When you speak of discharges often occurring, is there a complete list of them available?

Q. There is a complete list which has been set out in the NRPB R171 addendum. I list here the specific ones which I regard as of greater significance which I have treated specifically by modelling them separately. I think you will find the full list in the R171 addendum.

Q. Can one be confident that the list is complete, or might some have gone undetected?

A. That is a very difficult thing to be certain of, of course, because one relies on the incident either being detected by an abnormality in the plant being noted or perhaps by an abnormal environmental measurement, so there has to be some question about the completeness of any such list, but I feel confident that all the major ones, certainly all the ones which would have required separate treatment as I describe, we know about. There may be other small incidents which are not included on the list, and the extent to which those might have been significant overall in the environmental context comes back to the question of whether the amount of activity in the environment is in general agreement with the amount you expect based on the discharges you have assumed and the modelling, so I suppose that would have to be the final defence or assurance that could be provided.

Q. These short discharges no doubt came into or fell within a number of categories. What sort of categories, or were they all similar?

A. What do you mean by categories, my Lord?

Q. One can imagine that there might be a failure of the filters?

A. Perhaps I can give a brief description of each one on the list and that may give you a feeling.

Q. How many categories are there?

A. The first one was the pile fire which is well known.

Q. October 1957?

A. October 1957, in which the core of Windscale ---

Q. I think we know a bit about that, so I think it will be sufficient if you just give the categories and restrain the explanations unless they are needed. Do you mind doing it that way?

A. The failure of the plutonium evaporator I guess you would say came into the general category of failure of a

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containment of the radioactivity. The radioactivity should have been contained in the vessel, and a failure of the cooling coils led to that containment being breached, so I suppose that would be one general category. That failure of containment may perhaps involve a failure of the filtration system, but in this case it was a failure of the physical containment of the plant vessel itself.

Q. When I spoke of filters, I was thinking more of the stack filters.

A. Yes, I understand.

Q. Next?

A. The iodine releases from re-processing short cooled fuel were occasions where fuel which had been ---

Q. I am sorry, would you say that again? "Iodine releases..."?

A. Iodine releases from re-processing short cooled fuel, which is fuel that has only very recently been discharged from the reactor, and which therefore contains a higher quantity of those radioisotopes with a short half life.

Q. Iodine having 8.6 days, is that right?

A. That is correct, my Lord, certainly.

Q. Are there others as short as that, or is that the shortest?

A. There are a range of radionuclides some of which have even shorter half lives, but of course the very short ones diminish so quickly after removal from the reactor that they are not really of practical concern. Iodine 131 is the radionuclide which generally presents the greatest hazard within fuel which has not been cooled for sufficiently long, that is both by virtue of ---

Q. Iodine 131 is the nuclide 8.6 days?

A. That is correct, my Lord. That is both because of the quantities that are present in the fuel and also because being ---

Q. When you say "quantities", do you mean large quantities?

A. Yes, quantities relative to other radioisotopes, and because of the fact that it is a gaseous element and is therefore quite readily released from the fuel, so on those particular occasions fuel which had been cooled for too short a time was fed into the plant and I suppose that would come into a general category of mal-operation or inappropriate feed of material to the plant.

Q. It is feeding in fuel that has not been sufficiently cooled?

A. That is right. In that case, the appropriate safeguard was to leave the fuel for longer so that the iodine content diminished. So as a very broad generalisation, I think that would be classed as a mal-operation of some sort.



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Q. Mal-operation is a broad term which could cover I suppose a mistake by an operator or a failure in machinery or perhaps a failure in a thermometer?

A. That is correct, my Lord.

Q. What sort of thing are you thinking of?

A. It could be any of those, my Lord. That particular example I suppose you would class as operator or system management error somehow, where material which should not have been fed to the plant was fed to the plant.

Q. Yes, I don't think we need try and get any closer than that. That's another category.

A. The example of the swarf fire in the Magnox decanning cave, the next one, was simply another example of a fire within the process.

Q. Yes. Swarf is generally thought of as being something which is lathed off or shaved off?

A. Yes, that is more or less precisely what it is. This material is a magnesium aluminium alloy which sheaths the fuel. It has to be removed prior to reprocessing and it is done by a machine which literally forces it off by pushing the fuel through a die. The cladding material is then in the form of rather coarse swarf, but it is just broken up chunks of magnesium aluminium alloy. The material is inflammable and there are various safeguards to prevent it catching fire. In this case those safeguards failed. I don't know enough about the incident to determine whether that was due to a maloperation or other cause - whether it was a plant failure. I suppose it could have been either. Certainly the safeguards that existed to prevent the Magnox swarf from catching fire did not operate for one reason or another.

Q. Yes, thank you. So that is the swarf fire, of which as far as your account goes there was only one? You have no reason to think there was more than one swarf fire?

A. No. Certainly in terms of a fire that released any significant or measurable quantity of activity, I think that was the one.

Q. Only one significant one, if any more?

A. Yes.

Q. Or shall I say only one significant one, perhaps the only one?

A. I am sure there have been other minor swarf fires, but this particular one, as I remember it, released in old units about a Curie. That is 37 GBq, I think, of caesium. So it did release a significant quantity of activity.

Q. There were other smaller ones?

A. Yes.

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Q. Any other readily identifiable categories?

A. No. The release of the plutonium from the effluent treatment plant was another failure of containment. Material which should have been contained spilled out from a vessel and was released to atmosphere. The final one, the release of americium-241 from a sludge storage tank was another example of a release caused by a small fire within a process plant, or, in this case, a storage tank.

Q. Caused by a small fire in a storage tank.

A. I would guess if I was trying to make some general categorisation based on those they would have to come under the general categorisation of maloperations, failures of containment. Perhaps other plant failures and fires would be one way of categorising different types.

Q. So far you have been kind enough to identify major events.

A. That is correct.

Q. When you are speaking of the relatively smaller events, the ones that often occur over relatively short periods, what sort of thing are you speaking of there?

A. Those might range from anything from an abnormally high level of stack release, which occurred over a short period.

Q. What release?

A. An abnormally high level of release from a monitored stack which might occur over a very short period.

Q. Releases from monitored stacks? Can we think about the stacks a bit? The stacks weren't designed to have filters?

A. That is only true of the stacks for the Windscale piles.

Q. I think about the piles when I think about the stacks. I should think about the other stacks as well.

A. There are other stacks or chimneys on the site, all of which were designed with some degree of filtration or other effluent treatment.

Q. At all events, high filters were placed in the two pile stacks?

A. That is correct.

Q. After they had been in operation for some time?

A. No. The filters were placed in before operations commenced, but during construction. I think the sequence is the chimneys had literally been partly built by the time the design decision was made and that is why they are at the top. The filters were in place from the time the piles first operated.

Q. Getting access to the filters, (a) so you could measure that which they had prevented going to atmosphere and (b)



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so that you could replace them if they got defective, must have been a very difficult task?

A. Yes, it certainly was. There was access, and still is access to the filter galleries at the top of the piles. The filters were changed and were worked on, but you are right to observe that the positioning of the filters at the top of the stack would have made the problem of actually monitoring emissions from the piles particularly difficult. To my knowledge there was certainly no systematic monitoring of the particulate released after the filters. Such measurements as I have seen tend to be of the nature of the measure of the particulate challenge which is being presented to the filters. That is simply a consequence of the location of the filters. It is very difficult to do measurements in the gaseous effluent after the filters.

Q. No routine measurement of what passed through the filters?

A. That is correct.

Q. The pile stack filters?

A. The pile stack filters. In the other stacks the layout was very different and in all cases where we talk about sampling of the stack effluent we are referring to sampling which takes place after the final stage of filtration or off-gas treatment.

Q. Would you have to shut down the piles in order to remove or replace filters?

A. I am not sure. I would imagine that would be the case but I am simply not sure.

Q. It sounds a terrifying amount of air going through it if you are actually...

A. Yes, I was thinking the same thing. I am afraid I don't know.

Q. An expression which has been used today which is new to me is "low burn". What does that mean?

A. Low burn-up, this relates to the period of time for which the uranium has been left in the reactor. It is sometimes referred to as burn-up. It is sometimes referred to as irradiation. Strictly it is a measure of just exactly how much of the uranium-235 in the fuel has actually undergone the fission reaction. That is one way of looking at it.

Q. Can you explain to me how the concept becomes important? One would suppose that with these 70,000 slugs or cartridges in a pile, and you are pushing them through, as I understand it, not all 70,000 at one go but batch by batch? Have I pictured it correctly?

A. That is correct. Certainly the pile was not discharged with the entire contents discharged all at once and with another fresh lot put in. The reason why that was so was that the degree of burn-up or irradiation of the fuel



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had to be carefully managed. The physical reason underlying that is that the degree of burn-up or irradiation of the fuel affects markedly the composition of the irradiated fuel in terms of the isotopic ratios of material present within it, particularly in relation to the whole reason for operating the piles and also in relation to the matter we were discussing. A matter of particular significance is the ratio of the different isotopes of plutonium that are present. You will have heard, my Lord, of the isotope plutonium-238, plutonium-239, plutonium-240? There are others, plutonium-241 and so on.

The irradiation, or burn-up, that the fuel has experienced markedly affects the ratio of the isotope plutonium-238 to the isotopes plutonium-239 and 240, and since by normal methods of measurements, the normal method of measurement will give you a separate measure of plutonium-238 together with the sum total of plutonium-239, plus 240, people may well have referred the plutonium-238 to 239/240 plutonium ratio. That is the relative proportions of those three isotopes.

That ratio which you can measure, whether the sample is taken from the environment or an autopsy sample or anywhere else, will give you an indication of the history of the uranium fuel which was irradiated to produce that plutonium. The reason why the irradiation has to be controlled in the piles to these relatively low values is that the isotopic composition of plutonium, which is suitable for military purposes, is achieved at low burn-ups. If you are operating a reactor to generate power on a commercial scale you will want to go for much higher burn-ups because that is more economical and efficient.

Q. You get more heat and therefore more energy?

A. That is right, but the plutonium you produce has the wrong isotopic ratio for military purposes.

Q. The picture you are giving me is this, that because of the military purposes of the plutonium production the two piles were designed to function on a low burn basis?

A. That is correct, my Lord.

Q. Would there be any difficulties of which you are aware in ensuring that that end was achieved?

A. No, I don't think so. It simply requires a knowledge of two things, really. It requires a knowledge of how the flux of neutrons is distributed within the core of the reactor. There would be more intense neutron irradiation at the centre of the core than at the edges. It requires then a knowledge of where each particular fuel element is and how long it has spent there. From that the irradiation can be evaluated and the elements would be discharged at the appropriate time, whatever that might be. It would be something that would be



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achieved by management control or control of the core inventory, not by any process of monitoring any individual cartridges.

- A Q. A question which is perhaps taking a step away from what you have been helping me with: the associated radionuclides like strontium-90 and caesium-137, would they be reasonably constant throughout the working life of the piles by way of emissions, or would they vary with perhaps the source of the ore which was being used, or would there be other reasons for the proportions varying?
- B A. The proportions would vary essentially only according to the irradiation history of the fuel and also to some extent the time since the fuel was removed from the pile, since of course radioactive decay will occur, but for strontium-90 and caesium-137 that process is really sufficiently slow that you can ignore it over a period of a year or two. So the relative proportions of strontium, caesium and plutonium to uranium in the fuel would depend essentially on the burn-up or irradiation.

- C Q. It won't vary with the source of the ore which is being...
- D A. No, not at all. It would vary if the fuel had been enriched in the isotope uranium-235, but the fuel that was used in the piles had the isotope uranium-235 present in its natural proportions. It would not depend at all on the source or history of the uranium. It would depend only on the degree of irradiation within the piles. To an approximation, and it is an approximation, the strontium and caesium and plutonium contents of the fuel all build up with time in the reactor, and therefore with irradiation. The ratios of all of those to uranium increase almost linearly with irradiation. It is not really linear, but as a very crude understanding it would be almost linear.

E

F However, the ratios of strontium to plutonium and caesium to plutonium are much less sensitive to the level of irradiation since all three, if you like, build up together with irradiation, so that relative to uranium the proportions are quite sensitive to irradiation. Relative to each other the proportions are much less sensitive.

- G Q. I cannot find the exact reference, I won't try and search for it and perhaps you can help me without it. There was a discussion between you and Mr. Hytner about "unaccounted for" plutonium.
- A. That is correct, my Lord.
- G Q. If I followed that discussion correctly, what you were discussing was plutonium found in soil - in the environment?
- A. That is correct.
- H Q. Which was over and above that which could be accounted for by emissions from the plant?

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A. That is correct.

Q. Can you help me as to where that "unaccounted for" plutonium came from?

A. Certainly. That was the subject of one of the responses I gave to Mr. Hytner this morning. It might assist if I went through a little the process of logic by which I investigated the matter of plutonium deposition.

Q. It would help me if you could say where it came from and then tell me why you say that.

A. I had perhaps approached it rather the other way round, my Lord! There are a number of plants or facilities that were present on the site in the 1950s and early 1960s which have the potential to release plutonium to atmosphere, either not through a monitored stack outlet or perhaps even through a stack outlet which might have been monitored but for which we cannot now locate any records. There were the pile ponds themselves, which can act as a source of material being resuspended from the pond's surface.

Q. Can I make a note of this? I have put "unaccounted for" plutonium, could come from or did come from...?

A. Could come from the pile's ponds by virtue of...

Q. You needn't go into that. I have got the discussion about the resuspension and so forth. (1) Pile ponds?

A. They could come from (2) the early plutonium production facilities on the site. One specifically identified in R171 Addendum is the final plutonium metal finishing facility.

Q. (2) the finishing facility?

A. Yes, the plutonium finishing facility at the north end of the site. I suppose you could add to that...

Q. Is this (3) or part of (2)?

A. I would add to it as (3) because the locations are rather different, other facilities on the site which handled plutonium which had been separated from the irradiated fuel.

Q. Other plutonium handling facilities.

A. (4) is the basin of the Calder cooling tower, which I have referred to.

Q. That was the accident?

A. Yes.

Q. The basis at the foot of the cooling tower.

A. I think perhaps I had better just check in my report to make sure I have recalled them all, my Lord. Yes, that is a complete list in terms of what I would describe as the unaccounted plutonium which seems to have arisen during the early phase of operation of the plant.



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A Q. I think the last thing I wanted to ask you was this: going back to the radionuclides of iodine. First of all, having such a short half life, its detection whether in the environment or in the human body, or elsewhere, requires the detector or detective to be very quick off the mark?

A. Yes, certainly within a few weeks of the event.

B Q. So that there could be a significant release of iodine or of the radionuclides of iodine which could be ingested and then their presence disappear forever?

A. Yes, certainly within a matter of a few weeks or a month.

Q. So that if you came along trying to find out what had happened after a few weeks there simply wouldn't be any evidence?

A. That is correct.

C Q. Unless, I suppose, and I think this must be fanciful, any damage it caused was so great as to leave biologically detectable effects?

A. That is correct. The recording of iodine releases, of course, rests partly on measurements made in the stack themselves. From the late 1950s - I would have to check the date - there were regular measurements made of iodine-131 concentrations in milk.

D Q. From when?

A. From the late 1950s. I suspect in the immediate aftermath of the pile fire measurements were made of iodine-131 levels in local milk and given that those measurements were made with such a frequency, I think there would be a reasonable assurance that abnormal levels of iodine resulting from a significant release would appear in the milk monitoring data.

E Q. Of course, for reasons we have already discussed, that would give no help as to the iodine that had been released before the monitoring started?

F A. No. If we said for the purposes of argument that the monitoring started in 1958, that would give no indication about what had happened prior to that time. During the work that was done for the preparation of the R171 Addendum, there was a specific search made for the detailed records of what fuel had been fed to the plant and what its cooling characteristics were, specifically to address the question of whether there were any other releases of iodine due to the reprocessing of short cooled fuel. Prior to the date at which the milk sampling commences, the veracity of the iodine-131 discharge record is dependent on the completeness of the search against the records of fuel that were fed to the plant.

G H MR. JUSTICE FRENCH: I think those are all the questions I have to ask. Mr. Rokison, would you like to deal with your re-examination now or after the adjournment?

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MR. ROKISON: I think I could deal with it now. I have very little to ask, although it is possible I might get bogged down in the first question, but I hope not.

Re-Examined by MR. ROKISON:

Q. I just want to clarify one thing with you, Prof. Jones, which arose in the course of your cross-examination yesterday. Do you have a copy of yesterday's transcript? It is Day 6. This is in relation to the topic of unexplained plutonium, if I could put it that way.

MR. JUSTICE FRENCH: Which is what I have been calling "unaccounted for".

MR. ROKISON: Yes, unaccounted for plutonium:

Q. It is page 72, at B. It may be clearer if we go back to the previous page where at B on the previous page my learned friend Mr. Hytner was trying to clarify which figure was the 74 and which was 66 and so on. You referred to your fourth report and to Figure 2 of your fourth report. I wonder if you would just take that out and have that handy.

MR. JUSTICE FRENCH: Having been told to ignore Jones number 4, I haven't got that either.

MR. ROKISON: My Lord, I only raise it because my learned friend asked about it.

MR. JUSTICE FRENCH: Yes, I am not criticising you. I am only saying I haven't got it!

MR. ROKISON: I am sorry, I am over-sensitive, my Lord!

Q. Do you have your Figure 2?

A. I do, Mr. Rokison.

Q. You say just below B on page 71:

"Perhaps if I may refer to my fourth report, to first of all Figure 2 of that report, Figure 2 shows what I have described as the excess deposition of plutonium as a function of distance from the site, the excess being the amount of measured deposition less the calculated level of deposition from high stack releases, low stack releases including the Magnox ponds, sea to land transfer, weapons test fall-out, but excluding the effects of the additional plutonium releases I have described and excluding the effects of uranium oxide deposition;..."

So what we have at Figure 2 of your fourth report is something which is showing excess plutonium but that



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excess plutonium has not taken into account the uranium oxide releases?

A. That is correct.

Q. This was the first integration exercise you carried out, was it?

A. That is correct. This is the first time I tried to arrive at a quantity by integration.

MR. ROKISON: I don't know whether your Lordship is wholly happy and familiar with that concept, of what is the difference between this exercise - the integration - and exercises which Prof. Jones had carried out before:

Q. In case it may not be wholly clear, what is the difference between the exercise you did here of integration and the exercise you had done before for the purposes of your first report?

A. Perhaps I had better define two convenient terms first of all. I would define one term as being the integration method, which I will now describe, and the other term would be the source adjustment method, which was the method I used in my first report.

What the integration method involves is first of all describing the deposition pattern by a mathematical expression, a mathematical curve, if you like, so that you derive some algebraic relationship between distance from the source and level of deposition.

Q. MR. JUSTICE FRENCH: First, describing deposition by a mathematical curve, showing differences in deposition in relation to distance from source?

A. That is right. It is effectively a mathematical equation which says deposition is a mathematical function relating to distance from the source. That function may be quite simple or it may be quite complex. The reason for doing that is to get a general mathematical description which best fits, which best explains, the rather variable measured deposition data. If one was doing it by eye, for example, one would by eye draw a smooth curve through the middle of all those points, but there are mathematical techniques to do that with a certain amount of objectivity.

MR. JUSTICE FRENCH: Is this going to take more than another five or...

MR. ROKISON: It might take a little more than another two or three minutes. I was just about to suggest that perhaps we could continue after the short adjournment, my Lord.

MR. JUSTICE FRENCH: Yes. We will start again at five minutes past two.

(Luncheon adjournment)

PROFESSOR JONES

MR. JUSTICE FRENCH: I said five-past but, as we are all ready, I thought we might....

A MR. ROKISON: We are all here, but Prof. Jones does not appear to be, my Lord. I am sorry.

B MR. JUSTICE FRENCH: Perhaps while we are waiting for Prof. Jones, there was a discussion - I am not sure it went as far as an agreement - that, when appropriate, at the closing of a section of the evidence, submissions might usefully be made at that juncture, and I simply enquire whether that is a view that commends itself, or still commends itself, to you, as the case may be.

C MR. HYTNER: My Lord, we have discussed the matter. We are agreed. My Lord, subject to any pressures from your Lordship to spur us on, the way Mr. Rokison and I at the moment view it is that we should prepare our closing submissions on dose but, so that we are not under too much pressure, my Lord, that they should be, as it were, ready for delivery or submission shortly or just before the epidemiological evidence opens.

MR. JUSTICE FRENCH: Yes.

D MR. ROKISON: For our part, I would not have thought they would be very long and what I had in mind was that we may be able to finalise them by the end of this week and it might be convenient to put those submissions before your Lordship when we next convene, which, as I understand it, is for the purposes of the medical evidence, which is on Thursday of next week. It may be convenient then, but we are in your Lordship's hands.

E MR. JUSTICE FRENCH: I do not wish to put anybody under pressure because, heaven knows, there is enough already and, if you tell me you would find it more convenient to do it at that stage, so be it.

F MR. ROKISON: Certainly we are agreed that it will help us as well as, we hope, your Lordship for us to carry out that exercise and we discussed it, in fact, this morning. We have it in mind to do it at a mutually convenient time to your Lordship.

G MR. JUSTICE FRENCH: If given an absolutely free choice, I would prefer it at the close of the evidence but, as I say, if that is putting pressure on Counsel or anybody else, then by all means....

H MR. HYTNER: My Lord, I would certainly be prepared to address your Lordship on oral submissions at the close of the evidence tomorrow, but it would be, as it were, the normal, conventional oral submissions and they would not have been fully thought out. My Lord, they would be rather along the lines of the sort of oral submission one



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would make after a two or three day QB action. My Lord, I do not anticipate that that would be of the greatest help to your Lordship in three, four, five months' time.

MR. JUSTICE FRENCH: No, as I say, as to the timing of it, I am in your hands, whatever my preference be, so that if you tell me that next week would be more appropriate, then by all means.

MR. HYTNER: I am much obliged.

- Q. MR. JUSTICE FRENCH: Prof. Jones, you were not late. I thought everybody was here so I came in early.  
A. Thank you, my Lord. I was a little worried.

Re-examined by MR. ROKISON (Cont.):

- Q. MR. ROKISON: Prof. Jones, you will recall that before my Lord rose for the short adjournment I was asking you about a passage in your evidence yesterday afternoon and, in particular, your reference to Figure 2 appended to your fourth report. I think you were explaining to my Lord the nature of the integration exercise which you had carried out?  
A. That is correct, Mr. Rokison. I had been explaining, my Lord, that the integration process involves explaining the experimental measurements, which, of course, have a degree of scatter or irregularity, by a smooth curve described by a mathematical expression. The purpose of doing that is so that the mathematical expression which then best represents that pattern of data can be treated by the methods of calculus to integrate the total deposit contained underneath it. It is a little difficult to describe in words what is done. The normal process of integration of the mathematical expression which describes a curve through that data would yield the area underneath the curve. That is a straight forward integration of the curve which fits the data.

In this case, we are not actually interested in the area under the curve. We are interested in the volume under the witch's hat shape that the curve describes or is a section of, so there are some further manipulations that need to be done in order to achieve that mathematical effect, but it is a matter of straight forward calculus to do that once you have the expression that describes the curve.

So that is the integration procedure and what that is doing is to take the shape of the curve out to some specified distance and estimate by this mathematical process, if you like, the volume of the solid shape which you would obtain by rotating the curve round through 360 degrees - the volume under that solid witch's hat type of shape that was in the document you saw earlier.

- Q. And the reason why you rotate it round is this is simply taking a distance and what you are interested in is that which is all round the point of axis?



A. That is correct, Mr. Rokison.

MR. JUSTICE FRENCH: If you do not rotate through 360 degrees, you have got a line....

MR. ROKISON: Exactly.

MR. JUSTICE FRENCH: ....of no dimensions, under which anything can sit.

MR. ROKISON: My Lord, I am very grateful for your Lordship's explanation. We are all ad idem about that:

Q. That was the first time, as I understand it, that you had embarked upon an integration exercise?

A. That was the first time I had done it in relation to the plutonium deposition data.

Q. That is what I meant?

A. I carried out precisely that exercise in relation to the caesium and strontium deposition data, and I think I described that in my second report.

Q. But this exercise which you here carry out provides you with an approximate figure for the total deposition, or the total excess of the deposition, of plutonium within the distance taken, which is what?

A. The distance taken and shown on Figure 3, which is over the page, is distances up to 5 km and the relevance of the 5 km there is that, given the shape of that curve, which you will see actually the axis is offset from zero so that at distances beyond 3 km the curve is actually effectively running along the zero line, the base line. Therefore, the integration of what is under that excess curve is effectively complete by the time you get to 5 km. There is no more. That is why the graph stops at 5 km.

Q. What Figure 3 then shows - is this right - is that, on that basis, on the basis of that exercise, one finds that the excess of plutonium which has not been accounted for by known discharges?

A. Yes, that is correct.

Q. But which includes whatever may be the uranium oxide component?

A. That is correct.

Q. Is approximately 70 GBq?

A. Yes, that is right. In this exercise, the integration is dealing with, if you like, the residual plutonium, which will include contributions from uranium oxide and the other sources of plutonium emission which I have discussed and, on this treatment, the net total of that material within 5 km is some 70 GBq total.

Q. Yes, and so that it follows that if, for example, uranium oxide were 20 kg and if it be right, as you have said in



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your reports, to take that as being the equivalent of 20 GBq, one would be looking for approximately 50 GBq from other sources?

A. That is absolutely correct.

Q. I think in your evidence yesterday afternoon - and this may be where the confusion arose, certainly in my mind - you also referred in your evidence on page 72 yesterday afternoon to what, at first sight, appears to be a similar figure, which appears in Annex 10 of your report, and that is Figure 10C-7. That is in your first report?

A. Yes, I have that figure. This figure shows the result of the exercise that I carried out in my first report to assess the excess or additional plutonium deposition, which was done in a rather different way. This is what I described or defined just before lunch, in shorthand notation, the source adjustment method. What this entails, although the steps are not shown separately in figures, is to start off in essentially the same manner as I started for the integration exercise. That is, to calculate the plutonium deposition at each of these points, which is not accounted for by the discharges I have so far considered. In this exercise, shown in Figure 10C-7, I was including 20 kg of uranium within the discharges I had considered. So, in this case, I am looking for the residue of what I perhaps might describe as pure plutonium, if you want to refer to it in that way, not accounted for by the 20 kg figure for emission of uranium oxide.

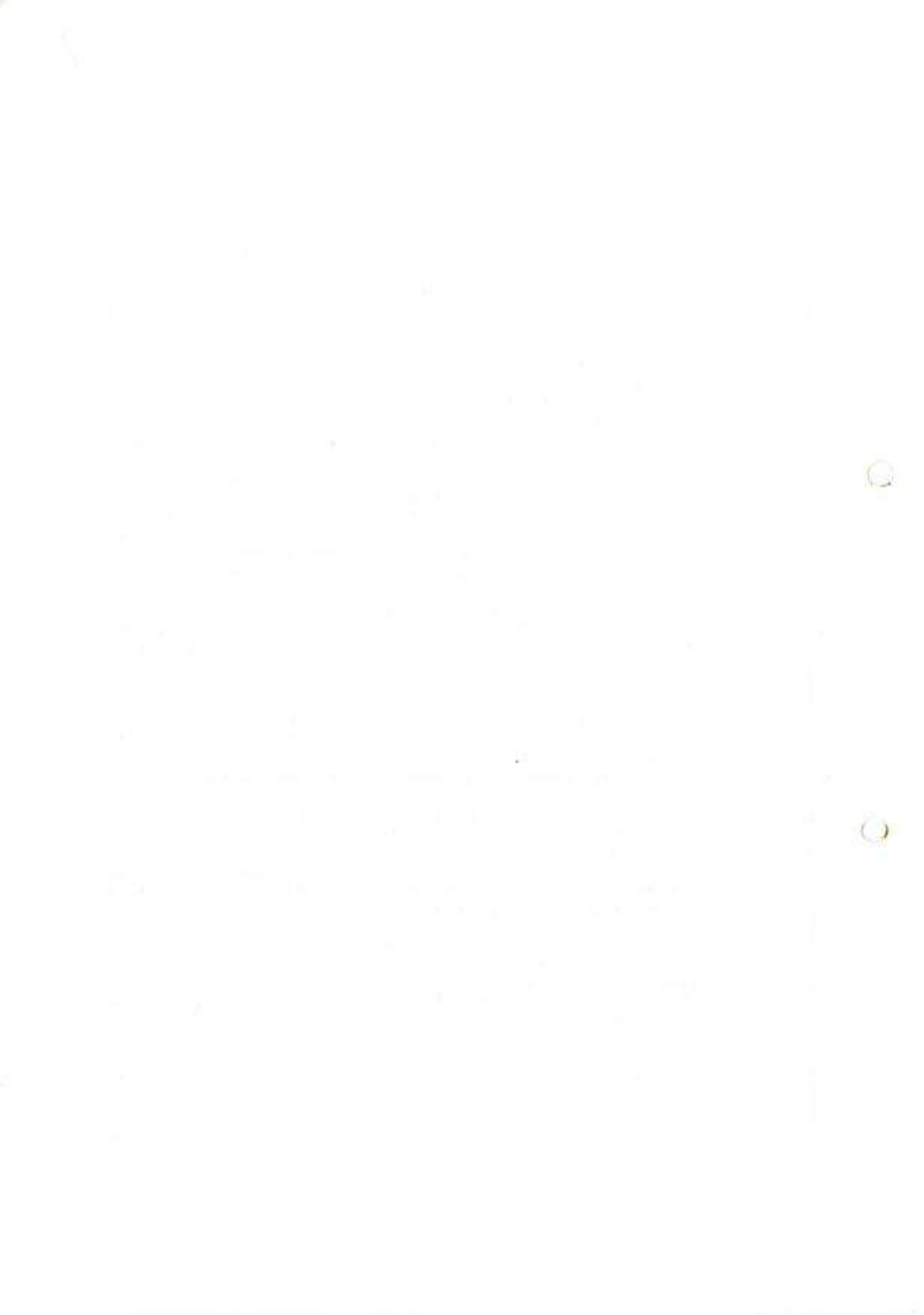
However, having established the residual contamination as a function of distance, I do not then try to integrate it. What I do is to take the level of deposition from the SEAM model, which would be predicted by a given level of release of radioactivity, of plutonium in this case, and I adjust the magnitude of that release until the predicted curve of deposition versus distance best fits the data points. So this is an exercise of a slightly different nature. It is estimating the same quantity, but the precise mathematics and method by which I go about making the estimate is actually quite different.

Q. MR. JUSTICE FRENCH: Tell me if this is right. It estimates the distance/deposit ratio by use of the SEAM model?

A. That is correct. The SEAM model predicts that, for a given quantity of activity released at a certain distance, there will be a given level of deposit.

Q. I think I have got that in principle, if not in....?

A. And then simply what this method does is, rather than to integrate, it adjusts the magnitude of the quantity emitted so that the calculated level of deposition best fits the measured data points.





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Q. It adjusts the....?

A. The assumed level of emission until the calculated level of deposition at each sampling point best fits the measured level of deposition at that same location.

Q. At each measuring point best fits....?

A. The measured level - perhaps it would be better to say the residual level - of deposition.

Q. The residual level of deposition at those points?

A. That is correct, my Lord.

MR. JUSTICE FRENCH: Yes, thank you.

Q. MR. ROKISON: I think you clarified that, whereas the 70 approximately GBq which one derives from your figures in your fourth report?

A. Yes.

Q. Which does include uranium oxide discharges?

A. The 70 GBq in the fourth report does include uranium oxide, yes.

Q. Whereas this, which you say, corrected, should be approximately 66 GBq?

A. That is correct.

Q. Does not take account of uranium oxide?

A. It does not take account of uranium oxide. The uranium oxide is already included in the subtraction to yield the residual level of plutonium.

Q. Can one draw any sort of conclusions from that as to the accuracy of the exercise or the accuracy of the model or the likely amount of uranium oxide?

A. One can obviously draw the conclusion that you can get a slightly different answer, whether it is by integration or by the source adjustment method, depending on exactly how you carry out the process of fitting a curve to the data, and the root cause of the difference, I believe, lies in the nature of that process and, in particular, in relation to the exercise on Figure 10C-7 that I have referred to, I was calculating this excess release only from data points within 2 km of the site and, therefore, the method of calculation was placing some emphasis, some particular emphasis, on explaining the highest levels of deposition which are close to the site.

The integration method is slightly more sensitive to the level of deposition between 2 and 3 km and it may be that that partly explains the difference, but....

Q. Is it a difference, Prof. Jones, that concerns you or is it the sort of difference that one might expect?

A. No, it does not concern me in the slightest. I take it that there are bound to be uncertainties of that sort of level in trying to make an estimate from environmental





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A data, which is in itself variable. To the extent that the discharges that I finally develop in my first report very adequately explain the levels of deposition and, indeed, in some regards, perhaps slightly almost over-explain them - the predicted levels of deposition probably tend to be, if anything, a little bit higher than those which are actually seen or actually measured - then I take it that that provides some reassurance that the discharge scenario and the model are reliably describing the environmental conditions and, once I have got to that point, it really does not matter greatly where the plutonium has come from. It merely matters that I have provided for sufficient of it to be released to reproduce the observed environmental conditions and hence lead on to a calculation of dose.

C Q. Yes, I was going to ask you about that a little bit later, but perhaps I can deal with it now. My Lord was asking you just before the short adjournment about the evidence you had given in Chapter 5, I think, of your report in relation to possible other sources of plutonium releases which may account for the excess or the unaccounted for plutonium. I was going to ask you this, that, in relation to the exercise that you have done, which is, with the use of the SEAM model, to arrive at an estimation of radionuclides in the environment and hence dose to those who were exposed to that environment, does it actually make any difference precisely where the excess or unaccounted for plutonium comes from?

D A. To a very large extent, the answer is no. The nature of the release, in terms of the particle size and other properties, are, of course, relevant to the assessment. I have adopted parameters to describe the release, which, in terms of a deposition velocity, match the way the deposit appears in the environment, so I think that is a sound basis.

E Having said that, I then take no account in the subsequent assessment of intake of the fact that the particle size might have been large. I assume it is all respirable.

F Q. Just pausing there, in assuming that it is all respirable, is that an assumption which is neutral, optimistic or pessimistic?

A. I think we defined the term "cautious" before as tending to lead to larger intakes or uptakes than would actually be the case and, in those terms, it is a cautious assumption.

G Q. Perhaps I can just ask this. My Lord also asked you a question about possible releases of short-lived radionuclides, which would not, therefore, be found, such as iodine. Is that a matter which you consider - and I mean no disrespect to my Lord - as being a matter which is relevant to the subject matter of this litigation?

H A. It could potentially be relevant, depending on the magnitude and nature of such releases. Iodine itself, as





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A I understand it, is not a radionuclide that contributes greatly to the dose to the target organs that are relevant for this litigation. It may be that Dr. Stather could give more definitive evidence on that particular point.

B In relation to other short-lived nuclides, there could, I would imagine, in principle, be a large release of a short-lived radionuclide which would lead to large radiation doses from external irradiation, from external contamination, which would be relevant, but such releases, if they were of sufficient magnitude to be of real significance, would, I believe, very likely have been detected by the monitoring that was carried out.

C Q. In your research of the documents involved in the history of the operation of the plant, have you come across any such releases which would not be accounted for within your model?

A. No, I have not.

Q. MR. JUSTICE FRENCH: In considering that answer, you said there could be large releases of short-lived radionuclides which could be relevant. That is compressing it a good deal?

A. Yes, in principle.

D Q. You say the records that you have seen do not suggest that any such took place?

A. That is correct, my Lord.

Q. Equally, I suppose - tell me if this is right - you are unable to vouch for the comprehensive nature of the records?

E A. That is correct, my Lord. Clearly it is possible that there are releases which were not recorded and, if that were the case, the defence against that particular eventuality would rest on whether the monitoring that was carried out at the time would be likely to detect such releases.

F In relation to releases which emit short-lived gamma emitting radionuclides, those are very readily detected. As an example, the deposition of radioactivity from Chernobyl in Cumbria raised the level of gamma radiation to five times the normal background level, and that was, to say the least, very noticeable.

G So I am quite assured that there are not any big releases of short-lived gamma emitting radionuclides that we do not know about by one means or another.

H Q. The question then would be whether detection methods would pick this up. "I feel confident that gamma radiations would be picked up"?

A. That is right. There has always, or since, at any rate, the mid-1950s, there has been monitoring of external





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gamma radiation around the site and around the district around the site and, in the very earliest days of operation, there were specific measurements made to measure the level of gamma radiation in the plume of effluent from the piles chimneys, the reason....

Q. Just pause there a moment. I am getting a bit behind. "I feel confident that gamma radiation would be picked up by the monitoring arrangements in existence from the mid-1950s on." Then you proceeded and I stopped you?

A. Yes, sorry, I was proceeding by way of explanation just to say that I am not sure whether this was a practice that was carried out from 1952 or just from the mid-1950s, but it was certainly the practice specifically to seek to measure the level of gamma radiation within the effluent plume from the piles chimneys.

Q. To seek to measure the gamma radiation from the pile chimney plume?

A. And that was specifically to measure the dose rate from the Argon-41, which Mr. Hytner has earlier referred to.

Q. So if I add, "It was the practice to seek to measure the gamma radiation from Argon nuclides"?

A. From specifically the radionuclide Argon-41.

Q. From Argon-41 emitted by the pile chimney plume?

A. That is correct.

Q. Carried in the pile chimney plume?

A. Or carried in the pile chimney plume, yes. Those particular measurements were certainly sensitive enough to detect a variation from the normal level of natural gamma background radiation.

MR. JUSTICE FRENCH: Yes, thank you.

Q. MR. ROKISON: If there had been any significant release from the site which involved gamma, is that a matter which would have been detected on film badges worn by those who were on the site?

A. If the nature of the release was such that there was a lot of deposition on the site, then that is certainly a possibility, yes, indeed.

MR. JUSTICE FRENCH: That goes without saying, I think, Mr. Rokison.

MR. ROKISON: I think a lot of questions and answers do, my Lord, but, nevertheless, they may have to be said.

MR. JUSTICE FRENCH: I know. The trouble is one's level of understanding varies from topic to topic.

MR. ROKISON: Yes, indeed, but I thought I ought to ask Prof. Jones about that:





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Q. Can I move on to the question of the SEFs?

A. Yes.

A Q. And the point that was put to you yesterday afternoon and which was pursued again this morning. In particular, the question of whether it is more accurate to take the amended figures in the application for authorisation of release as opposed to the estimates which you have taken for the purposes of your evidence. This morning you produced this document, which I think is document D2, and it appears from this document, Prof. Jones, that if one compares the corrected totals for the amended authorisation application, which we find in the right-hand column of the second block?

A. Yes.

C Q. For 1988/89/90/91, with your best estimates, which are then summarised in the table below, what you have then done is to compare the two in the last column. Is that right?

A. That is correct, expressing the difference as a percentage increase over the authorisation.

D Q. I think you expressed it in that way because there had been some discussion between yourself and my learned friend Mr. Hytner yesterday afternoon as to what was the correct percentage?

A. That is right, and, indeed, because in the document Mr. Hytner supplied the increase was assessed in that way and I simply wished to produce something which was exactly comparable.

E Q. May I ask you this. If one assumes that the figures in the amended application for authorisation are more accurate than yours and if, therefore, yours should be adjusted or corrected to take that into account, what effect would that have on the plutonium discharges which could be accounted for from those stacks which are the subject matter of this piece of paper?

F A. If I take the figure of 30 per cent, which I arrive at as the average for the three years 1988/89/90, that means that my figures are 130 units, whereas the correct figure is 100 units. Therefore, I must deduct 30 over 130 from my figures to arrive at a correct figure, if you wish to describe it like that, which is a reduction of rather less than 30 per cent. I have a calculator. I may even be able to determine what it is. That would be a reduction on my figure of 23 per cent on that basis.

G Q. If you were to deduct 23 per cent from your figure which you have attributed to these particular discharges, what would the consequence be on the overall exercise upon which you embarked?

H A. Very little. On the basis of the two estimates I have made of the additional plutonium emission - that is the 74 and 66 GBq - adjusting the B204 stack emissions by 23 per cent would push the 66 back up, but not as high as





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74. So, in other words, using my first method, the source adjustment method, would have very little effect on the value for the additional plutonium emissions. Reducing the stack emission figure by 23 per cent would have the virtually pro rata effect on the inhalation exposure of people in Seascale or at any other position in the county over the period when the stack discharges were highest. That is 1952 to 1960 or 1964. So if I were to do that, I am quite sure that the intakes and doses that would be calculated would be smaller and, in particular, the dose due to plutonium inhalation would be about 23 per cent smaller. It would be virtually pro rata.

Q. You would need to find some other source for the increased excess, if I can put it that way, to the extent to which it could not be accounted for from the stack discharges. Is that right?

A. By the residual excess, you mean the 66 or 74 GBq?

Q. Yes?

A. As I have said, that figure would change on the basis of my first assessment method, but not by very much. For the purposes of argument, it might go up from 66 to 68. Whether that is the right figure, I do not know, but it would be a change of that sort of magnitude.

Q. Having done the exercise, do you consider that your failure to adjust your figures to bring them into line with the latest amended application for authorisation is something which really makes any substantial difference to your report or its results?

A. No, I do not think it is. As I think I have already explained, I think the uncertainties in the exercise of retrospection are such that adjustments by 23 per cent one way or the other are really within the limits of uncertainty of the estimate that I have made and the reason why I decided to adopt the simplified approach that I have described was really precisely for that reason, that to me the uncertainties did not seem to justify anything more specific.

Secondly, as a subsidiary point to that, in any case, the difference between myself and the methodology used for the authorisation becomes smaller and, indeed, possibly even vanishes in the 1950s and early 1960s, when the discharges of alpha activity from B204 stack were so dominant. You can actually see this from the figures in my notes, if you understand how the figures arise, because, if you look at the lower table, the Jones best estimate and the percentage increase Jones to amended application, you can see that the figure is 49 per cent in 1988, 17 per cent in 1989, 24 per cent in 1990.

The reason why the figures in 1989 and 1990 are lower is that during 1989 certain effluent streams were re-routed from the B6 stack outlet - I think it was the





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vessel ventilation outlet - into the B204 system, so that in 1989 and 1990 a bigger proportion of the total discharge is coming from B204 and, as that happens, my figures and the authorisation figures, or Dickinson figures, come closer together. That situation would apply especially in the earlier years, when discharges from the B204 stack were so high.

Q. I just want to ask you this. In the conclusions of your first report in Chapter 12, where in the concluding chapter you deal with dose assessments, you refer, on page 3 of Chapter 12, to your case by case results, which you have set out in Annex 12C, which we looked at earlier?

A. That is correct.

Q. You refer to the validation exercise and your conclusion which you reach on page 7, to which I referred you, is that you consider that the assessments which you have made are likely to err on the side of over-estimating intake and external radiation exposure and you are encouraged by the data, to which I also referred you, of autopsy and whole body monitoring?

A. That is correct.

Q. You have been asked questions in relation to your exercise over the course of the last nearly two days, Prof. Jones. Is there any respect in which, as a result of the questions and answers, you consider that that conclusion should be changed?

A. No, Mr. Rokison, I do not believe there is. I still hold to that conclusion.

Q. It has been suggested by the Plaintiffs, although not, I think, specifically put to you, that the uncertainties, which were emphasised by my learned friend Mr. Hytner in his questioning, in this exercise are so great that it is not really possible to reach any confident assessment of the environmental irradiation doses to the individuals with which this litigation is concerned. Do you agree with that?

A. No, I do not agree because any attempt to elevate discharges or doses by large factors would have to comply with the constraint that the measured levels in the environment are as they are and that, where we do have these measurements in people, that the measurements in people are as they are. I think that provides substantial defence against uncertainty in the estimation of discharge or even uncertainty in the workings of the model itself, because of the validation procedures that have been gone through to compare the predictions with actual measurements.

MR. ROKISON: Thank you, Prof. Jones.

MR. JUSTICE FRENCH: Yes, Prof. Jones can be released if he wishes to go. That does not mean to say that Mr. Rokison may not want to keep you, I do not know.





MR. ROKISON: He may be released and discharged, as far as I am concerned.

MR. SPENCER: My Lord, I will call Roger Dickinson.

ROGER JOHN DICKINSON Called (Sworn)

Examined by MR. SPENCER

MR. SPENCER: My Lord, your Lordship should have a copy of the short proof of evidence of Dr. Dickinson although I understand your Lordship has only just received a copy of it.

MR. JUSTICE FRENCH: That is right.

MR. SPENCER: My Lord, I will proceed accordingly:

Q. Is your full name Dr. Roger Dickinson?

A. It is.

Q. And your address, Dr. Dickinson?

A. 16 Wallings Lane, Silverdale, Carnforth, Lancashire.

Q. What is your present employment, Dr. Dickinson?

A. Manager of Business Planning and Technical Appraisal with BNFL.

Q. MR. JUSTICE FRENCH: Speak up a little, would you and say that again?

A. Manager of Business Planning and Technical Appraisal, my Lord.

Q. MR. SPENCER: Mr. Dickinson, everybody in Court is entitled to hear your evidence so do not be shy to keep your voice well up so that everybody can hear. How long have you been employed by the Defendants, British Nuclear Fuels Limited?

A. Since 1975.

Q. I think from 1975 to 1981 you were a Development Chemist at the Research and Development Department at Sellafield, though it may not have been called precisely that, is that correct?

A. That is correct, yes.

Q. From 1981 to 1987 you worked at the Defendants' Risley Headquarters in the International Safeguards Department, correct?

A. Correct.

Q. Providing an interface between various Government Departments, for example, the Department of Energy and the Defendants?

A. Correct.

Q. You have academic qualifications of BSc in chemistry, a doctorate in philosophy and you are a member of the Royal Society of Chemistry, is that right?

A. Correct.

Q. My Lord has heard that the Inspectorate of Pollution and the Ministry of Agriculture, Fisheries and Food, pursuant to the 1960 Radioactive Substances Act, set quantitative limits for the disposal of waste, gases, mists and dust from the Sellafield site for various radionuclides, is that right?

A. Correct.

Q. In that regard they provide on application from the Defendants a Certification of Authorisation for the Disposal of Gaseous Waste, known as an "authorisation", is that correct?

A. Correct.

Q. I think since 1st January, 1988, new authorisations were in force that imposed numerical limits?

A. Correct.

Q. Prior to that the authorisations did not include a quantitative limit but the Defendants were required to use their best practicable means to minimise discharges, is that right?

A. That is correct.

Q. It came about that in April of this year application was made by the Defendants for a new authorisation to take effect from the beginning of 1993?

A. Correct.

Q. I think that as we shall see one of the reasons for the new application was the planned coming onto stream of the reprocessing plant known as THORP?

A. That is correct.

Q. Did you take any part in the drafting of the authorisation application?

A. I did, yes.

Q. What part did you play in it, Dr. Dickinson?

A. My role was to coordinate the technical input to the application and to ....

Q. Not too fast.

Q. MR. JUSTICE FRENCH: "My role was to coordinate the ...."?

A. Technical input to the submission, to draw on whatever resource was necessary to achieve that and to place the application with the Authorising Departments, and to undertake ....

Q. To place the authorisation ...?

A. Application with the Authorising Departments.

Q. Send it to them?

A. Yes, basically, and to lead any discussions that were necessary to achieve that.



DR R J DICKINSON

- A Q. MR. SPENCER: Dr. Dickinson, I am having difficulty in understanding your evidence and I understand for that reason my learned friends are having greater difficulty, so please keep your voice much louder.

MR. HYTNER: My Lord, the bulk of this statement is wholly non-controversial. If my friend would care to read it out himself from the statement, I am perfectly content.

- B MR. SPENCER: I am grateful for that. We will go to paragraph 3:

"An important consideration which both BNFL and the Authorising Departments have been concerned with in determining future atmospheric discharge limits has been the calculation and application of Sampling Efficiency Factors, known as SEFs."

- C Q. Is that right?  
A. Correct.

- D Q. "Since the mid 1980s BNFL has conducted research into the efficiency of stack sampling systems around the Sellafield site. Since 1st January, 1988, SEFs, which have been approved by the Authorising Departments, have been used in the derivation of BNFL's reported atmospheric discharge figures. BNFL's published data giving atmospheric discharges from 1986 onwards takes account of the SEFs approved from 1988. BNFL has recently completed a review to take into account new experimental data. Following discussions with the Authorising Departments values for SEFs have been approved and these have been used by BNFL in calculating the projected discharges given in the Application."

E Pausing there, can I ask you to look, please, at the folder called P1? If you go in that folder to page 235 is that the original application?

- A. It is, yes.

- F Q. Just so we can see, there is a table of contents on page 236 and it contains a number of tables. There is a Figure 1 which we can look at, and five appendices, is that right?  
A. That is correct.

- G Q. On page 238, the application deals with past and current discharges and the third paragraph:

"Control of aerial discharges by the Company has resulted in a general decrease in emissions to the atmosphere since the late 1970s (Figure 1) although fluctuations have occurred."

H

DR R J DICKINSON

The Company has recently completed a programme of work to upgrade the sampling systems used for assessing stack discharges. In addition the Company is undertaking a programme of research into possible improvements to sampling and pollution abatement techniques, and dispersion of material released to atmosphere from the Sellafield Site - both from stacks and from ground level sources. The results of this work will help to identify practicable ways of further reducing and refining estimates of releases of activity."

From your knowledge was all that correct?

A. Yes, it was.

Q. If we can turn to Figure 1 at page 256, just so we can understand that figure it has two parts to it, the top part deals with beta discharges and the lower part dealing with alpha, and the component parts of each have been divided up. In the beta discharges the black parts of the bar chart refer to caesium-137 and the white parts to iodine-131, is that right?

A. That is correct.

Q. Then in relation to alpha we see that the black parts of the bar chart are the plutonium component and the white parts the americium?

A. Correct, yes.

Q. It goes back to 1975 in respect of beta and 1977 in respect of alpha?

A. Correct.

Q. The vertical axis is the quantity of the discharges measured in giga Becquerels?

A. Correct.

Q. Also in this document we find in Table 1 tables of historic discharges going back to 1988, is that right? Page 249 is the start of Table 1. Would this be right, Dr. Dickinson, insofar as Table 1 is represented in Figure 1 it would only be obviously for all those later years, from 1988 onwards, to the right of each bar chart?

A. That is correct, yes.

Q. What was the purpose of Figure 1?

A. Simply to show the trend in discharges that we have seen from the stacks over a period of time and to demonstrate that the discharges were decreasing over time. It was illustrative only, not used for purposes of deriving any projected figures at all. It was just a historic statement.

Q. Where had the historic data come from?

A. These two figures are drawn from the Company's annual report, and reports have been issued for 1988, 1989 and 1990 also.



DR R J DICKINSON

Q. What about the earlier years?

A. This is actually the diagram that is drawn from that report.

Q. So if we looked in the annual report for that year you could see precisely the same diagram?

A. Correct, yes.

Q. Subsequently there was correspondence, I think, with the Authorising Departments, is that right?

A. Yes, that is correct.

Q. Again I think we find at page 292 the formal request for further information, is that correct?

A. Could you just give me the page number again, please?

Q. 292.

A. Yes, this is the correspondence.

Q. That is the formal document and we have at page 291 the letter which accompanied it dated 27th August, the same date as the formal document, addressed to the Legal Director of the Defendants, Mr. Alvin Shuttleworth:

"At the recent presentations to the Authorising Departments the Company supplied additional information which was subsequently used in the determination of the authorisation limits. We will require this information to be placed on the public registers unless there are confidentiality issues. We have therefore issued the attached schedule requesting the additional information. A form declaring that this information is or is not confidential is supplied for your use. We would appreciate a response to this request by 4 September 1992."

And at page 292 of the bundle, the next page, under "Amended Stack Efficiency Factors":

"The historic discharges for schedules 1, 2 and 3 in the application are the figures as previously reported to the Authorising Departments and are based on the best estimates of stack efficiency factors at the time. The figures do not take account of the recent review of stack efficiency factors and the changes agreed by the Authorising Departments. Provide the historic data for schedules 1, 2 and 3 adjusted to take account of the revised SEFs."

So they asked for that to be done, did they?

A. They did, yes.

Q. And I think they obviously, it is plain from that, knew about revised Stack Efficiency Factors because we find those actually referred to in the original application, do we not, at page 266?

A. Yes, that is correct.

Q. "Revised Stack Efficiency Factors":

"The Company has recently completed a review of Stack Efficiency Factors and agreed their implementation with the Authorising Departments. The calculated projected discharges take account of the findings of this review."

Were you, Dr. Dickinson, involved in the provision of the revised figures for the assistance of the Authorising Departments?

A. The person working for me at the time on the number generation did provide those numbers to the Authorising Departments.

Q. Was that done under your direction?

A. Yes.

Q. Just help me - I may be wrong - but do I find those at page 297?

A. Yes.

Q. Those are the revised figures?

A. Yes.

Q. Carrying on, if I may, in your proof of evidence, at paragraph 5:

"Following recent discussions with BNFL'S solicitors I ....

- that is you, Dr. Dickinson -

"... understand that the Plaintiffs have suggested that BNFL has misled both the Authorising Departments and the public generally in relation to the historic atmospheric discharge data contained in Figure 1 of the Application of April 1992. I do not accept that Figure 1 of the Application can be regarded as, in any way, misleading.

6. Figure 1 was set out in the Application to illustrate, in graphical form, the annual historic discharge data as published by BNFL in its Annual Reports up to and including 1991. Moreover, Figure 1 is not relied upon in any way to derive the projected future limits for gaseous discharges. I would like to stress that only data from 1988 to 1991 has been used in projecting future discharges. The methodology which has been used to derive the proposed limits for future atmospheric discharges, and which as I have already indicated, takes account of the new values for SEFs, is set out at Appendix 3 of the Application."



and that is page 265, if you care to look at that. We need not go through it but that is where it is to be found.

"7. As I have already indicated and, as is explained at page 2 of the Application, the Figure was designed to demonstrate the general downward trend in the level of gaseous emissions since the late 1970s. Far from any intention to mislead, if the most recent experimental data in relation to SEFs had been applied to the historic data then the already apparent downward trend in discharges since the late 1970s would have been magnified. I have not undertaken the calculation but it is self evident on the face of the document."

and for it to be self evident, if we look again quickly at Figure 1, is what you are saying this, that it applies probably to the chart of the alpha discharges, is that right?

A. Principally it applies to both, of course, but yes.

Q. One would see it, I think, more clearly on the alpha. The fall in the recent years would appear to be greater, is that correct?

A. Yes.

Q. "8. Following the submission of the Application in April 1992, the Authorising Departments sought further information from BNFL. The Authorising Departments requested that Tables 1.1 to 1.3 should be revised for Schedule 1, 2 and 3 stacks, for the years 1988 to 1991, to take into account the most recent experimental data in relation to SEFs. These revised Tables were formally provided to the Authorising Departments on 9th September 1992. The data had previously been supplied informally on 24th July 1992, following a meeting on 22nd July 1992. They made no similar request in respect of the years prior to 1988 and must have been aware that no such revision had been made. Undoubtedly, they would have taken that into account in their interpretation of Figure 1.

9. There have been numerous meetings between BNFL and the Authorising Departments since the submission of the Application, many of which I have attended. At these meetings a number of matters in relation to the Application have been discussed and BNFL have provided, at the request of the Authorising Departments, technical information to enable the Authorising Departments to reach a determination in relation to the Application. I confirm that BNFL has always been open and frank in its dealings with the Authorising Departments and I therefore find it inconceivable that they have been misled by BNFL in relation to the historic atmospheric discharge data and SEFs.

10. I understand that the Plaintiffs have also alleged that there is a discrepancy between the atmospheric discharge values given by Professor Jones in his Expert Report and the amended Tables 1.1 to 1.3."

I do not know whether you had a copy of it but Prof. Jones produced in evidence today a document we have called D2 which sets out the differences that appear between his figures and the correctly totalled figures.

A. Yes, I did see that.

Q. "Both BNFL, in revising the Tables and Professor Jones in preparing his evidence have had available to them the most recent data on SEFs. Professor Jones has played no part in the Authorisation process and I understand, quite independently, has taken his own view as to the manner in which SEFs should be applied to the historic atmospheric discharge data so as to arrive at "cautious" dose assessments based on that data."

I think that is a reference, is it not, to his first report, chapter 5, pages 11-12?

A. In fact, I have not seen his reports; I have not read his proof of evidence.

Q. Have you been present in Court when he has given his evidence?

A. Yes, I have.

Q. You have heard all the evidence that he has given?

A. Yes.

Q. Then despite the fact that you have not seen it, I think you have heard it?

A. Yes, I have heard it.

Q. "To suggest that there is any discrepancy between the Application and the Report of Professor Jones is to misunderstand the nature and purpose of the respective exercises.

#### CONCLUSION

11. In summary, I do not consider that BNFL has in any way knowingly misled the Authorising Departments or the general public in relation to its historic atmospheric discharges for the reasons I have given above. Further, I do not believe that it is valid to suggest that there is any discrepancy between the atmospheric discharge figures presented by BNFL in relation to its Application and by Professor Jones in his expert evidence."

Have you any reason, Dr. Dickinson, to alter that conclusion having heard the evidence that Prof. Jones has given in Court today and yesterday?



DR R J DICKINSON

A. No, I have no reason for doing that.

Cross-Examined by MR. HYTNER

Q. Dr. Dickinson, since you were informed that the Plaintiffs have made an allegation that you sought to mislead the Authorising Departments, have you been re-informed that you were misinformed about that allegation?

A. I understand that there was some doubt about it, yes.

Q. Only that there was some doubt about it? Well, so that you can go home happy in the knowledge that no such allegation was made, may I read what was actually said and see if there is anything in it which you resent or which you disagree with. This is the transcript of the opening, Day 1, page 40D:

"My Lord, there is a third matter which is somewhat bewildering for which there may in the end be an wholly satisfactory answer although it is difficult at the moment to see one and which ought to be put forward. My Lord, in April the Defendants made an application for authority from the Ministry of Food to discharge plutonium from their new plant at Sellafield, known as THORP.

In doing so they gave figures for historic discharges of plutonium. My Lord, I am going to advance this in the least controversial fashion possible in the hope that there is an explanation for it, rather than put it forward abrasively with figures. My Lord, certainly the figures given in that application document were what I may call the "old" figures. Within a month or so Professor Jones was providing the Plaintiffs and the Defendants with massively higher figures. The Defendants have been asked to provide explanations and one explanation they have given, which we are happy to accept, is that the Ministry were aware that those figures were historic and that they fell to be amended upwards by application of a filter efficiency factor for stacks and that therefore they weren't in any way being deceitful. My Lord, I am sure that is right."

Is there anything in that that you resent?

A. Could you do me the honour of repeating the part which refers to the Sampling Efficiency Factors, please?

Q. "The Defendants have been asked to provide explanations and one explanation they have given, which we are happy to accept, is that the Ministry were aware that those figures were historic and that they fell to be amended upwards by application of a filter efficiency factor for the stacks and that therefore they weren't in any way being deceitful. My Lord, I am sure that is right."



DR R J DICKINSON

A. In terms of the application of that statement to the figures prior to 1988, then those figures came out of the Company Reports and Stack Efficiency Factors, I understand, were not applied. In terms of the figures from 1988 to 1991 the Stack Efficiency Factors had been applied which were introduced in 1988.

Q. Is there anything in that statement into which you read any allegation that you were seeking to mislead the Ministry?

A. In terms of it was, I believe, unclear as to whether we had or had not applied SEFs particularly in the case of the data between 1988 and 1991.

Q. That is the view that you take as an employee of BNFL, that what I have just read out makes it unclear as to whether we were attacking the integrity of BNFL?

A. I believe that we had applied those, we were open with the Authorising Departments and with the general public and I do not think the statement you have read actually reflects that in total.

Q. The next sentence has nothing to do with the Ministry:

"However, a member of the public reading that document would not have known that."

Do you agree or disagree with that observation?

A. Given that those numbers and those figures came from the Company Reports and given that those Company Reports would reflect what the status of that data is, then the public would have access directly to information that is available in the public domain and would be able to determine that statement.

Q. Are you qualified and authorised to give that answer, Dr. Dickinson, in the sense that you have read the Company Reports and you are giving that answer with care having considered the Company's Annual Reports?

A. I have not read every aspect of the Company's Annual Reports, no.

Q. From what part of which Company Report do you derive the information to enable you to give that answer, that the public would know from the Company Annual Reports that these figures fell to be adjusted by application of a Stack Efficiency Factor of 4?

A. I cannot direct you to any point in the Company Report that identifies that number of 4.

Q. It is very difficult to put this shortly because in order to demonstrate to you that you are quite wrong it would be necessary to put to you each and every Company Annual Report, but I shall put it to you broadly and if I am wrong somebody else will re-examine you. I put it to you that there is nothing in any Company Annual Report that would give an informed member of the public interested in



this subject any clue that prior to 1988 the figures that are shown as discharge figures fell to be adjusted by means of a Stack Efficiency Factor whether of 1, 2, 3 or 4. Can you dispute that from your own knowledge?

- A. The reports of 1986-7 indicate the application of SEFs for those periods. I am not clear, because I have not read the documents in absolute detail, as to whether they refer to data before those dates.

- Q. Could we look at the bundle in front of you, at page 301, the 1986 figures? It is paragraph 52:

"The 1986 figures in the Table reflect very recent improvements in the assessment of discharges from the various stacks, as a result of the review of sampling and measurement techniques referred to in last year's report. For the first five isotopes in the Table, the 1986 figures can be compared directly with those for 1985 and the differences reflect variations in the nature and scale of operational programmes. For the remaining isotopes the figures quoted are somewhat higher than if these improvements had not been made. It is emphasised that the figures do not imply any increase in actual levels of discharge. Nor are there any consequential changes in the estimates of radiation dose to the public, which are as always based on the environmental measurements reported in the following paragraphs. As reported last year, small amounts of airborne radioactivity also arise from open ponds and other sources, and these also contribute to the radioactivity in the environment which is measured."

Where do we see in that paragraph any clue given to a informed member of the public that the figures in the table prior to 1986 are not accurate discharge figures?

- A. In those paragraphs that you have quoted to me, and as I have read here, they do not, except we do obviously refer to the fact that we are reviewing sampling and measurement techniques, which was referred to in paragraph 52 to the previous year's report, but it does not go on to say it has necessarily been applied in ....

- Q. Would you turn to page 256, the document at Figure 1, "Discharges to Atmosphere (Alpha)", starting in 1977? Do you agree that for every year up to 1988 if one wanted to see the accurate figures for discharge one would have to multiply by 4, increase each of those bars by 4?

- A. Whether or not one applies retrospectively Sampling Efficiency Factors, and certainly in the discussions I have had with the Authorising Departments with respect to the authorisation, which is what I am qualified to talk about, we have not sought to apply those factors retrospectively nor seen the need to do so in terms of the submission that we have made, the data which both the Authorising Departments and ourselves have used are those which refer to 1988-91 only. The data prior to that is,



and it is stated quite clearly in the authorisation submission, taken from the Company's published reports. It is no more than illustrative of what the trend in discharges is. That is all it sought to actually provide, a trend analysis.

Q. How would a member of the public know, from this document, that the figures given for 1977-87 inclusive are a quarter of the actual discharge figures for those years?

A. All I can say is that in the submission I referred this back, these two figures and the tables that apply to the period 1988-91, back to the Company documentation, the Company published Annual Reports. As far as the ....

Q. Dr. Dickinson, I appreciate what it was the Ministry may have wanted and what it was you supplied the Ministry with. I hope you are following the question I am putting to you. It is not that you misled the Ministry. I am asking you how an interested member of the public, reading this document, would know or would have known that the figures for actual discharge were four times the figures given in Figure 1?

A. Reading the document that we prepared I have not commented on the data prior to 1988 and therefore I have not commented as to whether SEFs have been applied or not.

Q. MR. JUSTICE FRENCH: If you are just looking at the bar chart, you would be misled as an ordinary member of the public?

A. I would, my Lord, if the data that is presented here was taken out of context and ---

Q. Yes, you have got to know the whole context in order to begin to see that perhaps it is not inaccurate?

A. Yes, I agree.

Q. MR. HYTNER: I leave that point. Can I ask you this: when you did your exercise - this is for THORP - did you know that Professor Jones was involved in an exercise relating to this litigation?

A. Could I just correct one point? This exercise was not entirely done for THORP alone.

Q. I think we appreciate that. You need not worry, there is no sinister connotation in my mentioning THORP. This is an annual application for authorisation, is that right?

A. No, incorrect.

Q. Incorrect?

A. Incorrect. What we do, and what has been the practice in the past, is that the authorising departments under the Radioactive Substances Act issue us with authorisations, they determine the period for which those authorisations will apply unless we have new plant which has been brought on, and we give them notice that we would like to apply for a new authorisation. They determine the



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revised authorisation; they tell us when they wish to start with the negotiations. They have done that this time and have reacted both to our need to bring the new plants on and also request re-authorising departments to review all the authorisations that apply to the Sellafield site.

Q. When you undertook this operation, did you know that Professor Jones was involved in an investigation of his own relating to this litigation?

A. Yes, I did.

Q. When did you start your work?

A. We started collecting the data for this exercise in the latter part of 1990.

Q. Did you know at that time that Professor Jones was undertaking work relating to historic discharges?

A. I knew by inference, given that the litigation referred to discharges prior to the date or period that I was considering, but, having done that and having known that he was doing that, given that my interest is constrained or confined to that period 1988 to 1991 to provide sufficient base data to project discharges forward, which is the essence of the document and the approach that I have taken, is not to look at historic discharges and comment on the acceptability or not; it is to use historic data and project forward to provide for technical support and submission to the authorising departments as to the proposed limits we would need to operate the site. So in that sense, whilst Professor Jones was looking at historic data, it had no relevance to the exercise I believe that I was undertaking, given that my base data was only confined to 1988 to 1991.

Q. The stack efficiency factor that you came to for your work was one of four, was it?

A. We applied the revised SEFs agreed by the authorising departments and, from memory, I think it was the higher one in actual fact.

Q. I would like you to try and be accurate. When you put in your first application - and please do not worry, this is not leading up to a suggestion that you have done something wrong, do you follow, I am just trying to find out information - when you signed or completed your first application which went off in April, is that correct?

A. Correct.

Q. What sampling efficiency factor had you then applied?

A. The factors that we applied were those that were borne out of the recent assessment of stack efficiency factors for the various sampling points that are attached to the stacks that we were looking at. We did it on a stack by stack basis; we did it on a radionuclide by radionuclide basis; and without referring to my notes, I cannot remember the precise number that we used for any one particular radionuclide, but I am sure I can get hold of that information.



DR R J DICKINSON

Q. When you did that, were you aware of any work being done by Professor Jones which would have a bearing on the sampling efficiency factor?

A. Actually on the factor?

Q. Yes.

A. Not that Professor Jones was doing, no.

Q. When you agreed amended SEFs with the Ministry as a result of their request for further information, was that agreement based on anything that you had known of Professor Jones's work?

A. Maybe if I hopefully make it slightly clearer, we applied the revised stack efficiency factors at the time of the application. The request for information later that year - and I think from looking at this the letter is dated 27th August - was to enable the authorising departments to determine discharges so that they could compare their discharges with ours and look at the proposed limits that they would set and see whether we were being realistic, which we believed we were, or whether in fact they agreed or disagreed with our assessments. So it was to provide them with the same base data that we had used on a year by year basis. If you look at the data we provided, it is a yearly summary, but if you look at the application we made, it is quite clear that we used monthly data; we did not use the cumulative yearly figures for the purpose of our exercise because the statistics would not have been satisfactory. So at that time they were seeking effectively a re-statement of what our data set was that we had used or would apply.

Q. So the sampling efficiency factor that you have used both for the original application and the amended application is the same SEF that you negotiated with the Ministry?

A. Correct.

Q. Have you been in court while Professor Jones has given evidence?

A. I have, yes.

Q. So you know that by and large he has, as he put it, cautiously or conservatively (whatever that means) applied an SEF of eight to the historic discharges?

A. Yes, I understand that.

Q. That is very considerably higher, is it not, than the SEFs that you had negotiated and agreed with the Ministry?

A. I would have to refer to my notes.

Q. Would you do so?

A. They are at the back of the court.

MR. JUSTICE FRENCH: You go and get them if you can find them easier. (Pause) Mr. Hytner, I think the figures are now in front of the witness.



DR R J DICKINSON

MR. HYTNER: I am obliged, my Lord.

A Q. Would it be right that the SEF of eight is substantially higher than the SEFs that you applied having agreed them with the Ministry?

A. No. We applied eight.

Q. You applied eight?

A. Between 1988 and 1991, we applied - this is Building 204 stack, and if you want me to go through the whole of these stacks ---

Q. No.

A. Are you looking particularly at plutonium or have you got any particular ---

Q. Plutonium and B204?

A. Published data was an SEF 4. That is the figure that we used in reporting to the authorising department; and in the adjusted data set the figure that we used was 8.

Q. That is what I thought, because if you look at page 292, this is additional information and clarification sought by the Ministry in August and it says:

"Amended Stack Efficiency Factors. The historic discharges for schedules 1, 2 and 3 in the application are the figures as previously reported to the Authorising Departments based on the best estimates of stack efficiency factors at the time. The figures do not take account of the recent review of stack efficiency factors and the changes agreed by the Authorising Departments. Provide the historic data for schedules 1, 2 and 3 adjusted to take account of the revised SEFs".

A. The schedules that are presented in the application, the statement at the top of those schedules is that that is the historic data. Those are the data that we reported to the authorising departments, and you are correct in saying that we applied the SEFs that applied at that time and were agreed by the authorising departments, which for the purposes of the discussion we have had would be four. In terms of presenting the data to the authorising departments for a submission, we took, with the authorising department's knowledge because we informed them of what we intended to do, the 1988 data through to the 1991 data and applied the SEFs that would come into effect on the 1st January 1992, which are the ones that would have an SEF of eight for the 204 stack plutonium, by way of projecting forward what the discharge arisings would be for individual radionuclides and individual stacks, and we used that data for the determination of the numbers. In actual fact, in the application itself there are another three schedules which are headed, I believe from memory, "Projected discharge data", and for each stack we have shown what our projected data on that basis is. We have used - and it is clear in the



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application - month by month data, which is what we report to the authorising departments, and that data is not presented in the application; some of that information is information which we cannot release to the public domain. In essence, all of that data, all of the SEF information is contained and held by the authorising departments. They had a full knowledge of what our data set was in terms of both the discharges and the SEFs, how they had been applied, when they had been applied and the like. The purpose of the question was to satisfy a number of issues: one was that we recognised that the data set that was in the application did apply to the historic information and therefore felt it was important to release the data in the revised form for people to understand, but in essence we did not or would not have used the annualised data with SEF supply for purposes of deriving discharge numbers.

Q. In fact, that was not the answer that I was requesting but you have given it. It appears that the answer to my question is very simple: that you did not apply the new SEFs in the original application? You applied the old SEFs in the original application and the new ones in the amended application?

A. Only in so far as we reported historic discharges.

Q. What I now want to know is did you arrive at an SEF of eight independently of or in some way in collaboration with Professor Jones?

A. The value of eight came out of a study that was done by the Research and Development Department and presented to the authorising departments and SEFs agreed. I took no part in that discussion. I took the SEF data that was agreed with the authorising departments and applied it.

Q. I see. Do I take it from your evidence that if your application had been incomplete in May, so that it was not to be completed until August and you had had a sight of Professor Jones's first report, the application would have been in exactly the same form?

A. Yes, I believe it would have.

MR. HYTNER: Thank you.

Re-examined by MR. SPENCER:

Q. Let me try and just trace the figure 1. If you look please at page 307, do we find the Annual Report on Radioactive Discharges and Monitoring the Environment for 1990, or part of it?

A. Yes.

Q. If you go please to page 309, paragraph 54, you will find this:

"Radioactive effluents are discharged to atmosphere from stacks on the Sellafield site. Discharges made during 1990 are presented in Table 4. Since 1986



A improved methods for assessing stack discharges have been used and a programme of work continues to review sampling arrangements. Aerial discharges consist principally of ventilation air from the process plant and Calder Hall. The radioactive content consists of noble gases .... other gases and vapours ..... and suspended particulates. Major release points are filtered to reduce quantities of radioactivity discharged, and are monitored continuously. Since the late 1970s there has been a general decrease in emissions to atmosphere (Figure 2) although fluctuations have occurred".

B If we go on two pages, we find Figure 2a I think, and 2b. Is that fundamentally the source of the trend figure that you inserted into the authorisation application?

A. Yes, I did, that's right.

C Q. That paragraph that we have just read, 54, reflects I think an earlier paragraph in the Report for 1987 which starts at page 303 as the title sheet of the report or the extract from the report that we have had, and I think the corresponding paragraph is paragraph 25, is that right?

A. Yes, it is.

D Q. "Radioactive effluents are discharged to atmosphere from stacks on the Sellafield site. In 1987 the review of the Authorisation governing these discharges was completed. A new Authorisation came into effect on 1 January 1988 and is included in Appendix 1. This introduces quantitative limits on discharges for individual radionuclides, and makes separate provision for high, intermediate and low stacks, and for discharges from the Calder Hall reactors. Discharges are presented in Table 3 in a format compatible with the new Authorisation, even though it was not applicable to 1987.

E 26. Aerial discharges arise principally from ventilation air from the process plants and Calder Hall, and comprise noble gases ... other gases and vapours ... and suspended particulates. All major release points are subject to gas cleaning systems and/or filters, so minimising quantities discharged, and are monitored continuously. Since 1986 improved methods for assessing stack discharges have been available. A programme of work continues to review and improve sampling arrangements as available, and some minor amendments in data published for 1986 have been incorporated in Table 3. Further information about the origin of gaseous discharges from the Company's Magnox reactors is provided in Chapter 4".

F Just so that I have understood it, it would seem from your evidence that for certainly the plutonium from the B204 stack a sampling efficiency factor of four was in

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place in respect of 1988-1991 published data, correct?

A. Correct.

Q. In 1992, a new value of eight was agreed, is that correct?

A. Correct.

Q. In the application, the original tables were based on the SEF of four, correct?

A. Correct.

Q. And the revised tables were based on the SEF of eight?

A. Correct.

Q. We have not looked at the projected discharges, but the tables, as you have said, are appendices to the application report, all based on the sampling efficiency factor of eight?

A. Correct.

Q. From that information, would it be apparent that the up to date sampling efficiency factors had not been applied to the historic data?

A. They were not applied to the historic data. It was a decision that I made purposely.

Q. In doing that, you of course have differed from that which Professor Jones has done?

A. I agree, yes.

Q. Of course, he was engaged on a quite different purpose to the one that you were engaged upon?

A. Exactly.

Q. To round it up, Mr. Hytner put to you various parts of the transcript so that you could understand what was being said, but it may be that he did not actually put the relevant part to you. Perhaps I can do that so that you can have, in fairness to you, an opportunity to deal with it. My Lord, it is page 41 in the transcript at C:

"MR. HYTNER: No, my Lord, we understand that is their explanation, that Professor Jones has been pessimistic and the Ministry figures are right. It all adds up to this: what do we gain by this? What we gain is that when this body (BNFL) which is discharging radioactivity into the environment, gives figures to either the public or to public bodies or to anybody else or its workforce, they really do not seem to appreciate the need for accuracy. Whether or not people over-react to radiation, irrespective of whether the fears of workers or the local population are unfounded, it is not for those who discharge the radiation to be cavalier in their attitude to accuracy. My Lord, at all times they should be.



DR J W STATHER

A My Lord, what we say throughout this case, and of course it is prejudice, it is prejudice that is legitimate because at the end of the day your Lordship is going to be asked to assess the accuracy of the Defendants' present figures and their present estimates, is that they are people who lamentably because of their past, because of their record in this matter, simply cannot be relied on".

B So that is what was being said, that in relation to information provided to public bodies, the public or anybody else, BNFL and by implication, because it relates specifically to the authorisation applications, you, are people who are cavalier in their attitude to accuracy. Do you regard yourself as being cavalier in regard to accuracy in relation to discharges of radiation from Sellafield?

A. Very firmly not.

C Q. Would that adjective, so far as you know, characterise those of your colleagues with whom you work at BNFL?

A. Very firmly not, no.

D Q. When you drafted and submitted the authorisation application, had you any reason to doubt the accuracy, given that which you were intending to do or attempting to do, of its content?

E A. No, I had no doubts in the sense that we had applied knowing a check system was in place. We have found mistakes within the document. We have owned up to those, we have told HMIP that we have found the odd error that they need to take account of, but in essence we have taken every step that we thought was possible to ensure that the accuracy of the data that we had presented was correct.

Q. Specifically so far as you are concerned did Figure 1 accurately reflect the trend of downward emissions which you were intending to portray?

A. Yes, it did.

F MR. SPENCER: Thank you, Dr. Dickinson, unless your Lordship has any questions ...

MR. JUSTICE FRENCH: No, thank you very much.

MR. ROKISON: My Lord, I would like to call Dr. John Stather.

G DR. JOHN WHARWICK STATHER - Sworn

Examined by MR. ROKISON:

Q. Your name is John Wharwick Stather?

A. That is correct.

H Q. Is that how you pronounce your second name, and it is set out on page 1 of your report spelt correctly?

A. Spelt correctly.

MR. JUSTICE FRENCH: It has an unusual 'h' in it.

A Q. MR. ROKISON: Your address is 198 Andover Road,  
Newbury, Berkshire?  
A. That is correct.

B Q. You state on page 1 of your report that you are employed  
by the National Radiological Protection Board which we  
have referred to as NRPB, as I think it is commonly  
referred to?  
A. That is the way I prefer to refer to it.

B Q. At Chilton in Oxfordshire?  
A. Yes.

C Q. Is it right that you are the Assistant Director  
responsible for the work of the Environmental  
Measurements Department and the Non-Ionising Radiation  
Department?  
A. That is correct.

D Q. You set out in the paragraph to which I have just  
referred the organisation of your department and what it  
does. Dr. Stather, you have produced for the Court a  
report in this case which runs, I think, to seven  
chapters with a number of appendices, indeed mine spills  
over into two volumes. Is your Lordship's all in one?

MR. JUSTICE FRENCH: I have got mine in one fairly  
fat one.

MR. ROKISON: It is quite a hefty volume, my Lord.

E Q. I think that is signed and dated by you on page 86, Dr.  
Stather, on the 12th June 1992?  
A. That's right.

F Q. You also produced for the purposes of this litigation a  
second expert's report which comprises 21-odd pages plus  
appendices and that document was signed by you on page 12  
and dated 3rd September, 1992?  
A. That is correct.

G Q. I will come to that, if I may, just a little later on.  
In relation to your first report, may I ask you whether  
you adopt that report as your evidence to my Lord in this  
case?  
A. Yes, I do.

G Q. I ask you in case you wish to amend it in any way, is  
there anything which you wish to change in any way before  
your report is put in evidence as your evidence?  
A. No.

H Q. My Lord has read the report. My Lord, I do not intend to  
go through it in detail paragraph by paragraph. I intend  
to deal with it in the same way as I did with Professor  
Jones, simply going through it to outline what is there  
and picking up certain points to highlight.



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MR. JUSTICE FRENCH: Yes, certainly.

- A Q. MR. ROKISON: You deal on the first page with your employment from 1968, Dr. Stather, when you joined the Radiological Protection Service of the Medical Research Council, and you say that you became a member of the NRPB in 1971 and you set out the various positions which you have held at the NRPB. On the second page, you set out your academic qualifications which culminated in a Ph.D in Comparative Anatomy and Physiology at the University of Birmingham in 1968, and you refer my Lord to the subject of your research. You then set out your participation in a number of committees, bodies and task groups with particular areas of interest relevant to the preparation of the evidence, which includes participation in ICRP and in UNSCEAR which I think my Lord had explained in the course of the evidence of Dr. Hilton-Smith. You then in paragraph 1.2 on page 4 deal with the NRPB. Perhaps before dealing with that, may I pick it up in the third paragraph of page 4 where you say:

D "Following screening of the Yorkshire Television programme 'Windscale - The Nuclear Laundry', I was given the specific responsibility for leading much of the Board's work concerned with assessing doses and risks to children and young persons at Seascale and for preparing a report for the Black Advisory Group on this topic".

That is the report to which we have been referred several times, is it, Dr. Stather?

- A. That is the report R171.

- E Q. Which was published in July 1984, and you subsequently led the team which prepared a report for COMARE on The Risks of Leukaemia and Other Cancers in Seascale from Radiation Exposure. That is COMARE what number?

- A. That is the first COMARE report.

- F Q. You set out on page 4 in paragraph 1.2 the NRPB's function and position. I want to be very careful about the way in which I put this because I don't want to misrepresent or misunderstand the point which is being put on behalf of the Plaintiffs. I don't know whether you were present during the evidence of Prof. Jones when he was asked questions about BNFL's relationship with NRPB. I think the suggestion in summary is that somehow the relationship between NRPB and British Nuclear Fuels is so close that it in some way could influence NRPB's professional judgment and behaviour. If that allegation were to be made, do you have any comment about it?

- G A. I would say NRPB is an independent advisory body and we would jealously guard that independence.

- H Q. So far as your own activities are concerned, which have been related to British Nuclear Fuels' activities at Sellafield, and by that I include your involvement with



R171, and I include your involvement in this litigation as a witness, has that in any way been influenced by any relationship which you have with British Nuclear Fuels or anybody at British Nuclear Fuels?

A. No, but clearly over the years we have had to develop contact with representatives of British Nuclear Fuels because the expertise of NRPB is about dose calculations and environmental models. We clearly do not have expertise on discharges from nuclear sites or other site, so we have to rely on the operator to provide us with information on discharges, which clearly means close contact with individuals in BNFL or other organisations for whom we do the same type of work, or for whom we do the same type of calculation.

Q. Do you consider that you are able to adopt a stance for the purposes of giving your evidence to my Lord which is independent of either party to the litigation?

A. I believe we can and I hope we have demonstrated we are able to do that in the substance of the document.

Q. Now you set out on page 5, paragraph 1.3 the purpose of your report which you state is to:

"...quantify the doses received by Mr. and Mrs. Hope, Vivien Hope, Mr. and Mrs. Reay and Dorothy Reay as a result of releases of radioactive materials into the environment from the nuclear fuel reprocessing plant and reactors currently operated by British Nuclear Fuels at Sellafield."

May I just clarify this? Your word "currently", is that to show it is currently operated by British Nuclear Fuels or are you saying you have restricted your investigation to those aspects of the plant which are currently in operation?

A. The calculation relates to current and past discharges from the plant.

Q. As you say, the assessment is specifically concerned with doses resulting from the release of radionuclides into the environment as a consequences of discharges into the atmosphere and into the Irish Sea and is not concerned with the assessment of occupational doses. You say that in assessing the risk to Vivien Hope you do take account of any relevant doses received by her when she was working on the site?

A. That is correct.

Q. You go on to say that in preparing your report you have made use of the results obtained from measurements of the concentrations of radionuclides in environmental materials, that is, air, food, water, soil, etc. in the area of West Cumbria and where appropriate environmental measurements are not available you have had to rely on the results of modelling studies to assess the concentrations of radioactivity in environmental materials from information on discharges from the



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Sellafield plant provided by British Nuclear Fuels. You say that where modelling studies are required you explain the extent to which doses can be validated from environmental and biological monitoring data. To what extent is your assessment dependent upon what has been provided by BNFL and to what extent do you rely upon environmental and other monitoring data?

- A. The ingestion pathway in foods, drinking water, to a large extent we rely on results of environmental measurements, although we have to intersperse the measurement data with model predictions where we don't have the specific information.

For inhalation we largely have to rely on discharge data from the plant. The same is true for external dose for some released radionuclides. We come back to looking at how we can validate that information in chapter 7.

- Q. Would you take it quite slowly because I see my Lord is noting.

- Q. MR. JUSTICE FRENCH: For inhalation you rely on discharge data. For ingestion...

- A. Much of the dose is based on environmental measurements. I believe that is one of the strengths of the document, the report.

- Q. Of course the boundary between inhalation and ingestion is one which is crossed when mucus, which surfaces, if I can use that expression, is then swallowed?

- A. Yes, certainly. A small proportion of the material inhaled will pass through the GI tract and be absorbed.

- Q. Yes. I suppose it may be small, it may be larger, depending on the individual?

- A. It depends on the particle size inhaled. It would vary with individuals.

- Q. It might depend on whether the inhaler is a smoker or not?

- A. Definitely.

- Q. A lot of factors like that?

- A. Yes, and the age of the individual.

- Q. MR. ROKISON: Are these the sort of considerations which are taken into account in an overall assessment exercise?

- A. Breathing rates are taken account of, age dependent breathing rates.

- Q. You mentioned while my Lord was noting that there is, of course, the validation which you refer to in chapter 7. I will come to chapter 7, if I may, but in what context were you referring to that in the answer you just gave?

- A. Well, plutonium, for example, we get intakes by both inhalation and ingestion, but we do have autopsy data on people who have lived in Seascale over the period with

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which we are interested so we can look at the total body content from both pathways and compare our predictions of body content with the actual measured concentrations.

Q. So that relates to the combination of the information which you have derived from your environmental measurements as well as your assessment based on information provided by BNFL?

A. That is correct.

Q. MR. JUSTICE FRENCH: When you are giving that answer, I imagine Dr. Stather you are referring to those who are believed not to have worked at Seascale, Sellafield?

A. Yes, that is right. These are obviously adults.

Q. What I have written is this: "For post mortem results we look at whole body contents of non-worker residents..."

A. In the Seascale area.

Q. Yes, of course, that goes without saying - "This gives some cross-check as to the doses inhaled or ingested"?

A. Yes, for plutonium particularly.

Q. For plutonium?

A. Yes.

Q. MR. ROKISON: Would that also apply, if one were seeking to cross-check, to that proportion of dose which those who did work at Sellafield had received from the environment outside the Sellafield site?

A. It would serve that purpose.

MR. JUSTICE FRENCH: I am sorry, would you repeat the question for my benefit?

Q. MR. ROKISON: Would that validation exercise also be applicable in order to provide a cross-check in relation to the doses received by those who did work at the Sellafield site insofar as it relates to the doses which they received by inhalation...

A. Off-site, for those who lived in Seascale.

Q. Yes.

MR. JUSTICE FRENCH: Yes, but it is particularly pure and simple in the case of non-worker subjects.

MR. ROKISON: It is purer and simpler, I quite agree, my Lord. Of course, as your Lordship knows the totality of doses received through occupation have been agreed, but of course as far as Vivien Hope is concerned this is a matter which, as we will see, Dr. Stather has looked at specifically.

MR. JUSTICE FRENCH: Yes, you will come to her.



A Q. MR. ROKISON: Chapter 2, I don't want to go through with you. You deal with general concepts and quantities used in radiation protection which my Lord has already had some evidence about in particular from Dr. Hylton Smith and I wasn't going to ask you about it all again.

MR. ROKISON: Your Lordship will see a quite useful table of prefixes on page 12, which

B MR. JUSTICE FRENCH: Yes, I have seen that, and I have already been supplied with an even bigger one on a spreadsheet.

MR. ROKISON: Yes, bigger is not necessarily better in these cases!

C Q. In chapter 3, again it is not a matter I want to ask you about, you deal with the sources of ionising radiation, both lateral and artificial.

A. Maybe I could say that I think we have always felt it important when we have been calculating doses from nuclear sites or other operations, is to put those doses in the perspective of doses that people receive normally in their everyday lives from natural radiation.

D Q. We find at page 25 in Table 3.1 that you have tabulated the annual average exposure of the UK population from all sources of radiation in micro Sieverts?

A. Yes.

Q. MR. JUSTICE FRENCH: We have got our pie chart at page 27?

A. That would be for about 1989.

E Q. MR. ROKISON: That would be around 1989?

A. Yes, because I have mentioned Chernobyl, and obviously that is a dose that is reducing with time.

Q. Yes, I see that. The total you come to at page 25, is 250 milli Sieverts?

F A. 2.5.

G Q. 2.5 milli Sieverts, 2,500 micro Sieverts. Then chapter 4 you come back to matters which are perhaps more specific to this litigation. You refer on page 28 to the Yorkshire Television programme. You refer to the advisory group set up under Sir Douglas Black and to report R171, based on information on discharges that were available at the time. Then you refer to on page 28 to the query raised by Dr. Jakeman giving rise to the R171 Addendum. On page 30 you deal with discharges from the Sellafield site, the history of the site and its operations. You deal with the pathways of exposure, which you there summarise and on page 33, paragraph 4.7 you refer to the results of the study, R171 Addendum radiation doses calculated for typical children with normal habits at Seascale at those intervals.

H

One finds those referred to at Figure 4.2 which is on page 41, where one finds the annual doses to red bone marrow of the average Seascale child born in 1950 from Sellafield discharges and the Windscale fire, and the risk of leukaemia calculated to twenty years. Could you explain that figure?

A. On page 41?

Q. Yes.

A. For this particular assessment we looked at the doses from the Windscale fire, separately from all the other discharges from the Sellafield plant, hence the two curves. I will explain first of all the curve giving the doses from the Sellafield discharges. As you can see, it rises and falls. The initial rise is due to the beginning of operations on the Sellafield plant, starting in 1951, and the first peak is reached in 1954/55. That is mainly due to releases of uranium oxide particles from the Windscale piles, coupled with the release of Argon-41 discharged into the atmosphere.

Then there is a peak because we assume - and I am sure we will come back to that - all the release of uranium oxide particles occurred in mid-1954.

After the closure of the Windscale piles in 1957, after the fire, then there is a rapid fall in the dose, reaching a low value in 1965. Then there is a subsequent increase again in Sellafield discharges and that second increase is really due to ingestion of locally produced food, particularly seafood, and reflecting the progressive increase in discharges of both caesium and actinides into the Irish Sea. Obviously their consumption by the local population.

By 1975 the discharges had started to decrease, and the subsequent decrease from 1975 through to 1979 reflects the decreasing concentration of these radionuclides in seafood.

For the Windscale fire, there is simply a peak at the time of the accident, mainly due to external dose and intakes of caesium-137 and some polonium and then that dose rapidly falls away with time as it was a single release into the atmosphere.

Q. MR. JUSTICE FRENCH: The peak that one sees somewhere about 1954, that is the start up?

A. That is not the start up but it is when we modelled the maximum release of uranium oxide particles into the atmosphere from the Windscale piles, but this is prior to the fire.

Q. Exactly. The fire, we are on a downward curve and there is no increase there?

A. There was a release of uranium oxide particles that you have discussed already, I believe, which occurred from 1955 through to the time the piles were closed. In our



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calculations there was evidence available to us that most of the release occurred in 1954/55, so we assumed all the release occurred in 1955.

A Q. You did not regard the fire as producing any sort of peak?

A. That was a separate dose assessment for the fire, which is the second curve.

Q. But even that is on a declining figure. Yes, I see.

B A. There is a release of radioactivity into the environment as a result of the fire which gives a dose mainly at the time of the release, and then that falls away.

Q. Yes, I am with you. The beginning of the fire emission is in its appropriate place about 1957....

A. That reflects the fire in 1957.

C MR. ROKISON: Yes, this runs from start up, my Lord. The first part started in 1951.

Q. MR. JUSTICE FRENCH: Yes. What was the nature of the big release which gives us our 1954-ish peak?

A. It was mainly due to intakes of strontium-90 and caesium in foods.

D Q. Derived from where?

E A. Derived from estimates of concentrations in food. It is based on measures of the level of strontium-90 in milk made in 1958. There were very few measurements made before 1958, and the first year for which comprehensive measurements were available was 1958. So we took this measure of strontium-90 in milk from the Seascale area in 1958 and then we used food chain models that we have developed at NRPB to calculate what the concentrations in milk would have been in previous years, on the assumption that the original deposit occurred in mid-1954.

Q. You don't ascribe this to any incident? You infer backwards?

F A. We infer backwards. The incident is the release of uranium oxide particles from the Windscale fire.

Q. There was an identifiable incident then, was there?

A. There was an incident that occurred over a period of time, but we assumed that it occurred in mid-1954. In practice some of the release would have occurred in later years but we felt this was a cautious assumption to make, as most of the release did seem to occur in 1954/55.

G Q. "We assumed a release of uranium oxide in 1954 by inference from monitoring strontium-90 in milk"?

H A. Yes, but the basic inference we made was what the concentrations of strontium-90 in milk would have been in previous years. Essentially there is a release of radioactivity into the environment, strontium-90, for example. It lands on the pasture. Cows are grazing on the pasture, strontium-90 gets into milk. Because

strontium-90 over the years is progressively less available to the food chain so the concentration falls with time and we have developed models at NRPB to represent that change in concentration of strontium-90.

Q. Which allowed you to work back?  
A. So we can work backwards.

Q. Yes, I think I follow all that. I am using layman's language rather than mathematician's language, if I say that you assumed a release of uranium oxide in 1954 - about?

A. That's right.

Q. Circa 1954. By inference from monitoring strontium-90 in milk starting from at what?

A. 1958 was the first full year for which there was monitoring data available.

Q. Starting in 1958, and working backwards set the peak in about 1954?

A. Yes. Well, the peak actually occurred in 1955 because we assumed there were releases in mid-1954, so there is six months in 1954 and there is a whole year in 1955, so the actual peak occurs in 1955 for the dose.

Q. All right, we will say 1955.

A. Once we have the concentration of strontium-90 in milk then we can also infer from other models what the concentration in other foods would be to get the total consumption.

Q. "This permits an inference as to strontium-90 in other foods, thereby enabling a calculation of ingestion of strontium-90..."

A. Associated with uranium oxide.

Q. "...of strontium-90 associated with uranium oxide." Yes.

Q. MR. ROKISON: May I just clarify one matter? I think my Lord had noted that the assumption of a discharge in mid-1954 was an inference from the measurements taken in 1958 onwards?

MR. JUSTICE FRENCH: Something like that.

MR. ROKISON: I just wanted to clarify this:

Q. I think you had said in your evidence that making that assumption that that it was one discharge in mid-1954, I think you said that that was a cautious assumption to make. You cannot actually infer from what you find in 1958 when it occurred, but if you take it back and assume it all occurred in 1954, then you are having a greater quantity with therefore potentially greater effect? Is that correct?



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MR. JUSTICE FRENCH: I did start my record of the answer by saying, "We assumed a release of uranium oxide in about 1954."

MR. ROKISON: Yes, but I think your Lordship went on that that assumption was based on an inference from what was then measured in... I was merely trying to clarify this and it may be there was no misunderstanding at all, my Lord.

MR. JUSTICE FRENCH: I will read the complete answer. It is as well to get it right, even though I am trying to put it into layman's language. What I have written is this:

"We assumed a release of uranium oxide in about 1954 by inference from monitoring strontium-90 in milk, starting in 1958, and working backwards. This set the peak in 1955."

Q. It is very compressed, I know, and if it is wrong you tell me.

A. The essential point is we had information in 1958 and we assumed the release was in mid-1954 and then we inferred concentrations of strontium-90 in milk over that time period.

Q. I will alter it in any way you tell me will make it more sensible. Would you like to repeat what you have said? Would that make you happier?

A. Based on concentrations of strontium-90 in milk...

Q. I will start writing now, shall I? Is that what you want me to do?

A. The first full year for which measurements of strontium-90 in milk were available was 1958. Using food chain models levels of strontium-90 in milk in previous years were calculated on the assumption that the release of uranium oxide occurred...

Q. You say "the" release?

A. On the assumption of a release of uranium oxide...

Q. I thought you might prefer "a"!

A. Right. ...in mid-1954...

Q. "Occurred in mid-1954." Is that it?

A. That's it.

MR. JUSTICE FRENCH: That will do for today.  
10.30 tomorrow.

(Court was adjourned until 10.30 the following morning)

