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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

COMMONWEALTH EDISON COMPANY

Docket No. 50-454-OL
50-455-OL

(Byron Nuclear Power Station,
Units 1 & 2)

Location: Rockford, Illinois **Pages:** 10,932-11,139

Date: Thursday, August 23, 1984

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	:	
COMMONWEALTH EDISON COMPANY	:	Docket Nos. 50-454 OL 50-455 OL
(Byron Nuclear Power Station, Units 1 and 2)	:	

U.S. District Courtroom
Second Floor
Federal Building
211 South Court Street
Rockford, Illinois

Thursday, August 23, 1984

The hearing in the above-entitled matter was reconvened, pursuant to recess, at 9:00 p.m.

BEFORE:

IVAN W. SMITH, Chairman
Atomic Safety & Licensing Board

A. DIXON CALLIHAN, Member
Atomic Safety & Licensing Board

RICHARD F. COLE, Member
Atomic Safety & Licensing Board

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APPEARANCES:

On Behalf of the Applicant, Commonwealth Edison Company:

MICHAEL I. MILLER, Esq.
MICHAEL GOLDFEIN, Esq.
MARK FURSE, Esq.
Isham, Lincon, & Beale
Three First National Plaza
Chicago, Illinois 60603

JOSEPH GALLO, Esq.
VICTOR G. COPELAND, Esq.
Isham, Lincoln & Beale
1120 Connecticut Avenue, N.W.
Suite 840
Washington, D.C. 20036

On Behalf of the NRC Staff:

STEPHEN LEWIS, Esq.
MICHAEL WILCOVE, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

On Behalf of the Joint Intervenors, DAARE/SAFE and Rockford League of Women Votors:

DOUGLASS CASSEL, Jr., Esq.
TIMOTHY WRIGHT, Esq.
VICTORIA JUSDON, Esq.
Business and Professional People for the Public Interest
109 N. Dearborn
Chicago, Illinois 60602

DR. EUGENE P. ERICKSEN
Mathematical Policy Research
Box 2393
Princeton, New Jersey 08540
(Appearing as Expert Witness)

I N D E X

** Intervenor's R-1 not supplied to the Court Reporter.

P R O C E E D I N G S

JUDGE SMITH: Good morning. Is there any preliminary business, other than welcoming Ms. Wicher back to the courtroom. She is here, I understand, not as a counsel but as an observer and a gopher.

(Laughter.)

MR. CASSEL: Senior counselor.

MS. WICHER: Senior parther and coffee retriever.

JUDGE SMITH: Any other preliminary business?

MR. CASSEL: Just in reference to Mr. Stokes' testimony, Judge. But if there are any other matters before that?

MR. GALLO: There are none for the Applicant.

JUDGE SMITH: All right. Would you proceed, please?

MR. CASSEL: Yes, Judge.

Following the question from Judge Cole and Mr. Gallo yesterday afternoon, concerning various documents testified to by Mr. Stokes, and at the Board's suggestion, counsel for Intervenors and Mr. Stokes met, at some length, last night with representatives of Sargent & Lundy and again conferred briefly this morning with the Sargent & Lundy people, and counsel for the Applicant.

Based on those discussions, we have agreed upon a three point stipulation which we have not had typed out, so I will simply state it for the record.

The first point of the stipulation is that, based on Mr. Stokes' review of the calculations, in his discussions with the Sargent & Lundy personnel, he has found no Hatfield or Hunter calculations which show stress exceeding the code allowable based on the design criteria used by Sargent & Lundy. Is that an accurate statement of the stipulation?

MR. GALLO: Yes.

MR. CASSEL: Secondly, he did find, in his review of Hatfield and Hunter calculations, a few instances in which the 10 percent overstress factor was utilized at some point in the calculation, but in each of those instances it was not -- that is, the 10 percent overstress factor was not relied upon for the ultimate conclusion in the calculation that the code was not exceeded.

Is that an accurate statement, Joe?

MR. GALLO: That's an accurate statement, Your Honor.

MR. CASSEL: And the third point is that Mr. Stokes has searched through the documents which he has here with him and has been unable to locate any documents indicating the source of Attachment 7. Is that an accurate statement of the stipulation, Joe?

MR. GALLO: Yes, it is.

MR. CASSEL: I don't know what the procedure is, with regard to such stipulations before a Licensing Board, if

I need to ask that it be approved or admitted, or whatever?

JUDGE SMITH: I believe that is acceptable to the Board. Not only that, but we are pleased that you were able to work out the stipulation. It's quite reliable and certainly is more efficient.

MR. CASSEL: Thank you, Judge.

With that, we will be prepared to call our next witness.

JUDGE SMITH: Wasn't there one other matter that Mr. Stokes was to attend to overnight? My memory is incorrect. All right. Proceed.

MR. GALLO: I believe we ought to have the assent of the Staff on the record, to this stipulation.

MR. LEWIS: We have no objection.

MR. CASSEL: Our next witness, then, will be --

JUDGE SMITH: There is no need for anything further. It is in the record, on the transcript.

MR. CASSEL: Fine, Judge.

Our next witness will be Professor Ericksen, and I apologize again but I will need to go retrieve the witness and his counsel from his preparation.

JUDGE SMITH: Shall we send Mr. Wright along to make sure you get back?

(Laughter.)

(Pause.)

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Whereupon,

DR. EUGENE P. ERICKSEN

was called as a witness on behalf of the Joint Intervenors, and having been first duly sworn, was examined and testified as follows:

MR. CASSEL: Thank you, Judge. The last-minute preparations had to do with compiling various exhibits, Judge. That was the reason for the delay.

JUDGE SMITH: You may proceed, Ms. Judson.

MS. JUDSON: Yes.

Good morning, your Honors. Dr. Eugene Ericksen is a senior sampling statistician at Mathematical Policy Research, Inc. and a Professor at Temple University.

Dr. Ericksen has reviewed the Byron Reinspection Report and the testimony of various witnesses. He has analyzed the ways in which Edison used statistics and probability theory to support his conclusions concerning inspector qualifications and work quality.

Dr. Ericksen concludes that Edison's sampling design and statistical analysis suffer from four major flaws.

First, Edison failed to distinguish elements based on their safety significance when establishing its statistical criteria. The company did not properly select confidence levels and acceptable reliabilities, and failed to properly

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stratify its samples.

Second, Edison overgeneralized offering conclusions about inspectors and elements that had no chance of being included in the reinspected sample, without an adequate basis for drawing inferences to these elements.

Third, Edison used an inappropriate formula in calculating reliabilities. Two assumptions of the formula were violated; first, inspectors were not randomly selected; and second, inspectors were not homogeneous.

Fourth, Edison did not account for the added uncertainty created by clustering of inspections by inspectors.

For these reasons, Dr. Ericksen concludes that the sampling design of the Reinspection Program and the statistical analysis for the Reinspection Report are inadequate to support Edison's conclusions about work quality and inspector qualifications.

In addition to making these points, Dr. Ericksen will also be supplementing his testimony based on changes in responses to Intervenor interrogatories, and based on new data that was received after Dr. Ericksen filed his testimony.

He will comment on Edison's data collection and compilation and on assumptions made by Edison.

Your Honors, as to the supplement, I would

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like to make one representation for the record, and to do so, I wish to provide the Court and the Parties with Intervenor Exhibit R-11.

(Document distributed to Board and Parties)

(Intervenor Exhibit R-11 was

xxx marked for identification.)

JUDGE SMITH: We are following the practice that you only mark exhibits that you intend to offer.

MS. JUDSON: We do intend to offer it, your Honor.

Your Honor, before I proceed as to this exhibit, I also want to note that I believe I misspoke in my summary in discussing the use of an inappropriate formula. I should have said the first assumption of the formula that was violated was "inspections" were not randomly selected, so everyone here is clear.

As to this exhibit, your Honor, I am introducing it for two purposes: Initially, it is for information purposes, to let you know why we have not prefiled written testimony, and the problems we have had in getting correct responses to Interrogatory 12.

As you all may remember, when Dr. Singh was being cross-examined, Edison came back in and said there was a mistake in that response. Since then we have had three additional corrections to that response. We only got a correct answer

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after we compiled the breakdowns provided and gave Edison the accurate answer.

We determined that there were errors based on breakdowns provided to us when we asked for supplemental Interrogatory 12. This is important partly just procedurally for you to know why we are asking for oral supplement of his testimony.

It is also important and relevant to this case, because Dr. Ericksen plans to make comments about Edison's pattern of compiling data and the accuracy in providing certain data.

And therefore, at this time I offer it as Intervenor Exhibit R-11.

JUDGE SMITH: As I understand, there is a dual purpose. One is to explain why you did not have an opportunity to prepare testimony. The other is actual direct evidence of a corporate inability to provide accurate information?

MS. JUDSON: That's correct, your Honor.

MR.MILLER: Judge Smith, I object to the introduction of the exhibit. Indeed, what Ms. Judson ought to say is that perhaps this reflects not just the inability of Commonwealth Edison Company to compile data, but also that of Isham, Lincoln & Beale, because we certainly had a hand in getting this information together.

As the Board will recall, the original

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Interrogatory responses were acknowledged by Commonwealth Edison to be inaccurate when Dr. Singh was testifying, and we undertook to provide corrected responses in a very short period of time, and we did so.

The attorneys who were to have supervised that effort were engaged in this hearing room, and that has sort of been the pattern of our efforts to obtain as accurate information as we are able to in somewhat short timeframes.

For example, the response to the supplemental interrogatories was asked for within, I think, four days after it was served. And the data collection and compilation was entrusted to individuals who did the best they could. But we were unable to check it as carefully as we wished.

I had told Ms. Judson on more than one occasion that if she will tell me what numbers it is that she wants to use, I would probably stipulate to them because what we are talking about are changes of one or two or ten or a hundred out of 15,000. And I don't believe they are consequential.

I have also told Ms. Judson that I can't verify that the latest numbers are totally accurate. What is involved is a person sitting down and counting individual items from documents and writing down a number. There are many items, there are many documents, and people make mistakes.

I don't believe that the exhibit is necessary for

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the first purpose that is offered, because procedurally we have been trying to be diligent in our obligation under the NRC's Rules of Practice to provide correct information when we know that the information that we have provided previously in Interrogatory responses was inaccurate.

As far as the second purpose goes, that, too, is irrelevant unless there is some materiality. The fact, that given a period of some months -- not even months, really weeks--in which to go over extremely detailed records and pull this data out, we have made errors.

Now when I say "we" I mean people at the company who are responsible for this, and the attorneys at Isham, Lincoln & Beale who are also responsible for that, and that includes me. I think that we probably would have been justified in answering the original Interrogatory by saying: "There are documents out at the site that contain this information. You come and look at it. Make your own data compilation."

We didn't do that, and I don't think that there should be any inferences drawn about the overall data compilation by Commonwealth Edison Company on the basis of these answers to Interrogatories.

If the Exhibit is admitted, it seems to me it raises an extraneous issue. I don't know. Perhaps we have to have rebuttal testimony on the circumstances under which

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this data was compiled.

MS. JUDSON: Your Honors, may I add just one point to clarify. The Interrogatories where we have had these numerous revisions and mistakes was not the Supplement which is the breakdown, but was the total that was provided first in final form in June 25, 1984. There was some initial revisions of that data request even earlier than that.

What we are going to show is that some of these errors reflect problems not only in answers to the Interrogatories, but also tied into the data in the Reinspection Program itself. And we think that it is relevant in this proceeding whether the people who are compiling data on this Reinspection Program did their job right.

As Intervenors, we are entitled to correct answers.

It is true it is only because we insisted on the breakdown, that we found the errors. However, those breakdowns were the inputs used to generate tables in this Reinspection Program.

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MR. MILLER: I don't know that that inference can be drawn from anything that's going on, with respect to the answers to interrogatories.

JUDGE SMITH: That does not comport with Mr. Miller's statement. What is your basis for your statement?

MS. JUDSON: Well, that these -- my understanding -- we asked for the inspector by inspector breakdowns for certain elements and attributes reported in the Reinspection Program. And Dr. Ericksen is prepared to testify about the fact that the answers provided, in interrogatory 12, when added together do not conform with some of the data provided in the Reinspection Program.

And we believe that it's inaccurate and there are errors.

MR. MILLER: I'm sorry.

MS. JUDSON: If you wish to reserve a judgment on the admissibility of this document until after Dr. Ericksen supplements his testimony, we would be quite willing to agree to that.

JUDGE SMITH: Well, let's first address the first purpose for which it is offered, and that is justification for supplemental testimony. Is there an objection to supplemental testimony?

MR. MILLER: No, and I told Ms. Judson many times that I recognize the difficulties that she and the witness are

laboring under, with respect to this data. I have no objection to that.

JUDGE SMITH: So you don't have to offer it for that purpose. Now to offer it for the substance that you suggest, that is that it demonstrates a corporate inability to collate accurate information in the Reinspection Program, if Mr. Miller objects to that, he can put you through many, many, many hoops and putting you through proof of the summary and conclusions that you would have us draw.

I just wonder if, having obtained that, if it was going to have a probative value that would be of any worth. Just what exactly -- what finding would we make from Intervenor Exhibit R-11? How do we plug that in to our decision?

MS. JUDSON: Finding that Edison has not adequately kept records and compiled data relating to the Reinspection Program?

JUDGE SMITH: Okay, tear down the plant, that's it. And then just decommission it.

MS. JUDSON: Your Honor, this is clearly one point, but it's a point that we have a right to make. And I also think that it is grossly unfair for Edison to refuse to accurately answer interrogatories.

JUDGE SMITH: Well, that's another matter. That's an entirely other matter. There could be inferences that could be drawn from a refusal to accurately respond to

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interrogatories, a negative inference rule, for example. That you are offering this as evidence that the reinspection data is inaccurate.

MS. JUDSON: I'm offering it as evidence that there is a corporate problem in providing accurate data. And we have seen repeated circumstances --

JUDGE SMITH: A corporate problem in providing accurate data?

MS. JUDSON: Relating to the Reinspection Program.

JUDGE SMITH: Are you offering it as evidence that there is a corporate problem of using accurate data in the Reinspection Program?

MS. JUDSON: No. There will be additional evidence provided on that point, but this has not been offered at this time.

MR. MILLER: Judge, I just have one further comment to make. Frankly, I feel a little bit as if I have been sandbagged and I will tell you why. When Ms. Judson said look, we've done our own compilation. I want you to stipulate that those numbers are accurate. And I said, you know, tell me what numbers you want to use and I will stipulate that they are accurate because I believed that Dr. Ericksen needed these numbers to make statistical calculations and did not want to be subjected to cross-examination by me that he hadn't used the right number.

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I just wanted to get that issue behind us. It was never my intent and perhaps I wasn't as careful as I should have been to say that. These numbers are accurate for all purposes. And to the extent they are different from the numbers in the Reinspection Program Report. The Reinspection Program Report is therefore inaccurate and reflects an inability, on the part of Commonwealth Edison, to compile accurate data.

I think this is really just reaching --

MS. JUDSON: Your Honor, respectfully I beg to differ. I repeatedly asked for correct answers to his interrogatories. It was Mr. Miller who suggested the stipulation when, after repeated attempts, he couldn't provide an answer that seemed to conform with the disaggregated data.

But I really feel that we've been placed at an extreme disadvantage --

JUDGE SMITH: Well, let's say that that's true. Let's say that you were treated unfairly and bad. Let's just accept that for argument. What do we do with that information.

MS. JUDSON: I think you can use it as evidence that the Company has difficulty in keeping records and compiling data.

JUDGE SMITH: Well, I think we will take advantage of your invitation to defer ruling until you have established something. Now we are under one -- not inconsiderable burden

here. And that is we don't know what kind of data you're talking about. But other than that, let's proceed.

MS. JUDSON: Fine, Your Honor.

JUDGE SMITH: I mean, at least I don't know what kind of data you're talking about. Should we know? I mean, is there something that's been missed here? What type of figures are you talking about?

MS. JUDSON: These are --

JUDGE SMITH: You see we -- I have not, and by design, followed discovery requests. We do not monitor interrogatories and interrogatory responses. We don't choose to do that, even if we had time to do it, you see. So we don't know just what's involved in this.

So if you're going to make your case on this exhibit, you're going to have make a deminstration of materiality of it and just make your case.

MS. JUDSON: Fine, Your Honor. We'll do that. Thank you.

(Pause.)

MS. JUDSON: Your Honor -- strike that. I will start the cross examination -- I mean, excuse me, direct examination.

DIRECT EXAMINATION

BY MS. JUDSON:

Q Please state your full name and business address

for the record.

A My name is Eugene P. Ericksen. My business is Mathematical Policy Research, Box 2393, Princeton, New Jersey, 08540.

Q Do you have, before you, a document entitled Testimony of Dr. Eugene P. Ericksen, consisting of 17 pages preceded by a two page summary and with attachments consisting of Appendix 1, Table 1 and Attachments A and B?

A I do.

Q Was this document prepared by you or at your direction, for this proceeding?

A It was.

Q Are there any corrections, changes, or additions that you would like to make to this testimony?

A Yes, there are some.

JUDGE SMITH: We'll go off the record for these.

(Discussion off the record.)

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JUDGE SMITH: Back on the record.

BY MS. JUDSON:

Q Dr. Ericksen, do you have any changes or additions to make, based on the data that has been supplied to you by Commonwealth Edison since the time when you filed your initial testimony?

A Yes, I do.

Q And what is that?

A Well, I think that I would like to first of all note that Table B.3 is incorrect. In Table B.3, for example, under attribute number 1 -- .

Q Excuse me, Dr. Ericksen, is that Table B.3 from where?

A From the Reinspection Report.

Q Thank you.

A For Inspector A there were 51 reinspections and 47 of them had no discrepancy. And of the additional three discrepancies, there was no evalution made for design significance.

Q Do you refer to this in any table of your own?

JUDGE SMITH: Table 3?

MS. JUDSON: Right.

BY MS. JUDSON:

Q It's Table 3 and Attachments D and E.

A That's right.

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JUDGE SMITH: Ms. Judson, before you proceed, I am somewhat concerned that the record may be confused on the point, at least it misled me. I thought that he was beginning to testify as to errors in his own work, but he's actually testifying as to errors he has found in Commonwealth Edison's work, or perceived errors.

MS. JUDSON: Your Honor, I think that's correct and maybe I can give the witness a bit of guidance because we have had to add these --

JUDGE SMITH: Yes, I just wanted to clear up the threshold at which we entered this line of questioning.

BY MS. JUDSON:

Q Dr. Ericksen, first we were going to go through your substitution of Attachment B and your Table 2 to explain to everyone how the data has changed. Why don't we do that first?

A Oh, I jumped the gun. This new Table 2 --

Q First, why don't you discuss the new Ericksen Amended Attachment B, so everyone knows that it is being supplemented or replaced.

A That is right. And I believe that there are 17 elements where changes were made. And in 15 of those elements, the proportion of the original inspections that were reinspected went down. In one it stayed the same and in one it went up.

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In addition, there were three elements in which it turned out that there were no reinspections at all. The company previously reported that there were reinspections but I believe that they now say that those elements were not reinspectable.

So that changes -- I have to find the page --

Q I believe it's Ericksen Attachment B which is the number that would be changed.

A I was looking for the place where it was changed in the actual body of the testimony.

Q I can ask you a direct question about that later. Why don't we just get the amended testimony in first.

JUDGE SMITH: Ms. Judson, I don't think there would be any objection, at this preliminary stage, if you were to perhaps join Dr. Ericksen at the table and just help him organize. I mean, if you think it would be helpful.

MS. JUDSON: I think it would be, because of the delays in getting --

JUDGE SMITH: Right. Why don't you just do it whatever way would be most helpful.

(Pause.)

BY MS. JUDSON:

Q Dr. Ericksen, would you like to make any changes to your Attachment B, based on changes in Edison data?

A Yes, I would like to submit this Table 2. If

you look in my Attachment B --

JUDGE SMITH: This is amended Attachment B?

THE WITNESS: Yes, I think I got confused by the proceeding off the record. I thought we had already done that. In my Attachment B, starting on page two of six, I give names of inspection elements and indicated the total inspections performed, the total reinspections performed, and so on. And a lot of those numbers are now different.

To give you an example of one that's different, if you turn to page five of six, where it says "Finished weld inspection for piping and whip restraints" there were 4,395 and the new number is 10,981. So that's an example of the change that should be made.

JUDGE SMITH: Well, what are your long term intentions, with respect to these changes? I mean, how do you intend, if you do, to get them into the record?

THE WITNESS: Well, I felt that since I had testified in terms of the shortcomings of the sample, that I should make some comment, given that the numbers were changed. And the change in the numbers, in 15 cases, indicates that a smaller proportion of the population was sampled than I originally thought. In one case, there was no change and in one case the proportion went up.

JUDGE SMITH: I guess my question is more of a mechanical one, rather than a substantive one.

MS. JUDSON: Perhaps I can help. The mechanical changes that Ericksen Amended Attachment B will replace the former Attachment B and Table 2 is being introduced to show how the numbers have changed to support -- to show that the changes do not alter Dr. Ericksen's conclusion. And in fact, they are even stronger because of those changes.

JUDGE SMITH: All right. I understand.

MR. MILLER: Judge, I have no objection to simply physically replacing --

JUDGE CALLIHAN: Attachment B is correct, is it not, from what you just said? I will repeat. Ericksen Amended Attachment B, received today, page five of five, Item 29, is the correct number of total inspections performed, namely 10,981. Is that a true statement?

THE WITNESS: That's right.

JUDGE CALLIHAN: Thank you.

MR. MILLER: Your Honor, I have no objection to simply replacing the original Attachment B with this amended Attachment B. Can't that be done?

JUDGE SMITH: I thought that's what we did.

MR. MILLER: Is that what we have done? Then I don't understand why we are --

JUDGE SMITH: Well, there are errors in Amended Attachment B, also.

MS. JUDSON: No, there are not. The witness was

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merely trying to explain that the statements he made about inadequacy of sample size still hold true and may even be stronger. And that is the purpose of showing Table 2. Because he already filed testimony, he wants the judges and everyone here to understand that even though the numbers changed, those conclusions didn't have to change.

And in fact, they're a bit stronger than they were before.

JUDGE SMITH: I understand. Okay.

So Attachment B -- Amended Attachment B will be the one that's received into evidence.

MS. JUDSON: Right. And Table 2 will show the changes that were made between the first answer and --

JUDGE SMITH: All right. All right.

end4

BY MS. JUDSON:

Q Dr. Ericksen, do you wish to make any other changes based on the changes in Edison's response to Interrogatory 12?

A Well, if you look on page 7 in Answer All, I gave an example of out of 4,321 original inspections of piping and whip restraints, only 4 reinspections were done. The 4,321 is now 10,509, and the 4 is now 0.

And again, my conclusion has not changed substantially.

Q Do you wish to add anything to your Answer 11?

A Yes. The justification for the statement that Edison did not disaggregate Hatfield data by inspection element on page 8 -- the support for that is Attachment C.

JUDGE SMITH: Should we make a physical change in that testimony?

MS. JUDSON: Yes, you can add, See Ericksen Attachment C at the end of the last paragraph in Answer 11.

JUDGE SMITH: Following the word "element." And you're going to make that change in the copy you give the reporter. Everything that we do has to be made in the copy given to the reporter.

MS. JUDSON: Yes, that's right.

MR. CASSEL: That was "see Ericksen what?" Attachment C, was it?

MS. JUDSON: Attachment C.

BY MS. JUDSON:

Q Dr. Ericksen, do you wish to supplement your testimony in any way? And if so, why?

A Yes, I would like to supplement my testimony based on new information that has been provided by Commonwealth Edison. I think it will help me make my points somewhat stronger.

Q Do you wish to offer any comments concerning the changes in the data provided by Edison in response to Interrogatory 12?

A Well, I think I've already commented on the record concerning the error in Table B.3. Do I need to go through that again?

Simply that there were three additional discrepancies which do not appear to have been evaluated for design significance.

Secondly, --

MR. MILLER: Excuse me. I'm going to move to strike because there's not anything that I'm aware of in the record -- certainly nothing in Dr. Ericksen's testimony -- that says anything about the evaluation of discrepancies. Unless there's some foundation laid for his assertion that the discrepancies he has found were not evaluated for design significance, I object.

MS. JUDSON: I would like to respond to that. Table 3 of Dr. Ericksen's testimony is a reproduction of Table -- parts of Table B.3 for Hunter attributes. It lists the results of inspections by inspector.

Ericksen Attachments D and E show the breakdowns for individual inspectors for this reinspection attribute number 1. When you add up the total for Inspector A of the sample elements reinspected -- that is, 24 and 27 -- it turns out that there were 51 elements reinspected. Table B.3 shows only 48.

Ir the testimony of Mr. Singh, he indicated that 109 discrepancies were evaluated. That's a part of the record. Mr. McLaughlin indicated that he reviewed 60 Hunter weld discrepancies to determine design significance. Mr. Branch indicated that he reviewed 49, which gives a total of 109.

However, this disaggregated data shows that there were 112 discrepancies. Dr. Ericksen is not providing any opinion about whether these discrepancies were or were not design significant. He's merely trying to show on the record that there were recordkeeping errors, and it seems that there's no evidence in any evaluation for certain discrepancies.

MR. MILLER: Based on that explanation, I withdraw my motion.

THE WITNESS: Okay. Secondly, I am not sure if I have the right numbers even now. This seems to have been an extremely haphazard, sloppy data collection --

MR. MILLER: Excuse me. If the witness will testify as to fact rather than characterizing this, I think that the record will be useful to the Board. The Board will undoubtedly draw its own conclusions about data collection, and I don't think it adds anything to the record to have Dr. Ericksen call it sloppy or haphazard or anything else.

THE WITNESS: Well, let me simply state that my expectation was that these numbers, given the investment that's been made in the plant and the investment that's been made in these hearings, would have been readily accessible in a printout, and it would just be a matter of finding them.

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MR. MILLER: Judge Smith, I move to strike.

I don't know what, in Dr. Ericksen's background, qualifies him to state what should and shouldn't be on computer printouts at a nuclear power plant.

JUDGE SMITH: Okay. Now did you move to strike the "sloppy and haphazard?"

MR. MILLER: Yes, that's right.

JUDGE SMITH: So we have two motions, with respect to the computer printout opinion. Dr. Ericksen, do you really feel qualified to make that observation?

THE WITNESS: Well, in my background, in the survey and data collection business, at Mathematical Policy Research, and before that, any time we get involved in any large-scale data operation in this day and age we find it necessary to computerize and mechanize the procedure.

Therefore, any correction that comes up, assuming the computer programs are correct, we can get the answer simply by programming the computer to provide it.

JUDGE SMITH: Well, I think the better disposition of your objection is not to strike it but to understand the context in which he is making a judgment. And it's appropriate for cross examination, of course.

With respect to his characterization, he is making that not as an expert witness, but as an observer of certain facts, and he is describing what he inferred from those facts.

And you can cross examine him on that. So your objection is overruled.

I do believe, however, Dr. Ericksen, that your testimony might flow somewhat more smoothly if you select your words more for accuracy rather than for perjorative impact.

THE WITNESS: Okay.

BY MS. JUDSON:

Q Dr. Ericksen, what new data have you received since your testimony has filed?

A I have received data from the Hunter Company giving the discrepancy rates for individual elements and individual inspectors.

Q Have you formed any conclusions, based on this data?

A Yes, I have. An example of the data I've given in my Table 4. In Table 4 I have selected, for an example two elements. Element number one is finished weld inspections for piping and whip restraints. Element number two is finished weld inspections for component supports. And the inspectors who are listed are the nine inspectors who inspected both elements.

There are some other inspectors who inspected one but not both and these inspectors, most of them, also inspected other elements.

I am simply trying to indicate a result for the nine

inspectors who inspected both of these elements. Now what this table shows me, first of all there is variation between elements for the same inspector. If you look at Inspector A, his discrepancy rate was 12 percent for the second element and 4 percent for the first element.

Inspector E was 68 percent for the second element and 1 percent for the first element.

If you look within the element, you can see that there are also variations in the discrepancy rates among the inspectors, 12 percent, 0 percent, 68 percent, to give you an example.

I think that this is the best evidence that we have that indicates that inspectors and elements are not homogenous, that individual inspectors had error rates which were unique to them. Some were higher than average, some were lower than average.

It also shows that elements vary according to their difficulty of inspection. Some were more difficult to inspect, some were less difficult to inspect. These data also show that there were particular combinations of element and inspectors where the discrepancy rate was particulary high or particularly low.

Given that there was variation among inspectors and among elements, it is difficult to generalize to those elements where no inspections were done, to those inspectors

who did not come into the sample. Now the problem goes beyond just the Hunter Company. In Table 5 I have compared the discrepancy rates for the five companies who reinspected visual welds. And you can see that there was variation among the companies for this same attribute.

Now the Hunter Company was the one where the discrepancy rate was lower. For the Hatfield Company, I think it would have been very instructive to have seen the same kind of table by element and by inspector. I think that this issue capsulizes the disagreement between the two sides here.

My position is that any time a sample is selected and a person wishes to make a generalization to the population, that person is making a statistical statement. Now I have read that the assumption was made that inspectors and elements were homogenous and that those were made on the basis of engineering judgment.

It is my position that the data show that the engineering judgment is incorrect.

Q Do you have any further additions or changes that you wish to make to your testimony?

A No, I don't.

Q With these corrections, changes, and supplementary testimony, is this testimony true, accurate, and complete to the best of your knowledge?

A It is.

MS. JUDSON: Your Honors, I now move to have this testimony, as corrected, changed and supplemented, received into evidence and bound into the transcript of these proceedings as if read.

JUDGE SMITH: Are there objections?

MR. MILLER: Judge Smith, I would like to conduct voir dire examination of Professor Ericksen before stating my objections.

JUDGE SMITH: All right.

Ms. Judson, perhaps -- if you would return to your counsel table, please.

(Pause.)

JUDGE SMITH: I think this would be a good time to take our morning break.

(Recess.)

end6

JUDGE SMITH: If you are ready, you may proceed, Mr. Miller.

MR. MILLER: Thank you, Judge Smith.

VOIR DIRE

BY MR. MILLER:

Q Dr. Ericksen, it's correct, is it not, that you are not an expert in structural, mechanical, or electrical engineering?

A That is correct.

Q And it is also correct that you do not know what quality assurance is, in the nuclear industry?

A I have an idea of what quality assurance is, in the nuclear industry.

Q Dr. Ericksen, were you deposed by my, on July 19th, 1984?

A Yes, I was.

Q And at page 14 of that deposition, were you asked these questions -- and did you give these answers?

"Question --" I'm sorry. Page 14, line 17.

A This is the first one?

Q Yes, sir.

Were you asked these questions and did you give these answers?

"Question: Do you regard yourself as an expert in Quality Assurance techniques?"

"Answer: Could you be more specific about what do you mean by Quality Assurance techniques?"

"Question: Do you know what Quality Assurance is in the nuclear industry."

"Answer: Not in the nuclear industry."

Did you give those answers?

A I did.

Q Thank you.

A I would like to say --

Q Excuse me. Your counsel can, if she wishes, elicit questions from you when her time comes.

MR. MILLER: He has answered the question, Judge Smith, and I would like to proceed.

JUDGE SMITH: Dr. Ericksen, there will be times during your cross examination when you will be invited to explain your answer right at the time and there will be times when counsel will exercise his perogative simply to get yes or no answers. And I will leave it to your attorney to develop your explanation. That is his right.

If, after the end of your testimony, you believe that you have been denied an opportunity to explain everything that you wish to explain, you may seek leave of the Board to do it.

In the meantime, Mr. Miller does have a right to have a strict type of cross examination.

BY MR. MILLER:

Q Dr. Ericksen, it's also correct that you have not been involved in the design, engineering, or evaluation, of a nuclear power plant?

A That's correct.

Q You have never worked as a Quality Control Inspector at a nuclear power plant?

A That's correct.

Q And it's also correct that none of your previous consulting assignments involve nuclear power plants, is that correct?

A That's correct.

Q You were first contacted by the Intervenors in this proceeding in early July?

A That's correct, to the best of my memory.

Q Could you tell us about how much time you have spent on this assignment since you were first contacted by the Intervenors?

A I would say somewhere between five and ten days, five to ten eight-hour days.

Q You are an expert statistician, is that correct?

A I am.

Q Now, I would like you to turn to answer 10 to your prepared written testimony, Dr. Ericksen.

MR. CASSEL: Judge, I'm at something of a

disadvantage here. I haven't seen a cross plan. If the Board is confident that this is appropriate voir dire, I'm not going to raise any question. It does seem to me that this is appropriate cross examination on the merits, as opposed to a preliminary decision on the admissibility of the document.

JUDGE SMITH: I don't see anything that matters.

MR. CASSEL: Fine.

JUDGE SMITH: I think it's his choice and if he chooses to go this way, it's all right. I don't see any problem.

BY MR. MILLER:

Q Dr. Ericksen, in the first sentence of answer 10 -- first of all, right in the first line, you say we. That is, the sentence reads "In order to assure that a plant can be operated safety, we are primarily concerned --" and so forth.

Is that the royal "we" sir or are you talking about yourself?

A I think that "we" refers to society in general.

Q Of ccurse, that's why we're all here, to get the assurance tnat the plant is operating safely, correct?

A I think that your "we" is the same as mine, in that question.

Q Now in the third line of Answer 10, you referred to inspection elements, correct?

A That's correct.

Q And then you, in the following sentence, analogize those inspection elements to the parts of an automobile. And the analogy is that it really doesn't do us very much good to know that 99.5 percent of the parts of the automobile were inspected if the 5 percent that were missed are the brakes and the steering. That's the analogy that you draw, right.

A It's 0.5 percent.

Q 0.5 percent, correct. That's the analogy that you're drawing?

A That's right.

Q It's a fact, is it not, that brakes and steering in the automobile, those aren't inspection elements, those are safety systems, aren't they?

A Well, I think that the point is that if there is a critical part of an overal mechanism, that if that is incorrect, the entire mechanism is unsafe. Then you want to be absolutely sure that that particular component is correct.

Q Right. And a brake system in an automobile is composed of tubing, piping, and the electrical system that goes to the brake lights and the assembly of the brake pedal and the brake discs or drums, isn't that right.

A Well, the idea there -- that is certainly the case.

The idea there is that if you take all of those elements and put them together, and they're 0.5 percent of the parts of the car, that each one of those needs to be inspected properly.

As it happens, I once had a car that was supposed to have been properly inspected and it turned out that the only thing that had not been put in there was the brake fluid. I got out driving the car and the brakes didn't work. So that was one element. That's one part of the brakes.

Certainly I'm quite confident less than 1/2 of 1 percent of the things in the car that need to be inspected.

Q What do you understand the term "inspection element" to mean, as it's used in the Reinspection Program?

A It's my understanding that an inspection element is a unique part of the plant.

Q Of the --

A Is a unique part of the nuclear power plant, that has unique characteristics. There may be several of them, but I guess you would think of it as an indivisible grouping that would not have subparts.

Q Aren't inspection elements related to inspection tasks, rather than to specific systems within the nuclear power plant?

A I'm afraid I don't understand that question.

Q Let me try it again. Inspection elements are, for

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example, visual weld examinations, correct? Aren't visual welds an attribute?

Well, let's take one of your amended supplemental tables here, Dr. Ericksen. If we look at Ericksen Attachment E supplement, finished weld inspection for component supports.

A Okay.

Q Does that indicate what system, within the nuclear power plant, the finished weld inspection is going to cover?

A Component supports.

end7

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Q Do you know whether component supports are unique to specific systems within a nuclear power plant?

A Well, to answer what I understand the point of your questioning to be --

Q Don't answer the point of my question. Please, just answer my question.

Do you understand that component supports are unique to a specific system within a nuclear power plant?

A No, I don't.

Q Okay.

Now, I would like you to turn, if you would, to the last paragraph of answer 10. Now, once again in this sentence, the second sentence of that last paragraph it starts out: "Even if we are 95 percent certain. . ." and so on.

Once again, who is the "we" that you are referring to there, sir?

A I suppose that would be anybody who wants to make a comment on the safety of a nuclear power plant.

Q Well, do you include those persons who are entrusted by the laws of the United States with the regulation of the construction and operation of nuclear power plants within the word "we"?

A Let me make sure that we have the same sentence.

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We are talking of the sentence, "Even if we are 95 percent certain that 99 percent. . ."?

Q Yes, that's the second sentence.

A And your question again?

Q My question is, do you include within the word "we," those individuals who were entrusted under the laws of the United States with responsibility for regulating the construction and operation of nuclear power plants?

A That's right, because such a person would have to have some kind of statistical basis for making that statement and none has been proferred.

Q I see.

Do you know of any regulatory requirement by the NRC which says that in order for a nuclear power plant to receive an operating license, the Nuclear Regulatory Commission must be more than 95 percent certain that 99 percent of all inspections that had a chance of being included in a sample met design requirements?

A I'm not a lawyer, so I don't know the law.

Q You have never looked at the regulations, have you?

A No.

Q Do you know of any NRC -- I'm going to move down to the third sentence in that paragraph.

Do you know of any NRC regulatory requirement

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that says that the NRC wants to be more than 95 percent certain that more than 99 percent of very important safety elements met design requirements?

A No.

Q In your judgment, Dr. Ericksen, do the words "reasonable assurance" mean that you want to be more than 95 percent certain that more than 99 percent of the very important safety elements meet design requirements?

MR. CASSEL: Objection.

Is he referring to reasonable assurance in the sense that those terms are used in the law?

MR. MILLER: Just a second. Excuse me. I object to counsel's interposing at this point in time, because what we are testing here is Dr. Ericksen's knowledge of the regulatory process. And Dr. Ericksen is perfectly capable of picking up from his counsel the thrust of my question.

I believe I am entitled to his answer based on his knowledge as he sits there. The words "reasonable assurance" are perfectly straightforward English words.

JUDGE SMITH: May I have the question? Could you reread the question, or should I have the reporter read it?

MR. MILLER: The question was, do the words "reasonable assurance" mean that one wants to be more than 95 percent certain that more than 99 percent of very important

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safety elements met design requirements.

MR. CASSEL: And the objection, Judge, is to the absence of a definition of the term "reasonable assurance." It has a lay meaning, and it is a legal term.

JUDGE SMITH: Where does it derive? Where did you get the term? Is it in his testimony?

MR. MILLER: No, sir. I am testing his knowledge, frankly, of the NRC regulatory approach, as he purports to make statements about what it is that the NRC ought to be judging the safety of this plant by.

MR. CASSEL: If that is what his purpose is, then he should make clear in his question that he is asking the witness whether the term "reasonable assurance" as used in NRC Regulations, means what Mr.Miller is asking, rather than just saying "reasonable assurance."

MR. MILLER: I'll accept that amendment.

S2BU

BY MR. MILLER:

Q Now, Dr. Ericksen --

A Now could we have the question?

Q Sure.

Do the words "reasonable assurance" used in NRC Regulations mean that the NRC wants to be more than 95 percent certain that more than 99 percent of very important safety elements meet design requirements.

A I don't see how I could answer that question

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without knowing what -- As I understand the question you are asking me what the NRC means by "reasonable assurance."

Q Yes, sir.

A You are asking for factual --

Q I am asking you whether it means that the NRC wants to be more than 95 percent certain that more than 99 percent of very important safety elements meet design requirements.

A Oh, I would expect that the NRC's concern with the safety of the elements would be based on their assessment of the risks of the elements not being properly inspected. And those elements, where the consequences of an error were great, they would want to have much greater assurance.

I think Three Mile Island in Pennsylvania is an example of that.

MR. MILLER: I don't believe the witness has been responsive to my question.

JUDGE SMITH: I always have trouble with the word "reasonable" anyway. When you are going to introduce that into a question, you are inviting that type of answer.

MR. MILLER: Judge, I put a context on it at counsel's suggestion, which is NRC Regulations. What I want to know, basically, Dr. Ericksen, are you aware of any aspect of the NRC Regulation which quantifies the regulatory term "reasonable assurance" in terms of a confidence interval

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and a reliability calculation?

JUDGE SMITH: That is a good question, and that is a question as to which counsel is entitled to a yes or no answer.

THE WITNESS: No.

BY MR. MILLER:

Q Thank you.

Now, Dr. Ericksen, are you familiar with the scope and coverage of the quality assurance program at the Byron Nuclear Power Plant?

A I have reviewed the Reinspection Reports, so I am familiar to the extent that it was described in the Reinspection Report and in the testimony which has been given by certain Edison witnesses.

Q And are you familiar with the Nuclear Regulatory Commission's resident inspector program?

A No.

Q Are you familiar with the scope and coverage of routine Nuclear Regulatory Commission Staff inspections of the Byron Nuclear Power Plant?

A You mean in addition to those which were part of the Reinspection study?

Q Yes, sir.

A No.

Q Are you familiar with the NRC so-called CAT

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team inspection in 1982?

A Well, let me state in terms of all the questions you have asked me, I was aware that programs existed. I don't think that's what you mean by familiar.

I think what you mean by familiar is am I aware of how they are done and that sort of thing, and the answer is no.

Q Do you know whether or not -- have you ever heard of the initials ACRS?

A Certainly, I have heard the initials ACRS.

(Laughter)

Q As an acronym for a body?

A No.

Q So you don't know what function, if any, the ACRS, which stands for Advisory Committee on Reactor Safeguards, performs with respect to analysis of the safety of nuclear power plants?

A No. All that has been beyond the scope of my evaluation testimony.

Q I take it, from your previous answers, that you have never looked at Appendix A to 10 CFR Part 50?

A I don't know my titles.

Q Those are general design criteria for nuclear power plants.

MS. JUDSON: Can you show it to the witness?

MR. MILLER: I want to know if he can remember it. I'll be glad to show it to him.

MS. JUDSON: He said he doesn't remember his titles. I think it would be helpful for him to see the document.

(Document handed to witness.)

BY MR. MILLER:

Q It goes on for about seven or eight pages, in the bound volume of 10 CFR that I have tendered the witness. I don't ask that you read it all. I just want to know whether, scanning it, you can tell us whether you've ever seen it before?

A Yes, I have seen it.

Q When did you first see it, Dr. Ericksen?

A Sometime in July.

Q Did you read it from front to back?

A I read it in sections. I did find a sentence in there that I've seen before.

Q All right. Now in your answer to Question 10 at

page 7, the sentence we've been looking at, you talk about wanting to be more than 95 percent certain that more than 99 percent of the very important safety elements met design requirements.

I would like to ask you if you could identify for us what the very important safety elements are, in a nuclear power plant?

A This is an example of where the statistician relies on subject matter expertise. I believe Mr. Teutken provided a categorization of the safety significance of elements.

Q Well what does the word safety elements, as used in that sentence mean? Does it mean safety systems, like the brakes in a car, or does it mean inspection elements?

A It means the component parts.

Q And where, in Mr. Teutken's testimony, did he classify the component parts by safety significance?

A It's my understanding that Mr. Teutken was taking categories of things which are inspected and assigning them the safety significance. And I have simply taken all of the elements which would be part of that to have the same safety significance in grading.

Q From whom did you get that understanding of Mr. Teutken's testimony?

A That was my own.

Q Did you review Mr. Teutken's deposition?

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A I don't recall.

Q I think your counsel will stipulate, Dr. Ericksen, that Mr. Teutken was not asked to rank component parts in terms of their safety significance, but rather to rank inspection elements, all of which Mr. Teutken said were safety related.

MR. CASSEL: We will so stipulate.

end9

BY MR. MILLER:

Q Now, outside of your understanding of what Mr. Teutken said, is there any basis that you know of for differentiating a particular component part as a very important safety element?

A Well, I think it's simply a matter of common sense that the paint on the side of the pipes may not have the safety significance at the same level that the welding would have inside the center of the nuclear reator.

And as a statistician, a question that I would routinely ask an engineer would be to make a classification of the risk of failure of every element of a nuclear power plant.

Now, what Mr. Teutken provided was an approximation to that. And given that all I had was an approximation of that, I simply had to go with it. What that approximation told me was that there were variations in the safety significance of parts of the nuclear power plant; whether you call them elements, components or whatever.

Q Well, in other words, it doesn't make a difference to you whether he was talking about inspection elements or component parts?

A That's right.

Q They're interchangeable, as far as you --

A No, they are not interchangeable. But I think

that every subpart that could be inspected, there is a classification. One can assess the risk of error.

Q Well, would you agree, Dr. Ericksen, that the very important safety elements include those safety systems that would be called upon in the event of a LOCA?

A You'll need to define your last term.

Q You don't know what a LOCA is?

A No.

Q It's a loss of coolant accident. Have you ever heard that term before?

A A loss of cooling -- ?

Q Accident.

A I may have.

Q Are those systems that would be called upon to operate in the event of a loss of coolant accident a part of the ECCS?

A I don't know.

Q Do you know what ECCS stands for?

A No, I don't.

Q It stands for emergency core cooling system. Now let me just ask you one more question along this line. Which, if any, of the systems that I am going to name are a part of the emergency core cooling system at Byron?

MR. CASSEL: Objection. The witness has already testified he doesn't know what the ECCS is. If Mr. Miller's

point is that the witness does not know the engineering components of a nuclear power plant, we will so stipulate. This is simply beating a dead horse at this point.

MR. MILLER: Well, maybe. But I think I'm entitled to one more try at this. If the Board wishes me to move on to something else, I will be happy to.

JUDGE SMITH: Dr. Ericksen, I believe, has been quite candid in admitting to you that he has little knowledge of the operation of a nuclear plant. I don't think he's trying to inflate his expertise in that area. I think you have made your point.

MR. MILLER: All right. Let me just move on.

BY MR. MILLER:

Q Dr. Ericksen, with respect to any of the component systems that make up the emergency core cooling system at Byron, do you know what the scope of work of Hatfie. or Hunter is?

A If I understand your question, what you are asking me is, do I understan' what the systems are that were inspected by Hatfield, and what are the systems that were inspected by Hunter. I believe the answer was that they were listed in the Inspection Report.

Q Which inspection report, sir?

A There is only one.

Q I'm sorry, the Reinspection Program Report?

A Yes.

Q You have a copy before you, do you not?

A I do.

Q Would you point out for me where the safety systems that were inspected by Hatfield and Hunter are listed in this document? Unless your counsel wants to stipulate that they are not there.

MR. CASSEL: If the reference is to safety systems, I think we can stipulate that the safety systems are not listed in the Reinspection Report.

THE WITNESS: I misunderstood your question. I thought you were asking me what were the attributes which were inspected by those three companies.

BY MR. MILLER:

Q Okay, fine. Now turning back one page in Answer 10 to page 6, the sentence that begins at the top of the page talked about -- and you may have to read the preceding sentence to get the context of that sentence, but you talk about certain sample sizes that should have been taken, and that this would have enabled the Reinspection Program to establish acceptable confidence levels.

Acceptable to whom, sir?

A Would you give me --

Q It's the third line on page 6.

A Oh, I misunderstood you. Not to be difficult,

but could you repeat the question?

Q I'd be happy to. My question is, the statement in your prepared testimony says that if certain sample sizes and other statistical criteria had been followed, this would have enabled the Reinspection Program to establish acceptable confidence levels. And my question is, acceptable to whom.

A Okay. My answer to that is that in the document which you showed me there is a statement that you need to have assurance of the safety in the inspection of the plant.

Now, as a statistician, I come into it because a sample was taken and inferences are being made to a general population. And one of the things that a statistician requires for a proper statistical analysis to be done is a statement of a loss function. And a loss function has to do with the risk of error.

If you incorrectly assume that the plant is safe -- correct that, not the plant. If you incorrectly conclude that the safety element or the component or the attribute is safe and it is not, then you establish your confidence interval based on the risk of error.

And my point here is that it was incumbent, from the point of view of Edison, to have its engineers classify the things that were being inspected according to the risk of error in order for a statistician to make a reasonable

evaluation of what was done.

And my criticism is that that engineering judgment was not applied and stated in the report, which made it impossible to make a statistical evaluation. And given that a correct statistical evaluation could not have been made, it's impossible to support and verify the statistical procedures followed by Commonwealth Edison.

Q Well, so acceptable means acceptable to a statistician?

A No, it means acceptable -- the engineer is required to state -- let me back up. When an engineer wishes to make a statistical statement which -- or any statement where generalizations are made from a sample to a population of a statistical statement -- that person is required to state the costs of being wrong.

Q So you're also required to state a confidence interval and a reliability number?

A Yes, because you need to be able to make a statement that we are this much certain, and our statement takes into account the risks of error.

Q I see. But you can't tell me where in the Code of Federal Regulations that requirement is found, can you, that there be a statistical statement?

MR. CASSEL: Judge, I've got the same objection here. He said he is not a lawyer, he is not familiar with

the legal requirements --

MR. MILLER: That is certainly clear, but what his testimony purports to do is to establish certain standards.

THE WITNESS: Could we go off the record for a minute?

JUDGE SMITH: You don't have to be off the record for a request of help.

(Witness reviewing document.)

THE WITNESS: The sentence that I'm referring to is Part 50, Appendix A under Criteria. "A quality assurance program should be established and implemented in order to provide adequate assurance that the structures, systems and components will satisfactorily perform their safety functions."

Now, Edison chose to do this on the basis of sampling. It may not have been a proper sample, but nonetheless, they chose to do it on the basis of sampling.

BY MR. MILLER:

Q Chose to do what, sir?

A The Reinspection Program.

Q Is that the same as the quality assurance program, as used in that sentence from the General Design Criteria that you just quoted?

A That's what I'm taking that to mean.

And in order to do that, it's necessary to state the risks of error and a statement of the risks of error informs the confidence interval, and when the risk of error is greater, the confidence interval is to be more stringent; where the risk of error is less, the confidence interval can be less.

Now, 95 percent is not a particularly stringent confident interval, given the obvious risks of a failure of a nuclear power plant.

Q Can you find anywhere in the General Design Criteria a statement that a confidence interval of 90 percent, 95 percent, 99 percent, or any other number is the regulatory standard by which reasonable assurance is to be measured?

A I found a general statement. I didn't find any statement that contradicts it in terms of giving specific standards. And it's only reasonable that when you're going to be provided a safety assurance on the basis of a sample, that you state criteria by which you're stating confidence intervals and reliabilities.

Q All right. Now, at the bottom of page 7, you differentiate among four elements -- critical to safety, very important to safety, somewhat important to safety --

A What page?

Q I'm sorry. Page 6 again. Do you have those?

A Yes.

end 10

Q Is there anything in the Nuclear Regulatory Commission regulations, to your knowledge, which makes this four stage differentiation?

A That is only a reasonable thing to do, based on the sentence that I read you.

Q Well, Dr. Ericksen, I would like you to read the first paragraph of the introduction to the General Design Criteria, Part 50, Appendix A. Just read it to yourself and then I have a few questions.

(Pause.)

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A I have read it.

Q It's a fact, is it not, that that paragraph makes one differentiation between items that are important to safety and those that are not, isn't that correct?

A I believe you are referring to the sentence that reads "The principal design criteria establishes the necessa design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety. That is, systems and components will provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public."

I find that entirely consistent with my answer.

Q It doesn't break it down into four categories of safety significance. It is either important to safety or it's not, correct?

A That is a very general statement that needs to be specified for operations.

Q What is a very general statement, the General Design Criteria?

A Yes.

Q It could be, but it's all we've got.

Now, Dr. Ericksen, for the critical to safety element --

A You are referring to my testimony?

Q Yes. Your listing there. 100 percent reliability at a 100 percent confidence level, that's not a statistical evaluation. That is a complete, 100 percent reinspection, isn't it?

A That is exactly right.

Q Okay, thank you.

MR. MILLER: Judge Smith, at this time, I would move tc strike answer 10 in its entirety and the first conclusions of Dr. Ericksen that are found in answer 9 and answer 20.

JUDGE SMITH: The first conclusions in answer 9?

MR. MILLER: Yes, sir. I think -- they are identified in the answer. It's the cne that begins in answer 9 "First --" and so on. And it talks about failing to distinguish elements and so on.

And then, in answer 20, the first conclusion about

"The company did not properly select confidence levels and acceptable reliabilities --" and so on.

I think that my voir dire examination of Dr. Ericksen has demonstrated that he is an expert statistician and that he has simply no basis, in his expertise, or in anything in this record, or in the discovery that has preceeded it, which enables him to give opinions about what the regulatory requirements are for showing reasonable assurance, because that is what this answer 10 purports to do.

JUDGE SMITH: How much of answer 20?

MR. MILLER: I'm sorry. It is that first conclusion. The one that starts "Yes, first, Edison did not --" and so on.

MS. JUDSON: Your Honor, I have two things to say. First, procedurally, since we are in voir dire and this has not been admitted into the record, I assume the argument isn't to strike, but whether to allow it in.

Second, I would like to say that this witness has made clear, in the initial questions, that he is not an expert as to the NRC regulations or any legal requirements and that what counsel has done is he has converted a "we" and tried to press it to be more encompassing and then said we should strike all of his answer.

If he wants to limit it, the "we", to a general statement as opposed to NRC requirements, that is fine. But I think to strike this entire answer is inappropriate.

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MR. MILLER: Judge Smith, I specifically asked Dr. Ericksen whether the "we", who did those people who have the responsibility for regulating the Byron Station? And he said yes.

And what he has purported to do here is to express an opinion, as an expert, when there is simply nothing in his background as a statistician or indeed in the 40 to 80 hours that he has spent looking at the Reinspection Program which entitles him to give that opinion.

This is the same sort of situation that we faced with Dr. Bleuel. Indeed, Dr. Bleuel had perhaps some greater degree of qualification, in terms of being an engineer and being involved with hardware inspections of one sort of another.

Dr. Ericksen comes before this Board really as a statistician and is purporting to establish, by this answer 10, what a quantification of regulatory requirements is. I believe that if his testimony is not stricken, we can look forward to proposed findings from the Intervenors which say that Commonwealth Edison Company has not demonstrated reasonable assurance because for systems critical to safety, whatever they are -- and this witness certainly can't tell us what they are -- we didn't show 100 percent confidence -- 100 percent reliability and 100 percent confidence level.

Now the law is just to the contrary. We do not have

to quantify. There is a deterministic approach to regulation which involves the engineering judgment of the NRC Staff, the Applicant and -- on specific issues -- this Board. And to convert that into some sort of a numbers game would both be contrary to law and, I don't believe, would add to the safety of the public at all.

MS. JUDSON: Your Honor --

MR. LEWIS: I assume the Staff will be heard on this, although counsel for the Intervenor apparently is responding now. I would like to get my views on the record and perhaps she can then respond not only to the motion, but to the Staff's views as well.

JUDGE SMITH: Well, she has even greater options than that, too. She can redirect -- I mean, she can direct -- or whatever you call it -- in response to voir dire.

Everybody will have a chance to express views.

MS. JUDSON: I would like another opportunity to speak.

JUDGE SMITH: Certainly. Go ahead, Mr. Lewis.

MR. LEWIS: I think, Your Honor, that in question and answer 9 of the witness's testimony, there are three problems identified with the sampling design and statistical analysis. I approached this in much the same way I did the testimony of Mr. Stokes, trying to see that the impact is of an exclusion of certain portions and what the redeeming

value -- or whatever the word would be -- is of the sections that are not the subject of a motion to exclude.

It would seem to me that the second and third elements in answer 9 -- let's look at the second element first of all --

JUDGE SMITH: Well, these would survive under the motion.

MR. LEWIS: It's my understanding there's been no motion made as to them.

JUDGE SMITH: All right, fine.

MR. LEWIS: I am proceeding on the assumption that they would.

JUDGE SMITH: All right.

MR. LEWIS: At least in terms of an exclusion, on a preliminary basis.

The second one deals with the questions as to whether or not inferences can be drawn based upon the way the inspection program was put together, and speaks about lack of sufficient statistical basis for making inferences.

And the third one specifically addresses a formula used by Dr. Singh and criticizes it. To the Staff's way of thinking, those are matters that we understand to be within the area of expertise of a statistician.

By contrast, when we look to the first point, namely that the program fails to distinguish elements most

important to safety from elements less important to safety and to distinguish elements which are easy to inspect from elements which are difficult to inspect. We are unable to find any relevant expertise on the part of Dr. Ericksen, or perhaps any statistician to speak to those points.

Now conceivably, that information could have been imparted to a statistician by consultation with some subject matter expert. But I believe that the voir dire has established that that did not occur. Rather, what the voir dire seemed to establish was that Dr. Ericksen is relying upon a characterization made by Mr. Teutken of inspection attributes.

And we don't -- the Staff does not view that as providing, to Dr. Ericksen, relevant and necessary subject matter knowledge to be offering expert testimony as to whether or not matters important to safety were -- whether or not the program should have been designed, or was properly designed with levels of safety systems in mind.

In the same way, the question of whether or not something is easy to inspect, whether or not an element of the inspection program is an easy to inspect item, as opposed to a difficult to inspect item, I've heard nothing from Dr. Ericksen which indicates he has any expertise to offer an opinion on that subject.

I did hear something earlier in which he pointed

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out that there seemed to be, within a particular inspector even, some difference as to the percentage of discrepancies identified in one inspection element, as opposed to another. But I am unable to find that that is a material piece of information to enable Dr. Ericksen to offer expert testimony as to whether or not the elements of the inspection program failed to distinguish inspection elements on the basis of their difficulty.

It is for that reason that the Staff has also been of the view that, insofar as this testimony has sought to offer expert opinion as to acceptable -- as the term was used by the witness -- levels of confidence and reliabilities and to try to correlate those with some categories which he includes in his testimony, as to levels of importance to safety, that the witness is not qualified to testify on that point.

It seems to me that Mr. Miller has correctly identified the portions of the proposed direct testimony that are affected by his motion and we would support it.

end11

THE WITNESS: May I speak?

JUDGE SMITH: Just a moment.

(Pause.)

MS. JUDSON: Your Honor, I would like to make several points. First, Dr. Ericksen is not relying on his expertise to classify any elements by safety. There has been a stipulation that Teutken classified elements by safety; he is relying on those.

Second, as to the issue of the difficulty of doing various tasks, Dr. Ericksen did present supplemental testimony on the discrepancy rates that provides evidence that there really are differences in difficulties of tasks.

Third, as to the arguments of Mr. Miller on application of these regulations, they go to legal judgments. This witness is not offering a legal opinion about the NRC regulations; he is not offering expert testimony about the engineering differences of various components, elements or attributes. He is testifying as to what someone should do in establishing a sampling program to verify quality of work.

That is what Edison did here in this case, because of various problems with initial quality assurance. He then reviewed that reinspection -- Edison then put together a program. That program did use samples. Inferences were made from those samples, and there has been testimony

about those inferences, both by engineers and by one witness, Mr. Singh, who applied reliabilities, established confidence intervals and reliability levels.

Dr. Ericksen's testimony not only rebuts Mr. Singh's testimony, but it also gives some evidence of what can be done to properly design a sampling plan. And I therefore think that it is relevant and admissible.

Mr. Miller attempted to push the witness in a definition of "we" to be saying that he is providing a legal opinion about applications of these regs, and we are willing to stipulate that that is not true. If you would like us to do more redirect on what a definition of "we" is, we can do that. But if you want us to change it to "one" or "I", I think we're prepared to do that. But I think it is inappropriate to strike all the testimony on that basis.

The witness has been very honest --

JUDGE SMITH: I think that tends to be a little bit of a quibble as to how he expressed it. However, I thought Mr. Miller was entitled to make a point.

MS. JUDSON: I believe he is entitled, as cross examiner, to make a point, but I don't think it's a basis for striking the testimony.

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JUDGE SMITH: My reopened concern is twofold, I guess. One is on page 6. Where does he get this 99.5? Where does he get the 99? Where does he get the 100? Where does he get these classifications? Where do they come from. I think he does grab them out of the air.

MS. JUDSON: We can ask Mr. Ericksen.

JUDGE SMITH: Let's ask him.

Then my second concern, refresh our memory as to what is the basis for him making the statement that Edison failed to distinguish elements and that the elements did indeed fall into categories of most important and less important. Refresh our memory. Where did you get that? What is the basis for that testimony? Where did he get these 99 and 100 and these four classifications, and things like that? Where did he get them?

MR. CASSEL: Those are two very different question Judge. One, the question of where the classification comes from, we have a stipulation on the record which simply supports the earlier --

JUDGE SMITH: What is the stipulation? I'm just asking. I'm not saying it does not exist. I just want to be reminded about it.

MR. CASSEL: The stipulation is that in his deposition Mr. Teutken classified the inspection elements and attributes performed by Hunter and Hatfield and PTL in four

categories of safety significance. We offered that document earlier.

JUDGE SMITH: What are they?

MR. CASSEL: They were labeled, by Mr. Teutken, 1, 2, 3, and least important. And in his deposition he explained that by Category 1 he meant those inspection elements and attributes which were most important to safety of those done by Hatfield, Hunter and PTL.

In Category 2, he meant those which were second most important to safety. In Category 3, he meant those which were third most important to safety. And in the category of least, he put items such as housekeeping and documentation which he regarded as least important to safety of the elements inspected.

JUDGE SMITH: But my difficulty I had then, and I have now, you're talking about relativity in a vacuum and that's where I couldn't pick it up. I mean it was relativity -- here's a little capsule of relativity with respect, yes. 1 is related to 2 and 1 is related to 4. But how are 1 through 4 related to the universe? That's my problem.

MR. MILLER: I believe Mr. Teutken answered that in his deposition by saying remember, Mr. Cassel, all of these are safety related.

JUDGE SMITH: See, that's my problem.

MR. CASSEL: There are degrees of safety significance. They may not be formally recognized in the NRC regulations. I was about to give the same answer Mr. Miller just gave. They are all safety related.

But as the witness indicated from the stand, as a matter of common sense, and in the case of Mr. Teutken as a matter of his expertise as an experienced engineer and the startup manager for Byron, he specified which of those procedures done by Hatfield, Hunter, and PTL, were most important to safety.

MS. JUDSON: Your Honor, I think I can make one comment which may make this a bit easier to understand. I don't think that this witness is offering other categories set in stone. What the witness is saying is that there was a failure to make these judgments and set up these categories before the program was started. And that that is something that should be done in establishing a Reinspection Program.

And I think everyone is trying to push this witness beyond his expertise to tell you and not to the point being made in this question and answer.

JUDGE SMITH: I understand.

MR. MILLER: Judge Smith, with all due respect, I certainly didn't intend to push Dr. Ericksen. What I was trying to do was to establish just what it was, in his experience, in his education, in his training, that would

enable him to tell this Board that in order to have -- he says that we want to be more than 95 percent certain that more than 99 percent of the very important safety elements met design requirements. And when I asked him who the "we" was, it's everybody in this room. It's society at large, including the NRC.

And there is simply no basis, in the regulations or in his expertise, and I don't know about common sense. I think that reasonable minds could differ about the common sense of attaching numerical values to safety. But there is simply nothing that entitles Dr. Ericksen to express the very opinions that Ms. Judson says he should.

The other point I would like to make is that Mr. Teutken was asked about inspection elements. That's what the Reinspection Program is about. Dr. Ericksen is here talking about his analogy to braking systems. He's talking about the components of the nuclear power plant. We're back to Dr. Bleuel. That's what he is saying.

And I don't believe you've had an answer to your second question, as to where these numbers came from.

JUDGE SMITH: That's right. We don't have any answers to that. That's the thing that troubles me most. Where do those figures come from?

MS. JUDSON: Your Honor, before I ask that, I would like to just read one portion of this answer, which I think

does put in in context. And that's on page 6, where Dr. Ericksen states "In order to determine the amount of certainty and perfection required for each element, choices should have been made using engineering judgments. These judgments, along with their rationale, should have been determined when establishing the program and clearly stated in the Reinspection Report."

Then he offers some suggestions. He says "A reasonable Reinspection Program might have required --." So he's not saying this is set in stone, either. But what he's saying -- and this is the whole point of his answer-- is that before they started, they should have sat down with the engineers and figured out what was important to safety and categorized it and built up to your program on that basis. And that is the point of this answer.

He's talking about what was missing from the report. His criticism is this was missing. Then people are moving to strike because we haven't provided it. This witness is not providing that missing gap. This witness is merely saying that gap exists and that's the problem.

JUDGE SMITH: I think perhaps the Board has been somewhat remiss, in this reopened proceeding, in not insisting on the parties drawing up issues somewhat more precisely.

The Intervenors have taken a persistent approach that the Reinspection Program was faultily designed and

implemented to verify work quality. And this is the tenor. It's the tenor of Bleuel. It's the tenor here. And I may be crudely stating it, but that is the tenor of your position.

Now you certainly have a right to come in here and attack the validity of the inferences that Applicant draws from the inspection program. But we are arguing the whole nuclear power plant everytime a witness comes in here. And it's not of great value to the Board.

What the Board needs is more precise joining of the issues. That's what we need. We need guidance. We don't need lectures. We know something about nuclear industry. We need guidance as to the precise issues that we are here to decide.

Now I don't think it matters one way or the other whether your motion is granted or sustained. It really doesn't matter. You know, I don't fault you for making the motion. As a careful lawyer, you have to do it. But we know what his expertise is. We know what it isn't.

We have a firm memory of the events of last summer and our decision. We spent a lot of good time on it. We know why we're here and no one is going to confuse us about that. And we are not going to be confused. And we're not going to be confused by his idea of 100 percent critical to safety. We know he doesn't have any idea of what he means,

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critical to safety. What does that mean? You don't know, with respect to a pressurized water reactor.

This is just something that you think would be nice.

We recognize that. I don't care whether it's in or not, we recognize that.

What really would be helpful if we had a very careful -- very careful. You have a witness here who is fully qualified to attack Dr. Singh's testimony and we hope that you do, you know, and then we will read it very carefully. But we recognize Mr. Miller is entirely correct, and he has established that.

And to his credit, Dr. Ericksen freely concedes that is not competent to tell the nuclear engineers what's important and what isn't important.

And I don't really think there is any major dispute here. However, let's hear your arguments and we will decide.

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MS. JUDSON: Will you give us a moment?

(Counsel for Intervenors conferring)

MS.JUDSON: Dr.Ericksen, I would like for you to explain to the Board generally what the value is in using statistical judgment in an area about which you may not have subject matter expertise, and some of your experience in doing that in the past.

MR. MILLER: I think I have to object. I don't believe that that is appropriate redirect on this voir dire, because I am not quarreling with Dr. Ericksen's statistical expertise. He has already told us that he doesn't have the expertise necessary to enable him to draw judgments about the matters that you have stated. It is irrelevant.

MS. JUDSON: Your Honor, I got the impression that the Court was a bit frustrated and didn't understand why Dr. Ericksen was making some of these suggestions. And I think Dr. Ericksen can testify in his practice to what his role is. And he will admit both its limitations and its usefulness. And I am just trying to do that to respond to --

JUDGE SMITH: Go ahead, do whatever you choose to do. I think we want to be informed.

THE WITNESS: Will you repeat the question?

MS. JUDSON: Can you read it back?

JUDGE SMITH: If you could possibly rephrase it, it would be much better.

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MS. JUDSON: Let me rephrase it.

REDIRECT EXAMINATION ON VOIR DIRE

BY MS. JUDSON:

Q Dr. Ericksen, can you tell the Board why you feel that it is useful to apply your statistical judgments in this area in which you do not have subject matter expertise and any past experience you have in providing such judgments in areas in which you do not have subject matter expertise?

A I think it is a very common situation in which subject matter experts make statistical statements either without realizing that they are making statistical statements, or without understanding what the implications of their statistical statements are.

An example of that, which is not related to this case, in my past experience, has to do with a study I did in New York City hospitals concerning the proportion of patients who were undocumented aliens.

I went to one hospital to try to set up the study and the director of the hospital said, "You don't need to do the study here, we have no undocumented aliens among our patients."

It turned out the basis of his statement was that very few of the patients had Spanish surnames. It turned out the undocumented aliens in that hospital were from places like Haiti and Jamaica, that we found out on the basis of our

sample.

That was an example of a statistical statement made on the basis of a non-probability sample.

Now, getting into the point, one of the most important things that a statistician does with subject matter experts, is help them to assess the implications of their uncertainty. Now, uncertainty exists whenever you take a sample and you want to make a generalization to a population.

Now, in order to rationally deal with the uncertainty, you need to evaluate for yourself what the costs are of making an error. Now, that is something that a statistician should look for in evaluating any statistical estimate.

Now I read -- I am not certain if it is in Dr. Singh's deposition or Dr. Singh's testimony. He said that I used the 95 percent confidence interval because that is what statisticians always do.

Now that is simply not -- that is simply an incorrect statement.

So, what I was looking for was some kind of evaluation of the components or the elements being inspected that would do one of two things: Either it would say that all the elements have the same safety significance and they should be evaluated at the same level of risk.

If they said that with justification, that would have been fine. I would have considered my concern to have

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been taken care of.

Or, they would have given the classification such as I gave an example of at the bottom of page 6. Now what I gave at the bottom of page 6 was simply an example of what they might have done.

Now, my position is that they should have done this. They should have supplied the reliability percentages and the confidence level percentages with justification. It is the justification that I was looking for, and that is the basis for my criticism.

MR. MILLER: Excuse me, have you concluded?

MS. JUDSON: Yes.

MR. MILLER: What Dr. Ericksen has just explained to us is again very reminiscent of Dr. Bleuel's approach. Here is a man who has substantial expertise in an area but he is totally ignorant of the panoply of analyses, programs and other means by which the safety of the Byron station is established.

And what Dr. Ericksen is saying, "By golly, if we just had a proper statistical program here, then we could be sure."

That is where -- the regulations don't suggest that, the statistical inferences that are drawn in the Reinspection Program are the tip of the tail of what is a very long dog in terms of analyses and so on. Even if we

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just look at the Reinspection Program itself -- I'm not talking about all the other programs -- I believe this Answer 10 is totally without merit in terms of expressing expert opinion that is going to be of any use to the Board. I ask that it be stricken because I believe otherwise the Board will find itself confronted with findings,proposed findings that will lead it inevitably back to this answer, notwithstanding the Chairman's comments.

JUDGE SMITH: Do you agree with his characterizati of Dr. Singh's testimony?

MR. MILLER: Dr. Singh's testimony. Well, I would have to go and check, but Dr. Singh certainly did --

JUDGE SMITH: He said Dr. Singh picked out a 95 -- he says all statisticians always do that.

I don't believe that that is --

MS. JUDSON: I could help the Court by reading that answer provided by Dr. Singh.

MR. MILLER: Is this his deposition or his testimony?

MS. JUDSON: This is his testimony, on page 9059 of the transcript. He was asked:

"Mr. Singh, did you decide to use a 95 percent confidence level, or did someone else make that decision?

"Answer: The decision to use a 95 percent

mm6 confidence level" --

I believe it says computer, but it believe it means compute.

"-- compute reliabilities of the data which came out of the reinspection program was made by me. However, that has been a standard practice to computer reliabilities of 95 percent confidence for application. So it is consistent with our practice."

JUDGE SMITH: Yes, but aren't you overlooking testimony to his references to his colleagues on the panel and their use of it, and their input into thei acceptance of it. And that is the thing that I think the characterization is incomplete.

MS. JUDSON: He said that is their general practice. I can always -- I can look through here further. He made statements that they use the 95 percent confidence level.

JUDGE SMITH: In the general context. He uses that level in concern with the specialists and engineers that were on the panel with him and it was sufficient for their purpose.

JUDGE COLE: Dr. Ericksen, are you saying standard practice for engineers doing this type of work is to use something other than a 95 percent confidence level?

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THE WITNESS: What I am saying is, that there is no standard practice. And that what a statistician does is establish a confidence interval based on the risk of being wrong.

JUDGE COLE: We were talking about what engineers do in their work, and in the context of what Dr. Singh is saying.

THE WITNESS: What engineers making statistical statements would do if they are going to make proper statistical statements, is that they would select a confidence interval based on the risk of error.

JUDGE COLE: Do you know what engineers do in their standard practice?

THE WITNESS: I have looked at one textbook on engineering statistics, and I don't find any statement in there that says that the 95 percent confidence interval should be used. I am referring to the Miller and Freund book that Dr. Singh relied upon.

JUDGE COLE: I guess I am thinking more in terms of consulting engineering practice, and the standard techniques that they use in manipulating their data or interpreting their data.

I seem, personally, to recall that of all those confidence intervals that might be used, the ones most frequently used that I have personally observed, has been

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95 percent confidence interval.

THE WITNESS: I would agree with you, that that is probably used more often than any other. But that does not follow from that statement that it is correct to use it in this instance. I think that is a statement which pertains to the risk of error.

If the 95 percent confidence interval is used most of the time or the majority of the time, that simply states that a majority of the time the risk of error are mild enough that we can deal with the 5 percent risk.

JUDGE COLE: But the context of the question that was asked of Dr. Singh was, where did you get the 95 percent.

And his response was, it is our standard practice.

THE WITNESS: Right. And my statement is that should have been based on extensive conversation with engineers classifying the inspection elements according to the risk of error. Housekeeping is not the same as are welds inside the core of the reactor.

JUDGE COLE: I understand.

MR. MILLER: I think Dr. Ericksen has made my point again. That is, he persists in wanting to talk about the statistical statement as the only basis on which a reasonable assurance finding can be made.

And the risk of error, the cost of being wrong is not one that can be reduced to a statistical estimate. And

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it is not the basis on which a contrary finding is made.

JUDGE SMITH: I don't think there is need for anything further. I think we all understand the importance of his testimony, what his expertise is, what he knows and what he doesn't know.

I think we are ready to go ahead.

Anything else we haven't heard on this?

You realize, you persuade us -- either party, you persuade us over our better judgment to delete or to accept testimony. What do you gain? You know --

MR. CASSEL: We are in part --

JUDGE SMITH: We are going to have to make this decision.

MR. CASSEL: Exactly. In part, this is a formal argument of whether the testimony is technically in or technically out, and the outcome of that formal argument is not necessarily going to make a big difference on the larger issue which is being debated here.

And that larger issue is the extent to which the statistical inferences have relevance to the overall judgment on whether the plant is reasonably safe.

Now, Professor Ericksen has not come in and testified that the only way to ever find that that plant is safe is to do a reinspection program and to set it up in a statistically proper way. Rather, he is responding to the

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fact that Edison did set up a reinspection program and did draw certain statistical inferences from it, which he is critiquing.

He is not addressing the whole area of this case.

JUDGE SMITH: All right, if his testimony is limited to that, and understand it to be limited to the critique of the inferences drawn from the Reinspection Program, I think we could save a lot of trouble. But, he makes statements which go beyond that and I think that is what Mr. Miller is worried about.

That is what I meant about we were remiss in not requiring the parties to get together and address each other's issues head on, rather than zing the way you have been doing it.

However, we will rule. We understand.

If you will concede that the purpose of this testimony is to bring into question the validity of the inferences drawn from the Reinspection Program by theutility, I think maybe you can make an accomodation with Mr. Miller on this.

MR. MILLER: Judge Smith, I believe that Dr. Ericksen's other criticisms of the inferences that are drawn, are well within his expertise, and obviously I made no Motion. But this -- as you pointed out, this goes well beyond any criticism of the inferences that are drawn.

MS. JUDSON: I don't want to beat a dead horse here, but I believe it doesn't go beyond the inference, because Mr. Singh chose a reliability level and a confidence level, and he did not make certain distinctions, and he did not specify in certain ways.

MR. MILLER: Judge Smith, if the Intervenors will stipulate that they will draft no findings, proposed findings, for this Board which attempt to argue that the reasonable assurance finding needs to be based on some sort of statistical statement expressed in Dr. Ericksen's testimony, then perhaps I can withdraw my motion. I doubt they will do that.

MR. CASSEL: Judge, I'm not sure about the phraseology of Mr. Miller's suggestion, but as I indicated before in connection with Dr. Bleuel, there are several asserted bases in this case for you to reach a conclusion that the plant is safe.

One of them is the Reinspection Program and inferences drawn from that program about the quality of the work. Those are statistical inferences, and those are being critiqued by this witness.

Another asserted basis is the contention that one can infer from the fact that the Reinspection Program showed that most of the -- or purported to show that most of the inspectors were qualified, that the inspectors as a

whole were qualified and therefore, did not miss issue items of safety significance.

We have a separate critique, unrelated to this witness' testimony, to that.

Another asserted basis for the safety of the plant is Edison's overall quality assurance program and inspections by the NRC, and we have responses to that. No single piece of evidence needs to take on all of those theories in one piece, and we're not suggesting that this witness is doing that.

MR. MILLER: The only thing I can say is Dr. Ericksen told us anytime somebody generalizes in making a statistical statement, we've got to contend with that.

JUDGE SMITH: All right, I think that's good enough. We will consider it during lunch, and we will return at 1:30.

(Whereupon, at 12:15 p.m., the hearing in the above-entitled matter was recessed for lunch, to reconvene at 1:30 p.m. the same day.)

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AFTERNOON SESSION (1:40 p.m.)

JUDGE SMITH: Let's go on the record.

Whereupon,

EUGENE P. ERICKSEN

resumed the stand and, having been previously duly sworn, was examined and testified further as follows:

JUDGE SMITH: Dr. Ericksen, the Board has a couple of questions that we would like to have answered before it rules on the motion.

With respect to your answer A9, the first point, you state "In structuring the Reinspection Program and Report, Edison failed to distinguish elements which are most important to safety from elements which are less important." And then you go on.

Our question is what do you know about the structuring of the Reinspection Program and the history of it?

THE WITNESS: Well, I know that there was a previous -- I guess you would call it trial or hearing before the NRC and a decision was made that the inspections program had not been satisfactory.

JUDGE SMITH: Do you know in what respects it was unsatisfactory?

THE WITNESS: I believe that one of the problems was that there wasn't sufficient documentation of inspections and that -- the insufficient documentation of the qualifications

of inspectors.

JUDGE SMITH: Do you know how that came about, the Reinspection Program? What the history of it was? What, let's say, the chronology was? Or are you going from our Initial Decision? Or just what is your take-off point?

THE WITNESS: My understanding was that on the basis of -- I suppose the fact that there was a hearing, the litigation, that the Reinspection Program was put into place. What I don't know is whether it was put into place before or after the decision was made.

JUDGE SMITH: You don't know, then, that the inspectors of Region III required a response to a finding that the personnel files of some of the contractors did not demonstrate the qualifications and on the job training and testing of certain inspectors?

THE WITNESS: I think you have said it in more detail than I thought I had said it. It was my understanding that the qualifications of the inspectors had not been properly certified. I didn't know what the details of that finding were.

JUDGE SMITH: So you do recognize, however, that the Reinspection Program was a result of a finding of inadequate evidence of qualification?

THE WITNESS: That's right. I mean, like I tried to say earlier, I have not really focused on the legal aspects

of the situation.

JUDGE SMITH: No, we're talking factually.

THE WITNESS: Fine.

JUDGE SMITH: You also suggested that there was inadequate inspection documentation.

THE WITNESS: Right.

JUDGE SMITH: Is that your belief? Was that one of the driving factors behind the Reinspection Program?

THE WITNESS: I believe so, yes.

JUDGE SMITH: I suggest that you are wrong about that.

THE WITNESS: I base that on my -- I have read a section of the finding that was -- well, I can't remember the exact paragraphs of the decision, but I do remember seeing something about the Hatfield documents not being in order. But the main thing had to do with the certification of the inspectors.

JUDGE SMITH: That was the reason why the Reinspection Program was initiated?

THE WITNESS: Right.

JUDGE SMITH: Do you know what the purpose of it was?

THE WITNESS: My understanding of the purpose of the Reinspection Program was to determine whether the work was correct and whether the inspections that they had made were

correct.

JUDGE SMITH: You made the statement on voir dire that you feel that your comments, in answer 10 and part of answer 9, was appropriate because when Sargent & Lundy make a statistical statement, they have to make it in context of statistics. What statistical statement were you referring to?

THE WITNESS: Well, I think that the conclusions that they come to -- if I could back up a moment. The document that I was evaluating was the Reinspection Report and there are statements at the end of -- I believe it is Chapter 7, which make conclusions based on statistics, in my judgment.

JUDGE SMITH: Could you point them out, please?

THE WITNESS: Sure.

(Pause.)

Okay, I point out to you that on page 7-9 there is a section entitled Section D, inference of work quality from the Reinspection Program. And on page 7-11 is where the reliability results are presented. Then you turn the page and it says conclusions. Following directly after that --

JUDGE SMITH: Number one?

THE WITNESS: Number one, number two, and number three. And number one, as I read it, could or could not be interpreted as being derived from Section D. Number two, "With limited exceptions, the Reinspection Program verified the effectiveness of QC inspector certification programs

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prior to September 1982."

I interpret that as following directly from the reliability calculations that are shown in the preceeding sections. Also, point three.

end15

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JUDGE SMITH: You also had familiarity with Dr. Singh's testimony?

THE WITNESS: Yes, I did.

JUDGE SMITH: And you realize that Dr. Singh was expressing -- well, let's get actually what he said -- "that he has applied principal statistics and probability theory to the results of the engineering evaluations discussed in the testimony of Messers. McLaughlin, Leone, and French." He concludes with a 95 percent confidence level that, in general, the work performed by Hatfield and Hunter meets the original design basis with a greater than 99 percent reliability. You were aware of that, you say?

THE WITNESS: That's right.

JUDGE SMITH: And more specifically, his conclusion that it's the original design basis to which he is addressing his opinion. You know that?

THE WITNESS: That's right.

(Board conferring.)

JUDGE SMITH: Dr. Ericksen, if you were to accept the fact that has been established in this hearing earlier, that the reason for the Reinspection Program was because of Region III's concern that their may be failures in inspector training, testing, and on the job training -- I mean on the job training and testing and qualification, and nothing else.

Would you change any aspect of your question and

answer in the first part of 9 and question and answer 10, that the only thing that was being responded to by the Reinspection Program was the NRC's concern about the personnel files of the inspectors?

THE WITNESS: I think I would have amended it.

JUDGE SMITH: I beg your pardon?

THE WITNESS: I was trying to answer your question.

JUDGE SMITH: Would you just give me a moment, please? Wait.

(Board conferring.)

JUDGE SMITH: The qualifications of inspectors.

THE WITNESS: Right. I will confess to some vagueness about the objective of the Reinspection Program. Had I made the assumption that you have asked me to make, I would probably have restructured my testimony to say that special emphasis should be given to those elements which are both safety significant and more difficult to inspect.

JUDGE SMITH: All right. The Board grants the motion in its entirety. Dr. Ericksen does not have sufficient factual understanding of the history and purposes of the Reinspection Program to express an opinion as to how it should have been designed. Nor does he have the expertise to make the judgments that he has about the initial design of the Reinspection Program.

Despite Intervenor's disclaimers, the tenor of these

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questions and answers, as was the case with Dr. Bleuel, was how the program should have been originally designed. And it is not formulated to attack the inferences that Commonwealth Edison draws from the results.

Now again, I want to just place into perspective, for the rest of the afternoon, what the Board has previously observed and ruled on. And we might go a little bit more smoothly. Let's remember what happened. Bill Forney goes down, goes into the plant. He starts going through personnel files. And he sees that there are problems with documentation of on the job training and documentation of testing and maybe some high school diploma evidence isn't there. And there are some problems with the ANSI standards of inspectors.

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And as a consequence, in part of the CAT, there is a Category 4 violation. The response is okay, we will try to validate the inspector's qualifications by a Reinspection Program to look at what the inspectors did.

The inspectors, that is the whole purpose.

Now, when the Reinspection Program was completed, the results as to the inspectors appeared in the Reinspection results -- I mean the Reinspection Report. As I understand the testimony we have received, Sargent & Lundy has a body of data which was produced for the purpose of the inspector qualification and inspection. They said well, let's take a look at this data and see what it tells us.

Now that is something that any responsible person would do. They may not feel that they need it. It may not be the basis upon which the safety of the plant is assured or determined, but data exists. And a responsible person will look at it.

Having looked at it, it was not only the Applicant's perogative to bring to our attention the way they looked at it, what they did with it, but it was their duty under the law to tell us about it. And the way they went about it.

That's what brings us here today. You have every right to attack the inferences they drew. They are indeed telling us about it as one of the reasons why we should decide this case in their favor. And they have every right to attack it, tear it apart.

But let's understand that that is what it is and stop mischaracterizing the Reinspection Program as a work validating thing. We are not going to buy that.

MR. CASSEL: Judge, I wouldn't buy it either. We have taken the position, and perhaps we have not communicated it clearly enough to the Board, but our consistent position throughout this rehearing has been that the purpose of it was one thing. But then it was later used in the very way that you just explained for another purpose.

Dr. Ericksen's testimony is responding, is critiqueing the use for that other purpose. He is not saying,

in the body of his testimony, that for its original purpose it was deficient, for the reasons -- the principal reasons that he is raising.

JUDGE SMITH: That's exactly what he says in A-9. However, we have already ruled on that. "In structuring the Reinspection Program they failed --." And that's what gets him into trouble.

MR. CASSEL: Well, there are two ways to interpret that, Judge. And I think his testimony should be received in this light. The same question and answer came up in the context of Dr. Bleuel, for the use of validating work quality or for the use. You distinguished earlier between purpose and use. We're not suggesting that it was an initial purpose.

Mr. Del George, I believe, has testified that they didn't even consider that use until after the program was already underway. But for the use of validating work quality, the program was not designed in a way that would have effectively met that use. Understandably so, given the purpose they had in mind.

We are not, and we never have. And Dr. Bleuel didn't and Dr. Ericksen's testimony does not purport either to say that they were wrong in designing it the way they did for the purpose they had in mind, with some minor exceptions. Because both Dr. Bleuel and Dr. Ericksen have raised issues about the design, even with respect to inspector certification.

For example, he just mentioned, from the stand, the fact that they didn't distinguish among difficulties of inspections. But that's really a subsidiary element of his testimony. But the rest of his testimony, and the thrust of Dr. Bleuel's testimony, is clearly aimed at responding to the inference of work quality.

And Intervenors do not suggest any disagreement whatever with the history and purpose of the program, as you just described it.

JUDGE SMITH: All right. Our ruling remains. And I'm going to let you begin cross examining, but there is one question that I'm sure if it is not put to you, the individual Board members will put to you. And we might take this opportunity to do it. And that is, given your critique of the use of the data, and assuming that you are correct, what use could you put the data to? What can you learn from it? Anything?

THE WITNESS: Yes, yes. I learned that making the assumption that the discrepancy rates are correctly presented and that the statements concerning design significance are correct, I have some certainty that the inspections -- original inspections -- were mostly correct, that the discrepancies are not of design significance.

I think that there are perhaps three other conclusions. One is that I have some certainty about all

all elements taken together. I have less certainty about certain categories of elements that may be important. And I am quite uncertain about inspections that took place after the first three months and about the work of inspectors who did not have a chance to be selected.

So from the point of view of a statistician, one solution to the impasse that we have is simply to direct Commonwealth Edison to expand their sample and increase our certainty.

MR. CASSEL: Judge, before we proceed to cross -- and I would be happy to defer it until later, but I do want to raise one matter concerning an exhibit. As you may recall, when Mr. Teutken was on the stand, Intervenor's Exhibit R-1, I think it was, was offered in evidence. And I asked Mr. Teutken whether this was a correct description of the categorizations of inspection elements he had made in his deposition and he replied that it was.

And I offered it into evidence and the objection was made that it wasn't clear for what purpose. And I indicated that I would, rather than try to argue in the abstract, reserve it until the first opportunity for its use arose.

Well, a couple of opportunities for its use arose in testimony, which has not yet made it into court, and I will pass by those. But in this testimony, you will note that

on answer 11, page 7, Professor Ericksen -- at about the seventh line down there, in answer 11 -- relies on Mr. Teutken's safety categories, which were Attachment B to Mr. Bleuel's proposed testimony.

Now this instance is for a particular use of it, more broadly during Mr. Miller's voir dire. Professor Ericksen, when he was asked what is your basis for suggesting that the statistical analysis was not grouped according to safety significance, he indicated that he, of course, has no basis for making that engineering judgment. He was relying on Mr. Teutken's categories.

I would suggest, at this point, that the use to which those categories will be put by this witness is clear. The proper foundation for the document was laid during my cross examination of Mr. Teutken. I understand that Mr. Miller has reservations or disagreements with the weight to which th might be put, but I believe the admissibility of Mr. Teutken's safety classifications, in Intervenor Exhibit R-1, is not at this point something which should be subject to dispute.

And I ask that Intervenor's Exhibit R-1, Mr. Teutken's safety classifications, be admitted into the record.

MR. MILLER: Judge, I don't have any objection to that. Certainly, in Answer 11 in Dr. Ericksen's testimony it will provide a convenient reference point for the basis for some of the statements that are made in that answer. And I suspect that for the convenience of the Board, or the appeal board, it would be useful as a reference to Dr. Ericksen's responses to my voir dire, so I have no objection to its admission at this time.

MR. LEWIS: Staff has no objection.

JUDGE SMITH: So Intervenor's Exhibit R-1 is received.

(The document referred to, previously marked for identification as Intervenor's Exhibit R-1, was received in evidence.)

MR. CASSEL: Thank you, Judge. For purposes of clarification, I didn't quite catch which part of Answer 20 was subject to Mr. Miller's -- oh, I'm sorry. It was the first paragraph of 9?

MR.MILLER: The first paragraph of 20.

MR. CASSEL: And the first paragraph of 20. And that was the entirety of the testimony that was subject to your motion?

MR. MILLER: And Answer 10.

MR. CASSEL: And Answer 10. Could I have a

moment, Judge?

(Pause.)

MR. CASSEL: Judge, if I could inquire of the Board if I understood your discussion of the first paragraph of Answer 9. In other words, the Board seemed to be saying that he was criticizing them for doing something when really they were designing the program for another purpose?

JUDGE SMITH: Well, the use of the word "failed" suggests a duty to do it the way that they failed to do it.

MR. CASSEL: Well, it is conditional on the use, but is the Board of the view that simply because of the use of the word "failed" -- well, let me withdraw that.

Is Answer 10 really something which ought to be excluded? I mean, it's not based on the purpose of the program; it's a response to the use of the program.

JUDGE SMITH: Well, we heard arguments all morning on this. Now it seems to me that you want us to revisit it.

MR. CASSEL: If you look at the last two sentences of Answer 10, it says, -- you raised the point that Mr. Singh testified about meeting design requirements. On page 7, the second to the last sentence, or the next to the last sentence in Answer 10 is, "We, of course, want to be more than 95 percent certain that more than 99 percent of very important safety elements met the design requirements."

JUDGE SMITH: That is the one statement --

MR. CASSEL: And the conclusion relies on that statement because the conclusion says in order to make the next statement -- which is the next sentence there -- and that is the whole point of that answer.

MR. MILLER: Excuse me, Judge Smith, you never got an answer to the question you posed as to where these four categories of safety significance came from, and you never got an analog of that question. An analog of that question is, if you will, where the more than 95 percent certainty that more than 99 percent of the very important safety elements is. They're just floating around in the air somewhere.

JUDGE SMITH: Well, I don't think we have to revisit this. If we're wrong, okay. I mean, your basic problem is you disclaim and disclaim and you disclaim. But the fact remains that the tenor throughout is that they designed the program wrong.

Now go ahead, attack Singh, and attack those people on their conclusions, and tell us what they should have done with the data. Okay. That's fine.

MR. CASSEL: I wonder if we -- we can get into this orally if you will permit later, but first of all, Answer 9 in the first line refers not only to structuring the program, but also to structuring the report. If the

motion to strike were limited to the words "program and" in that first line --

JUDGE SMITH: "report," too. If he doesn't know or understand sufficiently the Reinspection Program, then how can he have the competence and information to attack the report?

MR. CASSEL: Because the report, in the pages which he quoted to you -- and specifically conclusion 3 at the end of Chapter VII on work quality -- draws inferences --

MR. MILLER: Excuse me, Judge Smith, I believe that's immaterial. The report is not in evidence, it has not been offered into evidence. The structure of the report itself is totally immaterial to the issues before this Board.

MR. CASSEL: It is not in evidence, and it is broader than the Hunter and Hatfield issue. But the same inferences are drawn in the report in paragraph 3, Chapter VII; namely, that without regard to the qualifications of the inspectors just looking at the inspections themselves, one can infer work quality.

That is an argument that has been in the report, it's an argument that's in Ericksen's testimony with respect to Hatfield, Hunter and PTL; it is parallel to the inference in the report; it's just more limited as to contractors.

Now, if one were to strike the words "program and" in the same structuring -- and even if he wanted to say

in reaching conclusion 3 at the end of Chapter VII of the Reinspection Program Report, everything else in the answer would support that statement. That would merely --

JUDGE SMITH: Look. Mr. Miller made the argument this morning. You are persisting on this point. You are not going to prevail. We know what the inspection program is with respect to our hearing, our issue, our Hatfield and Hunter issue. We know what it did. We know what it was intended to do, and I am not going to make any finding on item 3. We are not asked to make a finding on item 3. We don't even know who wrote the item 3. It is not something that we are requested to grant a license on.

end 17

MR. CASSEL: Judge, I think you have not been asked to reach or authorize -- maybe you've been authorized -- you haven't been asked by the Appeal Board to make a finding on Item 3. That is true only because Item 3 covers all the contractors and the scope of the rehearing -- unless you choose to broaden it -- is limited to the Hunter and Hatfield hardware and the SCC hardware.

But the Appeal Board clearly gave you the authority, and I have the Appeal Board decision behind me, not to limit your inquiry concerning Hunter and Hatfield to inspector qualifications, but also to the quality of the work.

Edison has recognized that by offering testimony to that effect. And it seems to me that we are entitled, through Dr. Ericksen, to respond at least to that point.

JUDGE SMITH: Respond to what?

MR. CASSEL: To the testimony offered by Edison.

JUDGE SMITH: All right, respond.

MR. CASSEL: I'm talking about responding through the evidence offered by Dr. Ericksen, including his answer to question 10.

JUDGE SMITH: You are succeeding in one thing, you are succeeding in confusing me. Because honestly, I just lost track of what you're talking about.

MR. CASSEL: Let me try to back up.

JUDGE SMITH: Let's go back to the Appeal Board. Do you want to do that, or do you want to go on to another point? We discussed the Appeal Board decision at great length when Ms. Wicher was up here before and you were not. We issued a memorandum on that.

MR. CASSEL: My copy is in the witness room.

JUDGE SMITH: Then I guess I'm in the driver's seat because I have it and you don't.

(Laughter.)

MR. CASSEL: All right. If you look at the section that discusses the scope of the rehearing, if memory serves correctly -- and I stand to be impeached on this, but I have been relying on this. If memory serves correctly, the Board indicates -- and I'll cite you the sentences as soon as Tim gets it from the witness room -- the public interest calls for a full evidentiary hearing on the Reinspection Program and its results.

Now the results, as they were put in the Reinspection Program Report, it is true, included some inferences about the qualifications of inspectors. But that report also included -- and Dr. Ericksen cited you the specific paragraph, paragraph 3 at the end of Chapter 7 -- the whole chapter is entitled work quality which draws an inference directly from the results of the inspections to the work quality.

To show you the specific sentences I have in mind, if you look at page 27, footnote 62, the portion that carries over to page 28, of the Appeal Board opinion says -- and I'll just read the part on page 28 -- "It seems to us that the public interest would be ill-served were final judgment to be passed on the operating license application without a full evidentiary consideration of the Reinspection Program and its results."

Immediately above that, on page 28, the Board -- the Appeal Board indicates -- this is the first full paragraph -- "At noon the following questions must be addressed in deciding whether the methodology, implementation, and results of the Reinspection Program were adequate to resolve the concerns about one, the capability of the inspectors --" and that's the purpose of the program, as you indicated -- "and two, the quality of the work performed by these two contractors."

JUDGE SMITH: With all due respect to the Appeal Board -- and if you're right and I'm wrong, they are not shy, they will reverse us quite quickly. With all due respect to the Appeal Board -- I don't want to state it that way.

(Laughter.)

MR. CASSEL: The chances of not being reversed just increased 75 percent from that comment.

JUDGE SMITH: The Appeal Board found we were in

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error in only one respect, and that is -- well, two respects. One was Systems Control, but they didn't put an error in there. And that is knowing -- having found that a Reinspection Program could be -- this is what we found. A Reinspection Program could be an empiric demonstration of -- I don't remember the exact words, but of the qualification of the inspectors, and we may even have said the quality of the work.

The only error that they found that we made was having found that, then we should have awaited the results before we turned down the license. Everything else we were right. We should not have granted it.

We understand why we decided the way we decided. I think that the Appeal Board did understand why we decided what we did. They returned it to us to finish the decision and that's what we're doing.

I don't care how eloquent you are or how forceful you are or how reasonable we are. You cannot change the fact that the Reinspection Program was designed, from the very first day, to answer the problem of the qualifications of inspectors.

MR. CASSEL: I have never, I hope, tried to disagree with that.

JUDGE SMITH: You say time and time again that you agree with that and you understand it and then you consequently

that fact in your argument.

MR. CASSEL: Judge, Mr. Del George -- I'll just cite one example. I believe Mr. Laney is another one. In their prefiled testimony draw inferences about the quality of work by Hatfield and Hunter.

JUDGE SMITH: Indeed.

MR. CASSEL: Not just the qualifications of the inspectors, but also by a separate route. And they are labeled as separate paragraph points one, two, and three, is in Mr. Del George's testimony?

JUDGE SMITH: Right.

MR. CASSEL: One of the points they made is that from the body of inspection data, they inferred that the Quality of Hatfield and Hunter work was good.

JUDGE SMITH: That's right.

MR. CASSEL: What I am suggesting is that Dr. Ericksen's testimony, in which he says you cannot draw the inference to the extent that Edison has attempted to draw it in the form of Mr. Singh's testimony, which parallel's the Reinspection Program Report, and which reaches a conclusion as well about design requirements, is perfectly appropriate provided it understood that that's what it's responding to.

And we tried to say, as clearly as we can, that we are not attacking the program design for the purpose

which you have accurately identified.

JUDGE SMITH: Right, and that is why we are eager to hear, if we are ever given the opportunity, what he has to say about the rest of the testimony and what he has to say about their analysis. But you are not going to change the fact that he answered A-9 and A-10 on an inadequate appreciation of what the program was about, how it was designed. And he went outside his expertise.

Now Mr. Cassel, I suggest that we have been very cooperative in listening to your motion for reconsideration. I questioned, if you ever appeared before a tribunal where you have had such an opportunity to move a motion of reconsideration to the extent that you have.

I would like to give you one last opportunity to summarize your motion for reconsideration and then we will move on.

MR. CASSEL: Thank you, Judge.

First of all, you are absolutely correct. I have rarely, if ever, encountered a tribunal which has been as patient to all parties and permitted all of us -- sometimes perhaps more than ample opportunity to make our point.

All I am suggesting, in summary, is that if one reads the answers to questions 9, 10, and 20, in light of what we have indicated and what Dr. Erickson can indicate, if you were to ask him, or we were to ask him, is his point,

namely that the program cannot be used to validate work quality directly in the way that Edison has attempted to use it. It failed to do the things that you would need to do in order to accomplish that purpose.

If you were to read the testimony in that light, then the testimony would be proper within the scope of the Appeal Board's opinion and relevant, and that is the purpose for which it is being offered.

JUDGE SMITH: Okay, that's fine. Unfortunately, I simply can't resist having the last word. I don't always have that opportunity. So collectively, we are going to take it.

We think that your message comes across. The rest of your testimony, had A-9 and A-10 been structured in the first instance the way you were describing it, perhaps you wouldn't have had any trouble. But it wasn't and it's too bad. You made a mistake.

So with that, you may proceed, Mr. Miller.

MR. MILLER: Thank you.

BY MR. MILLER:

Q Dr. Ericksen, would you turn to your prepared testimony, page 7, answer 11.

JUDGE SMITH: Wait a minute. Now we have not received the testimony.

MR. MILLER: I'm sorry.

JUDGE SMITH: Do you have any further objections?

MR. MILLER: I have no further objections.

JUDGE SMITH: All right. Then we will receive the testimony and would you follow the customary method. You may draw a line so that the part not accepted is still visible, but it indicates -- in the transcript -- that it is not available for findings.

(The testimony of Dr. Eugene Ericksen follows:)

Business and Professional
People For The Public
Interest

Date: August 13, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454-OL
	)	50-455-OL
(Byron Nuclear Power Station, Units 1 & 2)	)	
	)	

SUMMARY OF THE TESTIMONY OF
DR. EUGENE P. ERICKSEN
ON CONTENTION 1
(REINSPECTION PROGRAM - INSPECTOR
QUALIFICATION AND WORK QUALITY)

I. Dr. Eugene P. Ericksen is a senior sampling statistician at Mathematica Policy Research, Inc. and a professor at Temple University.

II. Dr. Ericksen has reviewed the Byron Reinspection Report, the testimony of Anand K. Singh, and portions of the testimony of Louis O. Del George, Robert V. Laney, and John Hansel. Dr. Ericksen has analyzed the ways in which Edison used statistics and probability theory to support its conclusions concerning inspector qualifications and work quality.

III. Dr. Ericksen concludes that Edison's sampling design and statistical analysis suffer from four major flaws:

A. Edison failed to distinguish elements based on their safety significance when establishing its statistical criteria. The company did not properly select confidence levels and acceptable reliabilities and failed to properly stratify its samples.

B. Edison over-generalized, offering conclusions about inspectors and elements that had no chance of being included in the reinspected sample.

C. Edison used an inappropriate formula in calculating reliabilities. Two assumptions of the formula were violated: inspections were not randomly selected and inspectors were not homogeneous.

D. Edison did not account for the added uncertainty created by clustering of inspections by inspectors.

For these reasons, Dr. Ericksen concludes that the sampling design of the Reinspection Program and the statistical analysis of the Reinspection Report are inadequate to support Edison's general conclusions about work quality and inspector qualifications.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-454 OL
COMMONWEALTH EDISON COMPANY	)	50-455 OL
	)	
(Byron Nuclear Power Station, Units 1 and 2)	)	

TESTIMONY OF DR. EUGENE P. ERICKSEN

Q1: Please state your full name for the record.

A1: Eugene P. Ericksen.

Q2: Please provide your job titles and business addresses.

A2: I am a Senior Sampling Statistician for Mathematica Policy Research, Incorporated, Box 2393, Princeton, New Jersey 08540. I am also an Associate Professor at Temple University, Philadephia, Pennsylvania 19122.

Q3: Please describe your job responsibilities at Mathematica Policy Research, Incorporated and list some of your clients.

A3: I am responsible for sample design of surveys and statistical evaluation projects. My work includes construction and evaluation of samples, including the computation of sampling errors.

I have done work for many federal agencies including the Bureau of the Census, the Department of Labor, the Department of Justice, the Social Security Administration and the Department of Health and Human Services.

I have also worked for various corporate clients such as AT&T, GTE, Metromobile, Inc., Blue Cross of Maine, Blue Cross of Massachusetts, and IMS America, and for private organizations such as the American Medical Association.

In addition, I have done work for New York City and for agencies of the States of New York, Pennsylvania and New Jersey.

Q4: Please describe your educational background and work experience.

A4: I hold a Ph.D. in Sociology and an M.A. in Mathematical Statistics from the University of Michigan and a B.S. in Mathematics from the University of Chicago. These degrees were awarded in 1971, 1965 and 1963 respectively.

In 1970, I joined the Institute for Survey Research and worked as a sampling statistician. From 1974 through 1981, I also worked as a Study Director at the Institute. I left the Institute in 1981 to became a Senior Sampling Statistician for Mathematica Policy Research, Inc. I have also taught courses in general statistics, survey sampling, and research methodology while working at Temple University as an Assistant Professor of Sociology from 1974 to 1978, and as an Associate Professor from 1978 through the present.

I have been an active member in many professional organizations for a number of years. Since 1975, I have served as a Proposal Evaluator for the National Science Foundation (NSF). I have consulted with the Center for Measurement

Methods and Data Resources of NSF on the development of standard procedures to evaluate surveys. I have served as the Chair of the Subcommittee to Review Proposed Internal Surveys of the American Statistical Association (ASA) since 1978, and was a member of the ASA Executive Committee Subsection on Survey Research Methods from 1975 through 1977. In 1978, I was appointed by the National Academy of Sciences to a committee evaluating the Census Bureau's method of estimating post-censal population size and per capita income of local areas.

I have published numerous technical papers relating to application of statistics and sampling methodology. A selected list of these publications is included in my resume, Erickson Attachment A.

Q5: Are you familiar with the Byron Reinspection Program?

A5: Yes. I have reviewed the Report on the Byron QC Inspector Reinspection Program (Reinspection Report), the Report Supplement, all testimony of Mr. Singh, and portions of the testimony of Messrs. Tuetken, Del George, Hansel and Laney.

Q6: What is the purpose of your testimony?

A6: The purpose of my testimony is to evaluate Edison's use of statistics and probability theory in reaching conclusions concerning inspector qualifications and work quality. I also identify the limits on conclusions which can be reached because not all work elements, work attributes and inspectors had a chance of being selected for reinspection.

Q7: Is it useful to apply statistics in this context?

A7: Yes. Where a 100 percent reinspection is not possible or practical but we wish to make a judgment about inspector qualifications and plant work quality, we can use statistics to draw inferences concerning many plant items and inspectors from inspections of selected items and inspectors. We must be very careful, however, to properly choose the sample and properly determine the population about which inferences can be drawn.

Q8: Have you formed an opinion on the adequacy of the samples chosen in the reinspection program and the statistical bases of Edison's determinations of inspector qualifications and work quality?

A8: Yes. The Reinspection Program's sampling design and statistical analysis is sufficiently flawed that it does not provide adequate support for Edison's general conclusions and inferences about work quality and inspector qualifications.

Q9: What are the major problems with the sampling design and statistical analysis?

A9: First, in structuring the Reinspection Program and Report, Edison failed to distinguish elements which are most important to safety from elements which are less important, or to distinguish elements which are easy to inspect from elements which are difficult to inspect. By lumping these elements together and failing to apply different criteria depending

(Rejected)

on the safety importance of the elements, Edison has not provided adequate assurance of work quality. (Rejected)

Second, in stating conclusions concerning all inspections at Byron, Edison has seriously over-generalized, making inferences to inspections, work attributes and work elements that had no chance of being selected for reinspection. Edison lacks sufficient statistical basis for making such inferences.

Third, Edison's statistical methodology was faulty. The Company used an inappropriate formula in reaching its statistical judgments.

Q10: Why should Edison have distinguished elements based on their safety significance?

A10: In order to assure that a plant can be operated safely, we are primarily concerned that proper inspections are made of those inspection elements which pose serious risks if not properly inspected, especially those which are hard to inspect. To give a simple analogy, it does us little good to know that 99.5 percent of the parts of an automobile were properly inspected if the 0.5 percent that were missed are the brakes and the steering. (Rejected)

To provide assurance that each type of element is properly inspected, Edison should have designed a stratified sample of elements. The strata would be groups of elements categorized by attribute, type of task, difficulty of inspection, and safety significance. In each stratum, we would

want to be assured that sample sizes were sufficiently large to be confident of the results. This would have enabled the Reinspection Program to establish acceptable confidence levels and reliabilities based on the importance of the element. Confidence levels indicate how certain a statistician is that his or her results are correct. Reliabilities reflect the percentage of inspections which are correct. For inspection elements where the risks caused by a poor quality are great, we might want to be certain that all were correct and, therefore, reinspect all elements. For inspection elements where the risks are not as great, but still substantial, we might want to be quite sure that 99.9 percent were correct. For other inspection elements which are less safety significant, we might be satisfied if we were reasonably certain that 99 percent were correct. In order to determine the amount of certainty and perfection required for each element, choices should have been made using engineering judgments. These judgments, along with their rationales, should have been determined when establishing the program and clearly stated in the reinspection report. A reasonable reinspection program might have required the following reliabilities and confidence levels for the following types of elements.

(Rejected)

Type of Element	Reliability	Confidence Level
Critical to safety	100%	100%
Very important to safety	99.9%	99%
Somewhat important to safety	99%	95%
Least important to safety	90%	95%

By aggregating data, i.e., lumping elements together, Edison failed to provide adequate assurance of safety. Even if we are 95 percent certain that 99 percent of all inspections that had a chance of being included in our sample met design requirements, this does not allow us to state that we are 95 percent certain that 99 percent of the more safety significant elements met design requirements. We, of course, want to be more than 95 percent certain that more than 99 percent of very important safety elements met design requirements. In order to make such a statement, the sampling plan should have incorporated special procedures for the more safety significant elements and should have disaggregated data, breaking it down by attributes and elements.

(Rejected)

Q11: Can you give us an example of a situation where a reliability was inflated because of aggregation?

A11: Yes. In the Reinspection Program, Table VII E-3, Edison lumped all Hunter "hardware" elements together and reported their reliability to be greater than 99.9% at a 95% confidence level. However, the sample size for the "component inspections for piping and whip restraints", which Mr. Tuetken classified in his second most important safety category (Bleuel Attachment B) is too small to provide any meaningful basis for reporting a reliability. Out of ~~4,321~~ 10,509 original inspections of piping and whip restraints, only 0 reinspections were done. (Ericksen Attachment B.) This is

far below the 200 minimum number of inspections required by Military Standard 105D, the standard which Mr. Singh applied in assessing the adequacy of sample size. (See tr. 9079.)

It is not possible to give an example for Hatfield because Edison did not disaggregate Hatfield data by inspection element. (See Ericksen Attachment C.)

Q12: In what way has Edison "over-generalized" in drawing conclusions about work quality and inspector qualifications?

A12: Statisticians are able to make generalizations to all population elements having a known, nonzero chance of being selected into the sample, and generalizations must be limited to this population. In the Byron reinspection program, numerous work elements and attributes had no chance of being included in the sample reinspected. Table 1, attached to my testimony, lists these items. In addition, in general, only inspections performed in the first three months of an inspector's employment were eligible for sample selection, and the sample provides an inadequate basis for statements concerning inspections in the second three-month period or later. Edison has not provided a statistical basis from which to draw inferences about the quality of work excluded from the sample.

Certain inspectors also had no chance of being included in the sample. Edison has not provided an adequate statistical basis from which to draw inferences about these inspectors.

Q13: Is it possible to use inspectors' performance in reinspecting those elements and attributes which had a chance of being in the sample as a basis for generalizing to elements and attributes that had no chance of being in the sample?

A13: Mr. Singh seemed to indicate during cross-examination (tr. at 9105-9106) that such inferences could be drawn because inspectors were homogeneous. However, actual data from the reinspection program show that inspectors were not homogeneous.

Q14: Why did you conclude that the Company's statistical methodology was faulty?

A14: Much of the important work in generating a statistical estimate should be done in advance. Decisions must be made concerning the reliability sought, the confidence with which the reliability must be demonstrated, and the populations and subpopulations for which generalizations are needed. Once these decisions have been made, the sample can be planned and selected. The statistical planner should determine how large the sample must be to provide the desired confidence intervals, and whether or not the sample should be stratified to provide estimates for important subgroups. Contrary to the Company's assertions, Edison failed to take large enough samples to even assure 90% reliability at a 95% confidence level.

Q15: What was the major problem with the Company's application of statistics in estimating reliabilities for work quality?

A15: Edison, in its analysis, applied a statistical methodology that assumes selection of a simple random sample of inspections (Reinspection Report, page VII-9), but the Reinspection Program did not take such a sample. Edison may have made this error because the Company designed its program to test initial qualifications of inspectors rather than quality of work.

In calculating reliabilities, Edison used the formula

$$R = 1 - \frac{2.9955}{n}$$

where R = reliability at 95% confidence level

n = number of inspections in the randomsample.

This formula was derived from page 246 of Probability and Statistics for Engineers by I. Miller and J.E. Freund (Prentice Hall, 1977).

According to Miller and Freund, the formula is an approximation that can be used, when no discrepancies are found, if the following assumptions are met:

> "1. There are only two possible outcomes for each trial ....
> 2. The probability of a success is the same for each trial.
> 3. There are n trials, where n is a constant.
> 4. The n trials are independent."

Id. at 54-55.

It was inappropriate for Edison to use this formula in calculating reliabilities in the Reinspection Report because assumptions (2) and (4) were violated.

Assumption (2) was violated because inspectors were not homogeneous; different inspectors had different probabilities of success. Assumption (4) was violated because inspections were not randomly chosen; the selections of inspections were not independent from each other.

Q16: What is the basis for your conclusion that inspectors were not homogeneous?

A16: Where inspectors are not homogeneous there will be similarities between inspections made by the same inspector. This creates a commonality within the cluster which can be measured by the "intraclass correlation." The intraclass correlation can range from a value slightly less than zero to +1.0. If the intraclass correlation is equal to zero, it means that inspectors are homogeneous and there is no increase in variance associated with cluster sampling. If the intraclass correlation is greater than zero, then inspectors are not homogeneous.

We can use data from Appendix B of the Reinspection Report to compute intraclass correlations. The computations show that for Hatfield, Hunter and Pittsburgh Testing Laboratory, each contractor's overall intraclass correlation was greater than zero. These positive intraclass correlations indicate that inspectors were not homogeneous.

Another indication of the lack of homogeneity among inspectors is seen from the results of "F tests." The F test is a common statistical tool that can be used to

determine whether observed variation in reliability among inspectors for a given attribute is greater than one expects by chance alone. For a sufficiently high F, we can conclude that inspectors are not homogeneous, at a particular level of significance.

Applying the F test to the data from Appendix B from the Reinspection Report, we reach the following conclusion: For Hatfield, Hunter and Pittsburgh Testing Laboratory, the F results for each contactor is sufficiently high to warrant rejection of the homogeneity hypothesis. In fact, the F results are so high that we are not only justified in rejecting the homogeneity hypothesis ~~at~~ at the 10% level of significance and the commonly used 5% level of significance, but also at the particularly stringent 1% level of significance.

Q17: What is the basis for your conclusion that the Program did not select a simple random sample of inspections?

A17: When a simple random sample is taken, the selection of each item is independent. The inclusion of any one item in the sample should not affect the likelihood that any other item will be included. In the Reinspection Program, the selections of inspections were not independent.

A simple example will make this clear. Assume Inspector A makes inspections numbered 1, 2, 3, 4 and 5 during his first three months of work. Assume that Inspectors B, C, D and E make inspections numbered 6 through 25 during their

first three months of work. If a simple random sample of inspections is taken, the fact that inspection 1 is included in the sample will not affect the likelihood that inspection 2 will be included. In the Reinspection Program, however, if inspection 1 was chosen to be included in the sample, there would be a 100 percent chance that inspections 2, 3, 4 and 4 would be included in the sample. Statisticians call this "clustering." In the example, inspections are clustered by inspector.

Q18: What is the effect of clustering?

A18: Clustering almost always increases the uncertainty with which statistical estimates can be evaluated.

Let me illustrate with a simple example. Let us assume that we have a population of four inspections with two inspectors, Mr. Short and Mr. Long, each making two inspections of a pipe that is three inches long. Inspector Short's measurements are both 2 inches, while Inspector Long's measurements are both 4 inches. The average of all inspections is $1/4(2 + 2 + 4 + 4) = 3$ inches. Now let us consider all possible samples of size 2 (i.e., that include two different inspections), where no one inspection can be chosen more than once. For clarity, we will call Short's first measurement 2_A and his second measurement 2_B ; likewise we will call Long's first measurement 4_A and his second measurement 4_B . There are six possible ways in which the inspections can be selected, disregarding the

order in which selections are made:

Sample	Sample Mean
2_A, 2_B	2.0
2_A, 4_A	3.0
2_A, 4_B	3.0
2_B, 4_A	3.0
2_B, 4_B	3.0
4_A, 4_B	4.0

In four out of six cases one would expect to pick a sample that yields the average inspection for the entire population. */

Now let us consider a second type of sample, a clustered sample where the inspector is the unit of selection. In other words, we take our sample of size 2 either by selecting Inspector Short's work or Inspector Long's work. Now there are two possible samples, namely:

Sample	Sample Mean
Short: 2_A, 2_B	2.0
Long: 4_A, 4_B	4.0

---

*/ In statistical terms, the sample mean is exactly equal to the population mean in four of the six samples, but differs by one inch in two of the six samples. Statisticians measure these discrepancies by a concept known as the standard error, which is the square root of the average of squared deviations of sample means from the population mean. It is approximately:

$$\text{Standard error } (\bar{x}) = \sqrt{\Sigma(\bar{x}_i - \mu_x)^2/n}, \text{ where}$$

μ_x = population mean
$\bar{x}_i$ = mean of sample i
n = number of samples.

For the example just described, the standard error is:

$$\sqrt{(1 + 0 + 0 + 0 + 0 + 1)/6} = 0.57735.$$

We have only two possible samples, and they happen to be the two whose values for the sample mean are farthest from the population mean. In no cases could we pick a sample that yields the average inspection for the entire population. The sample average would either be one inch too short or one inch too long. */

Hence, the uncertainty associated with the sample estimates generated from a clustered sample is greater than the uncertainty associated with the sample estimates generated from a simple random sample, in which all selections are independent from all other selections. Edison should not have used a formula that assumes simple random sampling in determining the reliabilities of samples that were clustered by inspector.

Q19: Can you give us an example from the Reinspection Program of a situation where a reliability was overstated because of the effect of clustering?

A19: Yes. A good example can be derived from data on the Hunter inspection element "Documentation on component inspections for piping and whip restraints." There were 37,230 original inspections of this element and 1,476 reinspections. (Ericksen Attachment B.) The 1,476 reinspections, however, are clustered.

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*/ The standard error is larger, namely:

$$\sqrt{(1 + 1)/2} = 1.0.$$

To determine inspection reliability for a clustered sample, the statistician must first calculate the "design effect," the quantitative measure of the extent to which a reliability estimate is reduced by the effect of clustering. When the actual sample size is divided by the design effect, we obtain the effective sample size, which should be used in computing reliability.

In the case of "documentation on component inspections for piping and whip restraints," the design effect is ~~5.2257~~ 5.2728. This yields an effective sample size of ~~282~~ 280 reinspections. Correcting for the effect of clustering, the effective sample size of this inspection element falls from 1,476 to ~~282~~ 280. (See Appendix 1.) ~~282~~ 280 reinspections out of 37,230 original inspections is far below the sample size of 500 reinspections required by Military Standard 105D. Edison, therefore, cannot assert a meaningful reliability for this element.

Q20: Can you summarize the major problems, with the Reinspection Program?

A20: Yes. ~~First, Edison did not establish adequate criteria for its statistical analysis. The Company did not properly select confidence levels and acceptable reliabilities, and failed to stratify the sample taking account of safety significance.~~ (rejected)

Second, Edison over-generalized, offering conclusions about inspectors and elements that had no chance of being included in the reinspected sample.

Third, Edison used an inappropriate formula in calculating reliabilities. Two assumptions of the formula were violated: inspections were not randomly selected and inspectors were not homogeneous.

Fourth, Edison did not account for the added uncertainty created by clustering of inspections by inspector.

For these reasons, the sampling design of the Reinspection Program and the statistical analysis of the Reinspection Report are inadequate to support Edison's general conclusions about work quality and inspector qualifications.

TABLE 1*

ATTRIBUTES AND ELEMENTS THAT HAD NO CHANCE OF BEING SELECTED FOR REINSPECTION

HATFIELD

Embedded conduit
Underground duct runs
Material and equipment receiving
Cable installation
Non-seg bus duct
Material handling
Stud welding
Limit switch gasket replacement
Removal of heat shrink tubing on conax penetrations
Housekeeping
All welds for which the original inspector could not be identified **

HUNTER

Visual inspection of valves
Ferrite inspection
Piping hydrostatic test
Piping weld interpass temperature inspection
Joules test inspection
Code name plate change
Inspection of weld defect removal cavity
Whip restraint - fitup and tack weld
Buried pipe covering inspection
Piping - pre-heat inspection
Whip restraint - pre-heat inspection
Pipe weld - Shield gas verification
Component support - snubber stroking
Bolting - turn-of-nut

* Source: Written testimony of Richard B. Tuetken, Attachment B, tr. at 8408.

** Source: Report on the Byron QC Inspector Reinspection Program, at IV-5, discussing Hatfield second audit.

TABLE 1 (cont'd)

Documentation

Ferrite inspection
Joules test
Code name plate change
Weld defect removal cavity
Component support - snubber stroking
Bolting - turn-of-nut

PITTSBURGH TESTING LABORATORY

Rebar detection
Bolting - turn-of-nut (connections)
Calibrations (torque wrenches, thermometers, feeler gauges, scales, gauges)
Cadwelds (rebar coupling)
Soils (back fill)
Concrete field (placement)
Concrete lab (aggregate)

ATTRIBUTES AND ELEMENTS WHICH WERE REINSPECTABLE BUT WERE NOT REINSPECTED

HATFIELD

Cable pan covers
Cable pan identification

HUNTER

Component support final inspection (type 3)
Component support final inspection (type 4)
Equipment installation

Documentation

Component support - final inspection (type 3)
Component support - final inspection (type 4)

APPENDIX 1

Calculation of Design Effect and Effective Sample Size

The design effect associated with a clustered sample can be calculated by using the following formula:

$$deff = 1 + roh\ (B-1)$$

where

deff = design effect
roh = the intraclass correlation
B = the average cluster size

Below, this Formula is applied to the Hunter inspection element "Documentation on component inspections for piping and whip restraints

Roh is the estimated intraclass correlation for Hunter inspectors and is equal to ~~0.0172477~~ 0.01744.

B equals the total number of reinspections divided by the total number of clusters (i.e., reinspectors). In this case, B equals 1,476 divided by 6, which is 246.

Therefore, deff = 1 + ~~0.0172477~~ 0.01744 (246-1)

= ~~5.2257~~ 5.2728

To calculate the effective sample size, and thereby adjust the actual sample size to reflect the effect of clustering, we use the following formula:

$$\text{effective sample size} = \frac{\text{actual sample size}}{\text{deff}}$$

In this case, the effective sample size is:

$$1{,}476 / \text{~~5.2257~~ } 5.2728 = \text{~~282.45~~ } 279.93$$

or approximately ~~282~~ 280 reinspections.

ERICKSEN ATTACHMENT A

EUGENE PENNELL ERICKSEN

EDUCATION:

1971	Ph.D., Sociology, University of Michigan
1965	M.A., Mathematical Statistics, University of Michigan
1963	B.S., Mathematics, University of Chicago

POSITIONS:

1981 -	Senior Sampling Statistician, Mathematica Policy Research, Inc.
1970 - 1981	Institute for Survey Research
1974 - 1981	Study Director
1970 - 1981	Sampling Statistician
1978 -	Department of Sociology, Temple University
1978 - 1981	Associate Professor
1974 - 1978	Assistant Professor
1969 - 1970	Student Fellow, University of Michigan
1967 - 1968, 1964 - 1966	Student Associate, Institute for Social Research, University of Michigan
1966 - 1967	Lecturer, Balham and Tooting College of Commerce, London

EXPERIENCE:

At Mathematica Policy Research, Dr. Ericksen has had responsibility for the sample design of surveys on diverse populations including households in the United States, industries using data communications equipment, physicians, social security recipients, and emergency rooms in hospitals. He has also conducted statistical evaluation projects including several which were the basis for expert testimony in courtroom litigation. He is currently the chief technical advisor for plaintiffs in several suits concerning the adjustment of the 1980 Census.

At the Institute for Survey Research, Dr. Ericksen worked on virtually every major project as Sampling Statistician. His duties included designing and constructing a national sample of households, adapting this sample to the sampling from lists, constructing national samples, and evaluating the samples with respect to computing sampling errors. He also designed, constructed, and evaluated subnational surveys for particular states and local areas. As Study Director, Dr. Ericksen conducted studies under three joint contracts with the Bureau of the Census. The objective of these studies was to develop a methodology for using regression analysis with sample data to compute postcensal estimates for local populations, and they were conducted from 1972 through 1974. He was also co-principal investigator on the studies "Ethnicity and Community in a Metropolis," supported by the National Institute of Mental Health, Center for Metropolitan Studies, 1975 through 1979, and "Fertility of an American Isolate Subculture (The Old Order Amish)," supported by the National Institutes of Health, 1976 through 1978.

At Temple University, Dr. Ericksen has taught courses in general statistics, survey sampling, research methodology, family sociology, ethnic groups, population, and human ecology. In the spring of 1980, as part of the Experimental Student Intern Program of the Bureau of the Census, he taught a special course whereby undergraduate students were trained to become enumerators in the 1980 Census.

At the Population Studies Center, University of Michigan, Dr. Ericksen, under a joint contract with the Bureau of the Census, wrote a Ph.D. dissertation to develop the methodology for using regression analysis and sample data to compute postcensal population estimates for local areas.

Mr. Ericksen is also a research associate for the Center for Philadelphia Studies, University of Pennsylvania. He is also a member of the American Statistical Association, the Population Association of America, and the American Sociological Association.

PROFESSIONAL ACTIVITIES AND OFFICES:

Member, Executive Committee, Subsection on Survey Research Methods, American Statistical Association, 1975-1977.

Member, Board of Review, American Statistical Association Project on the Assessment of Survey Research Practices, 1976 and 1977. The Committee evaluated the following report: "Developing of Survey Methods to Assess Survey Practices," by Barbara A. Bailar and C. Michael Lanphier, and published by the American Statistical Association, 1978.

Publications Liaison, Section on Survey Research Methods, American Statistical Association, 1978.

Proposal Evaluator, National Science Foundation, 1975 to present. He has also consulted on the development of standard procedures to evaluate surveys with the Center for Measurement Methods and Data Resources of the NSF.

Chair, Subcommittee to Review Proposed Internal Surveys of the ASA (American Statistical Association), 1978 to present.

Member, committee appointed by National Academy of Sciences to evaluate Census Bureau method of estimating postcensal population size and per capita income of local areas.

SELECTED PAPERS AND PUBLICATIONS:

"Voting Patterns in Pennsylvania Judicial Primaries: 1983" report to Judiciary Committee of the Pennsylvania State Senate. Presented November 30, 1983 (with Christena E. Nippert).

"Using Administrative Lists to Estimate Census Omissions: An Example," (with Joseph B. Kadane) 1983, presented at Meetings of American Statistical Association.

"Using the 1980 Census as a Popululation Standard," (with Joseph B. Kadane) 1983, presented at Meetings of American Statistical Association.

"Estimating the Population in a Census Year," presented to the Federal Court of the Southern District of New York, 1982, and to conference on "Data Needs for America in Transition," sponsored by the Congressional Research Service, Library of Congress, 1983 (with Joseph B. Kadane).

"Can Regression Be Used to Estimate Local Undercount Adjustments?" Proceedings of the 1980 Conference on Census Undercount, July 1980, pp. 55-61.

"The Cultivation of the Soil as a Moral Directive: Population Growth, Family Ties, and the Maintenance of Community Among the Old Order Amish." Rural Sociology, vol. 45, Spring 1980, pp. 49-68 (with Julia A. Ericksen and John Hostetler).

"Fertility Patterns and Trends Among the Old Order Amish." Population Studies, vol. 33, July 1979, pp. 255-276 (with others).

"The Division of Family Roles." Journal of Marriage and the Family, vol. 41, May 1979, pp. 301-313 (with Julia A. Ericksen and William Yancey).

"Antecedents of Community: Economic and Institutional Structure of Urban Neighborhoods." American Sociological Review, vol. 44, April 1979, pp. 253-262 (with William L. Yancey).

"Work and Residence in Industrial Philadelphia." Journal of Urban History, vol. 5, March 1979, pp. 147-182 (with William L. Yancey).

"Matching Criteria for Evaluating Local Estimates: Discussion of Papers by Gonzalez and Fay." In Synthetic Estimates for Small Areas: Statistical Workshop Papers and Discussion, National Institute on Drug Abuse Research Monograph No. 24, February 1979, pp. 185-191.

"A Tale of Three Cities: Blacks and Immigrants in Philadelphia, 1850-1880, 1930, and 1970. "The Annals, vol. 441, January 1979, pp. 55-81 (with others).

SELECTED PAPERS AND PUBLICATIONS: (continued)

"Immigrants and their Opportunities: Philadelphia, 1850-1936." Presented at a symposium on immigration held at the meetings of the American Association for the Advancement of Science, Houston, Texas, January 1979 (with William L. Yancey).

"Report of the Conference on Economic and Demographic Methods for Projecting Population: Summary and Recommendations." The American Statistical Association, April 1978 (with Richard Engels).

"Reply to Levine and Bergesen." American Sociological Review, vol. 42, October 1977, pp. 825-827 (with William L. Yancey and Richard N. Juliani).

"Some Lessons Learned from Conducting Federally Sponsored Surveys." Proceedings of the Social Statistics Section, American Statistical Association, August 1977, pp. 183-185.

"Sampling a Rare Population: A Case Study." Journal of the American Statistical Association, vol. 71, December 1976, pp. 816-822.

"Emergent Ethnicity: A Review and Reformulation." American Sociological Review, vol. 41, June 1976, pp. 391-403 (with William L. Yancey and Richard Juliani).

"Outliers in Regression Analysis when Measurement Error is Large." Proceedings of the Social Statistics Section, American Statistical Association, August 1975, pp. 412-417.

"Population Estimation in the 1970s: The Stakes are Higher." Report to Bureau of the Census, May 1975.

"A Regression Method for Estimating Population Changes of Local Areas." Journal of the American Statistical Association, vol. 69, December 1974, pp. 867-875.

"Recent Developments in Estimation for Local Areas." Proceedings of the Social Statistics Section, American Statistical Association, December 1973, pp. 37-41.

"A Method for Combining Sample Survey Data and Symptomatic Indicators to Obtain Population Estimates for Local Areas." Demography, vol. 10, May 1973, pp. 137-160.

"Test of a Statistical Procedure for Computing Estimates for Local Areas." Report to Bureau of the Census, January 15, 1973.

ERICKSEN AMENDED ATTACHMENT B

11c. Edison's Amended Response to Interrogatory 11(c) and Third Amended Response to Interrogatory 12(c)

I. Inspection (by attribute)	II. Total Inspections Performed through 8/31/82	III. Total Reinspections Performed	IV. Number of Inspectors Inspecting Attribute	V. Inspectors Reinspected
class I cable pan hangers	26,230	4,776	9	2
class I cable pans	1,643	80	10	1
cable terminations	78,548	7,784	16	5
equipment modifications	628	27	4	3
class I exposed conduit	30,210	2,793	15	6
A-325 bolt installation	14	8	3	1
conduit "as-built" program	180,000	44,777	28	8
visual weld inspection	312,000	27,844	17	8

Notes: The numbers in Column II are estimated and exclude inspections performed after September 1, 1982. The number of total inspections and total reinspections shown for attributes 4 and 6 refer to the number of items on an individual inspection report and inspection reports respectively. All other numbers in columns II and III refer to individual inspections of various components. The numbers in Column IV are the number of inspectors who, on their first date of certification, were certified in the inspection attribute and actually performed inspections of that attribute between the date of first certification and September 1, 1982. The total number of Hatfield inspectors employed between 1976 and September 1, 1982 is 86. Many inspectors are certified in more than one inspection procedure. For the objective inspections, inspection attributes 1, 2, 5 and 7 require similar inspection skills as do inspection attributes 3 and 4.

	Inspection (by inspection element)	Total Inspections Performed	Total Reinspections Performed	Number of Inspectors Inspecting Inspection Element	Inspectors Reinspected
1.	Documentation for piping mechanical joint witness of torque-initial, intermediate and final	9,745	247	12	1
2.	Documentation of piping hydrostatic test	430	120	3	1
3.	Documentation on piping inter pass inspection	5,896	321	13	4
4.	Documentation on name plate inspection	25	5	2	1
5.	Documentation on finished weld inspection of piping and whip restraints	187,129	14,584	16	11
6.	Documentation on finished weld inspection for component supports	29,272	963	10	6
7.	Documentation on component inspections for piping and whip restraints	37,230	1,476	16	6
8.	Documentation on fit up and tack welds for piping and whip restraints	98,861	3,609	16	9
9.	Documentation on piping field bonds-final visual, ovality and radius	2,434	41	10	1

	Inspection (by inspection element)	Total Inspections Performed	Total Reinspections Performed	Number of Inspectors Inspecting Inspection Element	Inspectors Reinspected
10.	Documentation on review of type a inspection for type 3 inspection final reivew	168,815	21,161	6	6
11.	Documentation on mechanical joint inspection for piping preassembly inspection (component)	5,929	82	11	1
12.	Documentation on piping mechanical joint inspections line up inspections (fit up)	4,355	29	8	1
13.	Documentation on location acceptance between component support and item being supported	3,219	86	5	2
14.	Documentation on component support inspection checklist	9,230	158	4	1
15.	Documentation on location of field welds for piping inspections	5,707	353	8	4
16.	Documentation on piping holiday jeep test	60	10	2	1
17.	Documentation on component supports concrete expansion anchors	2,589	782	5	4

	Inspection (by inspection element)	Total Inspections Performed	Total Reinspections Performed	Number of Inspectors Inspecting Inspection Element	Inspectors Reinspected
18.	Documentation on piping and whip restraints pre-heat inspection	2,483	231	6	2
19.	Documentation on piping verification of shield gas	685	10	4	1
20.	Documentation on piping and component supports temporary attachments inspection	401	122	4	2
21.	Small bore type 3 final hardware inspection reports	3,503	3,014	5	5
22.	Small bore type 4 final documentation inspection reports	47	35	2	2
23.	Whip restraints type 3 final documentation inspection reports	185	176	1	1
24.	Whip restraints type 4 final documentation inspection report	12	6	1	1
25.	Equipment type 3 final documentation inspection report	13	7	1	1
26.	Documentation on large bore piping types final inspection	401	395	2	2

	Inspection (by inspection element)	Total Inspections Performed	Total Reinspections Performed	Number of Inspectors Inspecting Inspection Element	Inspectors Reinspected
27.	Piping mechanical joints witness of torque initial, intermediate, and final	9,034	626	13	9
28.	Component supports torques	423	150	7	2
29.	Finished weld inspection for piping and whip restraints	10,981	2,291	17	17
30.	Finished weld inspection for component supports	15,844	1,437	15	9
31.*	Piping and component supports temporary attachments inspection	373	0	11	0
32.*	Component inspections for piping and whip restraints	10,509	0	16	0
33.*	Fit up and tack weld for piping and whip restraints	26,572	0	16	0
34.	Piping field bends inspection final, visual ovality and radius	1,032	417	10	9
35.	Verified location acceptable between component support and item being supported	1,996	254	10	4
36.	Component support inspection checklist	52,273	13,894	9	4

	Inspection (by inspection element)	Total Inspections Performed	Total Reinspections Performed	Number of Inspectors Inspecting Inspection Element	Inspectors Reinspected
37.	Dimensional on location of field welds for piping inspections	2,934	567	9	8
38.	Component support concrete expansion anchors inspection	4,882	772	9	4
39.	Small bore type 3 final hardware inspection reports	31,917	10,515	9	5
40.	Small bore type 4 final hardware inspection reports	1,312	43	3	1
41.	Large bore type 3 final inspection report	34,801	5,187	8	3
42.	Whip restraints type 3 final hardware inspection report	6,556	876	4	1
43.	Whip restraints type 4 final hardware inspection reports	134	22	1	1

NOTES: The Total Inspections Performed are those performed by the inspectors whose work was reinspected in the reinspection program. The total number of inspections is unknown. Inspections conducted after August 31, 1982, are excluded. The Number of Inspectors Inspecting Inspection Element is the number of inspectors who, were certified to perform inspections for the inspection element and whose inspections were reinspected. Information on the total number of inspectors inspecting each inspection element is not available. The total number of Hunter inspectors employed at Byron between 1976 and September 1, 1982 is 84. The certifications of these inspectors permit them to conduct inspections of more than one inspection element. Inspection attributes 1-26, 27-28, 29-31, 32-38, 39-41 and 42-43 require similar inspection skills.

* Portions of these attributes were nonrecreatable and thus were not reinspectable.

ERICKSEN ATTACHMENT C (SUPP.) 8/14/84

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454-OL
	)	50-455-OL
(Byron Station, Units 1 and 2)	)	
	)	

COMMONWEALTH EDISON COMPANY'S
RESPONSE TO INTERVENOR'S FIRST SET
OF SUPPLEMENTAL INTERROGATORIES

Interrogatory 11 Supplement: Separately, with respect to each "inspector reinspected" listed in Edison's First Amended response to Intervenor's Interrogatory 11(c), please list all inspection elements and for each inspection element, please provide:

(a) a description of the inspection element;

(b) total number of inspections performed;

(c) total number reinspections performed;

(d) the number of inspectors who inspected this element;

(e) the number of inspectors of that element who were reinspected and separately for each inspector reinspected: (i) the number of reinspections performed that agree with initial inspections and (ii) the total number of reinspections performed. (The tabulation for (e) should provide the same type of information provided in Table B-5 of the Reinspection Program disaggregated by "inspection element" rather than "attribute").

Answer (a)-(b). Commonwealth Edison Company ("CECo") objects to Interrogatory 11 Supplement on the grounds that it would be unduly burdensome to obtain this information and that the information is neither relevant nor calculated to lead to discovery of admissible information. Notwithstanding the foregoing objection, CECo further answers Interrogatory 11 as follows: Hatfield Electric Company has not maintained its inspection records by inspection element. Accordingly, answer to this interrogatory requires the analysis of tens of thousands of inspection reports and an identification of inspection elements. At Intervenors' request, documents containing information responsive to this Interrogatory will be made available for inspection and copying.

ERICKSON ATTACHMENT D (Supp) pg 1 of 3

1 FINISHED WELD INSPECTION FOR PIPING AND WHIP RESTRAINTS

	Total		Sample		Sample Rejects	
	Subjective	Objective	Subjective	Objective	Subjective	Objective
1284 P. PEPITONE (A) (NRC) Level II	195	N/A	27	N/A	1	N/A
9208 R. STURGES (B) (1st) Level II	237		14		0	
1211 J. OOTEN (C) (2nd) Level II	48		34		0	
1354 P. KILPATRICK (D) (NRC) Level II	135		31		0	
1714 W. TUCKER (E) (3rd) Level II	2175		279		3	
1515 R. CANTLEY (F) (4th) Level II	798		214		6	
9076 O. YOUNG (G) (5th) Level II	898		122		13	
1529 W. MADILL (H) (6th) Level II	159		55		6	
1980 S. BURSTEIN (V) (6th and next) Level II	914		8		1	

	Total Subjective	Total Objective	Sample Subjective	Sample Objective	Sample Rejects Subjective	Sample Rejects Objective
9446 E. SAUNDERS (I) (7th) Level II	1387	N/A	319	N/A	4	N/A
1605 J. CAMPBELL (K) (8th) Level II	1060		344		10	
1946 L. GEURTSEN (L) (NRC) Level II	1117		273		0	
1130 T. KELLEY (P) (9th) Level II	1061		182		1	
1533 R. MILROY (Q) (10th) Level II	53		33		1	
1562 J. BAKER (R) (NRC) Level II	413		237		5	
1313 M. WELLS (S) (11th) Level II	318		114		0	
1782 C. WIEDEMAN (U) (12th) Level II	11		5		0	

1 FINISHED WELD INSPECTION FOR PIPING AND MHP RESTRAINTS

		Total		Sample		Sample Rejects	
		Subjective	Objective	Subjective	Objective	Subjective	Objective
9357 G. FERRIGAN (NRC) Level I	(J)	N/A	N/A	N/A	N/A	N/A	N/A
1958 W. BAKER (13th) Level I	(O)						
1078 P. PEASLEE (14th) Level I	See Speed Letter from R. Klingler CECo 4-4-83						
1041 M. PELIKAN (14th and next) Level I	(N)						
1867 B. WYATT (15th) Level I	(M)						
1705 L. LINDGREN (16th) Level I	(I)						

18 FINISHED WELD INSPECTION FOR COMPONENT SUPPORTS

	Total		Sample		Sample Rejects	
	Subjective	Objective	Subjective	Objective	Subjective	Objective
1284 P. PEPITONE (A) (NRC) Level II	549	N/A	24	N/A	3	N/A
9208 R. STURGES (B) (1st) Level II	8		0		0	
1211 J. OOTEN (C) (2nd) Level II	3		0		0	
1354 P. KILPATRICK (D) (NRC) Level II	17		2		0	
1714 W. TUCKER (E) (3rd) Level II	1336		22		15	
1515 R. CANTLEY (F) (4th) Level II	0		0		0	
9076 O. YOUNG (G) (5th) Level II	14		7		0	
1529 W. MADILL (H) (6th) Level II	0		0		0	
1980 S. BURSTEIN (V) (6th and next) Level II	6712		58		3	

18 FINSIHED WELD INSPECTION FOR COMPONENT SUPPORTS

	Total		Sample		Sample Rejects	
	Subjective	Objective	Subjective	Objective	Subjective	Objective
9446 E. SAUNDERS (I) (7th) Level II	686	N/A	0	N/A	0	N/A
1605 J. CAMPBELL (K) (8th) Level II	3		0		0	
1946 L. GEURTSEN (L) (NRC) Level II	478		0		0	
1130 T. KELLEY (P) (9th) Level II	1517		81		13	
1533 R. MILROY (Q) (10th) Level II	1907		259		8	
1562 J. BAKER (R) (NRC) Level II	693		0		0	
1313 M. WELLS (S) (11th) Level II	88		67		0	
1782 C. WIEDEMAN (U) (12th) Level II	1832		817		19	

18 FINISHED WELD INSPECTION FOR COMPONENT SUPPORTS

		Total		Sample		Sample Rejects	
		Subjective	Objective	Subjective	Objective	Subjective	Objective
9357 G. FERRIGAN (NRC) Level I	(J)	N/A	N/A	N/A	N/A	N/A	N/A
1958 W. BAKER (13th) Level I	(O)						
1078 P. PLASLEE (14th) Level I	See Speed Letter from R. Klingler CECo 4-4-83						
1041 M. PELIKAN (14th and next)- Level I	(N)						
1867 B. WYATT (15th) Level I	(M)						
1705 L. LINDGREN (16th) Level I	(T)						

TABLE 2
Changes from Edison's Original
Response to Interrogatory 12 to Final Response

	# of Inspections	# of Reinspections	# of Inspectors	# of Inspectors Reinspected
	Finished weld inspection for piping and whip restraints			
Original	4,395	2,291	17	17
Final	10,981	2,291	17	17
	Component inspection for piping and whip restraints			
	4,321	4	16	1
	10,509	0	16	0
	Fit-up and tack weld for piping and whip restraints			
	9,395	5	16	2
	26,572	0	16	0
	Dimensional on location of field welds for piping inspections			
	967	567	8	8
	2,934	567	9	8
	Piping field bends, final visual, ovality and radius			
	729	417	10	9
	1,032	417	10	9
	Piping mechanical joints witness of torque initial, intermediate and final			
	2,714	606	12	10
	9,034	626	13	9
	Finished weld inspection for component supports			
	3,282	1,437	11	9
	15,844	1,437	15	9
	Component support location inspection			
	472	254	5	4
	1,996	254	10	4
	Component support checklist inspection			
	18,378	13,932	4	4
	52,273	13,894	9	4
	Component support torque			
	405	150	5	2
	423	150	7	2
	Component support CEA inspection			
	1,154	772	5	4
	4,882	772	9	4
	Piping and component support tamp attachment inspection			
	27	13	4	2
	373	0	11	0
	Small bore type 3 final hardware inspection reports			
	22,762	10,515	5	5
	31,917	10,515	9	5
	Small bore type 4 final hardware inspection			
	155	75	2	1
	1,312	43	3	1
	Whip restraints type 3 final hardware inspection			
	4,684	876	1	1
	6,556	876	4	1

	# of Inspections	# of Reinspections	# of Inspectors	# of Inspectors Reinspected
	Whip restraints type 4 final hardware inspection			
Original	134	22	1	1
Final	134	22	1	1
	Large bore type 3 final hardware inspection			
	1,535	195	2	1
	34,801	5,187	8	3
	Large bore type 4 final hardware			
	-- NO --	DATA --	PROVIDED --	
	490	0	5	0

(ERICKSEN SUPP.)

TABLE 3

Table B-3
Detailed Inspector Results
Hunter

Attributes

Inspector	Reinsp. Program No. 1	Int. Interrog. 12 Supp.(when differe
A	47/48	47/51
B	14/14	
C	34/34	
D	33/33	
E	283/301	
F	208/214	
G	116/129	
H	49/55	
I	315/319	
J	-	
K	334/344	
L	273/273	
M		
N	-	
O		
P	249/263	
Q	383/392	
R	232/237	
S	181/181	
T	-	
U	803/822	
V	62/66	
TOTAL	3616/3725	3616/3728
DISCREPANCIES	109	112
DISCREPANCIES EVALUATED FOR DESIGN SIGNIFICANCE	109	109
DISCREPANCIES NOT EVALUATED FOR DESIGN SIGNIFICANCE	0	3

(Ericksen Supp.)

TABLE 4

Percent of Discrepancies on Reinspection by inspector and element

Inspector	Element 1	Element 2	Average percent discrepa across all elements
A	4	12	2
D	0	0	0
E	1	68	6
G	~~3~~ (11)	0	10
P	1	16	5
[illegible]	3	2	2
S	0	0	0
U	0	2	2
V	12	5	6
Average percent discrepancy across all inspectors	2	4	3

Element 1 - Finished weld inspections for piping and whip restraints
Element 2 - Finished weld inspections for component supports

(Ericksen Supp.)

TABLE 5

Percentage of Discrepancies on Reinspection for Visual Welding by Contractor

Contractor	Visual Welding
Johnson Controls	4
Hunter	3
NISCO	0
Hatfield	7
Pittsburgh Testing	15
Peabody	24
Average percent discrepancy across all contractors	8

T19 MM/mml

MS. JUDSON: I just wanted to report to the Judges that Table 2 has now been reduced to the appropriate size.

JUDGE SMITH: Thank you.

MR. CASSEL: Courtesy of Ms. Ethel McGreavy.

JUDGE SMITH: You may tell the Marshalls, never mind.

MR. MILLER: May I proceed, Judge Smith?

JUDGE SMITH: Yes.

XXX

CROSS-EXAMINATION

BY MR. MILLER:

Q Dr. Ericksen, you are aware, are you not, that the Reinspection Program broke down the inspections into two main categories; objective inspections and subjective inspections, correct?

A Yes.

Q And the subjective inspections were only visual weld examinations, right?

A That's right.

Q Now, in answer 11, you refer to component inspections for piping and whip restraints. Do you know, Dr. Ericksen, what the characteristics of that inspection are?

A I think to save time I will say no.

You can infer from the words, but --

Q Do you know how, if at all, that inspection differs

mm2

from component support concrete expansion anchor inspections?

A No, I will simply state that since the engineers saw fit to characterize them as a different type of inspection element, that I went along with that judgment.

Q Okay.

Is it because you were relying on the engineering judgment of whatever individual set out these separate inspection elements as separate elements, that you conclude that it is -- it would not be proper to aggregate elements in calculating a reliability statistic?

A I think there are two parts to answer your question.

Q Okay.

A The first part -- and this applies really to any kind of data that you might be working with. It doesn't have to apply to a nuclear power plant. It could apply to testing drugs, it could apply to crops, it could apply to quality control of various products in a factory. That there are different ways of aggregating and combining things which are somewhat the same in some characteristics, and are different in other characteristics.

And the way in which the smallest components are aggregated is an important issue of statistical judgment. And one should indicate how those aggregation decisions were made.

The second part of my answer is that when you

mm3

look at different elements that are combined in the same attribute, the error rates do seem to differ.

Q I think the first part of your answer was that the way in which the smallest components of the element -- I'm sorry, my notes -- I wasn't able to keep up with my notes. I think you said that the smallest component of what, sir?

A Well, if we agree that there is a term to define the smallest unit that is inspected -- I think we have been referring to them as inspection elements.

Q All right, sir.

A Now, at one extreme, one could argue that every single inspection element, the results and the reliability should be presented separately.

At another extreme, one would argue that they should all be put together into one large category.

And what I am saying is that that is a substantive decision which requires justification. And the criterion on which that judgment should be made really would have to do with the difficulty of inspection and likelihood of discrepancy.

Q And that is something that an expert in the subject matter --

A Well, there are two ways in which that could have been done. An expert in the subject matter could have made

mm4

that judgment a priority. And the rationale for that judgment in normal statistical circumstances would be included in part of the report for evaluation.

Secondly, with hindsight one could look at the data and make the judgment based on inspection of the data.

Q I would like you to turn to answer 19, please.

Actually, I want to go all the way to the last paragraph of answer 19, which is found on page 16.

This is the calculation of the design effect that is described in your testimony, is it not?

A Yes.

Q And Appendix 1 to your prepared testimony gives some of the details of that calculation, correct?

A Yes.

Q You made some, what a non-statistician would regard as essentially small changes in the numbers. But with those changes do you believe that the calculation is correct as you have reported it here?

A Yes. The calculation is necessarily an approximation given the equation that was used. To the best of my judgment, the calculation is correct.

Q If we turn to Appendix 1, it is correct, is it not, that the calculation of the design effect itself is based on the calculation of intraclass correlation?

A Yes.

mm5

Q That's the necessary part of the calculation for design effect, right?

A Well, I presented it this way.

What I actually did was, I calculated the variants; estimated the design effect from the variants calculation; inserted the average cluster size into the design effect, and calculated intraclass correlation from that.

Q Returning to, for ust a second, to answer 16 on page 11, that is the same intraclass correlation measurement in the first paragraph of answer 16 that is a part of the equation for your calculation of the design effect, correct?

A I must apologize, I was reading the first paragraph. I didn't pay attention to your question.

Q Are you finished, I will reask the question.

A Please.

Q The question is, is the calculation of the intra-class correlation that is described in the first paragraph of answer 16, the same intraclass correlation which is used as a part of --

A Yes.

Q You have to wait until I am finished, I'm sorry.

-- which is used as a part of the calculation of design effect in Appendix 1, and in your answer 19?

A Well, in answer 16 I am really telling you about

mm6

the intraclass correlation. And it is a concept that is described in my answer 16.

In Appendix 1 I tried to estimate what the intraclass correlation might be for one example.

MR. CASSEL: Excuse me, just a minute.

Are the Judges having any difficulty hearing the witness? Does he need to speak into the mike?

JUDGE SMITH: No, I heard him.

JUDGE COLE: I heard him, thanks.

MR. MILLER: Dr. Ericksen commented before we started that it is difficult to speak to both the questioner and the Board.

JUDGE SMITH: No, I have no problems.

BY MR. MILLER:

Q Now, returning again to answer 19 -- I'm sorry to jump around like this-- but the calculation of the design effect is used, is it not, to take account of the clustered sampling of inspections?

A Yes.

Q And a clustered sample by definition is not a random sample as defined in the formula that Dr. Singh used and that you discuss in answer 15 on page 10?

end T19

A That's right.

Q As a result of your calculation of the intra-class correlation and the conclusion that this is a cluster rather than random sample, it is your judgment that assumptions number 2 and 4 that are the predicate, if you will, for use of the formula, have been violated. Is that right?

A No, that's not correct.

Q Okay. You conclude that inspectors are not homogeneous. Is that correct?

A Yes, I do.

Q And you do that on the basis of your calculation of the intraclass correlation; correct?

A This is one example. There are other intraclass correlations that were calculated for Hatfield and for Hunter.

Q Oh, I understand.

A This is one example.

Q Yes, I understand it's an example, but it is your calculation or calculations of intraclass correlations that lead you to conclude that inspectors are not homogeneous.

A I think that there are two or three questions embedded in here. Let me see if I can take them apart and answer them, because the thing that confused me is that you referred me to assumptions 2 and 4 in the Miller and Freund book, and assumptions 2 and 4 are violated because

we know that a clustered sample was selected. Now, what the calculation of intraclass correlation does is give us some indication of whether or not that matters. And if the intraclass correlation is larger than 0, then it probably matters.

Now, a third point to be made is that the reliability calculation, the R equals 1 minus 2.9955 over N, which is a particular approximation based on the chi-squared distribution, the effects of cluster sampling on that, to my knowledge, have never been studied. And it could be that the effects of clustering on that formula are far greater than the calculation that I have shown would indicate.

Q But in any event, the starting point for your analysis is your calculation of the intraclass correlation, correct?

A Intraclass correlations.

Q Correlations, thank you. Now, I think you state in your answer 16 that you used data from Appendix B of the Reinspection Program Report in order to calculate these intraclass correlations.

A That's right.

Q If you would turn to Appendix B, perhaps the easiest table to look at is Table B-3 on page B-4, which is the detailed inspection results for Hunter. And just taking the column that's labeled number 1, there were 3,725

visual welds that were reinspected, and of those, 3616 were found to be without discrepancies; correct?

A Correct.

Q Dr. Ericksen, do you know the difference between an observed discrepancy, a valid discrepancy, and a design significant discrepancy as those terms were used in describing discrepancies reported in the Reinspection Program?

A I used the term "discrepancy" to mean whatever was meant in the preparation of B-3. And I understand that a design-significant discrepancy involves some kind of engineering judgment applied to the individual discrepancies.

Q Yes, sir. I think you stated that you had reviewed the prepared testimony of Mr. Del George, Mr. Teutken, Mr. Laney, Mr. Hansel. Did you look at the testimony of any of the Sargent & Lundy witnesses? Prepared testimony.

A Could you suggest a couple of names?

Q Well, the one I'm specifically referring to is the testimony of Mr. Branch.

A I did look only at one point in Mr. Branch's testimony when I was trying to put the 109 and 112 together.

Q Well, I would like to show you Question and Answer 11 from Mr. Branch's prepared testimony and ask you to just read it to yourself and then I have a question or two.

(Document handed to witness.)

A Could I ask you a question?

Q Certainly.

A Can I assume that the term "discrepancy" in Question 11 is the same as the "discrepancy" that was used in preparing Table B-3?

Q Wait, I've got to read that.

(Pause.)

Yes, sir.

A Okay.

Q Okay. Now, that indicates, does it not, that there were certain observed discrepancies that were determined, after looking at current design parameters and tolerances, not to be discrepancies at all. Is that right?

A I found that a little bit murky. I wasn't sure if they were trying to -- they could have been doing one of two things. Perhaps you could educate me on this. Either he was giving testimony that said Table B-3 should somehow be altered, or he was giving testimony to say that a discrepancy -- say, the four discrepancies for Inspector D and attribute 1 were not of design significance.

Q I think maybe we can clear it up if we look at Appendix D of the Reinspection Program. And I think the simplest one is Table DE-3, Exhibit D-1, page 3 of 12. And if you look at the --

MR. CASSEL: Would you give us a minute. DE what?

MR. MILLER: D-1, page 3 of 12.

BY MR. MILLER:

Q If we look at the conclusion of that table we find of 441 discrepancies, all of them were found to be within parameters.

Now, having in mind what Mr. Branch said about the discrepancies being first compared with current design parameters and tolerances or other documentation to determine whether they were acceptable on that basis, can we agree that there's a difference between an observed discrepancy and a valid discrepancy. Is that how you believe, based on what I have shown you, the Reinspection Program --

A I believe that engineers are making some judgments. After this morning, I'm certainly not going to profess to expertise in the field of engineering. But let's assume for purposes of discussion that there's a distinction that can be made by engineers.

Q All right. Wouldn't the statistic that one would want to use in calculating an intraclass correlation be the statistic that was based on valid discrepancies as opposed to observed discrepancies?

A It depends on the purpose to which you wish to apply the intraclass correlation.

end 20

Q If the purpose was to -- assume with me that valid discrepancies and actual discrepancies and observed discrepancies may have resulted from the fact that the reinspector made a mistake.

A Yes.

MR. CASSEL: Is that assumption that some of them may have, or all of them did?

MR. MILLER: Some of them may have.

BY MR. MILLER:

Q And let's assume that what we were trying to establish is how well those original inspectors performed and whether they missed anything that they should have caught in their inspections. And for that purpose, what we are interested in is not observed discrepancies but the valid discrepancies. Wouldn't you agree that in that case, you would want to use the statistic associated with valid discrepancies, in calculating your intraclass correlations?

A Well, I think that one normally has -- I shouldn't has. One has an intraclass correlation for every variable that you are considering. And variable one would have an intraclass correlation and variable two would have an intraclass correlation.

Q You have calculated your intraclass correlations on the information in Appendix B, which is the observed discrepancies?

A That's right.

Q If you are willing to accept my assumption one more time, with respect to the objective discrepancy evaluation table for Hunter, with respect to documentation. If in fact --

A This is attribute two?

Q Yes, it's pages 3 and 4 of 12 of Exhibit D-1, the Reinspection Program. Would it be possible to calculate the intraclass correlation and design effect for the documentation, the subparts of the documentation attribute, if you were calculating it on the basis of valid discrepancies and that statistic was zero?

A Yes, that would simply be another calculation for another variable. I only did this to give an example, so I suppose it could have been another example.

Q But Dr. Ericksen, if you have a zero in the formula that you use, doesn't that result in the answer necessarily being zero?

A You mean if all the results are identical?

Q They are all identical because they are all zero.

A Right, for that particular variable, that is correct, that the intraclass correlation would show that the inspectors were homogeneous with respect to that particular variable, but only that particular variable.

To make a statement that inspectors were homogeneous overall, it would be necessary to do that for all the variables.

Q Correct. And as we have established, for all the variables you use the information in Appendix B, which is the observed discrepancies, and I think if you now continue on in Exhibit D-1, Table DE-3 --

A Moving on to hardware?

Q Yes, but let me get one thing straight. In terms of your formula on the documentation attribute, that's the formula that we find in Appendix 1 to your prepared testimony. If we are calculating intraclass correlation --

MR. CASSEL: He's looking for it. Just a moment.

MR. MILLER: I'm sorry. Take your time.

BY MR. MILLER:

Q If we are calculating the intraclass correlation for the documentation variable on the basis of valid discrepancies, is it correct that R-O-H, or ROH, would be zero?

A I believe that is correct.

Q All right. Now getting back to the next Hunter objective discrepancies, if we look at Table DE-3, pages 5 and 6 of 12 of Exhibit D-1, and accepting the assumptions that I asked you to accept about the difference between observed discrepancies and valid discrepancies, can we agree that if we were calculating the intraclass correlation based on observed discrepancies, we would be calculating it based on the total number of 684 discrepancies, correct?

A Define the variable.

Q It is the total quantity of hardware discrepancies reported in the second column of Table DE-3.

A Okay.

Q You agree that if one is calculating the intra-class correlation on the basis of observed discrepancies, that the number of discrepancies would total 684?

A Right.

Q If we were calculating it on the basis of valid discrepancies, the total number of discrepancies would drop to 70, isn't that correct?

JUDGE COLE: I don't know how you got to that.

MR. MILLER: You subtract 614 from 684.

JUDGE COLE: Oh, I thought you said 7.

MR. MILLER: No, I'm sorry. I swallowed my words. It was 7-0, 70.

JUDGE COLE: Okay, fine.

THE WITNESS: That is right.

BY MR. MILLER:

Q You haven't made any calculation of that intraclass variable?

A No.

Q You haven't made any calculation of that intraclass correlation based on valid discrepancies?

A No.

Q As the total number of discrepancies goes down,

is it likely that the intraclass correlation that is calculated will get closer to zero, or do you know until you do the calculation?

A There is no necessary relationship.

Q Now there were two supplementary tables that you have talked about.

A Are we leaving Table DE?

Q Yes, for the time being. And we are going to Supplementary Tables 4 and 5. And just so we are clear, Dr. Ericksen, these calculations, these percentages of discrepancies are based again on the information in --

A Are we looking at Table 4?

Q Yes, sir. That's based on the information in Appendix B to the Reinspection Program Report, or does it have some other source? Well, perhaps it's the Ericksen Attachments D and E that is the source for Table 4. Is that right?

A This is where they all came from, yes. I believe that element one --

Q This is on Table 4?

A Yes. I can find the attachment for finished weld inspections for piping and whip restraints. I just can't, at this moment, put my hands on the other one.

Q All right. Do you know whether these finished weld inspection or piping whip restraint tabulation is a

tabulation in the column entitled sample rejects are observed discrepancies or valid discrepancies?

A I simply took them as discrepancies.

Q In where, sir?

A I simply took them as discrepancies.

Q I see. While we are on Table 4, Dr. Ericksen, under the column headed one opposite Inspector G, there is a 3 percent discrepancy rate reported, correct? On Table 4, is that right?

A Right.

Q And if we look at Inspector G on Ericksen Attachment D, that's Mr. Young and we find that he had 122 sample inspections and 13 sample rejects, correct?

A Yes. You have spotted a transcription error. That 3 should be an 11. I think what must have happened is the number for Inspector F, which is 6 divided by 214, which is equal to 3 percent.

Q And does that change the average percent discrepancy across all inspector figure at the bottom of the calculation?

A No, because the figure at the bottom refers to all of the inspectors who inspected element number one. There was another set of about eight inspectors who inspected number one who did not also inspect number two.

Q I'm sorry. It's just a matter of my not understanding the arithmetic. Doesn't the --

A No, what you think is --

Q Oh, I see. In other words, the calculation at the average percent was correct; it was just the calculation of the --

A What I was simply trying to do is make an illustrative calculation for those 9 inspectors who were part of both.

JUDGE SMITH: I didn't follow that recent exchange very well, which is all right. But I don't know if there is a need to change the written testimony. Did you make a correction to your testimony?

THE WITNESS: Yes, perhaps -- what I would like to do is the next time we take a break I would like to check each one of these numbers and correct them all at once.

JUDGE SMITH: Well, my concern is that the copy in the transcript be conformed.

MR. CASSEL: Following the next break, if you will permit us to simply conform the reporter's copy, we will do so, Judge.

BY MR. MILLER:

Q Turning for a second to Table 5, Dr. Ericksen, this is another example by contractor of showing a lack of homogeneity, correct?

A That's right.

Q And what is the source of this information that is tablated here?

sy21lb8

A Table B.

Q And once again, that is observed discrepancies, correct?

A Right.

Q So we don't know what the calculation -- what these percentage numbers would be if we, instead of using observed discrepancies, used valid discrepancies?

A That's correct.

MR. MILLER: Could I have just one second please?

(Pause.)

JUDGE SMITH: Mr. Miller, would this be a good time for our afternoon break?

MR. MILLER: Yes, sir. It probably is. I really don't have a whole lot more.

JUDGE SMITH: All right. We'll take a ten minute break.

MR. CASSEL: Judge, before we all leave --

JUDGE SMITH: Off the record.

(Recess.)

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JUDGE SMITH: On the record.

BY MR. MILLER:

Q Dr. Ericksen, I believe over the break you were going to look over Table 4?

A The only error I could find was with respect to G, which should be changed from 3 to 11.

Q Dr. Ericksen, in answer 19, you make the correction to the sample size for that specific inspection element from 1,476 to 280?

A Right.

Q Do you know what the calculated reliability at a 95 percent confidence level is for that inspection element?

A This is the question you asked me at my second deposition?

Q Yes, sir. The same one.

A Then the same answer applies. And that is, that if I make the very strong assumption that the intraclass correlation in design effect that applies for the estimate of discrepancies applies to the reliability coefficient, then the reliability would be about 99 percent.

Now I say that's a very strong assumption because the intraclass correlations and design effects from the same body of data that apply to one statistic do not necessarily apply to another statistic. So we really don't know what the reliability is.

Q Of course if the inspectors were, in fact, homogeneous, then we would have met the requirements for the application of Dr. Singh's formula, correct?

A Under that hypothetical, I suppose that would be true.

Q And if we base the intraclass correlation calculation on valid discrepancies for documentation, as opposed to observed discrepancies for documentation, ROH has a value of 0 and we can conclude that on the basis of that calculation the inspectors are homogeneous, correct?

A That would not be a good thing to do, though, because that is only an intraclass correlation for one variable and we're really talking about many companies, many attributes --

Q I'm limiting myself to this calculation that is found or this example that is used in answer 19. That's the documentation on it?

A Yes, what you're really doing is substituting another variable. For your variable, the answer is yes. And for my variable, the answer is no.

MS. JUDSON: To make the record clear, are you referring to your Table B-3, in the inspection report, or Table B-3 that appears in Dr. Ericksen's supplemental testimony?

MR. MILLER: I don't know that I referred to Table

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B-3 at all.

THE WITNESS: We started off with Table B-3 and the document that you showed me, there was the denominator of 3,725 and it really should be 3,728.

MR. MILLER: Oh, I see. That's because of -- of Inspector A and that is the one that is reflected in your Table 3 of the Ericksen Supplement?

THE WITNESS: Yes.

end22

Q Let's turn to that Table 3, the Ericksen supplement. Dr. Ericksen, as I recall your testimony, this was an example of sloppy recordkeeping by Commonwealth Edison Company, and sloppy data management; correct?

JUDGE SMITH: I think he used two adjectives, but I think you've captured the thought.

(Laughter.)

THE WITNESS: To set the record straight, they were really -- I think I had two bases for that statement. One was the large number of changes that have been made that are reflected elsewhere in my testimony, and this is a very small example illustrating the problem with recordkeeping.

But I think that this does indicate that there are three discrepancies that, according to the testimony that I read, were not evaluated for design significance.

So I think the objective was the second rather than the first.

BY MR. MILLER:

Q I see. Dr. Ericksen, did counsel for the Intervenors show you a letter from Mr. Del George to Mr. Keppler dated January 12, 1984 to which was attached the draft reinspection report?

A Not to my recollection, but if you show me the document, it might refresh it.

MS. JUDSON: I can state for the record that

we did not.

BY MR. MILLER:

Q Dr. Ericksen, if you would turn to the first clipped page.

For the record this was, I believe, served on the Board and all the parties as a Board notification. I have turned to page 36 of the attachment to the letter, which is labeled Table B.3-Hunter.

(Counsel handing document to witness.)

A I have done so.

Q And there is an Inspector A whose results are recorded there; is that correct?

A That is correct.

Q And what are the results that are recorded?

A 47 out of 51.

Q Do you have any reason to believe that that Inspector A for Hunter is any different than the Inspector A for Hunter who was shown on Table B-3, Detailed Inspector Results for Hunter, in the Reinspection Report?

A I have no reason to believe that they're different.

Q I think you also stated that based on this difference that you observed that there were three discrepancies that had not been evaluated, and I am now going to turn your attention to page 42 of the attachment to the

January 12, 1984 letter and ask you whether that indicates the number of discrepancies that were evaluated for Hunter Corporation.

MS. JUDSON: I'd like to object. It's not clear whether this document is in the record. It's fine if we just want to clarify for the Board, but Dr. Ericksen was referring to testimony in the record, and the number used by Mr. Singh said that 109 discrepancies were evaluated. And Mr. Branch and Mr. McLaughlin -- Mr. Branch said he evaluated 49; Mr. McLaughlin said he evaluated 60.

It's on that basis, based on written testimony in the record and interrogatory answers that Dr. Ericksen made his determination.

MR. MILLER: I'm not questioning the basis on which Dr. Ericksen made his determination, and once again, I have to apologize to the Board and parties because some of this probably, the fault rests with me. But there will be a rebuttal witness to explain this apparent difference between the numbers that are shown in the third column on Ericksen Table 3 Supplement, and the numbers that appear in the Reinspection Program Report.

What I'm trying to establish through Dr. Ericksen at this point is that from the documents before him, did he concede in January of this year that Commonwealth Edison Company was aware of the different tabulation for Hunter

Inspector A. There will be a witness who will sponsor --

MS. JUDSON: It's unclear why this is rebuttal since Dr. Ericksen's point is that there were errors in the various numbering systems and inconsistencies between the report and the testimony, which is still true. And it's those errors that created his concerns.

JUDGE SMITH: He has charged carelessness and I think Mr. Miller is entitled to demonstrate that there was no carelessness, or little carelessness or whatever.

MS. JUDSON: It's unclear to me how a document outside the record which has a different number rebuts the idea that there was carelessness in presenting the testimony filed in this proceeding, in the Reinspection Report.

JUDGE SMITH: Well, we don't know yet. We're not done. Overruled.

BY MR. MILLER:

Q Dr. Ericksen, you did say that one of the things that concerned you was the fact that there were three apparent discrepancies that hadn't been evaluated for Hunter; is that right?

A That's right.

Q And how many discrepancies are reported on that page of the January 12th version of the Reinspection Program reported as Hatfield evaluated for Hunter?

A 112.

Q And that's three more than 109.

A Right. Now I have two documents. Which one do I believe? I have no basis for a choice.

Q I'm not asking you to believe either one, or neither, at this point.

I would like you to turn, Dr. Ericksen, to question and answer 12 in your prepared testimony. Dr. Ericksen, the first sentence in Answer 12 describes what is referred to by statisticians as a probability sample; does it not?

A That's a reasonable characterization of a probability sample.

Q And it's your opinion, is it not, that a probability sample is necessary, that it's a requirement in order to enable one to draw inferences to the remainder of the population using mathematical statistical theory?

A What I stated here is that statisticians are able to make generalizations if they have this probability sample.

Q Well, Dr. Ericksen --

A Which one, one or two?

Q Second deposition, August 16, page 19, line 12. You were deposed on that date by me, correct?

A That is correct.

Q And were you asked this question and did you

give this answer? "Question: Is a probability sample necessary; is it a requirement to enable one to draw inferences about the remainder of the population from which the non-probability sample was drawn? Answer: Yes."

Dr. Ericksen, if one is not drawing inferences on the basis of mathematical statistical theory, but simply on the basis of experience, judgment, based on all the data that one has at one's disposal, the science of classical statistics doesn't tell one anything, does it, about the population from which those inferences can be drawn?

A You inserted the word "classical statistics."

Q Yes, sir, I did.

A Statistics enables you to make generalizations to the population from which a sample is selected. Now, if you have a probability sample, then you can make a generalization simply based on a rather straightforward procedure that you weight the data by the inverse of the probability of selection, and complete your estimate.

Now, in the absence of a probability sample, one makes estimates on the basis of some model or view of what the real world is. That model or view of what the real world is requires assumptions. Those assumptions need to be stated clearly with justification.

Now, if it should occur that data exist which contradict those assumptions, then they need to be changed

and a different estimate needs to be made. At the same time that one presents an estimate, one needs to present some kind of indication of the uncertainty associated with that estimate.

Now, it's my position that anytime one generalizes to a population from a sample, one is making a statistical statement. It may or may not be a correct one.

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Q Isn't it a fact, Dr. Ericksen, that the only thing that a statistical statement enables one to do is to express the amount of that uncertainty numerically?

A No. I think I would have to go back to my answer. A statistical statement has at least two parts to it:

One is a statement of what you believe the world to be like, and the other part is your evaluation of the uncertainty which is associated with that depiction of the real world.

Q And typically that is expressed as a reliability calculation at a certain confidence interval, correct?

A Well, there are different terms that are used for that, depending on your perspective in statistics. Some statisticians would do it that way.

Q Is it your opinion that one must have a probability sample in order to draw inferences on the basis of experience and judgment?

A I have thought a lot about that particular question that you asked me at the second deposition, and I believe that the answer that I gave you at the second deposition was in the context of the reinspection report, in that no attempt was made to provide a model, except to state the assumption that the inspectors were homogeneous.

Now, if one can have a model of estimation with

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justification, then inferences can be made on the basis of that model with some statements of uncertainty. But, that requires a much more rigorous set of mathematical statements.

Q Suppose one doesn't wish to make a mathematical statement at all, but simply to express a generalization?

A That is a statistical statement.

MR. MILLER: If I might have just a minute.

(Pause)

BY MR. MILLER:

Q I know I asked this question before. Have you reviewed the testimony of the NRC Staff on Remanded Issues With Respect to the Reinspection Program?

A I'm not very good on these titles. I know I did review something by the NRC Staff.

(Document handed to witness by counsel for Applicant)

Q Let me show you that document that bears that title and ask you if you have had an opportunity to look at it?

(Witness examining document)

A I reviewed pages 21 through 25.

Q In your judgment, Dr. Ericksen, is the Staff making a statistical statement in its prepared testimony that we have just been reviewing here?

A I am going to have to be difficult. You are

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going to have to show me a sentence and I will tell you if that is a statistical statement.

Q Look at question and answer 19 on page 22.

A How much of answer 19 do you want me to read?

Q I was looking at actually the first paragraph, but continue on to the next page as well.

A So, you want me to read all of answer 19?

Q Yes, please.

(Witness reading document)

A I would prefer not to have to respond to this entire section, because there are a number of statements that are made. If I could give you one example of a statement?

Q Surely.

A It says:

"To the extent that nonreinspectable attributes are similar to the reinspectable attributes, the sampling of the reinspectable attributes can be readily applied to the nonreinspectable attributes. With respect to Hatfield and Hunter, the nonreinspectable attributes are highly similar to the reinspectable attributes."

Q And those two sentences that you have just read into the record are, in your judgment, a statistical statement?

A That is stating an assumption. It can be taken in two ways. Either one can take it as an assumption that they

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are similar, or that could be taken to be the result of someone making the evaluation of the characteristics of the inspectable and reinspectable attributes.

I cannot tell from what you show me, which it is.

Q In either of the alternatives that you posed in your preceding answer, is Mr. Muffett who is sitting right there at the counsel table, making a statistical statement in those two sentences?

A Well, if you apply my first characterization, then you would say that this is an assumption which would be part of a statistical statement.

But, if you take the second characterization then you would say that this was a result of some kind of analysis comparing the characteristics of inspectable and reinspectable attributes.

Q And that sort of analysis, that is something that would have to be carried out by a knowledgeable professional in that field, correct?

A Yes.

MR. MILLER: I have no further questions.

MR. LEWIS: Staff has no cross examination.

EXAMINATION BY THE BOARD

XXX

BY JUDGE COLE:

Q Dr. Ericksen, just a few questions.

You apparently had some problems with the way

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the Reinspection Program was designed and carried out from a statistical viewpoint. Is it correct to say that?

A That is correct.

Q Now with respect to the selection of inspectors, are you familiar with the manner in which the inspectors whose work was reviewed in the inspection program, were selected?

A Yes, I am.

Q I get the impression that that is a considerable departure from a random sample,do you agree with that,sir?

A Well, my understanding of how the inspectors were selected is, that someone started with the first inspector on the list and took every fifth inspector thereafter.

After that was done, somebody on the NRC Staff decided that certain inspectors should be added.

Q Okay. Why would we use a random sample, or why should we use a random sample?

I don't really want a long answer to that, but let's say is it so that you get a reasonable estimate of the population?

A You mean a random sample of inspections?

Q Of inspectors.

A Well, I think that there are three reasons.

Q All right, sir.

A The first reason is that we want to make sure that nobody has stacked the deck. So, it is conceivable that

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if everybody knew in advance that the second inspector was a terrible inspector, and you say well, I am going to start with number one, that way you are sure to avoid the second inspector. So random -- if you selected a random number between one and five, then you will be giving everybody their fair chance of coming in, and there would be no basis to make an allegation that somebody stacked the deck.

Q Sir, do you know how the program was originally proposed?

A You mean how the sampling --

Q Yes.

Was it originally every fifth inspector, and then somebody said start with one and then every fifth?

A I really don't know who decided it should be every fifth inspector.

Q Well, if somebody said let's just take every fifth inspector --

A Right.

Q -- would that be random?

A Well, I think that for mathematical precision, it would be random if you had a random number between one and five to start with. The fact that there was not a random number between one and five to start with, if nobody has any evidence that somebody has fiddled with the deck, it is probably of no practical importance. So, I didn't see the

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point of putting that into my testimony.

It is a problem that occurred to me without any reason to think that there might have been some kind of --

Q All right, sir, I understand that point.

A So that is one reason.

Q That's one, okay.

A The second reason to have a random sample of inspectors, is that a random sample is an example of a probability sample and we know the rate at which everyone had a chance to be selected and that makes it possible for us to make various kinds of statistical estimates.

And the third reason for having a random sample as opposed to another kind of sample is simply mathematical convenience.

Now I should also point out that strictly speaking a systematic sample is not a random sample because once you have picked that first person, then every fifth one thereafter is determined -- it is like a clustered sample. But in most practical applications that I have ever seen, one either improves the precision by taking syscematic sample, or it doesn't make any difference.

So, for all practical purposes, most statisticians would treat a systematic sample as if it were random.

JUDGE COLE: All right.

Now with respect to the first one about stacking

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the deck, are you aware of what happened after a decision was made to select every fifth?

A Yes.

Didn't I state that the NRC wanted to add certain inspectors that they had, presumably that they thought were problematic?

Q So what would this do to the reliability of the results with respect to getting some index of the qualifications of the inspectors?

A Well, the one very interesting analysis would be to compare the inspectors that the NRC picked with the ones that came in every fifth. That would be -- I have read somewhere an indication that the sampling procedure was partly to put a conservative bias into the results. It would be interesting to see if thee really was a difference, was the NRC really able to pick out which ones were bad.

end 24

Q That would be interesting. Thank you, very much.

I guess I had a little different idea, as to why we would want to random sample. And I think it's contained within your answer. But isn't it really to get the best estimate that we have of the population and work with that so that the results that we get would be representative of the population? Isn't that the bottom line?

A That's a reasonable way of saying it, yes.

Q Now how far do you think the Applicant departed from getting that best estimate of the population? Is there a serious departure here, with respect to the way they expected the inspectors to be participating, to be incorporated into the program?

A Well, I think there are really two parts to the problem. One is that there are certain categories of inspectors and inspections that didn't have a chance to be included, such as those which occurred after the first three months, such as those inspectors who did less than a certain amount. And we just don't know what or how they did.

Secondly, the fact that they had such a heavily clustered sample, makes it mathematically impossible to apply the reliability equation that Dr. Singh relied upon. So we don't have a mathematical way of expressing our uncertainty.

Q All right, sir. You indicated, in your testimony, that clustering was a serious problem. Could you tell me again

what clustering is and why it's such a serious problem?

A Well, if you can imagine that you have 1000 inspections and they were done by 10 inspectors. Each inspector did 100, well those inspectors are going to vary in their likelihood of making errors. So if you only pick two inspectors, you really don't have the same information that you would have if you had had a simple random sample of 200 inspections, because you're only finding out about two inspectors.

And you have less confidence in the estimate that you would make for all 10 inspectors than you would have if you had samples from all 10 inspectors who worked.

Q All right, sir, but we can handle that statistically, can't we?

A Yes. Well, there are two parts to that. One is that we really don't know how to apply that reliability formula that Singh used. So we don't actually have a way of calculating our confidence interval.

The second thing, though, is that it is quite likely that we had more uncertainty than the formulas used by Singh implies.

Q All right, sir. The particular formula that Dr. Singh used, the input to that formula was just the number of observations because you had zero design significant discrepancies?

A That's right.

Q So when you have zero out of 200 or 400 or 600 or 1000 observations, in a situation like that how much does statistics tell you?

A Well, the problem is that we don't really have a way of knowing what the clustering effect for that particular variable is. We get some kind of idea about what it might be by looking at the clustering effects for similar variables and we find that the clustering effect for a related variable is rather pronounced.

That indicates that we should probably draw back a little bit from the statements of uncertainty we would make, assuming random sampling. But we don't know how much to draw back, is the problem.

Q But if you have zero observed design significant discrepancies, how important then does the impact of clustering have on that equation? How much can you change zero by?

A It has some impact. I don't have a way of calculating what the impact is, that's the problem.

Q Okay. Now, on page 8 and on page 12, you referred to two different numbers that are associated with Military Standard 105D. I believe on page 8 you talk about a minimum of 200, referring to Dr. Sing. And at page 12 -- I believe it's 12 -- someplace -- no, page 16, I'm sorry.

On page 16 you refer to a Military Standard 500.

What is the difference there?

A As I understand the Military Standard 105D, the sample size is partly determined by the population so if it had a larger population, indeed a larger sample, than when you have a smaller population.

Q Okay, but you're not talking about the same population sizes that Singh is talking about?

A That's right. Well, I'm not sure if that's right. On page 16 I'm talking about the population which had 37,230 inspections. I believe on the other page I was referring to something Dr. Singh was talking about.

Q Okay. With respect to the two assumptions in Dr. Singh's equation, I will call it -- I don't know the name of the equation, but the equation that Dr. Singh used. With respect to the two assumptions that were violated, do you have any feel for how much relaxations of these assumptions or standards exist? I mean, because it's not a perfect world and I know in any statistics that I have used you rarely wind up with ideal data.

A Absolutely.

Q And that is when you need statistics to help you to manipulate this data.

A That is correct.

Q Not it seems to me that -- well, in order to better evaluate the data, it seems to me that you are taking a very

hard line on relaxation of standards. Now can you provide me with a little better feel on just how much relaxation you could use with that equation? Obviously if you take a look at the standards that are imposed before, that you list there, and particularly the two that were violated, it would be relatively rare to get data that would perfectly comply with those standards.

A Well, I could point out that it would have been possible for Edison to make simple random sample of the inspections, assuming that they have a list of which all the inspections were included.

Secondly, most of the work -- certainly not all of the work -- but most of the work that I do in statistics involves the selection of clustered samples. A very good example of that would be a national survey of the American population. We select clusters of people in the same county, the same block, and so forth. So we also have a clustered sample there.

And there are standard statistical procedures that our company uses and that companies and university centers like us use to take the clustering into account when calculating those variances. And I consider that to be a standard procedure.

I cannot imagine letting a contract from the Federal Government in areas that typically contract out this kind of

survey work that would allow us to get away with not taking the clustering into account. There are computer programs that allow you to make these calculations.

I would also say that in the standard statistical textbooks on sampling, and here I'm referring to a book such as Survey Sampling by Leslie Kisch, which I saw on the table to my right an hour or two ago, a Sampling Techniques by William Cochran, Sample Survey Methods and Techniques by Hansen, Horwitz, and Meadow.

I think it's not unfair to say that those are the three standard textbooks in the field. All of those books tell you about the importance of taking the clustering into account in calculating variances.

Q I believe you indicated that the effect of clustering has not been -- the effect of clustering on the equation that Dr. Singh used has not been studied. Did I hear you say that, sir?

A That is correct. If I could just say, I am not aware of it having been studied. I've done a fairly extensive review of the literature. It probably hasn't.

Q Could it be that because of the nature of that equation that you would enter in that equation with numbers of observations that are perfect in sample population in order to draw inferences about the population, that the effect of clustering could be very, very slight?

A It's possible. I'm not sure I understood your question but I think what you're asking me is is it possible, is it conceivable that the effect of clustering might have been slight?

Q That it might not make any difference, using that equation?

A It's possible but I don't think it's very likely given that there are fairly extensive clustering effects found in the discrepancy rates. And it's hard to imagine that you would have clustering in the discrepancy rates and not have clustering in extrapolating to a design [illegible] significance of those discrepancies.

Q Yes, how did you measure clustering in the inspector population, sir?

A What I did was I calculated the variance of certain estimates according to the standard equation and then I calculated the variance that you would get from the same data if you assumed simple random sampling. That told me what the design effect was and from that I could extrapolate the intraclass correlations.

The design effect is the increase in variance due to clustering.

Q All right, sir, and what sort of a result did you get?

A Well, it varied depening on the variable I was

looking at. But the design effects tended to -- some of them went as high as 40. Some were as low as 5.

Q 40 what, sir?

A What that means is that the actual variance of the estimate of discrepancies is 40 times larger than would be the case had there been the same sample size from the simple random sample?

Q 40 times larger?

A Yes.

Q That seems like an awfully large difference.

A It does.

Q Are you talking there about a very small sample size?

A Well, I think that that particular case, the sample size was about 27,000.

Q And you expect a difference of 40 times?

A No, what it meant was that the variance that you would calculate, based on that sample of 27,000, was about the same as you would have gotten from a simple random sample with approximately 680 cases. So the cluster sample of 27,000 was about as good as the simple random sample of 680.

Now what I would do with that would be to make some kind of conservative adjustment to the reliability equation and it may turn out that it would have been a simple matter of expanding the sample to increase our belief in Dr. Sing's

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results.

Q All right, sir. Is there -- are there other statistical techniques that, given the data that Dr. Singh had in his hands, are there other statistical techniques or tools that you would have used, rather than the tool or tools that Dr. Singh used?

A Yes. Yes, there are.

Q Could you tell me about them?

A Well, I would have to think about the details of this, but the general procedure that I would follow would be to try to estimate a model in which I was able to measure or estimate the influence of discrepancy rates for individual inspectors and also take the effect of the individual inspection element on the discrepancy rate. And to try to fit the matrix of inspector by element cells and I think that if I had done that, I would have been able to reduce the uncertainty beyond or below that which Dr. Singh had.

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There is a paper, published in the Journal of American Statistical Association in June 1983 which gave me ideas on how to proceed. I haven't actually tried to do so.

Q Even with the limitations of the design of the program and the kind of data --

A That is correct.

Q In answer 16, sir, you indicated that you calculated some intraclass correlations and you indicated that if the intraclass correlation is equal to zero, it means the inspectors are homogeneous?

A Yes. I should have, perhaps, expressed that a little better. What I mean by that -- I tried to use the meaning of homogeneous that Dr. Singh used and that was used in the Inspection Report. It means that all the inspectors were the same.

Q Well, that was my understanding of the word, also, sir. But in the sentence that follows, after the last sentence in that paragraph, you say "If the intraclass correlation is greater than zero, then inspectors are not the same."

A That's right.

Q Now greater than zero can be a very small number. Surely there is some flexibility there.

A Oh absolutely.

Q So what do you mean by greater than zero?

A By greater than zero it would have to be enough greater than zero that the design effect would be substantially greater than one.

Q Is it similar to the correlation coefficient, between zero and one? Is the ragne --

A Well no, the intraclass correlation can go for a number that's a little bit less than zero, to one.

However, the intraclass correlations can be very small, about .01 or .02, and have a very substantial impact on the design effect if the clusters are large. And I refer you to Appendix 1.

Q So, all right. So --

A So you see it says "Design effect F is equal to 1 plus ROH times B minus 1." And the DEF is the design effect, the increase in variance due to cluster sampling. And just to give a hypothetical example, if ROH is equal to .01 and the cluster size B is 500, then 499 times .01 is 4.99 and you add that to 1 and the design effect is about 6.

Q So the significance of it is highly dependent upon the average cluster size?

A That's right.

Q Now how do you calculate the cluster size?

A It would simply be the average number of inspections done by an inspector.

Q What if all the inspectors did a lot of inspections?

A Well, another strategy would have been to select a sample of each inspector's work. So let's assume that you have 100 inspectors. One way of doing it would be to take 20 inspectors and look at all their work. Another thing you could have done would have been to take 40 inspectors and inspect half the work of each.

Your overall sample size would have been the same, but your average cluster size would have been half as big and the design effect would have been half as large.

(Board conferring.)

Q If all the inspectors inspected the same number of items, would clustering be important?

A Yes.

Q Why?

A Because -- that's assuming you have a cluster sample.

Q Well, you say cluster sample. I guess I'm not quite sure what that means.

A Well, we have a cluster sample because we selected inspectors. But statements are made about inspections and we talk about the proportions of inspections that had discrepancies. And we have a confidence interval around the proportion of inspections that had discrepancies. Now the question is, how do you calculate their confidence interval.

Now if you had a clustered sample and a confidence interval is wider than it would be if the same sample of the same size had not been clustered. Now it really doesn't matter all that much if each inspector inspected the same number of items because if you take all of the inspector's work then that's going to determine the cluster size.

Q But you're giving the impression that cluster size is going to have a highly significant effect, impact, on the statistics, the reliability of the statistics that we might use.

A Right. And the way to get around that is to select your sample in a way that you have more inspectors but a smaller proportions of every inspector's work. Instead of looking at all of the inspector's work you would only look at half of the work of each of the inspectors picked in the sample. That would have been a better way to do it.

Q You're talking about already existing data?

A No, I'm talking about what you would do when you originally explained the sample.

Q No, I'm talking about looking at the data that we have collected.

A Okay, not looking at the data that we've collected, then you can make certain statements with a certain amount of uncertainty, when your variance calculations take the clustering into account.

Now if it turns out that the results don't give you the certainty that you require, the only answer is either to try to incorporate some kind of statistical model or the easiest thing to do is simply to go out and do some more sampling and expand the sample size.

Q Okay, I might have missed the whole boat on the impact of clustering. Let me try to briefly restate the question or pose a situation.

Let's say we have 10 inspectors that are included in the Reinspection Program. We are going to inspect the first three months of work of those 10 inspectors. Let us say that those 10 inspectors did approximately the same number of inspections.

A Fine.

Q I guess I do not understand why the number of inspections that each one of those has done, which is directly included in your calculation of cluster, is going to have a significant statistical impact on the results. Now could you explain to my why that is so?

A Okay. I think the best way to do that would be to refer you to page 10 of my testimony.

Q All right, sir.

A Now you see the formula is R is equal to 1 minus 2.9955 divided by n. So you can see that the sample size is what really determines reliability of that formula. The number

n in the denominator.

Now what clustering does is that it effectively changes that number n to a smaller value. And therefore, the reliability is less than you think it is. So if the design effect is 40, then the effective sample size is n divided by 40 and reliability is somewhat greater.

Q Well, you tell me how that applies in the formula, but the number of inspections -- why would the number of inspections change because of a cluster effect?

A Because this formula assumes that the information that you get from one inspection is completely independent of the information that you get from all other inspections. And what I'm telling you is that the likelihood of finding a discrepancy or not finding a discrepancy, in one inspection done by the same inspector, is related to the chance of finding a discrepancy in another inspection done by the same inspector.

Q Okay, well, let's talk about specific numbers, now. We have 10 inspectors. Each one of those has done 1000 inspections?

A Right.

Q Why can't I put 10,000 in here?

A 10 times 1000 is equal to 10,000.

Q That's the number of inspections that were done.

A This formula assumes that you have 10,000

independently selected inspections and you don't.

Q All right, so how many do you have?

A Well, how many you have depends on what your design effect is. If your design effect is 40 then you have 1000 over 40. That would be about 25 for each inspector. If you have 10 inspectors, the number would be 250.

Q Okay. Now the reasons why you would make that correction are what, sir?

A The reason why we make --

Q What is the effect that will reduce that number?

A It is the similarity in the likelihood of making a discrepancy from two inspections done by the same inspector. Some inspectors are more careful than others, and so the careful inspector on his first inspection is likely to be a careful inspector on his second inspection. The careless inspector on his first inspection is likely to be a careless inspector on his second inspection.

There's a relationship between different inspections done by the same inspector.

Q Okay, I understand what you mean by cluster effect now. I don't necessarily agree that the effect would be that large, but that's your area.

A Well, what I'm trying to tell you is that we're in a position where we have to speculate on what the clustering effect might be. We're pretty sure that there is one.

Q All right, sir. At page 12, I just want to make sure that I understand your result in question 16. The last part of your answer to question 16, you're talking about the results of the F test. And you set up a hypothesis that the inspectors are the same and then you put in the appropriate data and found out that the hypothesis failed, is that correct sir?

A That's correct.

Q Did you reverse that hypothesis and see if it also failed that they are not the same?

A I don't know how I would do that.

Q Couldn't you just set up a hypothesis that they are not the same and then test that?

A Well, we could set up a hypothesis that they differed by certain amounts and test those. I did not do that.

Q Yes, I guess I don't have a feel for the 1, 5, or 10 percent level of significance for rejection in that I don't know exactly data you inputed to that. So subsequently, I don't have a feel for the statement that the level of significance was 10 or 5 percent when you said that they are not the same.

A Essentially what I did was to compare the discrepancy rates of all the inspectors who were working for a certain company and you start with a null hypothesis that

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for all the inspectors they are the same. What you would observe in the sample would only be very minor, random types of fluctuations and the data indicate that the variation in discrepancy rates is greater than that.

Q Okay, now I guess I don't have a feel for what the 10 percent means. Does that mean that -- well, what does the 10 percent level of significance mean? Am I looking at a bell-shaped curve, at some tail of the bell-shaped curve, to get this 10 percent?

A That's right.

Q Should that mean that 9 times out of 10 they would be the same?

A Well, no. It means that if you start with the hypothesis that they really are the same and that if we'd been able to look at the results for all of the inspectors, let's say for Hatfield, that there would have turned out to have been roughly the same.

Then based on the inspectors that we did see, we rejected the 10 percent level of significance. That means if the probability is less than 10 percent that they really are the same.

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Q The probability is less than 10 percent that they really are the same, okay.

A That's right.

JUDGE COLE: Thank you, that's all I have.

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BY JUDGE CALLIHAN:

Q As I say, Dr. Ericksen, just one topic. I am sure you feel the day is lengthening.

We have sort of beaten this to death, but there is a little life left. As was said earlier this afternoon, the original intent of the Reinspection Program -- at least I have adopted the terminology here that we had inspections, and then we had reinspections -- the original intent of the aim of the Reinspection Program was to reinspect the inspectors. And we had reinspectors who reinspected original inspectors.

Well, for a number of reasons, some good, some bad probably, and because of the interest this aim drifted over into hardware, because maybe that is what some of us think most of. And there has been a lot of evidence everywhere on a hardware aspect and the goodness or badness thereof.

Suppose this drift had never occurred. Suppose that those responsible and ourselves, for that matter, had considered only the reinspection of the inspectors and not saying how that was done, parenthetically we have got to bring the hardware in, of course, but that is just a modus

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operandi.

Suppose we had done nothing but talk about the reinspection of the inspectors, would your testimony have been materially altered, or your conclusions materially changed?

A Well, I think that I would have to think a little bit about how I would define my criterion of judgment. But one criterion that I might look at would be how many inspectors made important errors.

And I would have to think about how I would define an important error. And I think that I would probably still say that they did not select enough inspectors to really say something with sufficient certainty about the population of inspectors.

It would have been better if they had looked at more inspectors, and perhaps looked at less of each inspector's work. For example, there is one case where they looked at over 7000 inspections that was done by the same inspector of the same element. And it would have been better to have perhaps looked at 500 of his inspections and used the other 6500 to look at another part of the plant.

So, I think the answer to your question is that I think for that objective it would have been better to include more inspectors in the sample. And, if you want to keep the number of reinspections constant, to have looked at

M3± a smaller proportion of each inspector's work.

JUDGE SMITH: Would that not then have required a change from the acceptance criteria? If you had designed a plan and you selected your inspectors on a systematic basis, and you found out that you came to one that had a very large inspection sample, and you said, "What, we don't want to use this acceptance criteria," aren't you doing exactly what you cautioned us not to do?

THE WITNESS: By acceptance criteria you are referring to Military Standard 105-D?

JUDGE SMITH: I am talking about, start with the first and the fifth and every fifth thereafter, and then you started. And then you find that one of these inspectors has 7000 or 12,000 inspections. You say, "Oh, we don't want that. That is going to be too many inspections for one inspector, so let's change the acceptance criteria and let's do something else."

THE WITNESS: No, what I am saying is, that I would probably divide the inspectors perhaps into two groups. And those inspectors whose total amount of work was less than a certain amount, perhaps I would reinspect all of their work or a high proportionof their work.

And those inspectors who did a very large number of inspections, I would perhaps review a smaller proportion of their work. But I would still include such an inspector

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in the program.

BY JUDGE CALLIHAN:

Q In your discussion to which there has been considerable reference already, on page 10, in your answer 15, where the Miller and Freund equation appears, just preceding that is a remark -- perhaps this is out of context. Nonetheless, for identification, the final sentence in the first paragraph of answer 15 says:

"Edison may have made this error."

It has to do with random sampling.

"Edison may have made this error, because the company designed its program to test initial qualifications of inspectors rather than quality of work."

Now, are your remarks that you have made in answer to the Chairman's question and mine,related to that situation there?

A Yes. I think so.

Now, I have been trying to -- in answer to your question, probably the sample of inspectors was not optimal for the objective of evaluating the inspectors.

Q So, this implies that at the outset when one was looking at inspectors only, that implies that the error on randomness of sample was not an error in that original design of the program?

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A I don't understand.

Q Well, let me say it again a different way.

This sentence to which I just referred, the final sentence in the first paragraph of answer 15 alludes to an error in the selection of the sampling. Is that correct thus far? And I admit I may be missing out.

A What I am really saying is that the error is to assume a simple random sample. And the reason why they are in a position to have to assume a simple random sample is that the original sample was clustered.

And, the reason why the original sample was clustered, I speculated as to what that might be.

Q Would that selection therefore fall, any results of inspector reinspections, to a degree different than it would fall, results of hardware inspections?

A It would probably be different.

JUDGE CALLIHAN: Thank you.

JUDGE SMITH: Ms. Judson?

MS. JUDSON: Can we have a minute to confer?

JUDGE SMITH: Surely.

(Counsel for Intervenor conferring.)

end T27

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JUDGE SMITH: Would you like to have a break, Ms. Judson?

MS. JUDSON: Maybe a short break.

JUDGE SMITH: Five minutes.

(A short recess was taken.)

REDIRECT EXAMINATION

BY MS. JUDSON:

Q Dr. Ericksen, first I'm going to ask you some questions to be sure that the Board understands some issues that they raised. Why was clustering a problem in the Reinspection Program Report?

A Clustering was a problem because the sample was selected of inspectors rather than of inspections, and if they had selected a sample of inspections, there would have been no problem with clustering.

Q Now, at one point Judge Cole asked you to explain cluster. Do you have an example in your testimony that does this in a simple manner?

A Well, I believe I could give a very simple example on page 13.

Q Would you like to explain that example a bit?

A Sure. We have a population of four inspections, one of which involves a measurement -- two of which involve measurements of two inches which were done by a Mr. Short, and two of which involve a measurement of four inches, which

were done by Mr. Long.

Now, if the sampling had been of inspections and we didn't allow any particular inspection to be picked more than one, then there would be six possible samples. And you can see that those six samples are listed at the top of page 14. And you can see that in four out of the six cases, the average of the sample is equal to three inches, which is the population average. And in one case, it's two inches and in one case it's four inches.

So your chances of getting a precise estimate are pretty good from that sampling plan.

Now, if you take a clustered sample where you pick one inspector or the other, then you're either going to get both measurements of two inches, or you're going to get both measurements of four inches and you can see that the only possible sample means that you can get are two inches and four inches.

So by taking a clustered sample you have a much lower chance of a sample mean being close to the population mean. This is an extreme sample just meant to illustrate the problem of clustering. What you had in the Reinspection Program was a problem not as extreme as this but still an important problem.

Q Now, at one point Judge Cole also asked you why in Answer 11 you listed a different number as the minimum

required under military standard 105D than you listed in your answer A19. Can you explain for the Judges and the parties how that military standard works and why the number was different?

A Well, there was a table indicating how to use military standard 105D on page 506 of the Miller and Freund book. In the lefthand column it gives lot or batch size, 228914 all the way up to 500,000 and over. And the inspection level 1, inspection level 2, inspection level 3.

Now, one would choose an inspection level according to the risk of error. Now, I believe -- it's my understanding that inspection level 2 was selected. So where the population size is 4000, look at the row that says 3,201 to 10,000. You go over to the letter L, and the letter L indicates that the sample size should be 200.

Now, for the other case where it's about 37,000, you would go over to the letter N, and the letter N on the chart on the next page indicates that the sample size should be 500. So military standard 105D, the sample size depends in part on the population size.

JUDGE COLE: I thought you had answered that question before.

THE WITNESS: Okay.

MS. JUDSON: It wasn't clear to me whether it was clear to everyone else that he was using the same

methodology as Dr. Singh but the number is different because of the different --

JUDGE COLE: That was my understanding.

BY MS. JUDSON:

Q Fine. Now, at various point, Mr. Miller asked you questions about aggregation of data, aggregating elements of data.

A That's right.

Q How can a statistician help determine a certain aggregation was appropriate?

A Well, one could create a table along the lines of Table 4 in my testimony. Table 4 presents the discrepancy rates among different inspectors for the same type of element. It also presents variations in discrepancy rates for different elements for the same inspector. And you can inspect these discrepancy rates to determine whether or not they are sufficiently similar that the elements should be aggregated.

Q So you're basically using data to test the assumptions made by the people who decided to aggregate or disaggregate?

A Yes. I would consider it -- let me put it this way. Every statistical estimate involves assumptions, and almost every statistical estimate that I have ever seen involves assumptions that cannot be tested. Statistics is

the science of dealing with uncertainty, and that is part of the uncertainty that we have to deal with.

However, it is incumbent upon the person making a statistical statement to bring any available information to bear in evaluating those assumptions. And this lays out the kind of analysis that could be brought to bear to evaluate whether it's reasonable to aggregate elements to create attributes.

Q So this is a way that a statistician can help an engineer determine if the decision was appropriate?

A Yes.

end 28

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There are tests of significance that could be based on these. There are various procedures that could be used.

Q Now at one point you were asked about Staff's testimony concerning the extent that non-reinspectable attributes are similar to reinspectable attributes. Can a statistician help determine the appropriateness of making certain assumptions about similarities of reinspectable attributes and non-reinspectable attributes?

A As I recall -- I really should have a copy of --

(Document handed to witness by counsel for Intervenors.)

Now I'm reading a sentence that says "To the extent that non-reinspectable attributes are similar to the reinspectable attributes, the sampling of reinspectable attributes can be readily applied to the non-reinspectable attributes."

Now there has to be an understanding of what we mean by similar and whatever the criterion is for saying that the reinspectable and non-reinspectable attributes are similar, it should be possible to apply that same criterion to evaluate the similarity of reinspectable attributes.

In other words, if you have attribute A and attribute B and you are saying to non-reinspectable attribute C, then in order to evaluate whether that's a reasonable

thing you should at least be able to demonstrate that attribute A is like attribute B. And those data are available and statisticians have procedures for carrying out that kind of analysis.

Q Is there anything in your Table 4 and the analyis that you did relating to that table, which could assist engineers in evaluating their assumptions about similarities among elements or inspectors?

A Well, I did do something very similar. I looked at all of the results for element one and for element two. In other words, I believe there are 17 inspectors who inspected element one and 9 inspectors who inspected element two. And I used the F test to determine whether they were significantly different.

And the results of the F test indicate that they are significant at the 1 percent level, significantly different. This significance test was made a little bit more complicated by the fact that there was clustering. Making reasonable adjustments for clustering effects, you still get significance at the 1 percent level and conclude, therefore, that the inspectors who inspected element one differ from one another. And you conclude that the inspectors who inspected element two differ from one another.

Now one could also test whether the one versus two were similar.

Q What, if any, problems exist with the way in which Mr. Singh shows his reliability and confidence level -- his confidence level and determined acceptability -- acceptable reliability level?

MR. MILLER: I'm sorry, could I have the question repeated, please?

BY MS. JUDSON:

Q What, if any, problems exist with the way in which Mr. Singh chose his confidence level and determined the appropriate reliability level?

MR. MILLER: I'm going to object. I believe that's beyond the scope of any cross examination or board questions.

MS. JUDSON: I will be frank with the Board. I understood that part of the problem with our previous objection to the issue of choice of confidence level and adequate reliabilities was due to our phrasing of the question and the answer. And it was an error of counsel, and I was going to attempt to provide the witness an opportunity to share this information with the Board.

MR. MILLER: Well, Judge Smith, it seems to me that the Board has ruled not just on the basis of phraseology that was used in the questions and answers -- which I find kind of startling since the testimony is supposed to be that of Dr. Ericksen and not that of his

counsel -- passing that question for a second, my understanding of the Board's ruling striking the answers and portions of answers that we referred to earlier was that they were also outside the scope of his expertise.

And at this point in time to simply rephrase the questions and go at this again I think is improper.

JUDGE SMITH: Yes. The phraseology comment was in response to Mr. Cassel's request that we construe all the stricken testimony as being something that it clearly was not.

But I am missing the relevance of the question to begin with. Could you state the question once again?

MS. JUDSON: What, if any, problems exist with Mr. Singh's choice of confidence level and acceptable reliabilities in his determination of the quality of work for Hunter and Hatfield?

MR. MILLER: Judge Smith, the only questions that were asked along that line were asked by, I believe, Judge Cole prior to the time that the Board made its ruling.

JUDGE SMITH: What type of answer would you expect to get? I don't know where you're going. Is the answer well, that's not good enough? You know, -- for important to safety things? Is that where you're going?

MS. JUDSON: I would expect him to say that it is not appropriate to always choose a 95 percent confidence

level and a set reliability and that one should make determinations based on the potential risk, if one is wrong, and set confidence levels accordingly and require higher reliabilities.

JUDGE SMITH: Sustained.

MS. JUDSON: Fine. I have no further questions, Your Honor. However, we have not had a ruling on Intervenor Exhibit R-11 as to whether it's being admitted into evidence.

JUDGE SMITH: In the first place, I don't understand R-1i, so -- I mean, I understand the chronology, but I don't understand what we're supposed to infer from it. Let me see. Let me read it.

(Pause.)

JUDGE SMITH: This document has no probative value whatever. There's no finding for the Board to make on that document.

MS. JUDSON: Your Honor, I think it shows a pattern of errors in providing certain information, and I think this becomes even more important given the cross examination we heard from the Applicant regarding this documents of January 12, 1984, which certainly precedes these dates.

And even though that information was in their possession, from what I gather incorrect answers were being

constantly provided to questions about number of discrepancies and reinspections. And we show here a pattern of the company being unable to come up with any answer and then a correct answer.

JUDGE SMITH: Part of the problem is there's no quantity. There's no quantitative information here.

MS. JUDSON: Well, the quantitative information is provided in Table 2, and what this shows is the chronology of the attempts that we have made to get the accurate information and the number of times that it has been erroneously provided.

JUDGE SMITH: All right, we will consult.

(Board conferring.)

JUDGE SMITH: Objection sustained. It will be in our rejected exhibit file.

(The document referred to, previously marked Intervenor's Exhibit R-11 for identification, was rejected.)

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JUDGE SMITH: Is there anything further for Dr. Ericksen?

MR. MILLER: I just have two brief questions.

JUDGE SMITH: Make them careful questions.

MR. MILLER: I will try to be, Judge Smith.

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RECROSS EXAMINATION

BY MR. MILLER:

Q Dr. Ericksen, I believe you said the greatest design effect you observed in the calculations you did was approximately 40?

A I don't believe I said that. What I had tried to do was to indicate to Judge Cole what the range was, and at that moment I can think of design effects that range from 5 to 40. I really don't recall how big they got, but I think they probably got larg r than that.

Q I think you said that the design effect of 40 was applied to a sample size of 27,000. Correct?

A That's right.

Q Is that the visual weld attribute for Hatfield? That's a sample size that's about 27,000.

A It could be.

Q Do you know -- the calculated reliability reported in the Reinspection Report for that attribute is greater than 99.9 percent. Do you know what the effect on the calculated reliability, using the Freund and Miller formula, would be if you reduced the sample size from approximately 27,000 to 680?

A Assuming for purposes of argument that that is correct, which it may well be, then I believe it would be about 99.5 or 99.6 percent.

MR. MILLER: Thank you, I have no further questions.

JUDGE SMITH: Ms. Judson, do you have a question?

MS. JUDSON: Yes, I do, Your Honor.

FURTHER REDIRECT EXAMINATION

INDEXXX

BY MS. JUDSON:

Q Were you provided with any data on results by inspector for Hatfield by elements as opposed to attributes?

A No, I wasn't. That would have been a very useful document to have because the discrepancy rates for Hatfield, as I recall, were higher than they were for Hunter.

MS. JUDSON: No further questions.

JUDGE SMITH: All right. Now, on your Exhibit 11, it goes into the Rejected Exhibit file, but what you have to do is you have to provide the copies of the exhibit as if it's been received in evidence. Do you understand that?

MS. JUDSON: I'll be glad to do that, Your Honor.

JUDGE SMITH: Anything further?

(No response.)

JUDGE SMITH: All right, Dr. Ericksen, you may step down. Thank you very much, sir.

(Witness Ericksen was excused.)

MR. MILLER: Judge Smith, I forgot my manners. At the beginning of the day I should have introduced Dr. Frankel who has been sitting at counsel table with me.

He is our next witness, and our first rebuttal witness.

Whereupon,

MARTIN R. FRANKEL

was called as a rebuttal witness by counsel for Applicants and, after being first duly sworn, took the stand and was examined and testified as follows:

DIRECT EXAMINATION

INEX

BY MR. MILLER:

Q Would you state your name for the record, please?

A Martin Frankel.

Q And what is your current business address, Dr. Frankel?

A My current business address is Bernard Baruch College, City University of New York, 17 Lexington Avenue, New York, New York.

Q Dr. Frankel, do you have before you a 9-page document which is titled, "Rebuttal Testimony of Martin R. Frankel," to which is attached a curriculum vitae?

A Yes.

Q By whom was that document prepared?

A By myself with help from counsel.

Q And are there any changes or additions you wish to make to your testimony at this time?

A Not to my knowledge at this time.

Q Is the testimony true and correct to the best of your knowledge and belief?

A Yes.

MR. MILLER: Judge Smith, at this time I ask that the Rebuttal Testimony of Dr. Frankel be bound into the transcript as if read.

JUDGE SMITH: Any objections?

MS. JUDSON: No objection.

MR. LEWIS: No objection.

JUDGE SMITH: The testimony is received.

(The Rebuttal Testimony of Martin R. Frankel follows.)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In The Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454-OL
	)	50-455-OL
(Byron Nuclear Power Station, Units 1 & 2)	)	
	)	

Rebuttal Testimony Of Martin R. Frankel

Q.1. Please state your full name for the record.

A.1. Martin R. Frankel

Q.2. Please describe your present positions and your job responsibilities.

A.2. At the present time I am Professor of Statistics, Bernard Baruch College, City Univeristy of New York, 17 Lexington Avenue, New York, New York, 10010. I am responsible for the teaching of all graduate and undergraduate courses in survey sampling. In addition I teach courses in general statistics and in computer languages. I have been at Baruch College since 1971 with the exception of a two year period when I was an Assistant Professor of Statistics in the Graduate School of Business of the University of Chicago.

I also serve as Technical Director of the National Opinion Research Center, University of Chicago. In this position I am responsible for the statistical and technical quality of all contract survey research conducted by the Center.

Q.3. Please describe your educational and professional background.

A.3. I hold an AB degree in Mathematics from the University of North Carolina. I hold an MA degree in Mathematical Statistics and a Ph. D. degree in Mathematical Sociology from the University of Michigan. My doctoral dissertation was in the area of inference from complex probability samples. This dissertation, which was published by the Institute of Social Research of the University of Michigan under the title Inference From Comples Samples, is currently in its fifth printing.

I have been actively involved in the use of probability sampling techniques for a period of 19 years. Over this time period I have been involved in the design, sleection and implementation of more than 100 different large scale samples. This work has been carried out for Federal Goverment agencies, Universities, International Organization and Business Firms.

The major professional organization for applied statisticians in the United States is the American Statistical Association. I was elected a Fellow of the Association in

1979 for my work in the area of probability survey sampling. I have served as Chairman of the Association's Section on Survey Research Methods and its Advisory Committee to the U.S. Bureau of the Census. I also served as an Associate Editor of the Association's Journal for a period of 8 years.

In addition to the title mentioned above, I am coauthor of 2 books in the area of survey sampling. I am coauthor and author respectively of the chapters on probability sampling in The Handbook of Marketing Research (McGraw Hill, 1974) and the Handbook of Survey Research (Academic Press). I have published articles on survey sampling in various scientific journals. I am one of the four members of the Editorial Board of the 8 volume Encyclopedia of Statistical Sciences (Jchn Wiley and Sons).

I was elected to membership in the International Statistical Institute in 1983. A copy of my cirriculum vitae is attached to my testimony as Attachment A.

Q.4. Are you familiar with the Byron Reinspection Program?

A.4. Yes, I have reivewed the Report on the Byron QC Inspector Reinspection Program (Reinspection Report), the Report Supplement, the testimony of Mr. Singh, Mr. Ericson and portions of the testimony of Messrs. Tuetken, Del George and answers to certain written interrogatories.

I have also held in person discussions with Messrs. Singh, Del George, Tuetken, Laney and counsel for Commonwealth Edison Company.

Q.5. Can you define some of the technical terms that you will be using in your subsequent testimony?

A.5. Yes. Four of the basic terms that I will be using in my testimony are probability sample, non-probability sample, random sample and systematic sample.

A probability sample is a sample that is selected by a procedure that gives each element in a defined population a known, calculable, non-zero probability of being included in the sample

A non-probability sample is any sample that does fall under the definition of a probability sample.

The term random sample is often used three different ways.

In the formal theory of probability sampling it is used to describe a type of probability sample in which all combinations of elements of a given size in the population and all subsets of this size have an equal chance of being selected into the sample. In this context, random samples of elements may be defined as "selected without replacement" or "with replacement".

In general statistical theory, the term random sample is used to describe a sample from a population that may be treated mathematically as the product of independent,

identically distributed random variables. As I will discuss later, there are numerous instances hwere samples which do not satisfy the probability sampling definition of random samples are treated as random samples in various analytical and inferential procedures.

The term random sample is also used by the general population and the media that serve this population. In this contest the term does not seem to have any clearly defined meaning.

The term systematic sample is used to describe a type of probability sample that is selected using a constant skip interval or pattern after a random start.

Q.6. Can you describe the role of probability and non-probability samples in drawing inferences from a sample to a larger population.

A.6. The use of probability sampling methods generally assure that objective statistical inferences may be drawn about the larger population from which the sample was selected. More specifically, support for one of the assumptions that must be made in order to apply various theories of mathematical statistics may be directly linked to the sample selection process.

However, it is important to recognize that the lack of a probability sample does not mean that inferences can not be made from the sample. When a non-probability sample is used in making statistical inferences, support for

assumptions contained within the mathematical theory of statistical inferences must come from other sources. Typically the source for this support is an individual or individuals who possess relevant substantive knowledge. In these instances, the inference is supported on the basis of subjective judgment.

The methods and techniques of probability sampling were first introduced in the late 1930's and early 1940's. While the use of probability sampling has generally increased over time, there are many areas involving both the public welfare and safety in which policy decisions are made on the basis of non-probability samples.

Examples of the use of non-probability samples in this context include the approval of drugs for general distribution and testing of products for the satisfaction of safety standards. The benefits and effectiveness of various social programs are often evaluated on the basis of small scale experiments or demonstration programs which involve individuals. Most often, neither the selection of geographic sites for these programs or demonstration projects, nor the selection of individuals for program enrollment is carried out on a probability sampling basis.

In general, the use of probability sampling can often simplify the process of drawing inferences from sample to the larger population. But, the lack of a probability sample does not preclude this inferential process in either theory or practice.

Inferences may be accomplished from non-probability samples if substantive subject matter experts provide subjective support for assumptions linked to the general statistical definition of random sampling. For persons who do not rely on mathematical statistical theory for making inferences from samples, the use of a probability or non-probability sample is immaterial. In such a case the adequacy of the sample is a matter of judgment on the part of the subject matter expert.

Q.7. What is your evaluation of the procedures used to select inspectors for the Byron QC Reinspection Program?

A.7. In my discussion of the sampling procedures used to select the sample of inspectors, I would separate the procedure used to select theinitial sample which was based on every fifth name from the ordered list of inspectors, and the procedure for the addition of certain inspectors by the NRC staff.

Within the formal definition applied in the context of probability sampling, the initial sample does not qualify as a simple random sample. It more closely resembles a systematic sample with implicit stratification by contractor and date of certification. It should be noted that systematic samples do qualify as probability samples and in certain instances may be more reliable than simple random samples.

The addition of names to the sample by the NRC staff does transform the resulting total sample into what

is best described as a judgment sample. Judgment samples of this type are often used by auditors in order to subjectively maximize the chances of uncovering discrepancies that might be missed in simple random or systematic samples.

Judgment samples do not satisfy the requirements to be classified as probability samples, and thus, the use of this type of sample in drawing inferences must be supported by the judgments of individuals with appropriate substantive knowledge.

Q.8. Can you describe the role of the sampling statistician in determining whether or not inferences may be drawn from probability samples versus judgment or other non-probability samples.

A.8. A sampling statistician can evaluate a sample selection process and determine whether or not a sample qualifies as a probability sample, then the sampling statistician is generally able to determine the type of inferential statements that may be supported for the sample data.

If the sampling statistician determines that the sample selection process does not produce a probability sample then the role of the sampling statistician becomes much more limited. The sampling statistician can not, within the boundaries of his or her sphere of expertise, draw inferences from the sample. At the same time, however the sampling statistician can not, acting within the boundaries of his or her sphere of expertise, conclude that the sample

is incapable of supporting inferential statements based on the subjective evaluation of experts. The sampling statistician can work together with subject matter experts in determining whether certain assumptions required for sample inferences are satisfied, but the sampling statistician must depend on subject matter experts for the required subjective judgments.

The sampling statistician has no role to play when the individual drawing inferences to a population on the basis of observations of a sample does not purport to base these inferences on mathematical statistical theory.

MR. MILLER: Would you like me to provide a brief oral summary of Dr. Frankel's testimony?

JUDGE SMITH: Yes, please.

MR. MILLER: Dr. Frankel is a Professor of Statistics at the City University of New York, and Technical Director of the National Opinion Research Center, University of Chicago.

He has reviewed the Byron Quality Control Inspector Reinspection Program and conducted certain other research into it, and after defining certain terms such that are used by statisticians, such as probability sample, random sample, systematic sample, he describes the role of probability and non-probability samples in drawing inferences to a larger population.

He then discusses his evaluation of the procedures used to select inspectors for the Byron Quality Control Reinspection Program, and concludes by describing the role which a sampling statistician can play in determining whether or not inferences may be drawn from a sample to a larger population.

end 30

With that, Dr. Frankel is available for cross examination.

MS. JUDSON: We have no questions of this witness.

MR.LEWIS: Staff has no questions.

JUDGE SMITH: Okay.

EXAMINATION BY THE BOARD

BY JUDGE COLE:

XXXX Q Page 7 of your testimony, Dr. Frankel, the second line of the bottom paragraph, the last word, "qualify" rather than "quality?"

A I'm sorry, the second-to-the-last one?

Q I'm sorry, the next-to-the-last paragraph on that page, the second line.

A Qualify is correct. Thank you very much.

(Discussion off the record)

BY JUDGE COLE:

Q I just really have one question, Dr. Frankel, and it has to do with -- you have studied, or at least read the Reinspection Report?

A Yes, I have.

Q And you have looked at some of the inferences that have been made by certain of the witnesses that have appeared before us. And your comments here are quite helpful in our evaluation of the value of the statistics that have been used.

mm2t

Is there anything you would want to tell us about how much confidence should we have in the kind of data that has been presented to us?

Can you speak in more quantitative terms rather qualitative? Most of your response here is of a qualitative nature as to how certain kinds of data can be used and received.

A Yes.

Well, maybe I can help out in adding some information about this effect of clustering as it impacts on the design significant discrepancies, the so-called design significant discrepancies which -- I am certainly not an engineer, but I understand that to mean that there is some departure from the way the building took place or the installation took place or something of that sort.

I find rather persuasive the fact that apparently with all of the inspections that were done, zero design significant discrepancies were located. One of the problems that I had in correcting for this potential clustering, the potential of clustering is definitely there in the sample of inspections, which is derived from the sample of inspectors. The potential for this clustering effect is there. However, when I look at the variable, that is the key variable, namely the number of design significant discrepancies, I find all zeros.

mm3

But, if I plug that into a standard formula I get an answer that is either zero or indeterminate.

If I then use the traditional correction factor that Dr. Ericksen started to use in his design effect formula, I basically conclude that the effective end doesn't have to be reduced at all. It doesn't have to be reduced at all, because if you take a look at Dr. Ericksen's formula, you will see that if you make ROH equal zero, then the design effect is one.

If the design effect is one, and you take the actual end --

Q Let me get that page. That is Appendix 1 of Dr. Ericksen's testimony?

A Yes. Here it is.

Appendix 1. The formula is DEFF equals one plus ROH times B minus one.

Now, you can let B, which is the average cluster size be as large as you want. If ROH is zero, design effects is equal to one. Now, when you get the so-called effective sample size down at the bottom, effective sample size is actual sample size divided by DEFF, that would indicate that in terms of the reliability statements which are made about the potential proportion or percentage of design significant discrepancies that might exist in the work that was uninspected, you get an effective sample size which

mm4

is equal to an actual sample size.

In other words, it is not reduced by this factor of six or seven, if you actually look at the intraclass correlation on the base of the sample data.

Now, quite frankly, I think that the truth is probably not that it is quite an intraclass correlation of zero, but it looks like it is very, very close to zero. So I guess what I am saying is that given that we didn't really start out with a probability sample, taking the data that we have, being somewhat subjective in applying statistics which we have to be in this case, those reliability calculations seem pretty reasonable to me simply because when I apply my standard corrective procedures, my corrective procedures don't change the ends.

Q Yes, but the average cluster size can be very large here, sir. Wouldn't that increase the effect even if ROH is small?

A Sure, sure. But unfortunately, when I put in the actual data -- now this is looking at design significant discrepancies -- the calculation that Professor Ericksen did when he calculated two variances and divided one by the other, you get zero over zero. That is what you get. It is indeterminate.

Now, he gave the answer that the intraclass correlation coefficient would be zero.

mm5

Q That is for the documentation section.

A Well, in fact it is my understanding that if we take a look at the design significant discrepancies that were found in the whole inspection program, my understanding was, and I may be wrong, that there was zero of them, total.

Q That's correct.

A Okay. If there was zero of them, total, the same kind of calculation applied to anything we were talking about design significant discrepancies is going to give you the same result.

The cluster size could be five million, for all we knew. But if the ROH was zero, the design effect would be one.

And that is one of the problems I have as a statistician in trying to quantify it. But this, I think, adds credibility to the quantitative statements that have been made. Although again I have got to say that they were made subjectively.

This is not a probability sample. This is not intended to be a probability sample.

Q All right, sir.

I want to make sure I understand what you just said. It is in the record of this case that they found zero design significant discrepancies.

And you just testified that if we use that value

mm6

and take that value that the intraclass correlation value would then be zero.

A Well, I think Professor Ericksen stated it would be zero if we had zero design discrepancies.

I get an answer that is indeterminate. But, for the moment, if we assume -- let me assume it is zero for the moment.

Q I want to make sure I understand. I can see if RHO is zero -- I can see where the design effect would be -- there would be no design effect.

A Right.

JUDGE COLE: All right, thank you. That is very helpful, sir.

MS. JUDSON: I would like to move to strike a part of that answer in which the witness said that he was impressed with the fact that there were no design significant discrepancies, as being beyond his expertise.

He has no basis for determining whether the discrepancies are design significant or not.

JUDGE SMITH: As a hypothesis he has to accept -- areyou talking about Dr. Cole's question?

MS. JUDSON: In the initial answer to Dr. Cole's question.

JUDGE SMITH: He has to accept that. That is not based upon his evaluation or his analysis. That is

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XXX

based upon the evidentiary record of this hearing, which he has to accept in his answer.

BY JUDGE CALLIHAN:

Q Dr. Frankel, I think I have the same questions as my colleague here, but I would like to put it in my own words.

First, do you characterize your analysis as evidenced by your filed testimony as being sort of a combination of statistical luck with a strong flavor of practical judgment and practical application and experience in the field?

Is that some sort of a characterization?

A To characterize my prepared testimony?

Q Yes.

A Yes.

What I was trying to do was to indicate what I felt statistics, formal statistics and statisticians might have to appropriately offer in these situations, and what the bounds were where they could make judgments.

I feel very strongly that -- if a sample is designed as a probability sample of a certain type, as long as the numbers are not -- getting the numbers, getting the basic data are not the responsibility of the statistician, but the statistician was handed the numbers, the statistician can project those numbers to what would have

mm8

occurred had the whole population been examined.

That is under some very, very tightly-defined circumstances, namely when we have a probability sample.

In situations where we don't have a probability sample, then the statistician has to be very careful because the statistician is not really qualified to make inferences from that sample. The statistician can assist the subject matter expert in making inferences from that sample.

But the statistician has to be very careful that he doesn't overstep his bounds.

That is what I was trying to get across.

end 31

I guess that characterizes practical experience as well as statistical fact. I think it does.

Q As a result of, or a combination if I may use the term, of approaches which I have defined -- I think you mildly concurred in it -- did you say that -- or within a judgmental sample -- can the reliability really be quantified with such and such confidence level?

A The number of assumptions that have to be made when you're dealing with a non-probability sample is greater than the number of assumptions you have to make with a probability sample. I would like to be able to characterize this as being black and white, with a probability sample you can do it and with a non-probability sample you can't, or it's more difficult.

It's really -- it's a gray distinction, rather than black and white. You can, and in fact people work with non-probability samples all the time. It is silly to deny that they do.

A lot of important decisions are made with them.

There are some statistical theories which address the question of how can you make quantitative statements from judgmental, non-probability samples? My general feeling, and this summarizes it, I am more comfortable if I can, if I have a probability sample to work with.

But that doesn't prevent me from making

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inferences from non-probability samples.

Q Do your most recent remarks have a bearing on the application of what I will characterize the Miller-Freund formula, which is the reliability of 1 minus a fraction, which I'm sure we all recognize? Does your most recent remark have some bearing on applicability of that formula?

A I think the applicability of that formula can be determined by a statistician acting solely as a statistician. The applicability of that formula has to be determined by a subject matter expert, possibly with help from a statistician. But a statistician is really not capable of determining whether or not that formula is appropriate or not.

end32

Q And consequently whether or not the results are descriptive?

A That's so.

JUDGE CALLIHAN: Thank you very much.

JUDGE SMITH: Any further questions?

CROSS EXAMINATION

BY MS. JUDSON:

Q Dr. Frankel, is there any evidence of homogeneity and the likelihood of making discrepancies?

A I'm sorry, Ms. Judson, is there any -- would you repeat the question?

Q Have you seen any evidence of homogeneity in the likelihood of making discrepancies?

JUDGE SMITH: Something's wrong with the question, I believe. Ms. Judson, if you prefer, Dr. Ericksen can ask questions directly.

MS. JUDSON: I was just about to do that, Your Honor.

JUDGE SMITH: Do you object to that, Mr. Miller?

MR. MILLER: I don't know --

JUDGE SMITH: It is provided by the rules.

MR. MILLER: It's probably going to expedite things if we have the experts communicate directly, although Dr. Frankel probably wishes that he had had the opportunity to cross examine Dr. Ericksen.

index

THE WITNESS: Nobody may be able to understand --

JUDGE SMITH: I observed Dr. Frankel. He was mentally doing it anyway.

BY MR. ERICKSEN:

Q I just wanted to ask you, have you evaluated the data indicating that there was a relationship between the likelihood of an error for the same inspector on different inspections?

A I have evaluated it and, in fact, you have -- when I turned over my work on those two, you saw my calculations. I evaluated -- I made several kinds of evaluations in homogeneity. One involved simple discrepancies.

Again, I'm not exactly sure what that means, but I have been told that it means that the reinspection was, in some way, different from the original inspection and I made calculations on the basis of the data that was provided in the report and I asked for some supplemental data.

And indeed, there is an indication of intraclass correlation, which is different from zero. When one tries to make that calculation on not just discrepancies in general but design significant discrepancies, which I understand are really the important ones to someone, then I'm in a situation where I've got zero and I've got zero over zero. So for one variable, as we statisticians say, I'm seeing intraclass correlation. For another variable, which I'm told is the

important one, I'm seeing either an indeterminate answer or answer of zero. There is no intraclass correlation.

Q Your calculations indicate a design effect of 557.69 for subjective attributes and 36.1161 for objective attributes. Is that correct?

A I don't remember, quite frankly -- what I don't remember is whether or not those values are correct. I wrote them down and ran them through once. And before I agreed with them I want to have a chance to recalculate them.

(Document handed to witness by Intervenor.)

Q Have you done any other calculations for any other variables of that nature?

A As I said, I tried to reproduce your calculations and I believe I was able to come close to your calculation. I couldn't hit it exactly.

Q Are there any other?

A Was there another work paper that was handed to you -- let me just answer the question. My impression was I may have done one or two more in my computer. And I don't think I wrote the results down, but I saw numbers that were different from zero.

Q Do you agree that there are inspection elements where there were no reinspections in the Reinspection Program?

A I'm sorry. You're asking -- is that a statistical question. Is it a question about reading the report?

mm331b4

Q It's a question about reading the report.

MR. MILLER: Judge Smith, I realize that when an expert is doing the examination that perhaps there ought to be some leeway, but I don't know that there was any examination by any of the Board members with respect to the question of whether or not there were zero elements or zero reinspections in a particular element.

JUDGE SMITH: That's correct. This is something that should have been done on the original cross examination, but if it was overlooked -- if you had intended -- we will accept it being done.

MR. MILLER: Let me try and be helpful and save the witness's time. I think we established, as part of what we had with Dr. Ericksen's testimony, that there are, in fact, inspection elements --

MS. WICHER: I believe it may be a foundational question.

THE WITNESS: Yes, okay.

BY MR. ERICKSEN:

Q How would you advise the engineers at Commonwealth Edison to evaluate the reliability of those elements?

MR. MILLER: Excuse me, but the question is evaluate the reliability and really, for the sake of -- I'm sure the two statisticians are communicating perfectly. But for the sake of the record, I think we ought to have a definition of

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when you talk about "evaluate the reliability" does that mean a reliability calculation or something else?

MR. ERICKSEN: Perhaps I could rephrase the question.

MR. MILLER: Okay.

BY MR. ERICKSEN:

Q How would you advise the engineers at Commonwealth Edison to draw inferences concerning those elements?

A I think, from what I've heard today, just sitting next to Mr. Miller, what I heard the panel talk about, this data was collected in conjunction with a study that never was designed to make determinations on an inspection element by element basis. We were in a situation where some data came up through a program and I believe I heard someone say that they would have been speaking about Edison, they would have been remiss had they ignored the data and not analyzed it.

So there is nothing there. There is nothing there, in terms of reinspections. What can they do about it? That specific 10,509, I don't know if they can make inference about. They might view it -- and again, this is where a statistician would have to work with a non-statistician. If it were felt, by a subject matter expert -- I presume an engineer -- or perhaps someone else. If it were found appropriate to group these inspection elements with other inspection elements, then it might be possible to aggregate.

Q And would you have suggestions to make, as to how

that aggregation might be done?

A I think that had I -- if I were asked the question, I would ask them what kind of elements are similar, in terms of what you normally do in your profession, what you know about and what the operation is. I don't know what a piping or whip restraint is. I have no idea.

Q Would you look at discrepancy rates among the elements that they consider to be similar?

A Among what different elements? Among the ones -- in other words, they would come up and say these are similar and then I would examine the rates?

Q I'm asking if you would do that?

A I'm not sure. I might. I might not. You know, I can't say that everytime someone wants to group things together, I say let's do a test to see if they're similar. For example, in the survey work, that you and I do, which involves household sampling, there are nine census divisions that the Census Bureau has chosen to break up the United States, into nine divisions.

Now typically, because of sample size considerations, we take samples of 1500. Typically, people don't use those full nine divisions because you get the mountain states may only give you 50 observations. So things are grouped in an aggregate unit, where we have four regions. Now the four regions are another way of geographically dividing the United

States, northeast, south, north central, and west. That's an aggregation of either individual states, it's certainly an aggregation of people, but it's an aggregation of individual states. It's also an aggregation of the so-called census divisions.

Now how often have we asked people, have you tested to see if the pacific and the mountain, which then form the west, are similar? We usually say well, you know, you're doing the analysis. You're the subject matter expert. You decide what's appropriate for your analysis. Very rarely does a statistician get involved in that decision.

Q Dr. Frankel, have you participated in the selection of households based on the 1980 census?

A I certainly have.

Q Did you stratify that sample?

A The sample was stratified, yes.

Q Did you participate in that decision?

A Yes.

Q Did you stratify on the basis of census divisions?

A Did I stratify on the basis of census division? I can't remember if it was based on division or it was based on region.

Q Did you make any -- do any kind of analysis to determine the best way of stratifying that sample?

A No. We know that samples are stratified certain

ways because people traditionally do it. We are as bad as we accuse people of doing. We say you always take 95 percent or 5 percent. We are creatures of habit, as well.

MS. JUDSON: We have no further questions.

JUDGE SMITH: Dr. Frankel, thank you.

(Witness excused.)

JUDGE SMITH: Anything further this evening?

MR. MILLER: No, sir.

JUDGE SMITH: Do we have a report then on what tomorrow looks like? I don't think we need to be on the record for it.

MS. JUDSON: No, we don't need to be on the record, but we'd like a one minute break to call one of our other attorneys.

JUDGE SMITH: All right. We are adjourned.

(Whereupon, at 5:30 p.m., the hearing was adjourned, to reconvene at 9:00 a.m. on Friday, August 24, 1984.)

CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the NRC COMMISSION

In the matter of: COMMONWEALTH EDISON COMPANY (Byron Station, Units 1 & 2)

Date of Proceeding: Thursday, August 23, 1984

Place of Proceeding: Rockford, Illinois

were held as herein appears, and that this is the original transcript for the file of the Commission.

Mimie Meltzer
Official Reporter - Typed

Mimie Meltzer
Official Reporter - Signature

Suzanne Young
Official Reporter - Typed

Suzanne Young
Official Reporter - Signature