Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Entergy Nuclear Operations, Inc. Indian Point Nuclear Generating Station Open Session
Docket Number:	50-247-LR and 50-286-LR
ASLBP Number:	07-858-03-LR-BD01
Location:	Tarrytown, New York
Date:	Wednesday, November 18, 2015

Work Order No.: NRC-2016 Pages 5322-5675

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

U.S. NUCLEAR REGULATORY COMMISSION

+ + + + +

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

+ + + + +

OPEN SESSION

In the Matter of:	: Docket No.
ENTERGY NUCLEAR OPERATIONS, INC.	: 50-247-LR
(Indian Point Nuclear Generating	: 50-286-LR
Station, Units 2 and 3)	: ASLBP No.
	: 07-858-03-LR-BD01

Wednesday, November 18, 2015

Doubletree Tarrytown
Westchester Ballroom
455 South Broadway
Tarrytown, New York

BEFORE:

LAWRENCE G. MCDADE, Chairman
MICHAEL F. KENNEDY, Administrative Judge
RICHARD E. WARDWELL, Administrative Judge

APPEARANCES:

On Behalf of the U.S. Nuclear Regulatory Commission:

DAVID E. ROTH, ESQ.
SHERWIN E. TURK, ESQ.
BRIAN HARRIS, ESQ.
of: U.S. Nuclear Regulatory Commission
Office of General Counsel
Mail Stop - 0-15 D21
Washington, D.C. 20555
david.roth@nrc.gov
sherwin.turk@nrc.gov
brian.harris@nrc.gov
301-415-2749 (Roth)
301-415-1533 (Turk)
301-415-1392 (Harris)

On Behalf of Entergy Nuclear Operations, Inc.:

KATHRYN M. SUTTON, ESQ.
PAUL M. BESSETTE, ESQ.
RAPHAEL "RAY" KUYLER, ESQ.
of: Morgan, Lewis & Brockius, LLP
1111 Pennsylvania Avenue, N.W.
Washington, D.C. 20004
202-739-5738 (Sutton)

202-739-5796 (Bessette)
202-739-5146 (Kuyler)
ksutton@morganlewis.com
pbessette@morganlewis.com
rkuyler@morganlewis.com

On Behalf of the State of New York:

JOHN J. SIPOS, ESQ.
LISA S. KWONG, ESQ.
MIHIR A. DESAI, ESQ.
of: New York State
Office of the Attorney General
Environmental Protection Bureau
The Capitol
Albany, New York 12224
brian.lusignan@ag.ny.gov

On Behalf of Riverkeeper Inc.:

DEBORAH BRANCATO, ESQ.
of: Riverkeeper, Inc.
20 Secor Road
Ossining, New York 10562
800-21-RIVER
info@riverkeeper.org

On Behalf of Westchester County:

CHRISTOPHER INZERO, ESQ.
Assistant County Attorney
of: Westchester County Government
148 Martine Avenue
Room 600
White Plains, New York 10601
914-995-2000

On Behalf of Westinghouse Electric Company:

RICHARD J. COLDREN, ESQ.
of: Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066
412-374-6645

TABLE OF CONTENTS

P-R-O-C-E-E-D-I-N-G-S

(8:34 a.m.)

CHAIRMAN MCDADE: Okay. The hearing will come to order. The first order of business, I believe we have some witnesses for 26 who were not witnesses on 25. Do we have anyone here who has not yet been sworn in who is going to be proffered on 26?

MR. ROTH: Yes, Your Honor. We do.

CHAIRMAN MCDADE: Are you going to move over to the witness tables?

MS. BRANCATO: Your Honor, this is Deborah Brancato from Riverkeeper. Would you like Dr. Hopenfeld to go over into the witness table, too?

CHAIRMAN MCDADE: Next to Dr. Lahey, Dr. Hopenfeld. Okay. And Dr. Hopenfeld was sworn on Monday, so he doesn't need to be sworn again. He's still under oath. The two new witnesses --

MR. HARRIS: Your Honor, Brian Harris, NRC. Do you want to swear the witness for 38 in also at this time?

CHAIRMAN MCDADE: I mean we're not going to be getting to 38 today, but we might as well.

MR. SIPOS: Judge McDade?

CHAIRMAN MCDADE: Yes.

MR. SIPOS: John Sipos for the State of New York. Just to note, Dr. Duquette is not yet present, but we do expect him.

CHAIRMAN MCDADE: Right, and before Dr. Duquette begins to testify on 38, we will swear him in. The new witnesses, would you please identify yourself, your name and your short job title and who you represent. Mr. Yee?

MR. YEE: On Yee, U.S. NRC, Reactor Systems Engineer with NRC.

MR. NG: Ching Ng with the NRC, Reliability and Risk Analyst.

MR. KARWOSKI: Ken Karwoski, Senior Level Advisor for Steam Generators Materials Inspection, NRC.

CHAIRMAN MCDADE: Okay. Would you please rise? Would you raise your right hand?

Will you swear or affirm subject to the penalties for perjury that the testimony you'll give at this hearing will be the truth, the whole truth, and nothing but the truth?

(Chorus of I do.)

CHAIRMAN MCDADE: Okay. Please be seated. Certain things we told the other witnesses, and we'll repeat for you right now.

First of all, it's important that we have a record of the proceedings so that if you are answering a question, before you answer the question, state your name.

Now if the question is designed directly towards you, so the judge has said Mr. Yee, and then asks the question, you don't need to repeat your name because the court reporter will have it right there in context.

But in many instances, we're going to be asking questions that are directed either to the NRC staff or to Entergy or to the interveners, and in which case then the individual who is speaking should state their name before they begin so that the record will reflect which one of the witnesses was actually speaking.

The other thing is we do take periodic breaks. If for any reason you feel that you need a break, don't suffer in silence. Let us know, and we can arrange to take a break. Are there any questions before we get started?

MR SIPOS: No questions.

CHAIRMAN MCDADE: Okay. There are a few things, administrative matters and some substantive matters that I want to take up before we started.

First of all, at the conclusion of yesterday, I asked a question I thought was a simple question that was designed to sort of summarize what had been said over hours of testimony to put it in one place in the record.

Perhaps because I was tired, but in any event, I failed miserably and wound up sort of running us down a rabbit warren and wound up confusing things rather than clarifying things.

Sort of a quote from the movie Cool Hand Luke, "We had a failure to communicate," and I apologize for that. We were talking about what has been developed and what has still to be developed.

And from the testimony, and what I want to do is to sort of summarize a little bit and then make sure from the witnesses, because nothing I say is evidence, that what I'm saying is correct.

That we look first of all to MRP-227,

which is NRC Exhibit 114. That sets out various inspection aspects. In Sections 4 and 5 of that document, it talks about examination methods, the qualifications for examination, the frequency of examination, sampling and coverage, the expansion based on observed degradation, evaluation of results and flaw evaluation.

Specifically in that, it also addresses Westinghouse manufactured plants specifically. They have tables for Westinghouse plants as well as for plants manufactured by other entities.

But as part of those tables, they have listed acceptance criteria. Among those acceptance criteria, they have one for the baffle former bolts.

But in that particular document, the MRP-227 and specifically the table 5-3, not all of the details with regard to the acceptance criteria for baffle former bolts are specified, that it indicates that for certain plant-specific, unit-specific details that they will be established as part of the examination technical justification.

Now that was then discussed back and

forth between the NRC and Entergy, and it was addressed specifically in Supplement 2 to the SER, which is New York Supplement, excuse me, New York Exhibit 503.

And in that, the NRC articulated its position that those specifics, the UT examinations for baffle former bolts have been performed since the 1990s.

There's more than 20 years' experience doing that inspections, which provide a reasonable assurance that the examinations can be implemented effectively and that finalizing the TJ closer to the date of the inspection would allow for the latest UT technology and lessons learned for previous inspections to be incorporated.

So what remained to be done, which isn't in the original document or in the SER that is in either MPR-227, Exhibit 114 or in the SER, New York Exhibit 507, is the technical justification for the examination.

Dr. Hiser, again, nothing I've said is evidence. What I've just gone through, does that accurately reflect the process here?

DR. HISER: Yes, I believe it does.

CHAIRMAN MCDADE: Okay. Do you have anything to add to supplement that --

DR. HISER: No, I don't.

CHAIRMAN MCDADE: -- or to correct it?

DR. HISER: No, I do not.

CHAIRMAN MCDADE: Okay. And from Entergy, does anybody have anything to supplement or to correct?

MR. DOLANSKY: No, Your Honor. This is Bob Dolansky from Entergy. No.

CHAIRMAN MCDADE: Okay. So what's left to be done has to do with the technical justification for the inspection, certain plant-specific details.

Dr. Hiser, could just very briefly just put on the record what the technical justification for examination is, or if someone is better suited to it?

MR. POEHLER: This is Jeffrey Poehler, the staff. I can address that. The technical justification would be a report prepared probably by the vendor that's performing, that will perform the ultrasonic examination.

And it would be a detailed report on the qualification of the ultrasonic examination procedures. It would address things like the detectability of flaws, like what's the minimum size flaw you could detect in a bolt, such as for example, 10 percent of wall thickness or 20 percent, something like that.

CHAIRMAN MCDADE: Okay. And has that technical justification been received by the NRC?

MR. POEHLER: No, it has not. It would not be something we would expect to be submitted or require to be submitted.

CHAIRMAN MCDADE: Okay. It is required to be prepared no later than six months before the first inspection, but that is a document that would be maintained at the facility subject to inspection by the resident inspector of the NRC. Correct?

MR. POEHLER: Correct.

CHAIRMAN MCDADE: Okay. And do you agree with that, from Entergy?

MR. DOLANSKY: Yes.

CHAIRMAN MCDADE: What is the status of the technical justification for the inspection?

MR. DOLANSKY: It has been written. This is Bob Dolansky with Entergy. You're asking

--

CHAIRMAN MCDADE: Yes.

MR. DOLANSKY: -- has it been written. Yes.

CHAIRMAN MCDADE: Okay. And can you elaborate on the kind of details that are in that document that are unit-specific?

MR. DOLANSKY: They talk about the parameters of the, that the NDE inspector would use, how he would set up his equipment, when he does his calibration what type of reflectors he would be looking for from the calibration block, that type of thing.

CHAIRMAN MCDADE: Okay. And this is intended, based on the words of the SER, to utilize more recent, the most recent UT technology as well as lessons learned from previous inspections?

MR. DOLANSKY: Correct. For instance, the vendor, Westinghouse, typically goes to outages in the spring and fall. That's when outages typically occur.

So they would go into outages this past fall, now basically, and anything that came out of those outages, if there any lessons learned or anything like that, they would incorporate that into the procedure before they give it to us.

CHAIRMAN MCDADE: Okay. Judge Wardwell, do you have anything further on that?

JUDGE WARDWELL: No, I think it's fine. Thank you.

JUDGE KENNEDY: No, I do not.

CHAIRMAN MCDADE: Okay. I believe that we had, I believe it was referred to yesterday as sort of homework assignments that we had questions that remained up in the air.

There was one, I believe, Dr. Lott. There was a question with regard to the lower support column of whether that was cast material, and were you able to identify any other cast RVI components?

DR. LOTT: I realize that question was addressed to me, but I think it might better, and I know this, some of my colleagues on the panel here have been doing some research on that. So I would like to turn it over to Mr. Azevedo.

CHAIRMAN MCDADE: Okay, Mr. Azevedo.

MR. AZEVEDO: Yes, Your Honor. We looked into this. There's a total of six components that are reactor vessel internals that are made out of cast material.

Two of those six are expansion components, which means they were determined to be moderately susceptible to some form of degradation mechanism. Therefore, they're expansion components.

The other four components were screened out as not being susceptible to any degradation mechanism per MRP-191.

CHAIRMAN MCDADE: Okay. When you're talking about expansion components, you're going back to Section 4 of MPR-227. Correct, where it lists primary then expansion and based on the susceptibility?

MR. AZEVEDO: That's correct.

CHAIRMAN MCDADE: Okay. Anything further, Mr. Azevedo, on that?

MR. AZEVEDO: No, Your Honor.

CHAIRMAN MCDADE: Okay. Dr. Lott, I believe there was a question left for you asking whether or not there was, you could point us to a basis for the statement that low ferrite CASS material would not show a meaningful combined effect from thermal aging and irradiation.

Is there anything you could point to us in support of that proposition?

DR. LOTT: Yes. I think that was, the particulars of a question was in relation to Question 8 of our supplemental testimony. And that was really addressed to concerns about embrittlement at or below the threshold for radiation embrittlement materials.

So I wasn't trying to, and I don't think we were trying to say anything about higher fluence materials. And there's admittedly very sparse data on this topic.

I think the statement itself contains a direct reference to VWR-VIP-2015-025, and that document does talk, I think part of the question was why are we talking about these high ferrite materials when you're telling us it's low ferrite material.

That document does site actually a Westinghouse study on a low ferrite, a 10 percent cast material that showed that that material was not subject to the same decrease in embrittlement that the higher cast material say inside 184 were.

And we believe that, those materials

and that's the basis for our document. We'll notice that the NRC has made similar arguments in their justification for their suggestion of 15 percent as a standing level for ferrite material, susceptibility in irradiated materials. And that's in NRC Item 201.

CHAIRMAN MCDADE: I'm sorry. It is in what?

DR. LOTT: NRC Exhibit 201.

CHAIRMAN MCDADE: Okay. And the previous document referred to, do you have an exhibit number for that?

MR. SIPOS: I think, Your Honor, it's NRC 209, if I recall Mr. Lott's, Dr. Lott's testimony from yesterday.

CHAIRMAN MCDADE: Okay. Thank you, Mr. Sipos.

MR. KUYLER: I believe that Dr. Lott was referring to Entergy Exhibit 663, Your Honor.

CHAIRMAN MCDADE: Well, we will go and look at both of them. Thank you.

Okay. Dr. Lahey, I think we had a question yesterday, and it may or may not have been answered regarding NUREG 7184, New York Exhibit 488. And we're talking about, I think at one point used the word synergistic in another combination.

And whether or not there was any evidence that demonstrated that the sum of the thermal embrittlement and irradiation embrittlement is greater than the sum of the parts. Is there any language that you can point us to that would support that proposition?

DR. LAHEY: I reviewed, at your request Your Honor, 7184. As I had indicated yesterday, I think, the original language in this report used the work synergistic. And then later on it was changed by the authors to combined.

In my view, when I use synergistic I allow for a number of possibilities. I'm not sure what the author allows for. For example, when I use synergistic for a fatigue in radiation, I mean greater than the individual effects.

When I use synergistic for thermal and irradiation, I mean combined effects, not necessarily greater than the individual effects. So I can't speak to what the author meant, but they used both at one time.

CHAIRMAN MCDADE: Okay. And Dr.

Lahey, I believe there was a question put to you as to whether or not you could identify other RVI components subject to A/LAI 7.

DR. LAHEY: Right. Your Honor, I did do a review of a document. It was MRP-191, which carefully went through the various components and the material that they had the radiation fluence that they were subjected to.

And as you heard from previous witness, there are a number. The one that appeared to me to be of most concern, other than the one we talked about yesterday, the cap on the lower support plate column is the upper support column base.

It has a fluence of around 10 to the 21st neutrons per centimeters square. The other ones, at least in my view, didn't seem to be as safety significant as that one might be.

CHAIRMAN MCDADE: Okay. Thank you, Dr. Lahey. Judge Wardwell, did that answer your question, or do you wish to follow up?

JUDGE WARDWELL: I think I'll follow up with Mr. Azevedo if I might. Was the upper support column base any one of those that you have identified, and was it an expansion or a screened out component?

MR. AZEVEDO: Yes, Your Honor. That's one of the six that I mentioned before, and it was screened out as a Category A, which means not susceptible to any degradation mechanisms.

JUDGE WARDWELL: Thank you.

CHAIRMAN MCDADE: Can you elaborate at all on why it was screened out, the sort of thought process that went on?

MR. AZEVEDO: I don't have the details to how each one was screened out?

DR. LOTT: Perhaps I could help here. This is Randy Lott --

CHAIRMAN MCDADE: Dr. Lott?

DR. LOTT: -- Entergy. In the process of the evaluation, those materials were originally identified as cast materials, but there was a step in the process where we did effectively FMECA analysis.

It's described in MRP-191, to look at what the impact of these degradation mechanisms were. There were certain components, including the upper support columns, where it was effectively decided that there was no credible damage in impact or need to do additional analysis on the upper support columns.

And they were put into Category A. So it was recognized there were cast materials, but it was also felt that there were no stressors that would challenge that particular component.

It was an engineering evaluation. I can't speak to the details of it here, but I know that that process is described in MRP-191.

CHAIRMAN MCDADE: Okay. Dr. Lahey, do you wish to comment on the appropriateness of that screening as explained by Dr. Lott?

DR. LAHEY: No, I understand what he said, and it has to do with the criterion that has been established for the onset of significant radiation damage.

CHAIRMAN MCDADE: Okay. Yesterday I believe there was a question to you, Dr. Lahey, about addressing the WCAP methodology for determining dynamic load, that you wanted to review some documentation to comment on that.

DR. LAHEY: Yes, sir. I spent many happy hours for that last night. And I was, so there were two things that you may recall I was concerned with.

It was the methodology that was used

to calculate the forces. Was it truly impact force, or was it smear down? And then the other one is what was analyzed. Was that appropriate?

So in this report, which was dated 2001, it was, and then it was the one that was reviewed and approved later on by the U.S. NRC. It was a generic study of a 4 loop Westinghouse plant to determine what the minimum number of baffle former bolts could be to withstand certain accident events.

The methodology that was used is called by Westinghouse a MULTIFLEX, and it's Version 3. And I view that as sort of the grandson or the son, I'm not sure, either an old son or a young grandson of the WHAM code to show it is, in fact, what I think should be used.

It's a sub-cool depressurization code, so it propagates at the speed of sound, the depressurization waves throughout the system. So that was good news for me. I was very happy to see that, and I think it's appropriate.

Later on in the transient, they switch over to a version of the track code, which has been married to a version of the Cobra codes. So it's W Cobra slash --

MR. KUYLER: Your Honor, if I may break in for a moment. This is Ray Kuyler from Entergy. I would just note that we are discussing a proprietary Westinghouse report at this moment.

DR. LAHEY: I'm sorry.

CHAIRMAN MCDADE: Well, let's ask whether or not, it does not appear that we're discussing it in sufficient detail or the proprietary aspects of it are going to be released.

MS. SUTTON: Your Honor, let me consult with Westinghouse's counsel. They need to consult with their expert. One second.

DR. LAHEY: You're actually going to like what I'm going to say, but go ahead.

MS. SUTTON: Okay, Your Honor. As long as he remains at a high level of detail, we can proceed, but if it sinks into greater levels of detail, we'll alert you.

CHAIRMAN MCDADE: Okay. And Dr. Lahey, actually we have the report.

DR. LAHEY: Right.

CHAIRMAN MCDADE: Perhaps can you focus on the conclusions that you have drawn from the report rather than going into the specific details of the report?

DR. LAHEY: Right.

CHAIRMAN MCDADE: We're interested in your expert conclusions.

DR. LAHEY: I am definitely not going to go into detail. In fact, this report has precious few equations. That's in references that I did not have access to. But anyway, the track code and the Cobra code are widely known, have been published in the open literature.

So they are the large control volume codes, but it's only used for the flashing part of the transient, and the loads there are very small.

So all the loads that we're concerned with in terms of the integrity of the bolts have to do with the sub-cooled blow down phase. And in that phase, the right technique is apparently being used. So I was happy to see that.

Now the other part of my concern has to do with what do you do with these methods, which I've now said I think look appropriate? I'm happy to see that.

What was done is a break size, which

was not the large design basis break size. It was a smaller break size. And then use what the NRC likes to call leak before break criteria for opening time.

So it wasn't an instantaneous full leg break of the reactor. It was a smaller line break. So that, what that does is it reduces the severity of the load, which propagates through the system.

Nevertheless, I mean this was a generic study, and I haven't seen what is being done for the Westinghouse Plants at Indian Point, and I don't think it has been published.

So all these things could have been addressed that I'm going to alert you to, but when this was done, it was found that about 50 percent of the bolts could withstand the transient.

Fluid structure interaction was modeled, all pretty much state of the art in my view for this type of analysis was employed. So that's good news.

If you then go to a design basis accident, even though the NRC has said that leak before break is what you do for such things as pipe width, you don't do it inside the core.

You still have to do the regular, local loads. So if these are applied, then it'll be significantly different in terms of the integrity of the bolting.

So that remains to be seen, what will be done there. And as I said, I haven't reviewed that. I don't think it's available.

CHAIRMAN MCDADE: Okay. Thank you. Judge Wardwell, does that answer your question?

JUDGE WARDWELL: Fine. Thank you.

CHAIRMAN MCDADE: Do you need any follow up?

JUDGE WARDWELL: No.

MR. SIPOS: Your Honor, this is John Sipos for the State of New York. I note in that report there is a reference to a code. And that we have checked, and we do not believe that code, we do not have the code that was referenced.

And the reference is to WCAP-9735, and it was in the bibliography. Just like to note that for the record.

CHAIRMAN MCDADE: Okay. Thank you, Mr. Sipos. Okay. Dr. Lahey, I believe there was a reference that you made yesterday to an Argonne report, and Judge Wardwell had asked you whether or not you had a cite to an exhibit for that report. Were you able to provide a cite?

DR. LAHEY: I believe you're talking about NUREG/CR-7184. Is that the right one?

JUDGE WARDWELL: No. It's what you, what are you talking about. It's not what I'm talking about.

DR. LAHEY: In my testimony, I look back at my testimony, and I did cite that particular report.

JUDGE WARDWELL: Let's make sure we're clear on this.

DR. LAHEY: Okay.

JUDGE WARDWELL: So your testimony 482, page 18, lines 16 through 22 says, "A recent report prepared by Argonne National Lab," and then it goes on for several lines with no cite of what that report is.

Two pages later, you cite to two or three different NUREGs.

DR. LAHEY: Right.

JUDGE WARDWELL: My question is, the 482, page 18, lines 16 through 22, Argonne National Laboratory report that you referred to, what is the cite for that?

DR. LAHEY: Yes. I believe that particular one was the Chopra report. The lead author would be Dr. Chopra from ANL.

JUDGE WARDWELL: And what's the NUREG number?

DR. LAHEY: Okay. Let's see.

JUDGE WARDWELL: Would it be 7027?

DR. LAHEY: It's possible.

JUDGE WARDWELL: The exhibit for that one, at 7027, is New York State 487.

DR. LAHEY: Let me look.

JUDGE WARDWELL: Not to take the thunder out of Entergy's crack cite locator, but I have to show off sometimes.

DR. LAHEY: All right. I don't carry around those numbers in my head, so I'm going to have to look, Your Honor. Let's see.

(Pause.)

DR. LAHEY: Bear with me please, and I'll search it down.

JUDGE WARDWELL: Let's just wait. Could we call up New York State 487 and see if, it would have the author as Chopra.

DR. HISER: Your Honor, this is Allen

Hiser of the staff. I think it is New York State 488 --

JUDGE WARDWELL: Okay.

DR. HISER: -- page XV. I believe that top paragraph is executive summary about two-thirds of the way down the paragraph.

DR. LAHEY: That one's the Chen report you just put up, but that's not it.

JUDGE WARDWELL: You say that's not it?

DR. LAHEY: That particular one that's on the screen now, the lead author is Chen. He's, I did reference that report, but you were asking about a different one, I believe.

JUDGE WARDWELL: I don't know which one you're asking.

DR. LAHEY: I believe it's --

JUDGE WARDWELL: I'm asking for your 482, page 18, lines 16 through 22, when you say, "A recent report prepared by Argonne National Laboratory for U.S. NRC" --

DR. LAHEY: Okay.

JUDGE WARDWELL: What is that report? And you say it's the Chopra report. Correct?

MR. SIPOS: Your Honor, it's John

Sipos for the State of New York. May I try to resolve this?

JUDGE WARDWELL: Sure.

MR. SIPOS: Lower down on line 22, I believe, of New York State 482 on page 18, that's where we are.

JUDGE WARDWELL: Yes.

MR. SIPOS: I believe there's a reference to Chen, et. al. on the very last two lines of that page carrying over.

JUDGE WARDWELL: Well, you address that to your witness to have him verify that that's what he's referring to is 488 then.

DR. LAHEY: Yes. What is the date of the testimony that you're talking about, or what is the New York State reference?

MR. SIPOS: June 2015.

DR. LAHEY: Okay.

CHAIRMAN MCDADE: Mr. Welkie, can you pull up New York 488? This is 487, isn't it?

JUDGE WARDWELL: No, it's 482.

CHAIRMAN MCDADE: Never mind. Thank you. All right.

DR. LAHEY: So this testimony is June 9, 2015, New York State 482. Is that the one, Your Honor?

JUDGE WARDWELL: It's your testimony.

DR. LAHEY: That's, I've done a lot of testimony, but that's the one you're concerned with?

JUDGE WARDWELL: Yes.

DR. LAHEY: All right. Tell me the page number again.

JUDGE WARDWELL: 18.

DR. LAHEY: Okay.

JUDGE WARDWELL: And it's line 16, if you go to line 16, that's where the, it's really on 17, "Moreover, a recent --

DR. LAHEY: Right.

CHAIRMAN MCDADE: -- laboratory report prepared by Argonne Lab."

DR. LAHEY: So that particular quote is for the Chen report.

JUDGE WARDWELL: So it is. If we go to the next page, it is 7184 then. Is that correct?

DR. LAHEY: Yes, sir.

JUDGE WARDWELL: Thank you.

DR. LAHEY: Sorry it took so long.

JUDGE WARDWELL: No problem. We got

it all straightened out. We have so many numbers of those.

CHAIRMAN MCDADE: Those were the only homework assignments that I recall. Is there any witness who right now was asked to look something up that we haven't addressed here this morning so far?

MR. GRIESBACH: Yes, Your Honor. This is Tim Griesbach from Entergy.

CHAIRMAN MCDADE: Yes.

MR. GRIESBACH: I believe Judge Wardwell had asked us to clarify the screening criteria that were used for the cast components, and I'm prepared to do that now.

CHAIRMAN MCDADE: Please.

MR. GRIESBACH: Let me go through the sequence. The original criteria in MRP-191 stated both criteria for thermal embrittlement and irradiation embrittlement. That's in New York State 321, Tables 3-5 and 3-6.

They went through and screened the various components, including the lower support columns. There were several criteria, one based on molybdenum content less than or greater than 0.5 percent, materials, whether they're statically or centrifugally cast.

And then the ferrite content less than or greater than 20 percent. There's separate criteria for irradiation embrittlement based on 1 dpa fluence. So that was the criteria that were used.

And in the NRC review of that, they took issue with the criteria. Although those criteria had been published in a letter, called the Grimes Letter, that's NRC document 213, new information particular to the effects of both thermal and irradiation embrittlement came to light.

And the NRC staff had offered revised proposed criteria taking into account both. In fact, NRC went back and looked at that, those materials that had screened out per the new criteria, and those can be found in NRC Exhibit 201.

The same molybdenum content, the same static statically or centrifugally cast material, but there was the combination of thermal and irradiation embrittlement could be screened out if the ferrite content were below 15 percent, which was part of the confusion that we had yesterday.

In fact, those components in Indian Point 2 and 3 did screen out for that very reason. Although the separate criteria to continue to look at them for irradiation embrittlement would be if they exceeded a dpa level of 1.5 dpa.

So that was the method, methods to use. I believe Dr. Hiser discussed that yesterday. And that is also very clearly stated in the NRC testimony in their question 163 on NRC Exhibit 197.

And that's stated on pages 94 and 95. So I believe that reflects why there may have been two different sets of criteria used and why there was some confusion yesterday.

JUDGE WARDWELL: Thank you.

DR. HISER: Your Honor --

CHAIRMAN MCDADE: Dr. Hiser?

DR. HISER: This is Allen Hiser of NRC. You also asked, posed a question yesterday that if Entergy were to implement the Westinghouse methodology on acceptability of their bolt configuration post-inspection what the NRC approval process, what process that would fit into, whether that would be something would be available for the public to comment on or exactly where that would fall. And I'm prepared to discuss that.

CHAIRMAN MCDADE: Please.

DR. HISER: If that case were to occur, that the applicant were to do it's inspection and find that there were degraded bolts that it could not justify, would they be able to perform the individual bolt function?

And they then move that condition to the corrective action program. If they were to implement this engineering justification that they discussed, then that analysis would be evaluated through 50.59 to determine whether a license amendment would be required by the applicant.

If the conclusion was that a license amendment would not be required, then 50.59 would be documented, and it would be available for staff review.

If a license amendment were to be necessary, then the applicant would follow the normal 50.90 process for license amendment. At this point, we cannot make, we cannot prejudge what that 50.59 process, what the result would be from that by the applicant.

CHAIRMAN MCDADE: Okay. Thank you, Dr. Hiser. I appreciate that. Okay. I think we're ready to get started then with regard to specific questions regarding exhibit --

MR. BESSETTE: Your Honor, this is Paul Bessette. Can we just have a moment to swap witnesses, move one of our witnesses from the back to the right? It might be more convenient for Your Honor.

CHAIRMAN MCDADE: Yes, sure.

JUDGE WARDWELL: And witnesses that are part of, that are only on 25 should leave the table. But before we do that, I would like to just thank all of the witnesses on 25.

I requested certain attributes that I wanted from your answers, and I think it was succeeded very successfully. We got through a lot of stuff in about a day's a little change worth of effort.

And it was due mostly because of your succinct answers that you gave, and I want you let you know I appreciate your responses.

MR. TURK: Your Honor, this is Sherwin

Turk.

CHAIRMAN MCDADE: Mr. Turk?

MR. TURK: Can we pause for a moment or two? Some of our witnesses are not in the room currently. They'll be back in a moment, or at least one of them.

MS. SUTTON: Your Honor, one of our witnesses needs to also take an emergency break. We'll be very brief.

CHAIRMAN MCDADE: We're sort of in a recessing place right now, so do you want to take a short break, Dr. Lahey?

DR. LAHEY: If we're on a recess, I will.

CHAIRMAN MCDADE: Actually, while we get organized, rather than just sitting here, why don't we take five minutes? And we'll come back in five minutes.

MR. TURK: Thank you, Your Honor.

(Whereupon, the above-entitled matter went off the record at 9:14 a.m. and resumed at 9:22 a.m.)

CHAIRMAN MCDADE: Okay. Judge Kennedy?

JUDGE KENNEDY: I guess this brings us

to Contention 26. Similar to Contention 25 where Judge Wardwell led the questioning, I'll take the initial cut at questions for the witnesses and New York State 26.

So it will proceed as we did for 25. I know there's some new folks here that may not have observed what we did, but I'm the lead questioner, if you will, have the lead on the contention.

But my colleagues here will also chime in at various points to ask questions and follow up questions. So I have a series of questions that I'm going to go through and then ask them to chime in as need be.

Contention 26, as the Board views it, raises a general challenge to Metal Fatigue Aging Management Program and in specific raises some challenges to the calculations of the cumulative usage factors and the CUFens that are used.

It appears to focus extensively on the methodology and approach used to calculate these, and so we'll get into a lot of discussion about those calculations.

I know we almost completely avoided any discussion on proprietary information, and right at the finish line we started to get close. I can assure you the Board's attempted to try to deal with the issues on Contention 26 in a level that we hope is high enough that we won't have to close the meeting.

But I do appreciate the efforts of Entergy to keep us on the right path here. As always, we're still technical people, and we get curious. And we raise questions, so I appreciate your efforts and we'll try to deal with it.

But I can see this is a very technical contention with a lot of methodology and a lot of proprietary information. We've attempted to try to address our questions at a level about the specifics, if that makes sense at this point.

Hopefully it'll make sense as we go through it. We've tried to stay at more of a concept level, not use specific values to try to deal with a lot of these issues from a conceptual level.

At the end of the day we may not be able to do that, so there may come times where it has to get down, to really address a specific question, into the details.

And again, we'll look to Entergy and

to Westinghouse to help keep us from revealing anything that shouldn't be revealed to the public.

MS. SUTTON: Your Honor, this is Kathryn Sutton for Entergy. We have advised our experts that if they believe that they need to wade into details that are proprietary, they should first alert you.

But at the same time, we are concerned that we do need to put the contention to bed and make the case. So we will work with you, Your Honor, to make sure that we protect the information. And we'll work with Westinghouse as well.

JUDGE KENNEDY: I appreciate that. And as we get through this and get a little experience with the issues at hand here, maybe a path will be clear on how we'll deal with this.

I mean it's possible we could move all of those issues to the end of the day or to an appropriate time. Having said that, we're going to try to not get down that road.

But I appreciate the difficulty in being able to do this. The Board has spent a lot of time reviewing the pre-filed testimony, and it contains a lot of proprietary information.

With that discussion, this is the issues related to Contention 26. Before I get into the specifics of my questions, it occurred to the Board that it would be useful to have some contextual discussion about CUFs.

We'll have to find out how to pronounce some of this so we can communicate, but have some initial discussion about what a CUF is, how it's calculated.

And again, my intent is to do this at a level to provide contextual information for the follow up questions. So if you feel the need to get way deep into a methodology detail, let us know.

We can maybe park that for a while until we get to more specifics on the details of the calculations. But I wanted to at least have some opening discussion about those parameters.

And then we'll use that in the subsequent questions as background material for our follow up questions.

My intent, at least to start, is to direct these questions to Entergy. It's their application. It's their CUFs for their plant.

And I guess Westinghouse has a role in this, too.

So I'm going start with a series of questions to Westinghouse, to Entergy, and I'll let you folks decide who the appropriate person is.

But I had put together, sort of at a high level, a series of questions that try to address this whole CUFs issue, not to solve it, but to provide some context so when we get into the specific issues that have been raised by New York State we have some backdrop information to help make it clear.

I'm going to try to do the easy one first. Someone can enlighten us at to what a CUF is, maybe with what it's an acronym for to start with.

MR. GRAY: Yes, Mark Gray for Entergy. CUF stands for cumulative usage factor. It's required by the ASME code. The calculation is according to Section 3 of the code, Section NB-3222.4(e)[5].

And that section gives a prescribed method for combining stress cycles that occur on a component in a method that allows you to calculate the usage factor, which is for each pair of stress cycles that form a range.

That's called the alternating stress range. It's the amplitude that you use on the fatigue curve. So you calculate the stress range. You get an amplitude, the alternating stress for some stress cycle pair.

That stress cycle pair then is assigned an allowable number of cycles from the design fatigue curve. From that allowable number of cycles, you also have the actual or design number of cycles for that stress cycle pair.

The ratio of the actual number of cycles in the design divided by the allowable cycles from the curve is the usage factor for that pair. So it's a calculation, to start with.

JUDGE KENNEDY: Yes, and sounds like a complex calculation that tries to provide an indication. Does it, the sense I get is it tries to provide an indication based on actual versus a design life of the component.

It sounds like it's a ratio. Is it a ratio?

MR. GRAY: So it's a ratio of the number of cycles expected for the component divided by the allowable based on the fatigue curve. So it's the fraction of the allowable life of the component from that stress cycle.

The cumulative usage factor is the sum of all those incremental usage factors for all the stress cycles in the design.

JUDGE KENNEDY: So all the stress cycles that a particular component or series of components would be exposed to?

MR. GRAY: Yes.

JUDGE KENNEDY: And so it's a design type calculation. In other words, it's done when the plant is being designed?

MR. GRAY: Yes.

JUDGE KENNEDY: And it's an indication based on some projected amount of actual cycles that would occur during the operation of the plant of how close you are to ultimate failure of the component, the fatigue life of the component, the design life of the component.

MR. GRAY: The design life of the component is represented by that allowable fatigue usage, cumulative fatigue usage factor of 1. So basically, it's 100 percent of the stress cycles allowed by the design curve.

And you calculate the fraction of that

based on the loadings postulated for the component of all the stress cycles that are postulated for the component.

JUDGE KENNEDY: Does that imply that the postulated cycles is less than the design cycles? Is that, would it always be 1? We know it's not, but --

MR. GRAY: No, let's clarify terminology a little bit. Section 3 defines that you need, requires a design specification for the component. That design specification tells you all the loads that have to be considered for the component.

When it comes to the fatigue loads, those loads are associated with a number of cycles. Those loads translate then into stress cycles on the component.

And then those stress cycles are used to calculate the usage factor. So the design cycles, when you say cycles, that's normally used to refer to those number of cycles in the design specification for the loads to be considered.

The allowable cycles are the allowable cycles that you get from the design fatigue curve for a given stress level.

JUDGE KENNEDY: So is the allowable some sort of measure from the design perspective of what that component is capable of withstanding?

MR. GRAY: Yes, the design allowable number of cycles is from the design fatigue curve, which is based on test data plus margins.

JUDGE KENNEDY: And if this is a ratio calculation, is that the denominator of the calculation?

MR. GRAY: The denominator, yes.

JUDGE KENNEDY: So then the numerator is an expected set of, expected level of --

MR. GRAY: Yes, expected number of cycles for that stress cycle.

JUDGE KENNEDY: Okay.

MR. GRAY: And yes, you're right. The stress cycles are a function of the number of transients.

JUDGE KENNEDY: Okay.

MR. COX: Judge Kennedy, this is Alan Cox with Entergy. One point of clarification. We say expected cycles. I guess another way to put that will be assumed cycles or cycles that were specified in the design.

Again, these calculations were done 40 years ago as part of the design, so what was assumed for some of those cycles, today we may not expect to ever get there.

So it's some slight nuance there, but it's something that could come into play because of the operating history of the plant.

JUDGE KENNEDY: So the CUF value has expected values in the numerator, and the denominator is based on the design parameters. And these are all done, the entire calculation is done during the design process.

So these are, as Mr. Cox said, historical values?

MR. GRAY: Well, this is Mark Gray again. The original CUF was calculated during the design process for the component when that component was a Section 3 component.

JUDGE KENNEDY: Are you going to go on to tell me that these have been recalculated during the operation of the plant or due to changes? Would you recalculate this design parameter?

MR. GRAY: Yes. You can recalculate that at any time. The reason I qualified what I said is not all of the Indian Point components that have been evaluated for environmental fatigue, had an original Section 3 design CUF requirement.

JUDGE KENNEDY: So did those need to be calculated to support the license renewal application then?

MR. GRAY: Yes.

JUDGE KENNEDY: Okay. Would there be any reason, during the life of the plant, to recalculate other than say a need that you have identified for the license renewal proceeding, to recalculate the CUF?

MR. GRAY: Yes. In fact, there have been instances of loadings that have been found in operation at plants that weren't considered in the original design.

And in those cases, a new analysis would be performed to demonstrate that the component was still good under the revised loadings.

JUDGE KENNEDY: If the operating history of the plant was different than the allowable cycles, maybe I'm using the wrong word. The actual cycles are allowable. I'm not sure.

Whatever's in the numerator, is that allowable?

There's head shaking going on over here. Let's stay with Mr. Gray for a minute. Am I getting crossed up again with this design versus allowable?

MR. GRAY: Yes. Let me define. When we, for a component that has a CUF calculation, that CUF is based on the design fatigue curve. And the denominator in those usage factor calculations came from the design fatigue curve.

The numerator in those calculations came from the design specification, the number of expected loadings for the component. For example, if there's an operational transient that's discovered, that changes the numerator.

When the plant is counting their cycles against what's been designed, now that numerator now becomes the allowable for the plant to track to because that's what was used in the CUF calculation.

JUDGE KENNEDY: Okay. Yes, that helps if I think in terms of fixed parameters versus non-fixed parameters. From your testimony, I get the sense that the denominator is a fixed parameter and that the numerator could be fluid.

That may be a bad term in this context but could change during the operation of the facility as the operating history of the plant changes. Is that fair?

MR. GRAY: That's a fair interpretation, yes.

JUDGE KENNEDY: Okay.

MR. COX: This is Alan Cox again. I think one clarification to that, or not clarification, but another way to say it is the allowable is the allowable for that analysis to remain valid.

If the analysis said you had a low CUF, you could allow additional cycles and revise the analysis to accommodate those additional cycles. But for that calculation, to calculate that particular CUF to remain valid, you have to stay below those number of cycles.

JUDGE KENNEDY: And I guess would the limit then be on the allowable cycles up to a value of, a ratio of 1.0? I mean if you recalculate it, is that the limit to where you --

MR. COX: Yes. That's correct. You could, that's the limit from the design spec. Those are limits to make, for the calc to remain valid. If you have a low CUF, you can revise the calc to use a higher allowable.

And it would be up to the point of where you exceeded 1.0

JUDGE KENNEDY: So starting at some initial point, you had allowable and the design values. Is that then the design basis for the operation of the plant?

Is that monitored? Again, this is probably not license renewal. Maybe it is license renewal, but prior to the period of extended operation, this was a design calculation that was in place. I guess --

MR. AZEVEDO: This is Nelson Azevedo from Entergy. Yes, Your Honor, just if I may try to clarify, and maybe I won't. But the way I think that they're the actual cycles the plant sees.

Then next, they're the design cycles that the plant was designed and then the allowable cycles that the ASME code provides. So that's the way I look at it, those three different numbers.

So when the plant was originally designed, or if it was modified, these calculations would get redone. It was designed for X amount of cycles to make sure there remained within the allowables from the ASME code.

And now we track the actual cycles versus the design cycles that were originally used to design the component, if that clarifies it.

JUDGE KENNEDY: The allowable, can that, is that specified by the designer, or is it specified by the code?

MR. AZEVEDO: The allowable cycles comes from the ASME code. There's a stress range versus number of allowable cycles. There's an SM curve in the ASME code.

And for that specific stress, for that specific cycle, you go to that curve, it'll tell you what the allowable number of cycles is for that specific condition.

JUDGE KENNEDY: And those constitute the allowables?

MR. AZEVEDO: Those are the allowables from the ASME code.

JUDGE KENNEDY: And that's in the numerator or the denominator?

MR. AZEVEDO: That's in the denominator.

JUDGE KENNEDY: Okay. So the actuals are, whatever you, whatever's specified for the design spec for the operation of a plant would go in the numerator. And then that's tracked. Is that tracked then through time?

MR. AZEVEDO: Yes. What we do is we actually track the actual cycles versus the design cycles that we used in the calculation. The analyzed cycles, design cycles, those are interchangeable terms.

JUDGE KENNEDY: Okay. Thanks. Mr. Hiser, or Dr. Hiser, sorry. We're getting a little, too. We've asked you too many questions. They're getting a little too friendly here.

You seem to be expressing some, that's the face. Are we tracking with how the NRC views this CUF picture?

DR. HISER: This is Allen Hiser with the staff. Yes, I think you're on the right track now. It's very confusing between allowable, design, projected and sorting that out, I think, is a very important first step.

JUDGE KENNEDY: You can. I'm probably

making the same face back at you because that's where I was when we first started reading this testimony.

DR. HISER: And I apologize. It's my thinking of things and not --

(Simultaneous speaking.)

JUDGE KENNEDY: I believe we all do it, and I apologize for bringing to anybody's attention.

CHAIRMAN MCDADE: And we certainly don't want to discourage you from thinking about this.

DR. HISER: Thank you.

JUDGE KENNEDY: Maybe to the witnesses for the State of New York, any concerns over the discussion that Entergy's provided?

DR. LAHEY: This is Richard Lahey. That's my understanding as well of the original CUF.

JUDGE KENNEDY: Dr. Hopenfeld?

DR. HOPENFELD: This is Joram Hopenfeld, Riverkeeper. There's one important point that I would like to, can you hear me well? Can you hear me okay?

JUDGE KENNEDY: Please take both, yes.

Maybe move the mic a little bit.

DR. HOPENFELD: It's not a detail, but it's an important point because it relates to your question as to what you do at the beginning during the design stage.

After you take your maximum stress to identify the minimal stress during that transient. Take the difference. You have to multiply that difference by a stress concentration factor to allow for the fact that LOCA stress may initiate or may propagate differently than if you had just considered only the average.

So the point is, that stress concentration factor is a factor. It depends on geometry. So if a situation in the plant, and it's on the secondary side, due to geometry of the changes or you have radiation effect.

JUDGE KENNEDY: Let me, I don't mean to interrupt you, but we're going to get to that. This, to me, is sort of setting the stage so that we're all on the same page.

I think you've raised some of those concerns in your testimony, and we'll get into the specifics later of the calculations and I think try to deal with some of the points you made.

I didn't mean to cut you off, but we're going to get way beyond where I think we need to be at this point. Appreciate it though. Thank you.

MR. SIPOS: Excuse me, Your Honor, John Sipos for the State of New York. Could I move Dr. Hopenfeld's microphone closer to him?

CHAIRMAN MCDADE: Please.

MR. SIPOS: Thank you. Mr. Welkie can do a better job of it than I can.

DR. HOPENFELD: Thank you.

CHAIRMAN MCDADE: All right. We're going to get you a different microphone, Dr. Hopenfeld. So we're going to continue. We've got some questions over here to Entergy.

So by the time you're called on again, Mr. Welkie will have a more effective microphone for you.

DR. HOPENFELD: Hope it's not a message for me.

JUDGE KENNEDY: Hopefully if you have any questions before we get your microphone in please jot them down so we don't lose them.

Let's go back to Entergy and maybe Mr. Gray, we'll start with you.

Are there conservatisms built into those calculations, and maybe, I guess I don't want a simple yes or no because we're going to get into conservatisms and margins later. But if you could maybe outline if there are and sort of in general terms, the types of conservatisms that could be at play here.

MR. GRAY: Yes, and as you eluded to, in our testimony we do make a distinction between the ASME code margins and ASME code conservatisms and analysis conservatisms.

Those are three categories of some amount of conservatism. And the calculations contain all three of those.

JUDGE KENNEDY: Right, and I appreciate that, and I do remember that from the testimony. And we'll have some specific discussion about that and give New York State an opportunity to weigh in.

But that's what I was looking for is at that level, yes, there are conservatisms built into it as you point out.

Does the WESTEMS code play a role in

the CUF calculation, or is that a different aspect of this, to this puzzle?

MR. GRAY: This is Mark Gray. The WESTEMS code is the tool that Westinghouse used for the ASME Section 3 evaluations, so yes, it does the CUF calculation.

JUDGE KENNEDY: All right. Thank you. Now let's move into, and I don't know how to say these either. There's the CUFens. What's going on there, and I'll start with Mr. Gray. And there are probably others to answer.

So we started with just CUF, and now we've added something to those calculations. Maybe if you could address in sort of general terms what that's all about and why it was done.

MR. GRAY: The CUF calculation was done according to the ASME code, Section 3. The penalty factor to account for the effects of reactor water environment is termed Fen.

That methodology is prescribed by the NUREGs, and there are a number of different ways that that Fen can be applied. But essentially the CUFen is the product of the ASME code CUF and the Fen penalty factor to account for reactor water environment.

And the reason that is done is because the NRC has required that plants doing a license renewal evaluation evaluate certain components for the effects of the reactor water environment on their design fatigue calculations.

JUDGE KENNEDY: And did you just mention that those Fens, I'm not sure what, so the environmental adjustment, that's prescribed by the NRC and was used in these CUFen calculations?

MR. GRAY: Yes. The Fen factors are defined in different NUREG reports.

JUDGE KENNEDY: Okay. Let me go backwards just a little bit because I was using some terms relative to conservatisms. Later on we're going to talk a little bit about safety margin and reductions in safety margin and conservatisms.

In your mind, is there a difference between the term margins and conservatisms? Are they different concepts? They trying to do different things, or should the Board view those as similar?

MR. GRAY: While they may have a similar effect on the results of an analysis, we do view those as having a different role. The margin is something that, as an analyst, I can't touch.

That's defined in the code methodology and allowables, particularly the design fatigue curve. The conservatism is a function of the way the analysis is performed.

And that conservatism can be a function of which section of the code I used to do my analysis. The code allows different types of analysis to be done that have different levels of conservatism in them.

The other aspect of conservatism is the assumptions that the analyst makes in the inputs and the modeling. And that has to be determined by the analyst and, of course, go through a verification process.

JUDGE KENNEDY: So one distinction that I heard you make is that margins are dictated by the code and cannot be adjusted or changed or reduced. Is that what I heard you say?

MR. GRAY: Yes. I'll only qualify that by the ASME code does have sort of a blanket statement that if you can justify something other than what it says, you could do that.

But generally speaking, and what we've done here, that hasn't been performed.

JUDGE KENNEDY: All right. Thank you. Dr. Hopenfeld or Dr. Lahey, do you, we're going to get into safety margins and reductions and stuff. But do you have anything you'd like to add to what Mr. Gray has said here about margins and conservatisms?

DR. LAHEY: Your Honor, this is Richard Lahey, not about the margins. When we talked about Fen, then I have something to say.

JUDGE KENNEDY: Yes, and I think we're going to get into, this is sort of the preliminaries. We're going to get into the details a little later, so just I'm sure we'll get a chance to get into that.

Too many stickies here. At some point in the testimony, and I guess New York State has raised some objections or discussions about the revision to the CUFen calculations that were performed.

What motivated the, well, is that true first of all? Were the CUFen calculations revised during the license renewal process? And if so, why was that done? And I'll guess we'll take it from there. Mr. Gray?

MR. GRAY: Yes. This is Mark Gray for Entergy. There actually, in the whole process there have been revisions to the calculations for different reasons.

But I think the main thing that you're referring to is that in the midst of performing their fatigue management program, the cycles, the actual cycles of different transients attract.

So as you know, this has been going on over a number of years, so some of those original CUFen calculations assumed a given number of cycles for analysis based on projected cycles for the plant.

As the cycle counts are updated, and those projections are revised, then the calculation may be revised to use a higher number in the analysis so that there is more room for the plant to operate within still an acceptable number of analyzing cycles.

JUDGE KENNEDY: So these calculations are revised to bring actual cycle information into the calculation from the operation of the plant. Is that what I heard?

MR. GRAY: Yes, and to allow more because the plant's going to compare what they've tracked against what we've analyzed.

So that's the plant's allowable versus the analysts' allowable, which is the assigned current allowable. I don't want to make, confuse that again.

JUDGE KENNEDY: Does this include being able to operate the plant beyond the 40 year life? I mean is that part of this puzzle piece?

MR. GRAY: Yes. Let me qualify that though by saying something, I think, that was mentioned yesterday. The 40 year life is tied an assumed number cycles in that 40 year life.

So the 60 year life, if it has been justified that that 40 year design number of cycles is really not even going to be reached in a 60 year life, it's the 40 and the 60, it's still defined by the same number of analyzed cycles.

JUDGE KENNEDY: Okay. It seems like, and this is, I don't really have anything here. But it seems like from memory that a lot of these revised CUF calculations were much lower than the original CUF calculations that were in the application.

It would seem to me if you're, and I'm not sure what caused that. Is it, as some would say, a reduction in conservatisms or is it bringing more actual plant data into the calculation?

MR. GRAY: Okay. I think now you've defined a context for me that I can better answer your question.

JUDGE KENNEDY: Okay.

MR. GRAY: When you're referring to the license renewal application, at that time, the penalty factors and the CUF values that Entergy used were simply, probably much more conservative design fatigue usage factors.

Maybe at this point I should mention that it's important to understand that when we do a CUF calculation for design, we're not looking to predict an exact or precise number.

We're looking to make sure that it's within the allowable of one. When the analyst gets the number under 1, he stops. And those would be the types of numbers that Entergy would've been taking from the design and applying a screening Fen factor, just to give an idea of what components had to be analyzed further.

And when those components were analyzed further within the details of how the NUREGs say to apply the Fens and the current industry practices, that analysis would have removed a lot of conservatism from those original design calculations. And that's why that big difference.

JUDGE KENNEDY: Okay. And I think we'll get into some of that discussion later on. I know New York State has some questions that we'll be addressing.

So there's now a set. At some point there were CUFs. Now I guess as part of the license renewal process, we have these CUFens. So the values of CUFen that were developed, were those developed as part of the license renewal process? And are those the numbers that are provided in the application?

MR. COX: This is Alan Cox with Entergy. I think Mr. Gray eluded to the initial calculations and using the initial CUF values from the original design and then applying the, what we consider bounding Fen factors, to give an estimate.

It was a projection that was put in the LRA, and you saw some of the CUFen values that were greater than one in that projection. So that was, like I said, an initial screening attempt.

The things that passed that screening attempt didn't require further consideration. The things that didn't pass that screening attempt were slated for the revision of the calculation, the more refined calculations that Mr. Gray has since worked with Westinghouse to accomplish.

JUDGE KENNEDY: All right. Thank you. Yesterday we had some discussion about, maybe it wasn't yesterday. It may have been Monday, the discussion of time limited aging analyses.

Are these CUF, CUFen values considered time limited aging analyses for the purpose of license renewal?

MR. COX: This is Alan Cox for Entergy. They are treated as time limited aging analyses for the purpose of license renewal. They are discussed in the same section.

A TLAA, by definition, is a current

licensing basis analysis. I believe, as Mr. Gray indicated, the CUF, the environmental factor was not a requirement of the initial design.

So that was not a, there was not a CUFen calculation that was part of the current licensing basis. So these environmental crushing factors are applied as part of the aging management program going forward for license renewal.

JUDGE KENNEDY: Let me make sure I got that clear. So the environmental adjustment is performed on the current licensing basis, cumulative usage factor calculations. Is that what you just said?

MR. COX: That's correct. And in some cases, that current licensing basis usage factor calculation was revised along with applying the Fen.

MR. STROSNIDER: This is Jack Strosnider. Let me see if I, I'd like to see if I can clarify one thing here that with regard to the TLAA, the original fatigue calculation originally calculated CUF without an environmental factor is the TLAA because it was in the licensing basis, the current licensing basis.

The environmental factor was not in the current licensing basis, but the NRC established guidance that it should be considered as part of getting a renewed license.

So it will become part of the current licensing basis when the license would be issued. All right, so I don't know if that distinction helps you.

But TLAA is actually the original calculation because that's what was in the licensing basis. And now there's some additional work being done in support of license renewal to adjust it for the environmental factor.

JUDGE KENNEDY: Just, Mr. Strosnider, just to make sure I've got this clear. I think Mr. Cox eluded to some revised CUF calculations that were performed.

Those would be TLAAs that are part of the current licensing basis once that revision was done?

MR. STROSNIDER: Yes, recalculations without the environmental factor would be one way to manage the TLAA.

JUDGE KENNEDY: All right. Thank you.

That's what I thought I heard from Mr. Cox. I appreciate it though. I don't know if anyone, I'll go walk down the row here if the staff has anything to offer in this sort of preliminary discussion of CUFs and CUFens.

DR. HISER: This is Allen Hiser of the staff. Now we agreed that CUF from the original license, there's your CLB analyses, the RTLAAs, revisions to those.

Clearly, it would just be updates to the TLAA. The CUFen values are not TLAAs because they are not in the CLB.

MR. STROSNIDER: Your Honor, this is Jack Strosnider. If I could, you're asking, I'd like to go back just for a second to the discussion on margins because I think there's something I should have pointed out that could become important later.

That is that the fatigue analyses that were being defined are captured in the regulations in 10 CFR 5055(a). And the NRC has said that you need to meet the fatigue analysis and that the margins associated with ASME code Section 3 analyses provide, essentially that's a conclusion of adequate protection.

So what that translates to from a practical point of view is that you need to meet the cumulative usage factor of one and that provides sufficient margin in accordance with the regulations.

All right. So that could be different than a margin less than one or something of that nature. What the regulations require is maintaining that cum and usage factor of 1 and that that provides adequate margin.

So that could become part of the discussion later.

JUDGE KENNEDY: All right. Thank you. And just to be fair, do the New York State witnesses have anything to offer in this preliminary discussion?

DR. HOPENFELD: Joram Hopenfeld. I can just make a comment, just an overall comment. I don't want to get into details. It's important to understand that the damage, the CUF really represents damage to the material, fatigue damage.

And that basically is a random phenomenon, but what we are doing here, we are using a deterministic method to calculate it.

And that's where the issue of conservatism would come in.

JUDGE KENNEDY: All right. Thanks, and we'll get into more of that as we move on. I'll walk down the table of judges here. Is there anything to ask in terms of the CUFs?

So we'll relieve you of this preliminary discussion and move into some specific questions. I have the questions organized or grouped by topical area.

The first area I'd like to look at is, as I mentioned in my opening remarks, the state, I believe, has raised an overarching concern issue with the adequacy of the Metal Fatigue Aging Management Program.

I guess, for the record, I'd like to ask Entergy to tell the Board what aging management program is used for metal fatigue or to manage?

MR. COX: It's the Fatigue Monitoring Program.

JUDGE KENNEDY: Back to Entergy. In your statement of position, you indicate that the metal fatigue amp is consistent with GALL Rev 1 and the guidance in NUREG/CR-6250 and NUREG/CR-

5999.

What's specific GALL AMP is consistent with the fatigue monitoring program?

MR. COX: Your Honor, this is Alan Cox for Entergy. That would be the GALL AMP that's in Chapter 10. It's amp with a designation of M1.

JUDGE KENNEDY: M1. What is the relevance and --

(Simultaneous speaking.)

JUDGE WARDWELL: Excuse me. What's the name on that one? Is there a name to that amp?

MR. COX: I can get back to you on it. I think it may be Fatigue Monitoring Program. I'll have to check and get the exact --

JUDGE WARDWELL: Well, I can probably look it up also myself. I just thought you might know off the top of your head. Sorry.

MR. NG: This is Ching Ng from the staff. The name of, the title of the amp is not, M1 is metal fatigue of the pressure boundary.

JUDGE WARDWELL: Thank you.

JUDGE KENNEDY: Mr. Cox or whoever's appropriate, the significance of the NUREG citations, NUREG/CR-6250 and NUREG/CR-5999. Is that 6260? I wrote 6250. Do I have it incorrect?

MR. COX: I believe that 6260 is the NUREG. And I believe, Mr. Gray can correct me if I'm wrong, this is Alan Cox again. I believe that NUREG 6260 is the NUREG that defines a set of representative components that should be assessed for environmental effects.

JUDGE KENNEDY: Any thoughts on CR-5999?

MR. GRAY: This is Mark Gray for Entergy. CR-5999 was the initial NUREG to the industry that identified a potential issue with the effects of the reactor water environment.

And so NUREG/CR-6260 actually did their evaluation to the curves of the CR-5999.

JUDGE KENNEDY: Dr. Lahey, and I guess in fairness Dr. Hopenfeld, other than the issues that New York State has raised with the CUFen calculations and the synergistic effects, do you have any specific concerns in your testimony that you've identified with the Aging Management Program for metal fatigue?

DR. LAHEY: Yes, Your Honor. And

later on I hope we can get into it. It has to do with the predictions by WESTEMS and the uncertainty or what they would call the conservatisms that are in there, how to quantify that.

JUDGE KENNEDY: Would that be the CUFen, the CUF calculations then? Yes. Okay.

DR. LAHEY: In the CUFen calculation.

JUDGE KENNEDY: And we will get to that. Dr. Hopenfeld?

DR. HOPENFELD: It's the same.

JUDGE KENNEDY: Okay. So we'll get to that. I just wanted to make sure there was nothing specific about the Aging Management Program that you had issues with outside of those calculations.

The CUF calculations, are they relevant to anything other than metal fatigue or the CUFen calculations? Is that strictly a, I guess I'll start with Entergy. Is that strictly a metal fatigue issue?

MR. AZEVEDO: Nelson Azevedo for Entergy. Yes, that's correct, Your Honor.

JUDGE KENNEDY: And so how does the fatigue monitoring program manage the metal fatigue aging effect?

MR. AZEVEDO: We have a site-specific procedure for each unit, and we have a table. And that table has the allowable number of cycles that were analyzed by Westinghouse to ensure that the CUF stays below 1.

So that is our allowable number of cycles for each transient. And then periodically, we go back. We actually review the operating blocks from the plant and count all the cycles.

JUDGE KENNEDY: So this is a monitoring and data analysis to deal with the numerator of the CUF calculation. Is that where this goes?

MR. AZEVEDO: That's correct.

JUDGE WARDWELL: And by each unit, you mean each plant and not some groupings of system, structure or components. Is that correct?

MR. AZEVEDO: Yes. We have one for Unit 2 and one for Unit 3 because they have different cycles.

JUDGE KENNEDY: And are those cycles monitored then for each? Are there different cycles that are monitored for each particular component that's identified as subject to metal fatigue?

MR. AZEVEDO: Whatever the number of types of cycles that were analyzed for each component, we monitored those, all those.

JUDGE KENNEDY: Okay. Thank you. I'm at the limit of my questions on the adequacy of the amp. Again, I think the real issues, as we pointed out earlier, lie in the CUFen calculations and the CUF calculations and the relative margins.

With that, I'm going to move away from the amp discussion unless anyone on the Board has, I'd like to start a little bit of discussion on synergistic effects.

I recognize that we spent quite a bit of time yesterday on synergism, but I thought it would be appropriate to at least touch this issue again with Dr. Hopenfeld sitting here today as a witness for 26.

I guess I would ask if there's anything that you could point to. Again, this is either Dr. Lahey or Dr. Hopenfeld, if there's anything in your testimony that would enlighten us beyond, that we didn't touch on yesterday in

25.

Any specific point in your testimony that you'd like us to be aware of that wasn't covered yesterday?

DR. HOPENFELD: Yes.

JUDGE KENNEDY: And what would that be, Dr. Hopenfeld?

DR. HOPENFELD: That would be related to the proposition that neutron irradiation is not going to affect metal fatigue RVI components because they do not contain flaws.

According to my analysis, that is not true. A number of them does contain flaws. So a crack will propagate from those flaws.

JUDGE KENNEDY: Can you point us to an exhibit or a place in your testimony for support for that assertion?

DR. HOPENFELD: Yes.

JUDGE KENNEDY: And if you need some time, we can move on, and we could come back to it. I'll give you a brief amount of time --

DR. HOPENFELD: Very brief. If you look at my June 15th report on page 18.

CHAIRMAN MCDADE: Okay. Dr. Hopenfeld, if you could, you tend a little bit to bob and weave when you're testifying --

DR. HOPENFELD: I'm sorry.

CHAIRMAN MCDADE: -- so you're coming closer and further away from the microphone.

DR. HOPENFELD: As you can see, I'm not a public speaker.

CHAIRMAN MCDADE: So maybe pull the microphone a little to you so that you won't get so far away from it.

DR. HOPENFELD: Yes. Page 18 on my June 15th report.

MS. BRANCATO: That's Riverkeeper Exhibit 144.

JUDGE KENNEDY: 144, and I guess that reminds me. I've been referring to these as New York State witnesses. I appreciate the fact that Dr. Hopenfeld is here representing Riverkeeper. My mistake. Thank you.

Page 18 of Riverkeeper 144. Is that what you said, Dr. Hopenfeld?

DR. HOPENFELD: Yes. Do you see I referring to numbers like CUFen of a factor of 3, larger than the numbers that they have presented. When you have factor of 3 on top of a number of, this is not proprietary information.

JUDGE KENNEDY: I guess, Dr. Hopenfeld, what support do you have for this factor of 3? I wasn't able in your report to --

DR. HOPENFELD: Thank you. Thank you very much. Can we go to Entergy 00683?

JUDGE KENNEDY: Are you asking us to call up that --

DR. HOPENFELD: Riverkeeper, it's NUREG 6909.

MS. BRANCATO: And that's actually --

DR. HOPENFELD: 857. Okay, NUREG 6909.

JUDGE KENNEDY: Dr. Hopenfeld?

CHAIRMAN MCDADE: Can you repeat the exhibit number, Doctor? What was the exhibit number for that, for NUREG 6909?

DR. HOPENFELD: It's New York 357.

CHAIRMAN MCDADE: 3-5-7?

DR. HOPENFELD: Yes.

CHAIRMAN MCDADE: Okay. You said New York. I believe, is that Entergy 357?

MS. BRANCATO: No. He misspoke when he referred to an Entergy exhibit. He's referring to NUREG 6909, which is New York State 357.

CHAIRMAN MCDADE: Okay. Thank you.

DR. HOPENFELD: Can we go, can I continue?

JUDGE KENNEDY: And this reference that you've had us put up, this is to support your assertion that there could be a factor of 3?

DR. HOPENFELD: That's correct, and when you have a factor of 3, we use that on top of their numbers. And again, I don't want to say the number. And you put the number on their numbers.

Then you come with the CUF or Fen larger than 1, which indicates that there is an engineering crack. There is a flaw. Furthermore, even if the CUFen piece below 1, you can also have a flaw.

JUDGE KENNEDY: I'm sort of a slow reader here, but is there some specific section, page that you're --

DR. HOPENFELD: Yes, page, I'm going to go on. It's page 26 on that NUREG. And page 37, 28 and page 47.

JUDGE KENNEDY: You're going overload us --

DR. HOPENFELD: Okay.

JUDGE KENNEDY: -- here, Dr. Hopenfeld. Do you want to start with one particular page?

DR. HOPENFELD: Let's start with page 26. Would you like me to make comment?

JUDGE KENNEDY: Point us to what you're --

DR. HOPENFELD: Oh, yes. Would you like me to comment on it?

JUDGE KENNEDY: In a perfect world I'm hoping that you can point us to the support for your assertion of the factor of 3.

DR. HOPENFELD: Yes, page 26.

JUDGE KENNEDY: Okay. Do we need to come down a little bit? This appears to be 26.

DR. HOPENFELD: My page 26 is different than this. Oh, here we go. Here we go. It's just on top of 4.2.4, just a trigger, just on top.

JUDGE KENNEDY: Are you, you want us to be looking at Figure 15?

DR. HOPENFELD: Yes, the other figure. This is for carbon scale. The other figure is of --

(Simultaneous speaking.)

MR. HARRIS: I can't hear you, Doctor.

DR. HOPENFELD: This is for carbon scale. The other figure is for stainless steel or similar.

CHAIRMAN MCDADE: So I see a factor of 3 on there.

DR. HOPENFELD: Yes.

CHAIRMAN MCDADE: Is that the point you're trying to make here?

DR. HOPENFELD: Yes.

CHAIRMAN MCDADE: And you're looking at Figure 15, the left hand side, the middle of it?

DR. HOPENFELD: That's correct.

JUDGE WARDWELL: And a factor of 3 basically covers the bounding limits, the upper limits of all the scatter of the data rather than the mean. Is that a fair assessment?

DR. HOPENFELD: That's correct. It covers the scatter, the data. They took a series of experiments, and obviously you have scatter. So then they tried to correlate the light, which is defined by a crack which is 3 millimeters deep.

They tried to correlate it with an

equation so they can deterministically calculate it. And if you see here, to be conservative, really you have to, you must calculate the numbers by a factor of 3.

So when they say that the CUFen is, and this is an inherent number in the calculation. There is not new modeling or anything up to this point.

The modeling would be the next step. The assumptions and uncertainties in the models have nothing to do with this. This is inherent in the equation that they are using to calculate the CUFen.

JUDGE KENNEDY: I guess, Dr. Hopenfeld, I'm not sure I'm tracking how this translates from this data to the need to apply a factor of 3 on the cumulative usage factor.

DR. HOPENFELD: Okay. I think the question is why do I apply a factor of 3.

JUDGE KENNEDY: Yes.

DR. HOPENFELD: If you take the Fen factor, which is a correction factor for the environment, and multiply it by the CLB CUF --

CHAIRMAN MCDADE: Okay. Excuse me, Dr. Hopenfeld. Let me interrupt for a second.

There's a popular book out now referred to as Lean In. Could you do that in a different context?

You need to lean in to get closer to the microphone. It's important for us to understand what you're saying.

DR. HOPENFELD: Absolutely.

CHAIRMAN MCDADE: But in order to understand it, we've got to hear it.

DR. HOPENFELD: Okay. The Fen, which is a ratio of light and air to life in water, so when you calculate the Fen, the Fen is based on the ability to predict life in water. And that represents, is represented by this data.

JUDGE KENNEDY: I guess, here's where I'm struggling.

DR. HOPENFELD: Okay.

JUDGE KENNEDY: Entergy, admittedly, was our overview discussion about CUFs and CUFens, but what I heard him say is when they apply the environmental adjustment factor, they use a set of parameters or a methodology that has been provided by the NRC and approved.

Is this suggesting that the NRC methodology is incorrect? I don't know how to reconcile this with what Entergy has just testified to how they adjust the CUF for environmental factors.

I mean they clearly, well, I don't think they apply a factor of three, yet they have adjusted the CUF values for the plant for environmental conditions.

We've got a lot of experts here. I see it. I see a factor of 3 that covers the spread in the data, but yet I recognize that the Agency has provided a set of adjustment equations that Entergy has said they faithfully have applied.

We have four NRC staff witnesses. Any thoughts on --

MR. STEVENS: Your Honor, Gary Stevens of the staff. We're looking at this figure a little bit out of context, so let me try and put it in context for you.

This is an interim figure that evaluating data scatter and material durability, and it's not in any way indicating that the Fen is off by a factor of 3.

And if you refer to page 25 at the bottom, the text, and the discussion about Figure

15, it in fact tells you that, the argument is being made is that this modified rate approach works very well and that most of the scatter is due to heat variation, which we call material variability.

The important discussion, therefore, is really in Chapter 7 of this document, which begins on page 71, Chapter 7, which discusses all the margins that need to be accounted for in doing these kinds of evaluation.

And specifically, material variability and data scatter is discussed in Section 7 that begins on page 90, or sorry, 73. And what you see from all of this discussion in this chapter is there are factors that are applied to the design fatigue curves to account for these kinds of variations that are picked up by the Fen.

One of those factors is data scatter and material variability, and that's really where this factor of 3 comes in.

DR. HISER: And I think, Your Honor, if you go to the figure or Table 12 --

MR. STEVENS: What page is it?

DR. HISER: It's on page 76 of New York State 357.

MR. STEVENS: So what you see in this table, and thank you Dr. Hiser for point that out, the very top line is material variability and data scatter.

And what you see is in the original Section 3, ASME Fatigue Curves, they considered a factor of 2 originally. And in this study, we've increased that.

These are log normal distributions that were considered, but the range is 2.1 to 2.8. And that's effectively that factor of 3 you saw in that other figure.

Those are built into the design fatigue curve for calculating the CUF itself. So, in fact, the factor 3 is accounted for in the CUF calculation.

JUDGE KENNEDY: So Mr. Stevens, it would be your expectation in the calculations that Entergy performed, they would have already considered this factor of 3 in the scatter of the data?

MR. STEVENS: Correct.

JUDGE WARDWELL: But this Table 12 says present report is 2.1 to 2.8. How do we get from that number to showing where the actual number that was used for the fatigue curves that demonstrate where in that range it was using?

Or does it have that range plotted that you use to then estimate somewhere in between it? How does that work?

MR. STEVENS: This is Gary Stevens with the staff. The factors that are shown in Table 12 are log normal distributions of how these factors play into, and there's a Monte Carlo statistical analysis that's done to develop a fatigue curve that it bounds 95 percent of the data with 95 percent confidence.

The results of that Monte Carlo statistical evaluation results in reduction factors applied to the curve, which if you scroll down to Table 13 on page 77, you'll see the end result is that there's a reduction in life of approximately 12 to 13 applied to the curves for the different materials.

So what you may have read in the, I'm sure you did read in the testimony, are factors of 2 and 20 or 2 and 12. This is where they came from. The life, the fatigue, the design curve is reduced by a factor of 2 on stress or 12 on life, whichever is more conservative.

And this is where they come from. So based on the statistical evaluation of those log normal distributions in Table 12, to get a 95 percent lower bound and 95 percent confidence curve, you would come up with these factors on life.

JUDGE WARDWELL: And again, just to make sure I'm clear, this is all in relationship to the Fen calculation.

MR. STEVENS: No. This is in relation to actually the design fatigue curve that would be used for the CUF calculation.

JUDGE WARDWELL: So I guess I'd go to Dr. Hopenfeld then. I think you said that this, that first graph that had the factor of 3 arrow applied to the water condition.

And doesn't that seem to conflict with where we've sugared this all down to in Table 13, where if it's only involved with the CU calculation, the CUF calculation?

DR. HOPENFELD: Yes. Can I answer now? We confusing two things here, I believe.

JUDGE WARDWELL: If you can't hear yourself over the speaker, we can't hear you for sure.

DR. HOPENFELD: I think we're confusing two things. Table 3 relates to the ASME code, to the uncertainty in the ASME.

JUDGE WARDWELL: You say Table 3 or 13?

DR. HOPENFELD: Table 13. Excuse me. Table 13 relates to the ASME code, to the margins that we talked. That's what he is talking about here.

What I was talking about, the factor of 3, has nothing to do, the ASME code never heard of Fen. They never heard of that. This was done 30 or 40 years --

JUDGE WARDWELL: But can you show that that previous figure you referenced, and what was the figure again? Let's go back to that quickly.

DR. HOPENFELD: That was --

MR. SIPOS: I believe it was Figure 15, Your Honor.

DR. HOPENFELD: 15.

JUDGE WARDWELL: Sorry.

MR. SIPOS: Figure 15.

JUDGE WARDWELL: Okay. There we go. There it is. It's in front of you now.

DR. HOPENFELD: Okay. This you can --

JUDGE WARDWELL: Where does that show that that deals with the water effects, the Fen part of this equation?

DR. HOPENFELD: Because this data was obtained in water. There is also --

JUDGE WARDWELL: Where is that stated?

DR. HOPENFELD: Yes. If you take a look at the equation that you have, you see, I don't know which page it is. The equation that comes from this figure, the mean equation, the average equation for Fen --

JUDGE WARDWELL: Well, maybe I can simplify it. Mr. Stevens for staff, do you agree that this Figure 15 relates to in water types of analyses?

MR. STEVENS: Yes.

JUDGE WARDWELL: Okay. Thank you. Dr. Hopenfeld, is that, do you have anything further to add? I mean it seems --

DR. HOPENFELD: Well, I just want to make sure that we understand that the uncertainties in the code have nothing to do with this factor of 3. It's just two different animals.

This factor of 3 is simply they took

a large number of tests, and they had to put it in a matter that one could calculate the conversion factor.

So they correlate it. You see, and they correlate it. You see that correlation is good within a factor of 3. And it's the same thing for, this is for carbon steel, but they are the same thing for stainless steel that use the other pages I gave you.

And there's more data than these, so there's a lot of data that all show that they fall within a factor of 3, the ability of Argonne to correlate their data so the user can put it somewhere in a deterministic way.

That's what I prefaced my presentation before. So you can calculate it analytically. But if you looked at this, it is because you are using a deterministic method to calculate the CUFen.

You have to use, you have to be conservative. You can look at a minus 3. You cannot look at the lower. You have to take the ends of your distribution.

You have to be conservative. That's why you have to multiply this by a factor of 3.

JUDGE KENNEDY: Said another way, Dr. Hopenfeld, are you challenging the final conclusions of this overall report, which seem to lead to a way to deal with the scatter in the data?

I mean it seems like these data scatter issues are addressed as Mr. Stevens has pointed out. And going back to the original figure doesn't seem to convince me that it's not included.

So I think we're at an impasse here. I appreciate you bringing to our attention, and I appreciate members of the staff taking us through the report.

This seems to me to be an indication that what you have identified is included in the ultimate calculation. I'm not suggesting you agree with that, but I haven't seen anything here that would lead me to believe it's not being accounted for.

And we're going to come back. I'm sure this is going to come up again. I know you've got issues all through here on the conservatisms and the margins embedded in the calculations.

But at least for now, I'd like to move off of this figure and off of this topic.

MR. SIPOS: Excuse me, Judge Kennedy, John Sipos over here for the State of New York. I understand Your Honor's desire to move forward. I'd just note for the record the Dr. Hopenfeld, I believe, also referred to page, to charts on page 37 and possibly 47.

And page 37 is PDF frame 57 of this document should we wish to ever return to it.

JUDGE KENNEDY: Is there something, let's at least put one of those pages up and see if it enlightens us differently, 37.

MR. SIPOS: So page 37 is PDF frame 57.

JUDGE KENNEDY: Is this not just the same data for different conditions and has a displayed scatter? It may lack the factor of 3, but it seems more of the same to me.

CHAIRMAN MCDADE: That's a question to you, Dr. Hopenfeld.

JUDGE KENNEDY: Oh, I'm sorry. Does this lead us to a different conclusion that we would have with Figure 15?

DR. HOPENFELD: Can I answer that?

JUDGE KENNEDY: Oh, I'm sorry, Doctor. Yes, I guess I'm not being clear.

DR. HOPENFELD: No. It's the same, just gives you more data. But the point is, it's more useful. And I should have probably started with this page because you can see when you derive the Fen, you see that Equation 21.

That equation that you see here is the best fit line, you see. So that is the best fit. It doesn't have a factor of 3 in here. It's for you to, when you calculate the CUFen, you should use the factor of 3.

JUDGE KENNEDY: I guess instead of me testifying, Mr. Stevens, would you care to address this yet again? It seems to me to be the same issue.

MR. STEVENS: You're correct. It's the same issue, just with more data. The previous graph on page 26 I think it was, was limited because it was doing an estimate using a modified rate approach.

So it was just done on a subset of the data, and here you're seeing all the data. So it's essentially the same thing.

The other thing that we should correct

in Equation 21 is not the best fit curve regarding the fatigue. Equation 21 has to do with the Fen factor, so I just wanted to correct that.

JUDGE KENNEDY: All right. Thank you. Just I guess as a curiosity, and we keep using the words margin and conservatism. Maybe I keep using them.

These factors to try to deal with data scatter, would you view those as, and I guess I'll direct it to Mr. Stevens first. Is that a margin, a conservatism, or are we talking about the same thing?

MR. STEVENS: It's a difficult question. Let me see if I can clarify. And I'm going to, if you'll allow me to back up just a little bit on the discussion on margins and conservatisms, I'm going to give you my spin on this.

So what I would call this is a part of a design factor that's built into the design curve. A design factor is, in fact, contributes to a margin.

The way I look at margins is it's a difference between where you are and where you're allowed to go. And I break it into two pieces. Some might think of margin as the difference between where you are and what might constitute a failure or a crack to initiate.

And another one is a margin between where you are and where you're allowed to go. In this case, we have an allowed CUFen of 1.0. There are two different margins. And one we can play with, and one we can't.

In the first case, the code itself applies to the design factors to come in and the methodology and the limit of 1.0 for CUF values. And we're not allowed to play with the margins that go into that value.

So these design factors we're talking about that go into the design curve, they contribute to that margin. And that's something that we must meet. We can't change that.

And there's not even an argument to be made where we can change those values and justify them. It's a requirement of the code to maintain those. That's one margin.

Another margin is if I calculate a CUF, say of 0.5, I have margin between that and the allowed value of 1. And that's something that I can deal with and address.

That allows me to, for example, apply more loading to the component and still maintain its original design because I'm allowed, the criteria that I'm allowed to go to is a CUF allowed of 1.0.

So I look at margin as those two parts. One is I can't touch, and the other I can. And these design factors that we showed here that went into the building of the design curve that's in the ASME code, we're not allowed to touch those.

Then we can talk about conservatisms because as an analyst, if I'm doing a calculation, the objective I have is to show acceptability, not margin.

So once I achieve a CUF of less than or equal to 1, my job is complete. I can stop work. Any additional margins to drive that calculated value lower, I'm not required to do.

JUDGE KENNEDY: But in the analysis to try to get to that acceptable value, did I understand you to say that there's a piece of margin there that you can't touch, and that's the stuff that's embedded in the code?

MR. STEVENS: The stuff that's embedded into the code with respect to the limit on the usage factor of 1.0 and the design fatigue curves and the margins they contain and the stress allowables and the design factors that might be applied to those, I'm not allowed to touch those.

Now another we can talk about is conservatism, and what I kind of view conservatism as are simplifications I might do as an analyst to get the job done quicker.

For example, if I have to evaluate 100 different loads, I may choose to pick the worst one and just assume all the other 99 are of that severity to make my job to complete it quicker.

And that's a conservatism that I as an analyst choose to put into the analysis, and I'm allowed to do so much as, so long as I continue to meet those required margins.

In this case, my CUF I calculate must be equal to or less than 1.0. If I don't achieve that, then obviously that simplification was a little too gross, and I might have to refine that simplification to still meet those margins that I cannot change.

So I look at, we have margins. Again, I'll repeat. We have a margin that I'm not allowed to touch. And these design factors we're talking about that are built into fatigue curves fall into that category.

Stress limits in the code and other design factors fall into that category. There's a margin I might obtain in my analysis with respect to what I calculate versus what I'm allowed.

And there's conservatisms that I might apply, which I look at as simplifications that I might use in my calculation process to get me to the end. And those are what I would call conservatisms.

Another form of conservatism, if there is some embedded in the methodology, specified by ASME code and by how they calculate, how they combine stresses and what limits they use.

And again, those are, I put that into the margin category as opposed to a conservatism. It is a conservative thing to do, but it's a margin that I'm not allowed to touch. I hope that clarifies.

JUDGE KENNEDY: Thank you, Mr.

Stevens.

CHAIRMAN MCDADE: If you could, regrettably, I need to ask you to clarify it a little bit more. We're talking about certain things that you can play with.

And to me, that's sort of engineering speak for what you can legitimately adjust. Can you give me a sort of summary of those kinds of factors that you can legitimately adjust and those that you can't, just sort of a quick summary of that? Give some examples.

MR. STEVENS: Some examples, I gave one, which would be in the number of different loads I might evaluate. I can adjust. I still must look at all the different loads, but how exactly I consider those loads is within the purview of what I can alter.

Things I can't change, I can't change the stress limit I'm designing to. I cannot change the usage factor limit that I have to design to. I cannot change the fatigue curve I use to calculate that usage factor in any way.

Other things I might change, heat transfer coefficient, things of that nature that go into the analysis. I can use different assumptions, apply different conservatisms in that.

So there's many aspects of the code methodology that are not explicitly defined that are left up to analyst judgment. And those things that are explicitly defined in words in the code are the things that I can't change.

CHAIRMAN MCDADE: Okay. Thank you, Mr. Stevens.

JUDGE KENNEDY: Not to keep this whole, Mr. Gray, earlier in the opening remarks you talked about different types of conservatisms and what was allowed to be changed by the analyst and where there was flexibility.

Could you maybe put the Entergy approach in the same context that Mr. Stevens just did, if it's possible?

MR. GRAY: Yes. This is Mark Gray for Entergy. I think what Mr. Stevens just said is just a different semantical way of saying what I said earlier.

The margins that are in the code methodology and design curve, we did not touch. We used the code design curve. We also used the Fen expressions that were defined by the NUREGs.

The conservatisms that were, for example, in that original, the original Section 3 design analyses were conservatism that we did touch. And so we performed a more detailed analysis of a component.

Find an element analysis versus an interaction analysis, for example, and used more specific loadings, using less enveloping or grouping, as Mr. Stevens referred to, to remove any gross conservatisms in the methodology, particularly with the loadings.

JUDGE KENNEDY: So later on when we, and I think we're going to get to a discussion with Dr. Lahey and Dr. Hopenfeld about margins and margin reductions.

I'm going to use that framework hopefully when we pose questions coming up. So Dr. Lahey, you have your hand up. I'll --

DR. LAHEY: Thank you. Can you hear me all right?

JUDGE KENNEDY: I can. Just recognize we're going to give you an opportunity to get into safety margins and conservatism.

DR. LAHEY: Yes. And I'm only going to talk about Fen right now because that's what you've been talking about, how to handle any uncertainty by that factor.

JUDGE KENNEDY: To be honest, this started as a discussion on synergism, and Figure 15 was used as an example of a synergistic issue that needed to be dealt with in the CUF calculation.

That's what I thought I had asked, and maybe I've taken us down a long road. But that's what I, my intent was to deal with synergism and to offer up an opportunity to put anything in the current testimony in front of us on Contention 26 that we didn't address yesterday.

And I know Dr. Hopenfeld didn't participate yesterday even though he was here. He wasn't a witness on 25. So I wanted to give him that opportunity to bring that up. And that's what he offered.

DR. LAHEY: So you don't want to talk about any other uncertainty in Fen that's not reflected here?

JUDGE KENNEDY: I believe we're going to get to that.

DR. LAHEY: Okay.

JUDGE KENNEDY: Okay. And I'm going

to give you an opportunity. We'll have an opportunity to go through that. I guess what I was trying to do is close out some issues on synergism.

And I've got a couple more questions here and then possibly we can take a break.

CHAIRMAN MCDADE: Before you do, Judge Kennedy, just to Dr. Hopenfeld, you had referred not only to page 37 but also to page 47. And on page 47, there's a Figure 36.

And that figure is basically the same sort of data that was on page 37, except here is relates to austenitic stainless steel and air as opposed to carbon steels and low alloy steels in the LWR environment. Is that correct?

DR. HOPENFELD: Probably, yes.

CHAIRMAN MCDADE: Okay.

JUDGE KENNEDY: Thinking back again to the synergistic effects, and again here we're dealing with the effect of potential irradiation on metal fatigue.

Dr. Lahey, you provided a number of references to support your synergism argument in your pre-file testimony.

If I put aside for the time being, the

expanded materials degradation assessment report or reference, what, I had a difficult time going through.

I went through all your references. I had a difficult time finding any examples that would support your synergistic argument.

So I'm going to give you the opportunity to point me to something in your references, your exhibits and pre-file testimony that would support your synergistic argument on the potential that I missed them when I reviewed your documents.

DR. LAHEY: All right, and thank you, Your Honor. There was a report, the technical paper by Korth, et. al. And I can get you a copy of that if you don't have it.

JUDGE KENNEDY: If you could just give me the exhibit number, that would be, and in a perfect world if you could point me, unless it's a short document. I'm pretty sure I've looked through these, but --

DR. LAHEY: Well, we talked about it. I would think you have. But anyway, in there is a discussion of experiments. Now this was done for fast breeder reactor conditions --

JUDGE KENNEDY: Right.

DR. LAHEY: -- higher temperature. But in there they stated that when they ran low cycle, I mean low amplitude, high frequency fatigue experiments, because of the hardening due to radiation-induced embrittlement, things were better in terms of the fatigue.

The failure cycles were increased. When they ran large amplitude, low frequency fatigue experiments, it was the opposite. In fact, in decreased by a factor of 2.

So there was a significant decrease. When we talked about the experiments that Mr. Lott was a coauthor of, that particular paper, they also made similar statement.

Although they, their particular experiments for light water reactor conditions, which are our concern, were only done for low amplitude, higher frequency fatigue.

But nevertheless, they cited the same issue. So there's no perfect data set that I know of exactly for our conditions, which would allow us to quantify the degradation due to embrittlement for fatigue for light water reactor conditions.

But there's indication that there is an effect, and this is being worked on for sure by the light water reactor sustainability folks in Chicago. So this is the basis of that assertion that I made.

MR. SIPOS: And Judge Kennedy, just for record identification, you were asking for exhibit numbers.

JUDGE KENNEDY: Please.

MR. SIPOS: Korth, K-O-R-T-H, Riverkeeper Exhibit 152, Arai, New York Exhibit 564 and Kanasaki, NRC Exhibit 177.

JUDGE KENNEDY: All right. Thank you, Mr. Sipos. This question, I don't remember if it came up yesterday, but this discussion about --

CHAIRMAN MCDADE: Excuse me. Just one second if I could, and the Kanasaki exhibit, that's the one that you were a coauthor on. Correct, Dr. Lott?

DR. LOTT: That's correct.

CHAIRMAN MCDADE: And that's the one you were referring to?

DR. LAHEY: Yes, Your Honor.

DR. LOTT: It's actually Kanasaki, Hiroshi Kanasaki.

CHAIRMAN MCDADE: Okay. Thank you.

JUDGE WARDWELL: And what's the exhibit number again?

MR. SIPOS: NRC 177.

JUDGE WARDWELL: Thank you.

JUDGE KENNEDY: I direct this question to Entergy. This fast breeder reactor data with the large amplitude, low frequency, is that data at all relevant for metal fatigue in light water reactors?

Is the type of fatigue that's being dealt with in Indian Point 2 or 3 subject to large, I guess, large amplitude, low frequency fatigue.

DR. LOTT: No, I do not believe that data is directly related to any PWR reactor internals application. And we actually have done some looking at the strain ranges that are in the irradiated internals.

It's a small, very small number of irradiated internals in the cumulative usage factor calculations. And those tend to be on the low side of the strain range within the limits that were in the Kanasaki paper.

JUDGE KENNEDY: Dr. Lahey, any

rebuttal to the assertion that large amplitude, low frequency isn't a concern for metal fatigue in Indian Point 2 or 3?

DR. LAHEY: No, I disagree with his conclusion. I think that remains to be seen. We do need a database sufficient to quantify, but there's no doubt in my mind there will be an effect, a detrimental effect.

JUDGE KENNEDY: All right. Make sure I understood what you just said. Are you disagreeing that large amplitude, low frequency cycles are not, now we've got too many nots here.

Dr. Lott seemed to testify that, appeared to testify that large amplitude, low frequency cycling is not of a concern at Indian Point 2 or 3. Is that what you're disagreeing with, or are you disagreeing with something else?

DR. LAHEY: Yes, Your Honor. I would disagree with that. The high frequency fatigue is associated with things like flow induced vibration, which have small amplitude but a lot of cycles.

And I can clearly understand how the hardening associated with irradiation can improve the fatigue life. But when you go to the type of cycles that we look at here, which are associated with thermal transients, with operation of the pressurizer, scram, so in many different cycles that they go through in a plant.

I think it's clearly a lower frequency, larger amplitude type of application.

JUDGE KENNEDY: Are you saying that you would characterize those types of transients to be large amplitude, low frequency?

DR. LAHEY: Some of them definitely will be.

JUDGE KENNEDY: Entergy?

MR. GRIESBACH: Your Honor, this is Tim Griesbach from Entergy. I've looked at that Korth and Harper paper also. That was done under the liquid metal fast breeder reactor program at very high temperatures, between 900 and 1100 degrees Fahrenheit and at very high strain levels.

That would be considered more of a creep fatigue rupture. And that describes mechanisms that clearly we don't see in the PWR operating environment under the stress levels and strain levels that we would expect.

JUDGE KENNEDY: Thank you. Maybe does

the staff have any view towards this large amplitude, low frequency? Should we be concerned about it for light water reactors?

MR. STEVENS: This is Gary Stevens of the staff. Those types of cycles are, which I think we're really going to, the discussion in the last few days has centered on accident loads, are not something that would be considered in a CUF calculation.

ASME code, it's not important to the evaluation of those events, and ASME code doesn't include the evaluation of those types of cycles in the calculation of CUF.

JUDGE KENNEDY: Would those types of events be more applicable to the shock loading type discussion that Dr. Lahey has brought up?

MR. STEVENS: That's correct. This is Gary Stevens of the staff. They're low frequency, low probably events. And crack initiation, fatigue crack initiation is not the important thing that you evaluate for for those events.

And that's not to say they're not evaluated by ASME code. In fact, they are. It's just that they're not included in a fatigue calculation.

JUDGE KENNEDY: All right. Thank you very much. Unless one of my board mates has a follow up question, I would like to offer this up as a time for a break --

CHAIRMAN MCDADE: Okay, it's just a --

JUDGE KENNEDY: -- if I may be so bold.

CHAIRMAN MCDADE: -- few minutes between 11:00 and 11:05. Should we come back at 11:15? Does anybody need any additional time?

MS. SUTTON: That works, Your Honor.

CHAIRMAN MCDADE: And we are in recess.

(Whereupon, the above-entitled matter went off the record at 11:01 a.m. and resumed at 11:15 a.m.)

CHAIRMAN MCDADE: Please be seated. The hearing will come to order.

JUDGE KENNEDY: I have a few additional questions on the general topic of synergism and its relationship to metal fatigue. Dr. Lahey, in my previous question I excluded the expanded materials degradation assessment.

And I guess I'd like to open that, let

that come back in. It seemed to me that that was a series of studies that focused on extension of operating licenses beyond the 60 years.

And I think you used the term sustainability a couple of times in the hearing. I guess what I'm really wanting to discuss, and conceding that there's work to be done to extend the licenses from 60 to 80 years, how should the Board view those particular references in this particular licensing proceeding here today?

What's the relevance of that material? Is there something in there that you can point to that we need to pay attention to even though it's for a 60 to 80 year license extension, if you could address that?

DR. LAHEY: Thank you, Your Honor. As I had indicated yesterday, this study is, in fact, funded to go out to as far as 80 years. However, no one believes, including those researchers, that there's a sharp demarcation in time.

So a lot of the issues that they're concerned with extend down to 50 years, 60 years, 70 years, whatever. All right.

So they're working on what happens in

terms of degradation, what we can count on as going longer, what we have to fix or replace in some way or what we can't do period.

And so that was the source of that. Some of the things we're talking about here are underway. The particular one we just got through talking about, irradiation and the synergism or possible synergism of embrittled material due to radiation with fatigue is an experiment that really there's only one place in the country it can be done.

And that's in Idaho in their hot cells and using their facility. And that's not an experiment that's underway to my knowledge right now because it's a big ticket, long duration item if you think about how you have to do their parametric experiments.

But it's definitely one that they have in mind doing. It's just a question when it'll be done. So my concern is not that we have data that we can use right now to quantify the effect.

I know we do not. However, there's indication that there is an effect. People say there's uncertainty. We ought to take data. Even the NRC said it's inclusive.

My concern is what do you do in the meantime. Do you just say okay, we'll press on and use our inspection program and that's good enough? Or do you say there's a possibility and try to put a factor in there so it's F embrittlement.

So it's not only CUF times Fen. It's times F embrittlement. And that's a number greater than 1. How big it is depends on what kind of margin you allow.

So that's really the crux of where we stand. I would never say that we have the data from the fast breeder program was sufficient to work up the effect. I know it's not.

JUDGE KENNEDY: Okay.

DR. LAHEY: But it's not irrelevant either. I do not believe it's irrelevant.

JUDGE KENNEDY: Let me turn it around just slightly since you seem to indicate that there's relevance in those documents.

Is there something that you could point to in those references that would call into question any particular decisions we would be inclined to make here in this proceeding relative to metal fatigue?

And maybe you've already done it, but I'm not sure. I've got it fixed in my mind.

DR. LAHEY: Well, I think we've talked about that issue. Yesterday, we talked about the fact that you have researchers, like Dr. Chopra, saying that we need, we don't have sufficient data to understand any synergism that may occur.

We need to take data. All right. And you have all these things that we've been talking about today and yesterday were reviewed by the NRC when they made a decision as to what to do.

And you had people make input as to what they should consider, what they should do. So it's not new. I'm not bringing up anything that hasn't been discussed before.

What I'm suggesting is it just seems to me to be questionable engineering to not take into account some uncertainty when there is uncertainty as to what's going to happen.

And it's going to happen. If it happens, it's going to happen in a bad direction, not a good direction.

JUDGE KENNEDY: Let me be more specific, be even more specific. Is there something in those reports that draws into question what has been going on over the last 20 years, which is extending licenses from 40 to 60 years?

Is there something specific that you would point to in there that would lead us to take note of what we're trying to do in this proceeding, which is grant a license for another 20 years of operation for Indian Point?

I think we all recognize on the Board that's there's a need to continue to grow the data set and to look at issues that have, that would resurrect themselves in the 60 to 80 time frame.

But I think what we're trying to point to is could we find something in those documents that would draw into question what we're trying to do here, which is extend a license from 20 to 60 years.

DR. LAHEY: In my view, not anything different than the opinions, the suggestions and the conclusions that we've already talked about in the various documents, both Argonne Lab documents, both informal discussions by people, researchers and the technical papers, which you had asked about earlier.

JUDGE KENNEDY: And in a nutshell, what are those conclusions that those researchers would offer to us?

DR. LAHEY: That there's the potential for degradation in the fatigue life due to embrittlement, and more work is needed to work up a database so that we can find what that degradation is, level of degradation.

JUDGE KENNEDY: And you view those researchers as being concerned in extending the life of a, extending a license from 40 to 60 years as well as looking forward beyond that?

DR. LAHEY: Absolutely, and you may recall, my overarching concern is not only the degradation of the fatigue life but at any time during the extended operation, if you have an impulsive load withstanding that in terms of core coolability and damage to those components.

JUDGE KENNEDY: All right. Thank you. Maybe I could turn to the NRC staff. Do you share Dr. Lahey's concern that there may be some issues that need to be addressed in this 40 to 60 year time period?

MR. STEVENS: This is Gary Stevens of the NRC staff. No, we don't. Specifically, I guess I'll point to a few things. We earlier were discussing NUREG 6909, which was New York State Exhibit 357.

And that document itself really doesn't have much in the way of discussion of radiation effects. However, New York State Exhibit 490A, which is the draft revision 1 of that document, we have a section, 1.3.2, that discusses this.

So staff is cognizant of the issue, and we're not ignoring it. And, in fact, the three citations that Dr. Lahey has offered in his testimony are discussed in that section of NUREG/CR-6909, one of the implicitly.

The Arai paper, which is New York State 564 is actually referenced in the Kanasaki paper, which is NRC 177.

You've already heard testimony from a lot of the experts regarding the impact of the radiation on strengthened materials and what all the experts say about the impact on fatigue crack life initiation, fatigue initiation crack life, sorry.

That tends to improve that. You've also heard testimony regarding the Korth and

Harper paper, which is Riverkeeper 152, that in fact that testing was done at very high temperatures, 900 to 1100 degrees Fahrenheit.

And the concerns we have with that is, as was mentioned by Mr. Griesbach, fatigue creep and other effects that aren't applicable to light water reactors.

From our perspective, if I could point you to one thing that probably does the best job to summarize where we are with this, it would be Figure 12 of the Kanasaki paper, which is NRC 177.

JUDGE KENNEDY: Should we call that up?

MR. STEVENS: That would be helpful. Yes, thanks.

JUDGE KENNEDY: Mr. Welkie?

MR. STEVENS: Okay. Figure 12 here is a comparison of the test data that was irradiated with respect to the ASME design fatigue curve, which is what is used to calculate CUF factors.

And as you can see, even though there's a lack of data, the data we see tells us that the ASME design sufficiently covers irradiation effects.

We've had a lot of discussion on low amplitude, high cycle, high amplitude, low cycle. And generally speaking, the differentiation between those two comes between 10 to the 4th, 10 to the 5th cycle.

So what you see here is the data stands low and high cycle regimes. In fact, this plot I would say covers the general level of strain amplitudes that are seen in light water reactor conditions under normal and upset conditions.

And so we have no evidence, and we're reasonably assured that radiation effects are adequately covered by what we know right now.

We agree that more data would be helpful and to quantify, but all the evidence we have to date supports that what we're doing is adequate.

JUDGE KENNEDY: All right. Thank you, Mr. Stevens. Dr. Lahey, would you like to respond to Figure 12?

DR. LAHEY: Yes. I'm certainly familiar with that and this paper, and I have no doubt that because of the hardening that occurs with irradiation embrittlement that when you have smaller amplitudes, like was run here, that things get better.

My concern is for larger amplitudes, and I really want to get into that when we discuss the WESTEMS code and what it calculates right now and some problems with those calculations. But I think it's not the right time at this point.

JUDGE KENNEDY: When you say large amplitude, small amplitude, how do I view that on this Figure 12? What would constitute, I guess, large amplitude? What would constitute low amplitude?

DR. LAHEY: To understand that, you really need to draw the stress-strain curve or a hardened material. And it steepens, the stress versus strain on the ordinate and abscissa.

And it steepens so you get a higher yield strength, a higher ultimate strength, but it drops off at a much lower strain. All right. So to know exactly what the strain is, you'd have to know exactly what the fluence is and the damage is.

JUDGE KENNEDY: Maybe I could go back to Mr. Stevens. This strain amplitude versus fatigue life, what's being represented on the Y-axis? And does it bear any, provide any input or insight to the large amplitude, low amplitude discussion?

MR. STEVENS: You heard testimony, this is Gary Stevens of the NRC staff. You heard testimony earlier of an S-N curve, and this is an example of one of those.

And what you see on the left, the vertical axis, is a measure of the stress-strain that would a complement where material would be exposed to. What I would call high amplitude, low cycle would be the left side of the figure.

JUDGE KENNEDY: Okay.

MR. STEVENS: Left, upper left.

JUDGE KENNEDY: Upper left. And Dr. Lahey, that would not be your characterization of large amplitude, low cycle?

DR. LAHEY: I mean you got to understand the strain is elongation over the initial length, right?

JUDGE KENNEDY: Yes, sir.

DR. LAHEY: I think it depends entirely on the forcing function that you put on a component, which strain it goes to. And I do not necessarily view this as large amplitude strain.

CHAIRMAN MCDADE: Can you quantify for me what you would consider high amplitude strain?

DR. LAHEY: Certainly strains that get you up into the plastic region. What I mean, beyond the yield strength, when you're up into the plastic region and beyond. Those are high strains.

So if you plot it, you have, you want me to try to draw it?

CHAIRMAN MCDADE: Well, just describe it for here.

DR. LAHEY: Okay. So it comes up. Then you have yield and then ultimate, and then you're gone. All right. And this is strain. So when you're up into the plastic region, when you're out of the elastic region, that's high amplitude. And then beyond it's higher.

JUDGE KENNEDY: What sort of events would we, would lead to those types of conditions?

DR. LAHEY: Significant bloating of structures, impulsive bloating of structures with thermal events.

JUDGE KENNEDY: Caused by?

DR. LAHEY: Caused by your normal operational transients. We'll talk about that in detail, how it's being done now and what I view as the deficiencies in the code.

My guess is we'll need to clear the courtroom when we do that.

JUDGE KENNEDY: I guess. I mean Entergy testified earlier that in terms of metal fatigue, they don't view these large amplitude, low cycle events to be of concern for metal fatigue.

Are you, again, suggesting otherwise? Are we back to that disagreement?

DR. LAHEY: Yes, sir. I think they get results, which depend entirely on the models they use and the transients that are assumed. And if you did things in a different way, you get a significantly higher amplitude.

JUDGE KENNEDY: So you're suggesting for the same forcing function or same event, you could get different results, depending on the methodology?

DR. LAHEY: Yes. And I'll show you some reasons why they get the results they get.

JUDGE KENNEDY: All right.

CHAIRMAN MCDADE: And the clarify in my own mind that it's the position of Entergy that these high amplitude events are not of concern is because they're not going to happen in the Indian Point environment. Is that correct?

DR. LOTT: This is Randy Lott for Entergy. That is essentially correct. Yes. We're not, we believe that the particular cases we have with irradiated internals will fit into the scheme that's described by this Figure 12.

CHAIRMAN MCDADE: Okay. And your disagreement is that you believe in the environment present at Indian Point, these will occur or may occur.

DR. LAHEY: Your Honor, I believe they're under-predicting it right now, and I'll show you why when we get into that.

CHAIRMAN MCDADE: Okay. And are you, to differentiate, are you saying they will occur, or are you saying they may occur?

DR. LAHEY: They may occur.

CHAIRMAN MCDADE: Okay.

JUDGE KENNEDY: All right. Thank you.

MR. STEVENS: Your Honor, if I could

make a clarification. This is Gary Stevens, NRC staff.

JUDGE KENNEDY: Okay.

MR. STEVENS: You have to recognize that if there's a load in the design basis, even one cycle of a load, it could not fall above the dotted line with respect to strain amplitude, or you would calculate a CUF greater than 1 and you would not have an acceptable design.

So I just wanted to make sure that we're not discussing strain amplitude loads that are off the chart here because you would not be able to qualify such a load for an adequate design.

JUDGE KENNEDY: Maybe I'm mishearing Dr. Lahey, but I believe he's suggesting for the same events that Entergy's analyzing, he's contending that he would get a different result or someone else would get a different result for the same event.

I don't know if that, where that falls in this fatigue curve discussion. But I think it, seems to have a general disagreement of what the amplitude would be for the same event.

CHAIRMAN MCDADE: Is that correct, Dr.

Lahey?

DR. LAHEY: Yes, sir.

JUDGE KENNEDY: I needed a couple minutes. There's a whole bunch of questions here that were already asked yesterday on 26, so I need to make sure I don't miss one nor ask you that you guys have already answered.

At this point, I'd like to start some discussion related to Dr. Lahey's supplemental reply testimony. In particular, so this is New York State 567.

And in there, there's a Figure 1, which I believe Dr. Lahey has offered to try to explain his position. And I think the Board has, at least a number of questions to try to understand what's being presented in Figure 1.

So Mr. Welkie, could you, if I've got the right citation, it's New York State 567. And there's a Figure 1 back about five or six pages.

DR. LAHEY: All right, Your Honor. As I discuss this, you'll need to tell me what is proprietary and what is not.

JUDGE KENNEDY: Are you suggesting there's real data in there?

DR. LAHEY: No, but I'm going to

discuss the way WESTEMS works and the way, what's missing and things like that. So I don't know how nervous that makes Westinghouse.

JUDGE KENNEDY: This is a great example where I thought I had a bunch of conceptual questions on a depiction that had no, I mean it has the concepts displayed but no basis in Indian Point data or WESTEMS methodology.

But is it, can we start first with just the figure itself? I know you don't know what questions we're going to ask. But is there any problem with that figure? I'm sorry?

MR. KUYLER: Yes, Your Honor. There's no problem discussing this figure.

JUDGE KENNEDY: So we'll ask our questions slowly, give you a chance to react.

MS. SUTTON: Yes, Your Honor. If we start getting into the WESTEMS methodology, in particular, we'll slow you down.

JUDGE KENNEDY: And I guess from my perspective, I would, I'm a little shocked to find out we're going to get into WESTEMS methodology.

But maybe I, maybe it's a good indication I don't understand this figure. So start to walk us through it, at least with an overview of what is being displayed here.

And we'll stop before you go into WESTEMS methodology unless you can't describe this figure without going into the WESTEMS methodology, and we'll go a different way.

Could you at least, from an overview perspective, describe what's being displayed here?

DR. LAHEY: Certainly. I will do my best to keep away from any sensitive information. On the vertical access, the ordinate, is CUFen. And you've now defined that carefully.

And on the abscissa, the horizontal axis, is a time scale. So there's actually two scales there. One is fluence, which is the integrated, high energy neutron flux times time, the time you're at that level and the other scale, which is time itself.

So both of them are proportional to time. So you can think about it, the horizontal axis is a time axis. The only reason it's not perfect is because you don't operate all the time.

There would be periods in which you

wouldn't be operating. But it's convenient to just think about it as a time axis.

JUDGE WARDWELL: I've got to ask this question right off the bat, I guess, Dr. Lahey. This is Judge Wardwell. There's only one value shown on each of the two axes.

That gives us no relation, no idea of how long any of the axes are. There's no way to, there's no scale, if you will, in regards to the two axes such that this is only a schematic. Is that a fair assessment? There's no --

DR. LAHEY: You should think about it as a cartoon, a schematic, yes.

JUDGE WARDWELL: Thank you.

DR. LAHEY: The 10 to the 17th there, when you think about fluence because it's normally quoted in decades, 10 to the 21, 10 to the 22, that sort of thing, you should think about it as a log scale.

And so, 10 to the 17th was put there just as a benchmark for the onset of irradiation damage to carbon steel.

JUDGE WARDWELL: Right, but it doesn't get us into any indication of where is 10 to the 22nd.

DR. LAHEY: No, but --

JUDGE WARDWELL: And same with the CUFen on the vertical axis, we've got one. That's fine, but I have no idea where 0.5 is.

DR. LAHEY: Well zero is on the bottom.

JUDGE WARDWELL: Well, there's not a zero there.

DR. LAHEY: No, but I'm telling you.

JUDGE WARDWELL: So that is a zero.

DR. LAHEY: It should be there, and so halfway in between would be the 0.5.

JUDGE WARDWELL: Is zero on the horizontal axis, or is that horizontal axis log rhythmic for both values?

DR. LAHEY: it's a log scale.

JUDGE WARDWELL: Thank you.

DR. LAHEY: But down to the left on that axis is a low fluence. So it's not of any concern in terms of radiation damage. So what I'm trying to show on this figure is at least three things.

I'm sorry if I put so much data on one figure, but hopefully I can talk you through it. So the first thing is just let's look at what I call the limit line, the LL.

The limit line is the predictions that are being done by WESTEMS now. And why do I call it a limit line? Because that's what you normally call a prediction or a correlation that is conservative.

And the way WESTEMS is used and the way it's been formulated is you try to make assumptions such that the results have conservatism in that.

And so it's always below. It's always better, or excuse me, not below. It's always closer to CUFen of 1 than what you really think it should be. Is that clear to everybody?

All right. So as time goes on, this dotted line goes up until you get to the end of light for the period of extended operations. And in this case, at that point, there's a margin, a small margin.

So it would be some number slightly less than 1. I don't want to quote a number, but less than 1. All right.

Now the question is, the fundamental question is because the way WESTEMS is used, you're allowed to systematically, if you're above

1, if you make assumptions which are too conservative and it gives you a result that's above 1, you're allowed to go back and recalculate, make different assumptions as long as you can justify them, until you get below 1.

So in the end, as that goes on and on and you get closer and closer to unity, which is your failure criteria, and you start really pushing it, then the question of how conservative is WESTEMS? What's the margin? What really is the margin that's there?

And everyone says it's conservative. Don't worry about it because we got a lot of conservatism in there. But then the question is we're willing to trust, but you need to verify.

So how do you verify the margin? So a good way to do that, the normal way to do that, is you make the run. It doesn't have to be for every component. You just pick one that's sensitive, and you make a best estimate prediction.

So instead of saying I'm using what I think is a large heat transfer coefficient, you use your best estimate for the heat transfer coefficient.

Instead of doing all kinds of assumptions that are built into the model, with some conservatism, use your best estimate. And then do what's known is a propagation of error analysis.

I know the NRC likes to think about it as a propagation of uncertainty. But I didn't make up the words. That's what people call it. And work out the intervals in plus or minus uncertainty.

And these are, if you read any technical paper, a journal paper and you see experimental data with an error band on it, plus or minus, that's what we're talking about.

It's the best fit to the data plus or minus the uncertainty due to measurement errors and whatever. Okay. So this is the uncertainty due to prediction errors, modeling errors, et cetera.

And that's what I've called delta. So I drew three cases here. Case 1, which is all the way to the right, is my best estimate line assuming no degradation in the prediction due to irradiation.

So this is no embrittlement. So BE

means best estimate. Sub NE means no embrittlement. All right. So that's what right now the licensing process would propose.

And so if we go out here at this point, then you look at plus or minus uncertainty. And how do I do that? I'm suggesting, and I've put in my testimony, you can use a number of ways to do it.

One way is the Kline & McClintock propagation of error analysis. And so I won't write it down, but I'll tell you how it goes. You just take the partial, so if you, partial derivative.

So if you're an engineer, you just love this method because you say the uncertainty squared is equal to partial of a function of different variables that contribute to error.

Partial of F, respect to X1 squared and then the error in X1 squared plus the partial of F at function, respect to X2 squared times the error of that variable squared. So --

JUDGE KENNEDY: So --

DR. LAHEY: -- let me just give you a specific example --

JUDGE KENNEDY: Okay.

DR. LAHEY: -- so it'll make it concrete.

JUDGE KENNEDY: That's what I was going to ask you for.

DR. LAHEY: Okay. So power is equal to I square R. Right? Everybody okay with that? Power is equal to I square R, electric power. R is --

JUDGE KENNEDY: I don't know what it does to fatigue, but I'll let you keep going.

JUDGE WARDWELL: You're just illustrating the propagation of error.

DR. LAHEY: I'm illustrating the method with something that's easy to do. So now the error in power is the partial of I square R with respect to I. So it'd be 2I times R times the error in our current measurement.

So if you run an experiment, you have plus or minus 2 percent error in reading the amps. Okay. Plus, and so you square that. Plus the partial of power respect to R.

So that's just I square times the error in R. So you go to the manufacturer of your resister, and it says this has so many ohms plus or minus 2 percent. Put that in.

You then take the square root of both sides. You have the error in your power measurement. So that's just a simple way. You can do it with any function.

And so it's not, I had the question or not the question, the criticism come back, you're talking about random sort of stuff. And this is deterministic. This is highly deterministic.

You're just talking about the uncertainty in these particular models. All right, or these particular evaluations. So that's how you get plus or minus delta.

Is that clear because I mean it's nothing magic? It's pretty straightforward. Engineers love it because it's easy to do. It gets them to use their calculus, and they crank their way to victory.

Okay. So now I've assumed, just for argument's sake, that my plus error band or my error bar plus delta is as shown there so that the upper part of it is above CUF of 1. Okay.

So what does that mean? That means that even my best estimate prediction has some chance of exceeding 1. The best estimate is significantly below, but there is an error or an uncertainty, which allows it to be above 1.

So even though, when I, now I compared the limit line with the best estimate, and I would say in that case, the limit line is not really conservative. It's not. They think it is. It's not. On the other hand --

JUDGE WARDWELL: But as I look at this, just to make sure I understand what you're saying, the error you have in that, your propagation of error results ended up to be about 0.25 worth of CUF.

DR. LAHEY: Yes. They're large.

JUDGE WARDWELL: Order of the CUF.

DR. LAHEY: It would be the error --

JUDGE WARDWELL: That's just your schematic assumption. It has, that was no calculation that you derived based on CUF analyses, right? That's just schematically showing if you did have --

DR. LAHEY: If I did have this 0.25 arranging CUF --

JUDGE WARDWELL: Right.

DR. LAHEY: -- that's what it would be. And it could be the other way. It could be the top of those error bars is below, in which case the conclusion is the limit line is adequately conservative.

JUDGE WARDWELL: Or another way to say it, if in fact the propagation of error was only 0.1 in the CUF, it would be well below it.

DR. LAHEY: Yes.

JUDGE WARDWELL: Okay.

DR. LAHEY: If, in fact, the best estimate is that far below, as shown here, exactly that.

JUDGE WARDWELL: Or on top of it. If the propagation of error resulted in 0.01 instead of 0.25 as you have schematically represented --

DR. LAHEY: Right.

JUDGE WARDWELL: -- then schematically representing this, it would show a very tiny, a bit above the best estimate line and be well below the limit line. Correct?

DR. LAHEY: Exactly.

JUDGE WARDWELL: Okay.

DR. LAHEY: Then I would be very happy. I'd say I'm happy.

JUDGE WARDWELL: And you don't have any data to show what that bar should be.

DR. LAHEY: I don't have anything, and

when they get really, really tight, and they start working out in the plasticity region, you're really pushing the envelope.

And I need to know what the margins, I think it's very imprudent not to know what the margin is. I mean if we're really working our way out in the bathtub curve towards the upper part.

JUDGE WARDWELL: This schematic, again, is just illustrating what it might look like, if in fact, you hit it up with --

DR. LAHEY: -- a large bar --

JUDGE WARDWELL: -- error bar like a quarter of a total distance.

DR. LAHEY: Where would that bar come from? For example, can I deviate, Your Honor, from this plot for a little bit?

JUDGE KENNEDY: Let's stay right here for a second.

DR. LAHEY: Because I can tell you why that error bar may be large. And we'll come back to it. All right. So the next part of this is, now let's say that the concerns not only that I have but others have about the possible degradation of the fatigue life due to embrittlement, due to radiation-induced embrittlement or thermally-induced embrittlement, but here, radiation because of fluence.

So now I have a curve, which goes up. And until it gets to about, I don't know, 10 to the 21 or six point, they have a criterion, 6.7 times 10 to the something or other, it'll stay essentially the same.

And then it starts getting worse because the denominator gets worse. Remember, it's the number of cycles over the number of cycles to failure times Fen.

So the number of cycles to failure. If embrittlement reduces that, the denominator gets smaller. Therefore, the CUFen prediction gets bigger. So now --

JUDGE KENNEDY: Just for argument's sake, we've been at this for a couple of days. I'm still not sure we've seen the support for the premise that that synergistic effect occurs.

I mean it's an interesting hypothesis, and this certainly demonstrates the hypothesis that's been in front of us through all this testimony. But I'm still looking for that citation that points us to where this hypothesis has been supported.

DR. LAHEY: I would love to bring you the data, Your Honor, but it won't be here for a few years. That's the problem.

JUDGE KENNEDY: So you're --

DR. LAHEY: But people aren't spending millions and millions of dollars of taxpayer money just for the fun of it. I mean they're worried about it as well.

CHAIRMAN MCDADE: Excuse me. Dr. Lahey, let me make sure I understand. What you're saying is because of an absence of data, that in your view, this error bar should be large?

DR. LAHEY: No. And Your Honor, I'm not trying to tie that to our uncertainty as to whether this embrittlement impacts it or not. I'm going to assume here it does for this particular curve.

JUDGE WARDWELL: The comment I would like to make would be to get this on even footing would be that you've got the lines labeled wrong. It's not BE with no embrittlement.

It's really BE assuming embrittlement doesn't affect the strength, and then your BE with the E isn't BE with embrittlement.

DR. LAHEY: Exactly.

JUDGE WARDWELL: It's BE with the assumption that embrittlement does affect fatigue life.

DR. LAHEY: I agree. That's a very good way to think about it. Or it could be something without embrittlement. I mean just no irradiation, but that's a very good way to think about it.

JUDGE WARDWELL: Right.

DR. LAHEY: So anyway, if you'll buy this just to see what happens, what happens as time goes on, this fluence goes on. It's gets worse and worse.

And at some point, it hits 1.0 well before the end of a period of extended operation. In fact, so that's 0.2. But in fact, at 0.3, if you tie on the uncertainty --

JUDGE WARDWELL: There's no facts in this figure. Is that correct?

DR. LAHEY: Well, in fact, that's the only fact. Yes. I mean this is my cartoon, man. I'm the cartoonist, so I can do as I wish. So anyway, when you get to 0.3, you now have that uncertainty bar.

And you see that well before the end of the period of extended operation, if it happens that there is synergism with irradiation and fatigue, you will have a good chance of fatigue failure.

So that's how this all fits together. Now, the reason I put this in my testimony was because we kept saying for years you're giving us this limit line prediction.

You're giving us these CUFen results, and you keep cranking it up, cranking it up. You're going to make sure what they call conservatism, you keep eliminating them.

And I'm worried about at some point, it's not longer conservatisms. It's necessary margins that you're cutting into, design margins. And so I need, to feel comfortable, I need to know what's the margin.

Is it really that conservative, to don't worry about anything? You can just keep iterating. Or at some point, are you non-conservative?

And the only way I know to get that, and we've been suggesting it for years is do an error analysis. And this is how you do an error analysis. I sent references to a textbook all sophomores at RPI used to learn how to do this. And it bounced.

It didn't work. They thought, it doesn't matter what they thought. But anyway, now I figure if I draw a cartoon and write down the equation for a propagation of errors, you can't miss it.

That's what I'm talking about. So this is a plea to do this because I don't know any other way to know what the margin is.

It's not good enough to say there's conservatism, and I've done this and that because later on I'm going to show you other pictures, which show you things that they believe are conservative assumptions, which are not.

They're doing them in the wrong way. I mean they're not conservative. They're missing the boat on some of these things.

JUDGE KENNEDY: I've got millions of questions. One thought that comes to mind, we had a lot of discussion earlier about margins, the margins that are in the ASME code calculation plus the margin to CUF of 1, and then on top of that, the concept of conservatisms.

I'm assuming you tracked that conversation before.

DR. LAHEY: Yes.

JUDGE KENNEDY: How does that bear into this cartoon here? Does the best estimate have margins in it?

DR. LAHEY: I would suggest to compare apples and apples, that all the ASME code conservatism, which is similar to what we talked about earlier, all right, should remain in the best estimate. I have no trouble with that.

JUDGE KENNEDY: Right. And I believe I heard Entergy testify that they don't and will not reduce those margins, that those are off the table.

DR. LAHEY: I think they're off the table.

MR. GRAY: Yes, that's correct.

DR. LAHEY: They're off the table.

JUDGE KENNEDY: So we've got margins --

DR. LAHEY: Yes.

JUDGE KENNEDY: -- that nobody's disputing.

DR. LAHEY: So you might quarrel with it being called best estimate, but anyway, those margins are in there because fatigue, the onset of a crack is a random process.

I used to do this at GE, and you run these samples. And they all look the same, but they all don't have the same number of cycles to failure. But if you then plot it up, they're within a band.

And then the uncertainty that the ASME puts on bounds that plus a little more surface finish and et cetera, et cetera. So I think that, you don't touch.

That's not part of the best estimate. Otherwise, it's really not apples and apples comparison with your limit line.

JUDGE KENNEDY: I mean I think the other question you've already, you already testified that the limit line, again, potential WESTEMS calculation has conservatisms built in it.

And it's difficult to me. I can sort of, I sort of understand your best estimate and then doing an error analysis and getting an uncertainty and laying that on top of there.

I don't know how to translate that to the load limit line and put an uncertainty on that in the same manner because it already has conservatisms built into it.

DR. LAHEY: I'm sorry I'm mislead you. I'm not recommending you put a plus or minus uncertainty on the limit line.

JUDGE KENNEDY: Well, I --

DR. LAHEY: The limit line, by definition, is supposed to be conservative.

JUDGE KENNEDY: But I thought I heard you say that because of the uncertainty, even though the limit line shows a CUF less than 1 at end of life, it could actually be greater than 1 because of the uncertainty.

And I guess all I'm suggesting, do you really intend to apply the same uncertainty to the best estimate line and the limit line?

DR. LAHEY: So let's go back to Case 1 again. And so we can say here's the best estimate, which I would agree with Judge Wardwell, we could think about as a best estimate calculation where no effective embrittlement is taken into account.

And then you have an uncertainty bar,

and we can talk about what goes into that, why I think it might be large. It exceeds unity at the top. The plus delta exceeds unity.

So that says if you really do the best you can do and do the error analysis or the uncertainty analysis, there's a pretty good chance you're going to have a failure at that point or actually a little before that point.

So your prediction in your limit line, which says it's below 1 is wrong. It really --

JUDGE KENNEDY: I'm sorry.

DR. LAHEY: -- is not taking into account what the true situation is. It can fail earlier. It's not conservative.

JUDGE KENNEDY: I guess I don't know how you, well, again, recognizing this is a cartoon, but we're trying to bring it into the real world here because it is demonstrative of the issues we're trying to deal with.

DR. LAHEY: Exactly.

JUDGE KENNEDY: And we're going to get to margins and conservatisms probably as we move through the day.

I have a difficult time trying to think in the same terms of a best estimate line with uncertainties and a limit line that has uncertainties or conservatisms already embedded in it with the same uncertainty band around it.

So, I mean I could argue on the other side, and maybe Entergy would and maybe we should give them a chance, that that limit line is so conservative there's no uncertainties to be placed on that limit line. And it's good to go.

DR. LAHEY: That's exactly what they do, Your Honor. And now the question is, is it that conservative? And here's how you determine. Let me tell you where, I'll give you another example.

I don't know exactly your background, so I don't know if this is helpful. But in the world that I have lived in, we worry about the thermal limits on the fuel, so-called critical heat flux.

So if you plot the flux versus quality, you take the experimental data. And one way to run your plant is draw a line underneath all that data. That's the limit line.

And as long as you don't go in heat flux greater than that, you're okay. The other way is to make a best fit of that data plus or minus uncertainty and then evaluate it.

Both ways have been used in the past. I've used both ways.

JUDGE KENNEDY: Are those the two ways that are evidenced on this chart?

DR. LAHEY: That's our two ways. But the question is, because we don't have any way to know has this been drawn under all the data. I mean is it, are they living in a fool's paradise, I mean is one way to think about it.

Do they think they're all that conservative, and they're not really?

JUDGE KENNEDY: I guess said another way, if that limit line isn't right, we should be seeing failures in real plant data with CUFs less than 1. So we have a CUF prediction based on the limit line that's 0.9. That component fails due to metal fatigue.

DR. LAHEY: Well, there have been some failures, which have been attributed to manufacturing flaws and things like that when they're below 1.

But in fact, we haven't run this out far enough to take into account the effect of embrittlement, for example, and what that might do to it.

JUDGE KENNEDY: And again, that's the inconclusive data that you constantly point to.

DR. LAHEY: That's one way to do it.

JUDGE KENNEDY: Maybe just in case I didn't hear it right, you don't, you're not aware of any metal fatigue failures where a predictive technique would have predicted that the metal shouldn't have fatigued and failed.

Is there any evidence of that that you've seen?

DR. LAHEY: Yes. There has been that data. I don't know I can give you the reference off the --

JUDGE KENNEDY: Is that different than the manufacturing defects that you just --

DR. LAHEY: That's what they attribute it to.

JUDGE KENNEDY: Maybe --

DR. LAHEY: I think it was a 0.7, Havana 0.7.

JUDGE KENNEDY: What would that be indicative of in this whole discussion here about trying to manage aging for metal fatigue? Is that an issue that's not included, not considered?

DR. LAHEY: The reason I'm doing this and I'm concerned with it is because we have been asked to trust the results are conservative. Trust us. They're conservative.

And then we can go back and keep reducing what we view as conservatisms that are unnecessary because we have so much margin we don't need them.

And it just gets tighter and tighter and tighter. And at some point, you worry about how do you know what the conservatism is. How much conservatism do you really have? And this is the only way I know how to actually get at that.

JUDGE KENNEDY: If Entergy reduced the conservatisms, took all the conservatisms out and left only the margin, design margins or whatever the right word is in the ASME code, is that still a conservative calculation?

DR. LAHEY: I think they could use, the WESTEMS code is really an encoding of a procedure that we used to do by hand. In 1961, when I did my first job, I was doing exactly this, thermal stress analysis, but we did it all by hand.

Now it's much more encoded, and I think that's great. It helps out as long as you get it right. I can show you later on what they would need to do to that code to do a best estimate calculation.

They do it with that code. And then do the error analysis and sit the problem, answer the concern. Is it conservative or not?

JUDGE KENNEDY: And again, I guess what we'd be most interested in is can you identify a problem with using the margins that are in the ASME code plus some conservatisms or no conservatisms to generate a load limit line. What is fundamentally wrong with that?

DR. LAHEY: At the end of the day, that may cover all the concerns. But it's not for sure. And when you're playing with the health and safety of people in this area of the country, I think it's not the right thing to do.

JUDGE KENNEDY: Are you suggesting that there's insufficient margin in the ASME calculation to cover the uncertainties in, I guess, the overall calculation?

DR. LAHEY: Yes. For example, the

ASME code, the 20 cycles and the factor, or excuse me, the two cycles and the factor of 20, 20 cycles and a factor of 2 on stress, that is for the air data.

If you look at the Fen prediction, and you think about how did they take that data. So how did they take that data? They did it in autoclave. So they put the little machine that runs the fatigue experiments, and you could control the chemistry, the temperature.

You could do a precise job. And then that's what they fit and got the Fen correlation. The problem is, when you go to the plant, then you look at a flow situation where you have turbulence and you start thinking about what the chemical engineers called surface renewal theory, sub-shielding of the oxygen.

You get a lot of sub-shielding in an autoclave that you would not get in the real application. So is the Fen really accurate, and how do you put that uncertainty into the thing?

Well, this is one way to do that. It's part of the delta.

JUDGE KENNEDY: So your concern isn't with the original CUF calculation and uncertainties in that. Your concern is with the environmental adjustment factor and covering the uncertainties in that.

DR. LAHEY: It's only one part. There's also part of the modelings that we can get into, which are not, which are really not conservative at all. They're non-conservative.

JUDGE KENNEDY: I think, let's stay on the cartoon for a while.

JUDGE WARDWELL: I got a question before we leave this cartoon.

(Simultaneous speaking.)

JUDGE WARDWELL: -- one clarifying thing that may --

JUDGE KENNEDY: Thank you, Dr. Lahey.

JUDGE WARDWELL: Give you some time, give you time to think of something else. But I do want to clarify one statement you made early on. You stated that that limit line is associated with the WESTEMS calculation. Correct? That's what you said.

DR. LAHEY: I'm calling the results of the WESTEMS calculation a limit line, yes.

JUDGE WARDWELL: Okay. But isn't the WESTEMS just a computer code that is one mechanism to calculate out the CUFs. The limit line is just a calculation of the CUFs. Could it not have been done by hand?

DR. LAHEY: Absolutely.

JUDGE WARDWELL: Okay. So that limit line is not necessarily indicate of WESTEMS or not. It's the calculation of the CUF line.

DR. LAHEY: Right. If you made the same assumptions that they make in the code --

JUDGE WARDWELL: Right.

DR. LAHEY: -- and did it by hand, well they may, you may have a WESTEMS limit line.

JUDGE WARDWELL: Right. You may have whatever, but a limit line is not unique, I'm saying, in regard, your cartoon is not unique to WESTEMS.

It could be a cartoon for any limit line that happened to be calculated to, happened to be done, calculating out the CUF relationship with either the time for a period event at operation or the fluence.

DR. LAHEY: Yes, sir. When I say limit line, what I mean is instead of a best estimate, it's a supposedly conservative calculation.

JUDGE WARDWELL: Right.

(Simultaneous speaking.)

DR. LAHEY: Right now the question is --

JUDGE WARDWELL: However it was done.

DR. LAHEY: -- is it really, and what's the margin.

JUDGE WARDWELL: Fine. I just wanted to clarify that point --

DR. LAHEY: Right.

JUDGE WARDWELL: -- that it's not just a WESTEMS calc.

JUDGE KENNEDY: All right. Dr. Lahey, is there anything additional that you'd like to discuss? This is Judge Kennedy, on this figure.

DR. LAHEY: Unless there's any questions, I've tried to explain it. If I didn't do it, please have somebody ask me.

JUDGE KENNEDY: I think we'll have additional questions when we get to the conservatisms discussion later.

DR. LAHEY: All right.

JUDGE KENNEDY: I guess I'll turn to Entergy. Do you have any rebuttal to this figure, this cartoon, other than what's been --

MR. GRAY: This is Mark Gray for Entergy. The concept is pretty straightforward, and if we were trying to do a precise calculation, we probably could use such a technique.

But what we would propose, in fact, is you can do this on the front end or on the back end. If you do it on the front end, you select your inputs in such a way that the only error that you're going to get is going to go below the limit line.

And so when we are maximizing stresses so that we can get a conservative usage factor, we select the inputs to the stress calculation, and we model the calculation that we do for the stresses, such that we're already calculating a larger than expected load and stress range that we use for the fatigue calculation.

So I would say that the calculation that we've done is sufficient because any uncertainty on our assumptions would go in the, would make the answer less.

JUDGE KENNEDY: So you don't, do you not feel the need to add any uncertainty upon your calculation, as Dr. Lahey has indicated, a delta above your calculation to account for uncertainties?

MR. GRAY: No, we do not.

JUDGE KENNEDY: Do you believe they're included in the original calculation, analysis method?

MR. GRAY: Yes.

JUDGE KENNEDY: This discussion of the ASME margins that I may have miscommunicated, going back to some conservatisms can be removed, margins cannot be removed.

So one thought I had in trying to address Dr. Lahey's concern about the reduction in conservatism is to suggest that there's still margins in the code evaluations.

Is that a true statement? Is their margin still, are those untouchable margins in the code something that can be relied on to give confidence in the final result?

MR. GRAY: Yes. As we said previously, we're not touching those margins in our selection of inputs and conservatisms in the analysis.

JUDGE KENNEDY: Are those margins sufficient to cover potential uncertainties in the analysis, or is that the wrong way to be thinking about this?

MR. GRAY: The ASME code doesn't dictate the method that you use to get your stresses, for example.

It has some very high level guidelines of the ways that you treat the stresses that you calculate and how you conform them to the equations that are stipulated that you meet in the code on your way to calculation of the usage factor.

After that, the analyst must justify that his stress calculation is a conservative.

JUDGE KENNEDY: Go ahead.

DR. LAHEY: Your Honor, could I say one thing on that his?

JUDGE KENNEDY: On the ASME margins?

DR. LAHEY: On the statement and your suggestion. By definition, a limit line shouldn't have any plus or minus delta on it. I mean it's very consistent to use ASME code assumptions of conservatism in a limit line.

It's very consistent to make assumptions to make it conservative. But by definition, it doesn't need any uncertainty because it's a bounding calculation.

It has enough conservatism built in. The only thing of concern is what is it. I mean --

(Simultaneous speaking.)

JUDGE WARDWELL: Yes. I think that will get into my questions I have for Mr. Gray. So as I heard you said that you know what those, as you're assuming conservative parameters for your input that you're allowed to do, you're aware of those that you are doing.

And you're usually motivated, as I heard Mr. Stevens say, usually probably because it's a less expensive analysis because you can simplify some of the runs or whatever else.

But you are aware of what those are. Correct?

MR. GRAY: That's correct.

JUDGE WARDWELL: Right. And so you are developing a limit line. And what you're saying is that with that limit line, as long as we're below 1, we know we're conservative.

MR. GRAY: That's correct.

JUDGE WARDWELL: But likewise, you could also take out all those conservatisms out of that for every one of the parameters. Could you not right off the bat?

MR. GRAY: Theoretically you could.

JUDGE WARDWELL: And so you could create a best estimate line because that's where you would be at that point. Would it not be the closest to your guess of what truth would be in that particular sets of materials and the resulting CUFs that you're calculating with the cycles that are applied to it?

MR. GRAY: While your suggestion might be a responsibility --

JUDGE WARDWELL: I'm not suggesting anything. I'm just saying you could come up with that best estimate line, if in fact, you eliminated all the, you took your best estimate of all the parameters that you're putting in, not incorporating any of the conservatisms, the margins.

MR. GRAY: If you had a way to do that, that might be possible, but I don't believe that that's possible. So we do always make some conservative assumptions, yes.

JUDGE WARDWELL: Well, I thought you knew how much conservatism, conservative nature of your inputs that developed your limit line.

MR. GRAY: You know what maximum loads are. You know what maximum inputs are, for example. That doesn't mean you know precisely what the actual value might be.

JUDGE WARDWELL: Or another way to say it, you really don't know what you would want to say is your minimum loads necessarily.

MR. GRAY: Or best estimate.

JUDGE WARDWELL: Best estimate load. Okay. Thank you. Let me just finish up. But if you could, if you were able, I understand what you just said.

But if you were able to, that would just create a best estimate line. Correct, in regards to just trying to correlate what you're saying with this cartoon?

MR. GRAY: That could be possible.

JUDGE WARDWELL: Okay.

MR. STEVENS: Your Honor, Gary Stevens as NRC staff. Would you mind if I said a few words here?

JUDGE WARDWELL: Not at all.

MR. STEVENS: I guess I would interpret it that he would not be allowed to do a best estimate line because, let's go back to the margin discussion that I had earlier.

Part of the margin is things he can't touch. In order to do an appropriate uncertainty analysis, if you could, which by the way you can't because the code would not allow that.

And the reason it would not allow that is because part of your best estimate analysis would be to use a best estimate fatigue curve, which you're not allowed to do.

JUDGE WARDWELL: Of the what curve?

MR. STEVENS: Fatigue curve or the S-N curve, to calculate your CUF. You're not allowed to do that with the code. You have to use the design curve --

JUDGE WARDWELL: But haven't we taken out, we all agree that we're not going to touch those code things. And those are as if there are no margin. We were taking those at those values, and we're not touching them.

MR. STEVENS: Well to me, that's not a best estimate analysis.

JUDGE WARDWELL: I'm only using that phrase in regards to this cartoon. I'm not giving it any other credence in regards to the bestness of it or the estimate of it. It's just nomenclature to relate to this cartoon. That's all.

You would create a line below your limit line that would have the conservative assumptions that you've made and are allowed to make out of it is all I'm saying.

You could derive a line for that is what I was asking. Okay.

MR. STEVENS: Okay.

JUDGE WARDWELL: Any other comments on that? So I understand that there are those margins from the code and actions required by the code that limit the degree that you can touch.

And I think we all agree those are untouchable and will always be in there.

MR. COX: Yes. Your Honor, one comment on that. I think if I understand Mr. Stevens correctly, you could do that, but you wouldn't have a best estimate line. You would have a lower limit line.

JUDGE WARDWELL: Well, call it anything you want to. I'm only using, again, I only use that nomenclature in reference to picturing this on this cartoon.

Call it an Ernie line if you want. I don't care what you call the line. I'm not giving it any credence that it is the best estimate. I'm just giving it a, being consistent with what's on the cartoon. That's all. Thank you.

DR. LAHEY: Your Honor, I certainly agree. And I think I said earlier, to do this "best estimate" --

JUDGE WARDWELL: You don't like my suggestion of Ernie?

DR. LAHEY: But I would recommend you retain the ASME code. And so it's not exactly a best estimate, but then it's apples and apples comparison.

So some things that, just so you understand, one of the things that we're talking about here is right now you make an assumption of so many scrams during the light.

Let's say your best estimate of number of scrams is 100, and so, but you really don't use the same thing. I mean you can use 200 in your limit line.

And you say I got conservatism here, which you do if you really believe you only have

100. So you'd use 200 in the limit line and 100 in the best estimate and go through each one like that.

And in the end, you have some way to define what sort of margin. We have some ability to understand what's the cushion, if any. Right now we don't know, particularly as you get closer and closer and closer.

I come from a background where if I'm sitting there in my office, and I ask somebody to design a piece of equipment to last for 60 years and fatigue is one of the issues, and they come in with a design where they're rapidly approaching 1 and they got all kinds of, it's really at the bitter edge, I'd throw them out of the office.

I'd say, listen guy. You're not going to design a piece of equipment like that. But now because we can't redesign the reactor, we're asking to get out there, the stuff that any rational engineer would never accept.

So what you need is enough confidence you got enough margin in there to take into account anything that may happen. That's where we're at.

JUDGE KENNEDY: I can't let the rapidly approaching 1 go by the wayside without asking a question. Do you perceive the CUF values that are calculated for Indian Point 1 and 2, 2 and 3?

I don't know what the values of 1 would be, for 2 and 3 are rapidly approaching 1 over the next 20 years?

DR. LAHEY: Well, they're --

JUDGE KENNEDY: And I'm not sure what --

DR. LAHEY: Yes, they're --

JUDGE KENNEDY: -- graphically approaching means in this context.

DR. LAHEY: I can give you a numerical value, but I was asked not to do it.

JUDGE KENNEDY: Well, let's --

DR. LAHEY: There are several components are --

JUDGE KENNEDY: Let's say for argument's sake they're all going to get to 1, 20 years from now. Is that your concept of rapidly approaching?

DR. LAHEY: Yes.

JUDGE KENNEDY: And why is that a

concern?

DR. LAHEY: If you get to 1 or beyond, you got a problem. Well, even in the licensing basis, they would have to take action at that point, yes.

JUDGE KENNEDY: Right.

DR. LAHEY: If I'm, if you calculate at the end of 60 years, end of period of extended operation, you have a CUFen of 0.2, I'm not really concerned about that.

But if it's decimal point, you know what I'm saying?

JUDGE KENNEDY: So your concern, as it gets to 1, what do you perceive happens when the CUF value gets to 1? Do we lose the intended function? Do we crack? Do we fail?

DR. LAHEY: The assumption, of course, is you get a crack of 3 millimeters. My, as you may remember from the last couple days, my problem is as this, and this is a new discussion I'm going to create.

JUDGE KENNEDY: It is.

DR. LAHEY: As this thing fatigues --

JUDGE KENNEDY: I started it.

DR. LAHEY: We hear and we hear, and

you get a number of microcracks. And all of a sudden you have an impulsive load. Then you've got a big problem. So I don't want a design where things get very degraded.

JUDGE KENNEDY: I guess I'm getting confused again because I thought we put to bed this question of did they analyze these shock loads. And I'm assuming that this covers all the way up to the maximum CUF values that they have in their analysis to date.

Are you suggesting they did not do that? I thought we just settled that question.

DR. LAHEY: What we talked about this morning was for the baffle bolt, baffle former bolts. An analytical method has been set up, which I believe will create the right kind of shock loads.

And they could be applied to other components as well. I haven't seen that, but this type of sub-cool decompression model could be applied throughout the system.

But as you may recall, right now I haven't seen them do the type of design basis LOCA breaks with a type of opening times that would create the larger ones.

In principle, they can get the loads. They can get the loads right, but it makes a huge difference if it's a snap load or a gradual load.

JUDGE KENNEDY: But didn't they do that for the original design, and why is it different?

DR. LAHEY: Using a different code, they have done that. And to assure if you have ductile structures, you will maintain an intact geometry.

And as I said yesterday, we spent a lot of taxpayer money verifying that in the LOCA program to show that indeed you could maintain the coolable geometry and cool the core.

Now that we're winding up with a highly degraded geometry, both due to fatigue and irradiation, that hasn't been done.

JUDGE KENNEDY: We have no CUF values at the end of life greater than 1 according to the testimony of Entergy. Why are we in a highly degraded condition?

DR. LAHEY: Okay. The CUF value is a moving target. I mean there was a really nice Westinghouse paper, and I think the author of it is in the room, which described the process for a RHR accumulator nozzle.

It's an iterative process. You make certain assumptions, and they're supposedly very conservative. And if you get a CUF of less than 1, CUFen less than 1, you stop. It's good enough.

Maybe that's fine, but if it becomes 19, which happened, then you go back and start looking at what did you do that you might want to relax. And some of them are obviously conservative.

If you assume too many cycles of a certain transient, so back it up. You did this or that. Back it up. But as you keep doing this and you keep going over and over, there's no limit to what you can cut in order to get below 1.

And that's where we become very concerned. At some point, you're cutting into design margins. It's not just conservatism.

JUDGE KENNEDY: This is where I keep getting confused. I thought there was a point beyond which these reductions are off the table.

And I guess maybe I keep getting myself confused between conservatisms and margins, which we tried to earlier have a lot of discussion about.

But I keep hearing from Entergy that there's a limit to this refinement of calculation, that there's areas that they do not go. Are you suggesting that's not true?

DR. LAHEY: Well, I think maybe the NRC should comment on it, but what I've read says that if they have that situation, they can either fix it or they can recalculate it.

They're allowed to recalculate it, and then if they can justify that that's a conservative calculation, fine. The problem is they just say it's conservative.

I mean there's no, there's nothing that has been defined as what conservatism really is in the code. That's the concern.

JUDGE KENNEDY: Are you saying in the code or in the analysis method, in the input, I mean are you opening it up to the whole --

DR. LAHEY: Into the results of WESTEMS, which includes all of those things.

JUDGE KENNEDY: I think we'll get back to this in the afternoon. But I appreciate your input.

DR. LAHEY: I mean, I want to say that I understand the approach. And even though if you don't really understand what they're doing, it looks pretty startling when you see numbers go from 20 down to 0.8.

And you say oh my God. What's going on? And then you realize it's a process that they do. And I don't even mind the process. I understand it.

It's just at some point as you keep doing it, you're cutting into the bone. All right. And we need to know --

JUDGE KENNEDY: How would you know when we're at that point? Do you have a sense of where that point is?

DR. LAHEY: The only way I know is to determine what sort of margin you have and to compare it, something like this.

JUDGE KENNEDY: To do a best estimates calculation.

DR. LAHEY: Best estimate with uncertainty. And then you say okay, compared to that, my error bar is below the limit line and --

(Simultaneous speaking.)

JUDGE KENNEDY: So you're not buying

Entergy's argument that in doing the calculations or in essence doing a load limit type calculation.

DR. LAHEY: I believe President Reagan was right. You trust but verify.

CHAIRMAN MCDADE: Okay. And I don't want to get into a big discussion here right before lunch.

But just to satisfy me, from your standpoint, if you were looking at it during the period of extended operation and the environmental adjusted CUF was 0.1, you wouldn't have very many concerns because you would believe that there would be sufficient margin there so that there would not be a potential for problem.

At the other end of the spectrum, if within the period of extended operation, the environmentally adjusted CUF was 0.99, you would be very concerned because of the possibility of insufficient margin.

(Simultaneous speaking.)

CHAIRMAN MCDADE: So that, in fact, it might be above 1, although their calculation is below 1. Is that correct?

DR. LAHEY: Yes, Your Honor. That's

exactly right.

CHAIRMAN MCDADE: Okay. And that in factoring, in preparing their environmental adjustment for the CUF, in your view, there are factors that are not adequately considered, such as the effect of neutron embrittlement and such as the fact that in your view, there are the potential for high amplitude events within the design basis that have not factored in.

DR. LAHEY: And we'll get into that after lunch, I guess, on some of the modeling assumptions that are made, some of the models that are used and how if you do those correctly, you dramatically increase the amplitude.

CHAIRMAN MCDADE: Okay. But at least the way I described it is consistent with the testimony you were hoping that we would understand this morning. Nothing that I said was --

(Simultaneous speaking.)

DR. LAHEY: I agree with what you said, except there's also modeling things that are influencing the result --

CHAIRMAN MCDADE: Right, in addition to --

DR. LAHEY: -- that were non-conservative in my view.

CHAIRMAN MCDADE: In addition to that we're going to get into later.

DR. LAHEY: Yes.

CHAIRMAN MCDADE: Okay. Thank you. Judge Kennedy, your suggestion?

JUDGE KENNEDY: I suggest we take a break at this time.

CHAIRMAN MCDADE: Okay. One quick thing before we do break for lunch, and let me just note for administrative. There was an Entergy document, Entergy R-00186. It was filed in connection with Track 1.

It was an R document. There was a new one that was filed in connection with the Track 2, and we are going to sua sponte make that Entergy R-20186. So when you do your revised exhibit list, if you could have that correspond.

It is now 12:40. Would it be appropriate to break until 1:40? Okay. And the next question is, and I'm thinking this may well be that when we come back at 1:40, it might be appropriate for us to go into a closed session initially so that Dr. Lahey might comment on some proprietary information.

So for the individuals who are spectators and all of the participants here have signed the non-disclosure agreements. But we will at least at 1:40 have a closed session.

And for anybody who is present probably we're hopeful that by 2 o'clock then we would be able to open up the session again to the public session.

So we will stand at recess until 1:40, have a closed session with anticipation we'll open it approximately 2 o'clock.

MR. SIPOS: Excuse me, Your Honor? John Sipos for the State of New York. I just wanted to clarify one question for the Board, and it follows up on a question from Judge Kennedy.

There was some discussion of the phrase "rapidly approaching 1 or 1.0 or unity," and that was a phrase that we picked up during the November 5 pre-hearing conference.

And it was our understand that that was a safe harbor phrase that would be acceptable.

MS. SUTTON: Your Honor, this is Kathryn Sutton. This is the third time counsel from New York has testified on behalf of his witnesses. And we object.

MR. SIPOS: I'm not.

CHAIRMAN MCDADE: Okay. I don't believe that Mr. Sipos was testifying. I believe that he was clarifying.

And I think that he correctly commented on what was said during the status conference, that we did not want the witnesses and asked parties to instruct the witnesses not to use specifics but that, again, the term that as I understood it, what Dr. Lahey was saying by rapidly approaching meaning in his view, the environmental adjusted CUF was close to.

It had nothing to do with speed. It had to do with its nearness to the 0.1 or 1.0, which then raised concerns in his mind. Is that how you were using the term, Dr. Lahey?

DR. LAHEY: Yes, sir. Yes, Your Honor.

CHAIRMAN MCDADE: And that is what you were referring to, Mr. Sipos?

MR. SIPOS: Yes, Your Honor. And I was not trying to testify. I was trying to provide --

CHAIRMAN MCDADE: I didn't anticipate that you were testifying. I thought you were trying to clarify something for the Board so that we would properly understand Mr. Lahey, Dr. Lahey's testimony.

MR. SIPOS: And it was a phrase that originated from the Board.

CHAIRMAN MCDADE: I believe, actually from me.

MR. SIPOS: I believe so, Your Honor. That's all I was trying to clarify.

MS. SUTTON: It's good to know, Your Honor, that we can make similar clarifications as necessary. So thank you very much.

CHAIRMAN MCDADE: If you believe that it is necessary to clarify something, I am confident that you will not be shot.

MS. SUTTON: Thank you, Your Honor.

CHAIRMAN MCDADE: We are in recess.

(Whereupon, the above-entitled matter went off the record at 12:41 p.m. and resumed at 1:44 p.m. in Closed Session.)

(The following pages have been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(This page has been redacted.)

(The above portion of this page has been redacted.)

CHAIRMAN MCDADE: Okay. Are we ready to go? We're on the record and we're in an open session. And the public has been seated. I've got two final questions back on the old synergism topic that we had this morning. Entergy, on Page 152 of your pre-filed testimony which I believe is Entergy 679, you state that fatigue in a radiation embrittlement contribute to potential aging effects in very different ways.

And then you go on to say, no basis to apply additional fatigue correction factor to address, there is no basis to apply an additional fatigue correction factor to address potential embrittlement. And it cites to ENT631 at D3. I can't find that statement at D3. Either my reading is failing or the cite may be inaccurate.

So it starts on Page 152 of the pre-filed testimony and it's discussing fatigue in a radiation embrittlement and how they contribute in very different ways. I mean, I think this is an attempt to address Dr. Lahey's thoughts of adding another additional factor to deal with embrittlement and its combined effect on fatigue.

MR. KUYLER: Your Honor, would it be possible to have Entergy Exhibit 631, Page D3 put up on the screen?

CHAIRMAN MCDADE: That would be fine. Mr. Welkie? It's not proprietary, it's just copyrighted, correct?

MR. KUYLER: Your Honor, I believe that exhibit is full text copyrighted but not proprietary.

CHAIRMAN MCDADE: Okay. Thank you.

JUDGE KENNEDY: It's quite a ways into the document. And if it leaps off the page at us, I'll stand corrected. So that's D3. I believe the discussion is related to fatigue and radiation embrittlement contributions, aging effects.

DR. LOTT: Can we go back up?

JUDGE KENNEDY: If it's going to be anywhere, it's probably going to be in that.

DR. LOTT: Yes. I think we were referring to the statement at the end of, I guess it's the top paragraph on this view at least. That the work of several researches suggest that neutron radiation does not result in further reduction of fatigue properties. And some cases suggest an improvement which is effectively a description of the discussion we've had in 6909.

However, minimal data on the combined effects of water chemistry and neutron influence currently exist in literature.

JUDGE KENNEDY: Okay. I mean I guess --

MR. LOTT: Did we present that as a direct cite? Or was it --

JUDGE KENNEDY: Well I was thinking it was a direct quote from your, in your pre-filed testimony from D3. So if that's the statement, the indication is that there's no data to support.

DR. LOTT: Well I think it suggests

that work of several researchers that neutron embrittlement does not result in further reduction. So I think that's a positive statement rather than a fairly negative statement as you suggested.

JUDGE KENNEDY: Oh I see. I got you. All right. I think I see the logic better -- I had a question about walk us through the logic but given the way the statement's worded here which is different than I had written down -- and I'll have to go back and check this out.

If your testimony is that this is the support for the statement of why no additional fatigue correction factor is warranted to address potential embrittlement --

DR. LOTT: Yes.

JUDGE KENNEDY: And I'll think about that in relation to the way it's, fold it back into the original testimony.

DR. LOTT: Okay.

JUDGE KENNEDY: So D3, the last sentence in the paragraph. I guess the first paragraph. All right, I'm going to have to think about it. I really just wanted to find the support and where I looked, I wasn't finding the words that were in the original testimony. That helps.

DR. LOTT: Okay.

JUDGE KENNEDY: Well it may help but I'll take it for now. It's the best we can do. I have a number of questions related to a safety margins discussion that Dr. Lahey has started. I'll start first with Dr. Lahey.

You've introduced a set of concerns related to the reduction in conservatisms in the CUFen calculations. And your concern appears to be that they could be reducing the safety margins. And I first want to start by having you clarify what you mean by safety margins.

I mean, we recognize we're reducing conservatisms. But I think your concern goes to a reduction in safety margins.

DR. LAHEY: That's correct. In the, what I call the limit line approach or the WESTEMS approach, what's assumed is that there's a lot of conservatism and from various sources, modeling or number of cycles or various ways that they proceed with this calculation.

As a consequence, when they make a calculation and they find that it's too high, it's above CUFen of one then they're free to go back and redo that if they can identify something that's a conservatism that's pretty obvious. And they can relax it and justify it. So they do.

And there's nothing wrong with that approach except at some point, you start cutting into -- you go from conservatisms to margins, engineering margins that allow for uncertainties. And if you keep cutting too much, you're really cutting into things that are important.

Normally, there's a demarcation for that but we see no demarcation at all. There seems to be no rules, no guidance as to what you can do or what you can't. To the point you have some components that -- I'm going to use, you know, my normal language. They're playing every trick in the book. All right?

They're doing all the things you're allowed. And they're all the way up to working in the plasticity range. And once you get there, you're pushing that thing pretty hard. You're way up there towards fatigue failure.

So to us, we believe it's very important to know what margins there are. I mean, I'm sure that the people who do that feel comfortable that there's enough residual conservatism so that that's not such a scary thing. But unless you know what that is, it's potentially pretty scary.

So that was the whole thing that I discussed earlier about how to quantify the margin.

JUDGE KENNEDY: So if I understand you correctly, you don't have necessarily a concern about reduction in conservatisms. It's constantly reducing the conservatisms and not knowing that you haven't eroded the safety margins.

DR. LAHEY: That's correct Your Honor.

` JUDGE KENNEDY: And this concern arose as you reviewed the revised calculations that were presented in the testimony. And the potential to redo those calculations, I guess at any time.

DR. LAHEY: That's correct. I mean, I've been looking at all this for eight years now. And you get a result that's high and then next time you see it, it's really low and then the next time you see it, it's halfway between. I mean it just floats all over the place.

And once it gets up, essentially to unity, then I'm very concerned. Because I don't know what's left. Is it enough?

JUDGE KENNEDY: Fair enough. Let's turn to Entergy. I think we talked a little bit about this this morning but I'm not sure we got all the way through the problem. So I thought I'd bring the safety margins discussion back up. We talked about margins and we talked about conservatisms this morning.

I guess I would like to see if you could address how the analyst knows that he can't continue to reduce conservatisms and erode safety margins. Where is the guidance for the analyst to know that they're not taking away margins that are needed to cover for uncertainties or other issues? And I'll look to Mr. Gray first.

MR. GRAY: Mark Gray for Entergy. I think the primary guidance that every analyst has in this industry is the ASME code. We must follow the code and the conservative methods that are explicitly given within the code.

As we said earlier, the code designed fatigue curve includes margin. The code methods for stress allowables -- for example, the design stress intensity allowable in Section 3 is an allowable stress with built in margin that affects factors in your evaluation.

And so, these are given margins that we must live with. We can't change. After that, as far as conservatism goes, I also have different methods that I can use within the boundaries of the code. And let me use the example.

These analyses that have been performed are still elastic analyses. They are linear elastic analyses. Now NB-3228 of the code allows you to do a plastic analysis. We have not done that yet. So at this point, we have not even gone to that. And that would be, within Section 3, that would be your next major step in reducing conservatism in your analysis.

So we haven't used that approach. We've used the linear elastic approach given in NB-3200 along with the other conservatisms that are there. There is such a thing called, in NB-3228.5 --

CHAIRMAN MCDADE: Sorry, could you repeat that?

MR. GRAY: NB-3228.5. There's a

penalty factor called K sub E which is known throughout the industry to give a very conservative correction when your primary plus secondary stress intensity exceeds an allowable value. You're allowed to that then check another equation and penalize your usage factor calculation with KE.

All of these are still in the analysis that we've been done. So at this point, even these calculations haven't used the least conservative method that the code allows.

CHAIRMAN MCDADE: And perhaps, is there any way that you can, you know, sort of briefly summarize that when the environmentally adjusted CUF is recalculated, how the analyst determines and quantifies the impact on the safety margin.

MR. GRAY: Once again, the safety margin is defined by the code. And so, the inherent margins that we're not allowed to touch, the analyst meets by meeting the 1.0 allowable in the code. And making sure that the corresponding stresses are within the design stress intensity allowables. And so, that's a place that we don't touch. And that's the margin in the analysis.

CHAIRMAN MCDADE: But what Dr. Lahey was talking about is that you look at the analysis, it is at a particular level, just it's X. That it's then recalculated and it's X minus .2. And then you look at it again and it's X minus .3.

When it's recalculated, how does the analyst determine whether that recalculation has an impact on the conservatism? And if so, what that impact is. Is there any way of quantifying that?

MR. GRAY: Your first question was how does the analyst deal with margin? Now you've asked me how the analyst deals with conservatism.

CHAIRMAN MCDADE: Well you seem to be saying that the margin is in the code itself. So that's I changed it from margin to conservatism.

MR. GRAY: Okay. So for conservatism, there are different levels of conservatism that are generally used in these analyses. For example, you group your transients. When you know that that's too conservative, when the answer is too high, you can ungroup those transients.

CHAIRMAN MCDADE: But why are those

two terms synonymous? That it's too high and therefore, it's --

MR. GRAY: Okay. I'll fix my words. When it does not meet the allowable. That's the only thing that makes it too high, when it doesn't meet the allowable. This is binary.

JUDGE KENNEDY: And by bundling them, that's an assumption the analyst has made to simplify the calculation?

MR. GRAY: Correct.

JUDGE KENNEDY: And so, they don't meet the allowable so now they're going to unbundle -- as if I know what these terms mean. Unbundle the transients and do individual calculations. And that's perceived as a reduction in conservatism?

MR. GRAY: Yes because all the transients are not of the same severity. So if I'm going to be conservative, if I have 500 cycles of different transients, I take the worst transient with the worst severity will give me the worst stress range. And I assume all 500 cycles are of that severity, that's conservative.

I can then -- if those 500 cycles are really distributed over ten different transients of different severities, I can unbundle, to use your word, those transients into ten different cases with their respective cycles.

JUDGE KENNEDY: In some ways, a more accurate calculation, maybe more reflective of the actual conditions. I don't know about accuracy but more reflective of the actual conditions. As opposed to bundling them and using a maximum --

MR. GRAY: Yes.

JUDGE KENNEDY: -- a parameter that would maximally impact the cumulative usage factor.

MR. GRAY: Yes.

CHAIRMAN MCDADE: That's your view Mr. Gray and the view of Entergy?

MR. GRAY: Yes.

CHAIRMAN MCDADE: Okay.

MR. STROSNIDER: This is Jack Strosnider for Entergy. I'd like to give a little perspective on this concept of margin in terms of what it takes to meet the regulations. I want to start off with the fact that the tendency of 55A endorses the ASME code which establishes a very clear demarcation in terms of what margin needs to be maintained.

You need to meet a usage factor, cumulative usage factor of one with those margins that are in the ASME code. And that's why you've heard numerous witnesses already testify that they don't touch that. That's what you have to maintain, the margin you have to maintain in order to meet the regulations and in order to satisfy Part 54 in terms of maintaining your current licensing basis.

The people also talk about a margin between what they're calculated cumulative usage factor is and that demarcation point of one. The example was given earlier today of what if it's .5? Then I've got a margin of .5 to one. That's not the margin that's required by the regulations. And you can go and you can recalculate and you can use up some of that margin if you want to characterize it that way.

But as long as you're meeting the usage factor of one as calculated with the margins that are in the ASME code, you're satisfying the regulations. And that is adjusted now for the environmental effects as consistent with the guidance to meet Part 54.

So I just wanted to make sure that it's very clear, the margin we're talking about that's necessary to satisfy the license renewal rule, if you will.

JUDGE KENNEDY: That's the, I guess to put it back to the original question, would that be perceived to be the safety margin at the untouchable part of the calculation?

MR. STROSNIDER: Yes, that's correct. And that is, you know, by endorsing that in the regulations, the NRC has concluded that that's what's necessary for reasonable assurance. All right, it's a regulation and that margin is there. And that's why people don't touch it and that's what you need to meet.

The rest of the margin and the conservatisms are things that people can work with. But they need to meet what's in the code as endorsed in the regulations.

JUDGE KENNEDY: Thank you. Dr. Lahey?

CHAIRMAN MCDADE: I was just going to say, our concern in understanding this is that when you take the first glance at this, you say that the environmental adjusted CUF can't exceed one. But when it approaches one, it's recalculated. And you know that it needs to be recalculated because it's approaching one.

And then if it approaches one again, you recalculate it again. So almost by definition then, it can never exceed one because before it reaches one, it's going to be recalculated. So what we need to have clear in our minds and on the record is the justification for the recalculation. And the assurance that the recalculation provides the accurate description of reality of what's actually there.

And that's, I think, what Dr. Kennedy's questions are and I think that was Dr. Lahey's concern. And we're just trying to see -- I want to make sure I understand how Entergy and the NRC staff is addressing the concern of that perception. Am I correct in what your concern was Dr. Leahy?

DR. LAHEY: Yes, sir. My concern is in this process of iterating, getting below one, that you don't throw out necessary design margin.

CHAIRMAN MCDADE: And necessary conservatisms.

DR. LAHEY: That's correct.

MR. STROSNIDER: This is Jack

Strosnider for Entergy. I'd like to address that again if I can. I think the problem is that people are dismissing those margins that are required by the ASME code. The margins are there. All right? That's what's required.

And when you recalculate because you're using a less conservative analysis method, you can do that. You haven't touched the margins that are required by the ASME code. And those margins, I mean those design rules provide margin.

The other thing I want to comment on is this notion that people keep saying that you can just redo this cumulative usage factor forever and never reach one. And that's not the case. There are examples and I know some of the people from Entergy can speak to examples where they've actually had to go in and do other actions because they couldn't.

You know, they have to change the loading or they have to change components. So it's not a given that you can always recalculate and get it less than one. All right? So I hope that's helpful.

MR. AZEVEDO: Your Honor, this is

Nelson Azevedo. If I may add some --

CHAIRMAN MCDADE: Yes, sir. Go ahead.

MR. AZEVEDO: Yes. In fact, Mr. Gray a few moments ago mentioned plastic analysis. We haven't gotten to that point yet. Some of the analysis, especially once again to the elastic plastic analysis become very expensive.

And there have been cases that I've been involved with, in fact some at Indian Point, where it's cheaper for us to either modify the way we run the plant or just replace the end component.

One case I was involved with was to pressurize a spray piping at another plant. We just chose to replace the piping. It was just more cost effective than getting to these elastic plastic analyses were very expensive.

Specific at Indian Point, back in the '90s on the charging nozzle, we use what we call the normal charging nozzle. And we were coming up to a CUF of one. And we just decided to use a different nozzle. So we changed the way we run the plant just to address, you know, these issues.

So the idea that we can just keep

going forever and ever and keep redoing these analyses, it's not practical and it's not even cost effective. If I may just say another comment, I heard statements like we play every trick in the book and manipulate these analyses.

I am the owner of these issues at Indian Point. And we absolutely make sure that we meet all our safety margins. And we do not manipulate any of these calculations.

JUDGE KENNEDY: Thank you Mr. Azevedo.

CHAIRMAN MCDADE: Dr. Leahy, do you now understand where the safety margins are?

DR. LAHEY: I like a couple of the comments and I agree with them. I like in particular, the last one. We wholeheartedly endorse that approach. My understanding is that for one of the Indian Point reactors, and I can identify if you wish, the CUF end is for the pressurizer spray nozzle rapidly approaching unity. And they have done what I call every trick in the book but they're allowed. I mean, they've done the averaging of the stresses, peak averaging, et cetera, including elastic plastic analysis. We had two -- that's the documentation that we were sent. So we've had two people say they don't do any elastic plastic analysis.

But that's very different from what we read. But the approach of, once you get to that point which is sort of pushing the envelope, then it should be a decision based on cost. And we wholeheartedly embrace the thought of replacement and make the problem go away versus keep iterating the calculation.

CHAIRMAN MCDADE: Okay. And if I could interject here, Dr. Lahey a couple of things. One, you know, when you use the term every trick in the book, we did not interpret that as a pejorative term in any way. I interpreted as, that there were certain mechanisms that are available to them and that they were utilizing the mechanisms that are identified.

The second is, you again used the term, you know, rapidly approaching unity. And as we had a discussion with Mr. Sipos before lunch, that that phrase originated with me. And perhaps it's, since it's not necessarily temporally related, getting darn close might be a better, more descriptive way of doing that.

So rather than just simply adopting

the inarticulate phrase that I used, you know, would getting darn close be a, perhaps, more accurate substitute?

DR. LAHEY: Extremely close, yes. I agree, darn close.

JUDGE KENNEDY: And again, that is darn close at end of life or today?

DR. LAHEY: Yes, calculated for the end of life or the extended operation.

JUDGE KENNEDY: Thank you. In the discussion that you heard from Entergy, did you understand there to be any reduction in safety margins or margins that you're concerned about in the approach that they've taken?

DR. LAHEY: I mean I understand the position that there's inherent margin in the ASME code. All right? We do appreciate that. That's from the error data. But now, they have other things going on. I've described some of them. The Fen factor has uncertainty. And I talked about, you know, what the real situation is in the plant versus the autoclave data.

There's a lot of things that, in the end, we would like to have some understanding of what the real margin is. If the only thing it is is this 20 cycles, factor 20 on cycles or two on stress, okay, that's where it's known. If there's other things, better yet. But we don't know what it is.

CHAIRMAN MCDADE: Dr. Hopenfeld, did you have something to add to that?

DR. HOPENFELD: Yes. Just as a note, I took a course from the father of all the ASME code, Dr. Cooper many, many years. One thing I do remember, what he said was that these things are not for modeling the margins that you have in the code off a scanner for materials variability. Some statistical as to how the stresses were counted.

They are not for stress concentration factors. They are not for the effect of the environment. They are not to affect for modeling or assumptions or input. This is up to the user.

Now according to Entergy, and I can quote it, according to them, because there is a margin there, a factor of two and a factor of 20 -- and I think they change it now. But because of those factors, they can go back and the analyst can come up with any model he feels or is in his judgment to use and he will satisfy the code. And that is just not true.

There's one example because I was concerned about the effect of it, was the effect of oxygen on the Fen. The Argonne recommended to use a certain value for a reason to which we will later go into tomorrow. They said well, we use this number, the result is too high. So it's too conservative.

In other words, the word too conservative is immediate tells you that what are they are doing, they're really shaving the margin. They are trying to get a number that they want to get.

So what you want to do to do it in an honest way, you put in your best estimate of what the input is. And in this case, you're supposed to use the conservative value of the input because it's a deterministic method. So you use a conservative value but if the result isn't, you use the result whatever it is.

But when they see the result is too high, they just say well, we changed the model. That's what they do. And that's what's wrong about it.

CHAIRMAN MCDADE: They're not just

changing it. They have to --

DR. HOPENFELD: So you can keep on going with it as long as you go back and devise another model. Now stress concentration, for example, there is a definite technical reason why there is a synergy. And what I mean a synergy, that one and one together more than one separately.

There is a symmetry between stress energy, stress corrosion cracking and metal fatigue. Both for the initiation part of it and for the propagation part of it. That additional static stress that you have due to stress corrosion cracking reduces the time of destroying the oxide layer. So it needs fixing. But they don't account for that.

This is just one example. That can go to the heat transfer too. We started discussing it. We'll get more into it tomorrow about thermal static. Most of the previous that occurred due to thermal fatigue were due to stratification. And they made a lot, all of it is based on models. They had lost but they don't have data for 20 years which is half of a lifetime of the plant.

For the thermal stratification on the pressurized, surge line on the pressurizer. There must be uncertainties. When you have data, you must have some kind of a model to come up with data. You don't have thermal data so you generate something. It's impossible to conceive that there are no uncertainties in this.

CHAIRMAN MCDADE: Okay. Thank you Dr. Hopenfeld.

JUDGE KENNEDY: One last question maybe for Mr. Gray and I'm trying to this from memory from the discussion this morning. I think we get the point about the code driven margins. And you know, I've been using the term safety margins because those seem to be areas that just aren't touched.

There are some modeling assumptions and user inputs that are adjustable. Are there likewise some user inputs, techniques that are applied to calculate the thermal stresses that are also off the table for the user?

In other words, the example I'm thinking of that comes to mind when I hear this discussion is the delta T that was applied for the stratification and the way that was done.

Could a user go in and change that? Could they do it differently?

I mean, I'm sure they can. But is that sort of thing that's not allowed within the process that you have built at Entergy for Indian Point?

CHAIRMAN MCDADE: And if I could add, and if so, what would be necessary to justify it?

MR. GRAY: The delta T is an input to the problem. In fact, my earlier example I think might be what you're talking about. Where I could look at the worst temperature difference that could ever occur across the component and use that for all the cycles that could ever occur.

But when we know better and we have information that tells us that it's not always that high, then what would be required of the analyst is to justify lower delta Ts for some number of cycles.

And for example, that's what I referred to earlier in WCAP 17199. You'll see that, for example, for the charging nozzle. That's what was done. The nature of the design transient, its shape was not changed but those values were. And those were based on a calculation and just a whole development of a methodology that had to be justified and verified by an independent verifier.

JUDGE KENNEDY: So the only rock solid margins that we can point to, the untouchables, would be the code based margins? I mean, other than the justification of changing techniques that would have to meet someone's review and approval. I mean, those are all on a case by case basis.

MR. GRAY: They are case by case.

MR. COX: This is Alan Cox for Entergy. Let me add just a little bit to that. I mean, we're talking about removing conservatisms. We're not removing all of the conservatisms. The analyst that's working for Mark doing these calculations, when he makes these changes to remove excess conservatism, he still has to justify that the result that he has or the input that he ends up with is still conservative.

The one exception I can think of to that might be the number of transients. Now you could say we're going to use a best estimate number for transients instead of using the design value. And you might say, well that's a problem.

Well it would be a problem except we have a program that's set up to monitor the number of actual transients to make sure that we don't ever go over that number without taking actions to address the situation.

So I think, you know, you never get to a point where you've taken all the conservatism out of these estimates. You always end up with a conservative input even though it may not be as conservative as where you started in the initial revision of the calculation.

JUDGE KENNEDY: So a check and balance on the reduction in conservatisms is the review of the calculation? And the need for the analyst to prove that the calculation is conservative with the new set of inputs?

MR. COX: That's correct. It's incumbent upon the analyst and his reviewer to make sure that those assumptions are justifiable.

JUDGE KENNEDY: Are these calculations all done under the Appendix B program for the station?

MR. AZEVEDO: Yes, Your Honor. This

is Nelson Azevedo. They're done under -- I can't speak for, I'm sure the Westinghouse methodology is similar to what we have at the site. So all calculations are done under our 10 CFR 50 Appendix B program.

Mr. Cox stated, they're independently reviewed and they're approved by a supervisor. In addition to that, we have an independent oversight organization. From time to time, they pull these documents and they go through and they verify that everything was done appropriately.

And on top of that, the NRC comes on site and audits as well. So it's not just the independent reviewer. It's the approver and the on-site organization and the NRC as well.

JUDGE KENNEDY: Thank you. And that brings up an interesting question. Maybe Mr. Stevens, you've heard the back and forth on the reduction of conservatisms and the redoing of calculations or refinement of calculations or whatever word that you want to use. From the staff's perspective, is there any level of discomfort in what you've heard here?

MR. STEVENS: No, sir.

JUDGE KENNEDY: So maybe to get you to

expand a little bit, what raises your comfort level in this discussion?

MR. STEVENS: This is Gary Stevens with the staff. So I guess I'll reflect first back to my discussion when I talked about two margins and conservatism. And I said, I'll call it margin one is something that's implicit or explicit in the code and we can't touch it.

And margin two is a result of our calculation and that we might be less than the allowable and there's some margin left. And then conservatism is simplifications we may have put into the analysis.

And I think the testimony has been pretty clear that nobody can touch margin one. I guess one observation I wanted to make, you know, because I think a lot of the discussion I've heard is we're trying to quantify margins. And in some cases we can do that.

I showed you factors of two and twelve on fatigue curves and two and 20. So we can quantify that. Section 3 tends to use a factor of three against ultimate failure. We can quantify that.

But there are other things that lead

to the margin one term that can't be touched. And one example that I'll give is, when you have several transients you're analyzing, how you combine those into paired loads for use in a fatigue calculation.

The code is explicit on how you do that and there's conservatism in that process. Because from a designer point of view, you don't know the order of occurrence that these loads may occur in. And the code, the way, the process they use is to take the worst case scenario of how those loads might occur to make a conservative evaluation.

So there's other things that go into that margin one term that really can't be quantified but they're explicit in the code methodology. And I tried to allude to that earlier when I talked about margin one and that there are certain design factors as well as explicit instructions in the code that lead to that margin.

So I bring that up because what the analysts can change or alter is those things that contribute to margin two and the conservatism. And where I can appreciate the observation that it seems like the analyst has an unlimited opportunity to go back and revisit those, the reality is there's not an infinite opportunity.

There were a finite amount of assumptions that the analyst would have built in. An experienced person like myself or some of the other expert witnesses, it would be a function of each analysis.

You know, they would look at an analysis and, from their own experience and industry experience and what they know about code analysis, they would come up with a list of those things that contributed to margin two and conservatism such that if they were going to revisit that analysis, they would pick off from that list those things they could do to come up with an acceptable result.

The staff doesn't have any discomfort with that process because in the final analysis, we have reasonable assurance, with our knowledge of the code, the processes used, the industry practices that have been adopted, that in the final analysis a CUF or a CUFen of less than one provides reasonable assurance that there's low likelihood of crack initiation.

JUDGE KENNEDY: All right, thank you. I hazard to look to Dr. Lahey. One final closure statement you care to make on safety margins and reduction in conservatisms?

DR. LAHEY: Well I think that it's been a good discussion. I find there's great inconsistency in the discussions we had associated with some of the issues I brought up with nodalization, heat transfer coefficient locally, that sort of thing and some other input that we had.

They can't both be true. So that's why I want to look at the record a little bit and try to understand what's happening. I mean, if in fact it doesn't matter what the heat transfer coefficient is, there's a lot of people talking about stuff that they don't have to. And a lot of write up on things they don't have to.

And why worry about the code going unstable at 8,00 BTU per hour foot square if it doesn't matter? So you know, there's things like that. But by and large, I think it was a reasonable discussion.

I want to say again -- I know for the people who have been here all the time, it seems like a long time now, three days. My overarching concern is not that you just cycle this baby until you get a crack. I mean, that's something we have to worry about.

But I'm really concerned about the weakening of the material as you cycle it. And at some point in time, you get a significant shock load which causes failure. And if that leads to a uncoolable geometry, we're in big trouble.

So I've merged all my silos with embrittlement, fatigue, and safety analysis. And hopefully, future meetings like this will involve it all. I noticed from day one, our discussion sort of covered everything. And that's a big change from when we started. Where we were told, look that has nothing to do with fatigue. You know, you're talking about embrittlement.

So I think we've made some progress. And I think in the right direction. And I appreciate the opportunity to participate.

JUDGE KENNEDY: All right, thank you. Dr. Hopenfeld, last words?

DR. HOPENFELD: I'd like to make a couple of words regarding conservatism. We can't just talk about conservatism. There must be some kind of a test to see what that really means. I can tell you what it doesn't mean.

It definitely doesn't mean that counting the number of that you repeat in your report, that you are conservative almost every second setting, that that is the proof that you are conservative. That is not proof that you are conservative.

So I would like to know when they keep on saying that they are conservative, that all their models, all their assumptions, even the over simplified model are all conservative, the inputs they used are conservative and Entergy, I mean NRC agrees with that. I'd like to know where is the test? Where is the verification of that? What's the philosophy behind it that you can show me yes, this is conservative.

And the reason it's important, because going back to what I said at the beginning, the CUFen are calculated, that's a deterministic calculation. The ASME requires you, that the burden of proof is on them, not on us. They have to defend it, not just say well, I'm conservative, the analyst thinks that this is fine. That is not enough.

And as regulations say, you have to verify it. And I don't believe that NRC, from what they have testified here, that they verify. They do not verify it.

JUDGE KENNEDY: All right. Thank you Dr. Hopenfeld. Maybe a question for, certainly related to the revision of the CUFen calculation. On Page 66, Dr. Lahey, of your pre-filed testimony which is New York State 530, you raised some concerns with these revised calculations.

Two things caught my eye. One is you had concerns related to the use of modified design transients and 60 year projected cycles. I guess first of all, what do you mean by modified design transients? And what's the problem with their usage?

DR. LAHEY: I don't actually recall the quote. But I think we did talk about the number of transients and that we have a track record. It seems right to me, if you know what the various transients are, to take advantage of it.

But you have to also remember that you have to extrapolate that out for 20 more years.

And so, you can't always tell when you're going to get a scram or some other event like that. So there has to be some margin built in.

And I take it from what I've seen, they've tried to preserve that. They've tried to do it.

JUDGE KENNEDY: Does it provide you any comfort that they're also monitoring these transients continuously?

DR. LAHEY: Yes, that's what I said. I think it's good to take advantage of what's happened historically, monitor it, you know, do a guesstimation of what it's going to be in the future, monitor it and then take whatever action you have.

And let me say why. Because we have a couple of components that I'm seriously concerned about. One we talked about that has already gone into the elastic plastic analysis so you're beyond the yield curve.

And the other one is your RHR accumulator, low pressure injection, intermediate pressure injection nozzle. So this particular nozzle is, I won't say rapidly approaching one, but darn high in CUF. And if it fails, you not only create a loss of coolant accident, but you knock our your accumulator, you knock our several of your engineering ECC system, emergency core coolant system.

If you want to fail something, that's probably the worst thing to fail. And so I think it's very incumbent upon us to make sure we don't push that margin too hard because there's some consequences for those kind of failures.

JUDGE KENNEDY: I understand your concern but is not, at least as I understand it, all the current cumulative usage fatigue values at Indian point less than one, project to the end of life today?

DR. LAHEY: They are. Some of them are hard to get to. All right? I don't want to say pulling all the tricks out but you've had to do a lot of things to get there.

JUDGE KENNEDY: All right, thank you. Another question for you, Dr. Lahey and I think it, well it comes out of your testimony. And I guess we may have to go to Entergy to get the answer. But you raised a question about the FEN values used for two similar reactor coolant system pressure boundary components. That for

IP2, they have one value and for IP3, another value.

And I think you raised the concern of why that would be. And I guess I don't have an explanation but I'm hoping that Entergy does.

DR. LAHEY: Let me tell you my guess and they can tell you what really happened. I think it's part of the game. They found in one, they didn't have to be any lower so they left it what it was and it wound up less than one. On the other one, that wouldn't do it so they did some averaging of strain rate or some other way to reduce it and they reduced it. Maybe I'm wrong, but I think that's just a reflection of this iterative game.

JUDGE KENNEDY: I guess --

CHAIRMAN MCDADE: Can we substitute part of the analysis for part of the game?

DR. LAHEY: What's that?

CHAIRMAN MCDADE: Can we substitute part of their analysis?

DR. LAHEY: Yes, sir.

CHAIRMAN MCDADE: To part of their game?

DR. LAHEY: Right. It's so much fun

to do stress analysis, I can tell you.

JUDGE KENNEDY: I may not have been clear on my question. I think you pointed to the FEN values for these components. That you indicate they differ substantially and you don't understand why they would between IP2 and IP3. And unfortunately, I didn't write down what this component was. It's on Page 28 of New York State 568. Maybe we could look it up. I don't know. Andy, is it something you could put up? 28 of 568, New York State.

DR. LAHEY: I have to get the -- oh you're going to put it up? Okay. Is that not it Andy, or was it? It's 568 which -- is it Dr. Lahey's supplemental pre-filed testimony on the cover?

567 has -- specifically 567, Page 28 it makes, for example, for the RHR accumulator nozzle fatigue analysis for IP2, it has a FEN of 13.8 and for IP2, 7.79 for IP3.

DR. LAHEY: So I gave you my guess as to why but I'd love to hear what the real reason is.

MR. GRAY: May I offer an answer to that?

JUDGE KENNEDY: Answers are good.

CHAIRMAN MCDADE: We hope so.

JUDGE KENNEDY: Go ahead.

MR. GRAY: Yes. I think it's a misunderstanding of the value that's in the table in the report. The process that's used to calculate the CUFen is using what the new regs call the modified rate approach. The modified rate approach actually calculates an integrated Fen based on the details of the stress cycle history for every fatigue pair.

And so, there's an integration done -- and this is described in our WCAP, of how that's performed. There's an integration done for the stress cycle applying the Fen equations for each one of the fatigue pairs that are then summed to give you a cumulative answer.

The details of all of that aren't, they're in the calculations but they're not in the final report. So that Fen is an effective Fen that you get from dividing the integrated CUFen that you did with that complicated process, divide that by the CUF before you did that. So that's an overall effective Fen.

So when you do that process for the

two different units, the inputs for the two units are different. They're a different number of cycles of different transients. Different transients will pair causing different strain rates to be used in those integrated processes.

So because they're a different number of cycles of different transients and all of those different fatigue pairs, it's very conceivable that you're going to get a final answer that's different. And then when you couple that with the fact that because the cycles are different, the CUF without the environmental factor, those were also different, that overall effective ratio is going to be different.

JUDGE KENNEDY: So it comes down to different transients for the two different plants? Different operating history?

MR. GRAY: Yes.

JUDGE KENNEDY: Dr. Lahey, does that help?

DR. LAHEY: Yes, I understood that. I mean, sort of, I view Fen as an environmental correction factor and it depends on various variables like oxygen content. So I'm not sure how all that is consistent but I understand what they've done.

JUDGE KENNEDY: Thank you.

CHAIRMAN MCDADE: Okay. Just a follow up. I mean, on the face of it, it would seem like these two would be relatively close given the relatively similar history of the plants. They would both have the same, basically the same water chemistry program. Although IP2 went online earlier, would have more transients. But wouldn't it, why is the number so different? Mr. Gray?

MR. GRAY: Mark Gray for Entergy. This is mostly going to be a function of the way, not only how long the plant ran but the way the plant was operated. And especially on these nozzles, you could have more safety injections, for example, at the beginning in life from testing or whatever other phenomena could happen in the operation of the plant. So yes, these things can be variable from unit to unit.

CHAIRMAN MCDADE: Okay. And there would be a sufficient difference in the way the plants were operated to, you know, explain the significant difference or at least the size of the difference between the two?

MR. GRAY: Yes, there could.

CHAIRMAN MCDADE: Okay.

JUDGE KENNEDY: Entergy, in responding to Dr. Lahey's interest in having an error analysis performed, you responded that the EAF calculation is deterministic and therefore, an uncertainty analysis is not required. What do you mean that the EAF analysis is deterministic? And I'll take anybody.

MR. GRAY: Mark Gray for Entergy. The term deterministic is in opposition to a probabilistic method where in probabilistic methods, error analyses are more appropriate and often done. And deterministic approach, as we have already discussed, chooses inputs that are chosen to be conservative inputs to give you conservative outputs.

JUDGE KENNEDY: So the uncertainty in various parameters is dealt with by selecting conservative inputs? Is that what you're saying?

MR. GRAY: The worst case or bounding value, yes.

JUDGE KENNEDY: So by properly selecting conservative inputs, you're suggesting that an error analysis is unnecessary?

MR. GRAY: Yes.

JUDGE KENNEDY: Dr. Lahey?

DR. LAHEY: Well I think we discussed that in great detail this morning. And hopefully, I allayed their fear that I was not looking for a probabilistic analysis. What's called an error analysis is this propagation of error type of uncertainty analysis that you apply to best estimate or such things.

And I gave the example of power equals I square R. So everything's deterministic but it gives you a measure of the uncertainty in the prediction.

JUDGE KENNEDY: Do you feel that the approach that Entergy has taken in performing these calculations by using conservative assumptions sufficiently covers the uncertainty in the inputs?

DR. LAHEY: No, Your Honor. I still have no clue as to what the margin really is. As they get up very close to unity, I don't know what the margin is compared to a best estimate plus uncertainty. Is it more or less? I mean, are they really where they think they are? Or are they on the other side of the line?

JUDGE KENNEDY: Thank you.

JUDGE WARDWELL: Can I interject some additional for Mr. Gray if I might? I believe your quote was, an uncertainty analysis is not required for a deterministic evaluation. That isn't necessarily an error propagation analysis, is it? As was highlighted in our earlier discussions looking at the cartoon that Dr. Lahey had put up.

MR. GRAY: Mark Gray from Entergy. My interpretation is that those would be synonymous terms.

JUDGE WARDWELL: The error propagation, as was discussed earlier, isn't that almost limited to deterministic analyses? You wouldn't need to do that with a probabilistic uncertainty analysis, would you? It's just the opposite of what you're stating it seems to me.

MR. GRAY: I don't see the connection you're making, no.

JUDGE WARDWELL: Dr. Lahey?

DR. LAHEY: You're correct Your Honor.

JUDGE WARDWELL: Thank you. I'm not thanking you saying I'm correct. I just wanted to make sure what your opinion was.

MR. COX: Alan Cox for Entergy. I'd like to add one point. I mean, when we talk about an error analysis, I mean what we're doing with the approach that we're using for these analyses, I want to say we're intentionally introducing errors in the conservative direction.

So it's not clear to me how you could get any benefit from an error analysis when you've intentionally not chosen the best estimate values. You have erred on the conservative side in all of your inputs. So what, you know, I see limited value in doing an error analysis when you've intentionally skewed your results in that direction.

JUDGE WARDWELL: Well okay. Let's talk about that a bit then. Why couldn't you come up with a best estimate, a best guess of what you think the actual CUF calculation should be? Is there any reason why you couldn't do that?

MR. COX: Well I think Mr. Gray talked about that a little bit this morning. It would be a difficult task because of all the --

JUDGE WARDWELL: Regardless of the difficulty. I understand why you may not want to do it. I'm interested in, could it not be done? That is taking your best guess at all your input parameters of what truth is.

MR. AZEVEDO: This is Nelson Azevedo for Entergy. Yes, Your Honor, you could do a best estimate analysis.

JUDGE WARDWELL: So by definition, that best guess is your best guess with what would be taking place there. And those input parameters, even though you still have that, will have some plus or minus associated with that. Would that not be correct in some of the cases? They're not absolutes.

MR. AZEVEDO: Well Your Honor, the difficulty comes in how you quantify that. I mean, if you have --

JUDGE WARDWELL: I fully understand the difficulty. Don't get me wrong. I'm not saying you should necessarily do this. But I'm countering your testimony that says uncertainty analysis isn't good for deterministic. And that I understand. But I don't think that's the same as an error propagation where it's only limited to basically, deterministic analyses where you're taking the error bars around a parameter input that you have and then seeing how that propagates. So that you can have an estimate of what is the total plus or minus once you're done through your calculations. And I'm just saying, could not that be done?

MR. AZEVEDO: This is Nelson Azevedo for Entergy. Yes, Your Honor, it could be done. Personally, I don't see how that would be different from what we already do which we take the penalty up front by assuming conservative values and then just do it that way. Also, if I may add --

JUDGE WARDWELL: Can I? Save your thought because I want to address hat comment first and then give me your next comment. Because you'll lose me and I'm going to put the burden on you to remember what you were going to say rather than me trying to remember when I'm going to ask you a question on your first statement. So I cheat because I've got the gavel. Or he's got the gavel and will let me use it.

Isn't the difference that with doing it up front, when you get to the very end and you have a number, you don't know what the plus and minus is around that number. Where if you did it the other way, you would at least have some estimate of what that might be. Would not that be the case?

MR. AZEVEDO: That is true. We don't know what the delta. However, what we do know is that whatever that number is, its below what we calculated.

JUDGE WARDWELL: Yes. And you know that in both too. But I just, I wanted -- so you do agree that at least there is some difference because you at least have some estimate of that number?

MR. AZEVEDO: Yes, I do agree.

JUDGE WARDWELL: Now what was your second comment? And I hope you forgot it because then I don't have to worry about it.

MR. AZEVEDO: What I was going to say is both the paper that's referenced by New York State on this issue and other papers that I've looked at and on the internet, this idea of propagation of error in similar evaluations are really applicable to random data.

Like if you're doing a test, you're collecting a lot of data and you want to analyze the data. This is definitely appropriate. In this case, I really don't see how that's appropriate.

JUDGE WARDWELL: Thank you. That's helpful.

DR. LAHEY: Your Honor, that is really incorrect statement. This is not for random data.

JUDGE WARDWELL: Do you have a comment on that Dr. Leahy?

DR. LAHEY: It's craziness, what you just heard.

CHAIRMAN MCDADE: Do you want to elaborate on that Dr. Leahy? You said this is not random data.

DR. LAHEY: No. I think the real confusion was -- I mean, I've been asking for what's the uncertainty, what's in their analysis for a long time. And I thought sort of everybody knew what that meant. But apparently not because when I send a reference, a book that we use at university in sophomore level so people know how to treat random data, how to treat deterministic predictions with plus or minus uncertainty.

The comment that came back is we don't

deal with random data, we do deterministic calculations. So I thought okay, let's try it again. And so finally, you know, I sent them the formula. And so I don't see why they're still thinking it's random data.

What I'm talking about is a deterministic calculation. And then you have a process which is called propagation of error. Kline and McClintock goes way back in time, been used for decades. And it will allow you to work out what the plus or minus uncertainty is.

It's wide used by experimentalists. That's how you get the error bars on your experimental data. So it has mothing to do with randomness.

CHAIRMAN MCDADE: Can you explain in, say a minute or less, what a propagation of error analysis would consist of?

DR. LAHEY: I didn't write it. Do you want me to write it?

CHAIRMAN MCDADE: No. Just explain it.

DR. LAHEY: It's the partial derivatives. You have a function of a bunch, the result is a function of a bunch of variables. So

CUF N depends on a number of things. So you take the partial of CUF N with respect to the first variable times the uncertainty in that. All right? You square it. Plus the partial of CUF N with respect to the next variable.

CHAIRMAN MCDADE: And how do you determine the uncertainty in each of these?

DR. LAHEY: It depends on what the variable is. You know, depending on the variable, you have information as to the uncertainty.

For example, if you did a best fit calculation, one of the parameters you'd have in there would be the Dittus-Boelter correlation. The Dittus-Boelter correlation has a plus or minus uncertainty of 25 percent. So that would be what you'd use there.

You go to the next variable that they're using. What's your uncertainty in flow rate, et cetera, et cetera. And you add them all up and then you wind up with this final estimate of the uncertainty. That's wide used.

The assumption behind it is you have independent errors or independent errors in these parameters. If you have couple errors, then there's another formula which has second derivatives we could talk about. But this, I think, would be a very useful exercise because for the first time, we can see how they, where they are when they're up against the limit.

Is there significant margin? If that error bar is below the limit line, I for one am pretty comfortable.

CHAIRMAN MCDADE: Okay. To Entergy, in light of the way Dr. Lahey just explained the propagation of error analysis as he understands it and believes that it's documented. What does that, what is random data? How does that fit in or affect that?

MR. AZEVEDO: Well Your Honor, this is Nelson Azevedo for Entergy. The basis for my statement is New York State 347, Page 311. And in the middle of the page, it says propagation of error formulas. For 5.58, 5.59 and the box starts, if X, Y, and Z are independent, random variables and G is well behaved. So that's where it comes from, from New York State Exhibit 347.

DR. LAHEY: So maybe I shouldn't have used the word random. They're independent variables. They're uncorrelated variables is what I meant.

CHAIRMAN MCDADE: Okay. But the question is, in a deterministic analysis, why is Entergy not doing a propagation of error analysis?

MR. AZEVEDO: This is Nelson Azevedo again. Again Your Honor, because we feel that the conservative assumptions that we're making by assuming conservative values bounds the problem that we're solving. So doing a -- personally I, maybe somebody else in the Entergy panel can speak to.

But personally, I don't know how to calculate these kinds of errors in a deterministic manner. I know in a probabilistic manner.

MR. STROSNIDER: This is Jack Strosnider for Entergy. I have some experience in performing probabilistic assessments of structural integrity issues. So my perspective on this -- and I think there may be some semantics here.

But I think in the first case, when you talk about a propagation of error analysis, as Dr. Leahy said, that's typically the way experimentalists, that's what they talk about doing. And it has to do with measuring. All right? Measurement errors and the various, the variables in an experiment that you're measuring and how you propagate those errors through the measurements.

If you want to look at a structural analysis from an uncertainty point of view, what you would do is a probabilistic assessment which means that each variable in the analysis, you treat as a random variable and then you put together a distribution.

And that's one of the challenges here, is if you really want to do an uncertainty analysis on a structural evaluation, you need a distribution. You need to know the shape of the distribution, you need to know the parameters of the distribution. And then you can go -- and you need to know their dependencies, if there are any.

Then you can go through and you can do an analysis. And when you want to understand the uncertainty in that, you do that by performing sensitivity studies and by doing calculations, for example, to look at confidence intervals based on the amount of data that you have and those sort of things.

It's a very sophisticated analysis, not easy to do, to collect all that information and do it properly. Now when you look at the deterministic analysis, you're taking each one of those random variables, you're making an assumption about what that variable is.

Typically and as explained in this case, a conservative assumption. And you run your analysis with that. One insight I want to share is that what you typically find, any time you compare deterministic analysis with a true probabilistic assessment where you assess the uncertainties.

If you look at, for example, a 9595 confidence level on an outcome from a probabilistic assessment of a structure, it is almost always lower than the numbers that you get when you do the deterministic analysis and assume all those bounding values.

When you assume all the founding values as they're doing in these analyses, you come out with things that are very, very high confidence levels, 9999 kind of stuff which, you know, typically what's used in these in these structural evaluations is 9595. That's what the NRC has found as acceptable.

So I don't know if that helps. But I think that's the range of the type of analyses that you can do. There's no -- to come back to doing this sort of uncertainty analysis which would probably be the more appropriate. You know, if you were going to do something, that would probably be what you want to do.

First of all, there's no requirement for it. The experience shows that when you do a deterministic analysis with bounding values, that you're going to come out with higher confidence levels than you would by doing the random, you know, the random probabilistic assessment.

And I just want to come back one more time to re-emphasize that the margins that are established in the regulations and the margins that are established in the ASME code, those things are not put in there lightly. All right?

There's a lot work. The ASME code is a consensus code. You've got some of the best people in the country. You've got the NRC participating. And they're looking to put the right levels of conservatism in those evaluations. And the NRC doesn't put it into regulations until they have it there.

So I don't know if that's helpful. But like I said, I've done probabilistic risk assessments on pressure vessels and piping and steam generator tubes. You know, when you do the deterministic analysis, it comes out with a higher confidence level than these other types of evaluations. That's what you typically find.

CHAIRMAN MCDADE: Okay. And Dr. Lahey, as I understand what your concern here is, is that in the absence of a propagation of error analysis, it's not possible to quantify with any degree of certainty, the margin of error. And that therefore, you are not sanguine that the conservatives built in are adequate to ensure, provide reasonable assurance with regard to the continued viability of the component. Is that correct?

DR. LAHEY: Yes. What I'm looking for -- yes sir, it's correct. I'm looking for some indication that the margin that they think is there is really there. This is one idea to do it. I don't disagree you can do a more sophisticated analysis. But that isn't what I think we need to do here.

Rather, I think we should assume, in the best estimate, the ASME code is there. All right? So you take care of that there. Same in your limit line. And then all the other parameters that affect the CUF end, those are things that you can get either analytically with the derivatives or numerically by running it with different ones and dividing it by the same and you get the numerical derivative. All right?

It's a very doable thing and it would give a lot of confidence in terms of where we're at.

CHAIRMAN MCDADE: And Mr. Azevedo, as I understand the position of Entergy is that given the margins that are built into the code and given the conservatives that are also present in your analysis, that you are satisfied that even with these adjustments, there are sufficient margins and conservatives left that were not close to falling out of, you know, that they still provide reasonable assurance. And they do it by, with a significant degree of reliability.

MR. AZEVEDO: Yes Your Honor, I agree

with that.

CHAIRMAN MCDADE: That's your position?

MR. AZEVEDO: Yes it is.

CHAIRMAN MCDADE: Okay. And Dr. Hiser, Mr. Stevens, what's the view of the NRC with regard to this?

MR. STEVENS: This is Gary Stevens of the staff. I think I can point you to a couple things in our testimony and in the exhibits that'll help out with this. First I'll say that, you know, the code approach that's being used to calculate CUF is not unique to that.

There are many other integrity evaluations that are done using code throughout the regulation that are consistent. And the intent is to use bounding values of inputs that lead to very conservative results. That's the definition of a deterministic evaluation.

I support the testimony regarding probabilistic. But if I go with the flow here, and I think what I'm hearing is what happens if I tweak some of the inputs in the analysis? How much does it affect the analysis?

And as you heard Entergy testify

earlier in response to Dr. Wardwell's question, yes it's possible to do that. It's very difficult but it's possible. And in fact, over the course of the history of the industry, there have been some attempts to do that.

I'm going to refer you to our testimony, Answer 163 on Page 177 of NRC 168. As you can imagine, some of these analyses get quite complicated. And the number of inputs you could potentially adjust for best estimate is large.

Our testimony here talks about adjusting one of the those which is the input loading. There's been many studies and we point out one, or actually two here, that looked at instead of using bounding design basis transients, what's the effect on CUF if we use best estimate transients like those actually experienced in a plant?

And so, if you will, the analysis that's cited here which is in NRC Exhibit 175. It's a 1973 pressure vessel and piping technical paper. That was an example of analysis that looked at, if all I did in the evaluation was to change the transient definitions to best estimate, what happens?

And what's been shown for more than 30 years now throughout the industry, that has a very overwhelming effect on CUF. It drops by as much as two orders of magnitude. What you get from these studies -- and there was also some in new Reg CR6260. I don't have the exhibit number for that off hand. It is one of the exhibits.

Similar things were done where they looked at not only transient severity, but some other inputs. And I'll put it in, they looked at best estimate type adjustments to those. And what you conclude from this wealth of experience is that when you look at best estimate evaluations of CUF, it drops substantially, if you will, the delta bar down from what we're calculating is orders of magnitude.

And what you conclude from those is that the calculations we're doing are very, very conservative. And if we were to go down the path of doing an error propagation analysis, we in fact would show that we have is very conservative.

So I would direct you to our testimony there. And that is just one example of how the industry has looked at best estimate types of estimates of CUF and the impact of that and what those errors might be.

CHAIRMAN MCDADE: Okay. Thank you Mr. Stevens.

JUDGE KENNEDY: All right, thank you. Moving on a bit, moving away from uncertainties and margins. I have a couple questions for Dr. Hopenfeld. On Page 4 of your pre-filed testimony which I believe is Riverkeeper 142, you raised concerns about failing to consider the impact of dissolved oxygen in the refined fatigue evaluations.

First of all, is this in regard to the environmental assisted portion of the calculation?

MR. HOPENFELD: Yes, in regard to the calculation of the Fen.

JUDGE KENNEDY: Relative to the Fen? Is that what you said?

MR. HOPENFELD: The Fen, yes.

JUDGE KENNEDY: It appears to me that the equations that Entergy's used for adjusting for environmental factors accounts for dissolved oxygen. Do you agree with that?

MR. HOPENFELD: No.

JUDGE KENNEDY: And why don't you agree?

MR. HOPENFELD: The equation they're using I agree. But how they use the equation, I don't.

JUDGE KENNEDY: Okay. So the equation is capable of accounting for dissolved oxygen?

MR. HOPENFELD: Oh sure.

JUDGE KENNEDY: Is that what you're saying?

MR. HOPENFELD: Yes.

JUDGE KENNEDY: But Entergy, in their calculations are not properly accounting for the dissolved oxygen?

MR. HOPENFELD: That's correct.

JUDGE KENNEDY: And why is that?

MR. HOPENFELD: Okay. This is an important subject and I feel that, from the testimony that Entergy provided and NRC, they don't understand how that Fen was obtained. So give me a minute or second just to go through it.

These tests were conducted in the little autoclave, like 20 gallon, little system where the water was circulating. The measurements temperature, the measurement of oxygen were extremely accurate. They were taken all the time. They knew exactly what happens at the surface with the oxygen.

So when the measurements of oxygen was taken, that reflected what happened with oxygen. Because this was a very small, small tiny little system. The water was pure, everything was clean, everything was known. And imagine if there were billions. They're not using continuous online but almost continuous online measurements.

Now what they said, what Entergy says or it's their perception that the Fens, as they were generated in these little tests, are directly applicable to the reactor system. Because everything in the Fen that was measured is really is directly applicable to the coolant chemistry of the reactor. And this is absolutely not true.

Again, what you are measuring, what you're supposed to do in calculating the Fen, you're supposed to put as specified by Argonne -- and they know what's involved in them, they ran the test. They know what you have to do.

And what they specify that you have to

calculate, you have to put it into the equation the -- for carbon steel you have to put the maximum oxygen during the transient. For stainless steel, you have to put the minimum oxygen you extract.

Now, they realized that we don't know that. There's no mention of it. Nobody sits there. In the plant, you measure the oxygen in the bulk, sometimes for the sampling, which also, you have to have a lot of correction. You do it maybe once a week. I don't know how often they do it but they don't do it during the transients.

So what Argonne has done and EPRI too, they specified look, if you don't know what it is, here's a guideline, use Form 4. And Entergy looks at it and said, .4, I get numbers larger than one if I use that. That is too conservative.

In other words, what I'm saying, when they talk about conservatism, they're not talking about conservatism. They're talking a number that they can adjust. And they're going to quote something conservative that's not conservative. The number they get to find an answer they want.

Now Argonne was very specific as to

what number should be used during the transient. EPRI was very specific. And they said no, we don't have to worry about that because all we have to do is use the steady state concentration during the transient.

But this has nothing to do with what happens at the surface. It's completely two different animals. Furthermore, now somebody at Westinghouse probably understood the problem. And what he did and he realized it -- and from my testimonies, I think other people in the country realize the problem.

It's not a simple thing to do, the way they are rationalizing it. What the person from Westinghouse -- I spent three or four pages on that. They said, look we know oxygen gets into the system during the heat up period. And when it gets in there, however, look at the equation.

The equation, it doesn't matter. In other words, he's saying and then he calls down and say, well the equation says that if the oxygen -- when it gets in there, that a temperature of 150 then the term in the exponential cancels out and it doesn't matter. And this is true.

But then he says it doesn't matter. He says well but, we have proven an assumption. Because originally, they made an assumption that oxygen is .05. What they said that we have proven with this equation that oxygen in the plant is .05.

That's equivalent to saying that you can have some equation that was the Fen equation that was done in laboratory as predicting its own input. That's exactly what it says. And then they extended that to the case that where they applied zero oxygen throughout the transients.

Now I have asked, we've asked for the last four or five years, please give us data on the transients during the heat up and cool down. We never got the answer. And I know there is such a thing because EPRI produced such data for BWRs.

And you can see that during the transient, the oxygen changes by orders of magnitude as the temperature changes. Now the first criticism that we got was, well this is not up to us because this is high oxygen, this is BWR.

It was the principle that I was

showing. During the transients, things change. Argonne, EPRI, all specified you have to account for oxygen during the transient and you have to use the maximum value. Well they say now the maximum value is .005 which is the steady state value. But that has nothing to do with the transient.

Now I don't know the physics of it, of oxygen mechanism during the transient for a particular component. This is not, I hope so, this is not a tiny little system about that size. In comparison, it's smaller than that. But you can get and you can see everything.

You're measuring and you say, well that's what's going to happen somewhere in the reactor vessel. These are two different animals. And they keep coming back to it and using .005 in the calculations. So when I put the number of .4 ppm which Argonne recommended, it's not my number. I cannot put a factor of five on the Fen which translates the factor and the CUF.

So you see, when I was telling you this morning that uncertain in the Fen which is a factor of three. That's just inherent uncertainty of expressing the experimental data.

That's all it is. That's in there, you can't get away from that.

In addition to have, you have these input calculations. Now if you go back -- if they want to do a deterministic analysis, do you say, look I don't know what the oxygen is but it's my responsibility to look at the end point. No matter what, even if I don't know, if you would happen to describe it, I have to use .4. That's what they're telling me that's an end point.

But the person from Entergy looked at it and said oh we're not going to use that, that's too conservative. So you see, they choose what conservatism that goes back to the modeling.

JUDGE KENNEDY: So Dr. Hopenfeld, your concern is they're not using a proper transient based dissolved oxygen content?

MR. HOPENFELD: I am concerned that during the transient, they should be using, during the transient they should not be using the steady state value of .005. They should be using the number that was specified by Argonne, the people who designed and ran these experiments. That's what they should be using instead of just

I will use something that, theoretically, it was calculated that we are running, that the reactor runs at .005 during the transient. That's just not true.

JUDGE KENNEDY: So the recommendation of EPRI and the Argonne people is to use .4?

MR. HOPENFELD: Correct.

JUDGE KENNEDY: For this parameter if you don't know the transient values?

MR. HOPENFELD: Yes. Take a look at NUREG-6905. Hopefully I remember this, at 85. Okay. 6909, I'm sorry, at A5.

JUDGE KENNEDY: Page 85?

MR. HOPENFELD: A5. A, it's Appendix 5 on the bottom.

JUDGE KENNEDY: All right, thank you. Entergy, do you have a response to the transient issue here, the issue with the transient dissolved oxygen?

MR. COX: This is Alan Cox. Let me start out and some of my colleagues may want to jump in here. But the first point I'd like to make is we're not using the steady state value. We're using a value that is an order of magnitude higher than the steady state value.

The normal operating concentration is .005 ppm, five ppb. And the threshold in the equation that we're using is .05. So it's an order of magnitude higher than our normal operating concentration. And we've not seen anything to indicate that, during a transient, that oxygen spontaneously appears in the system in such a way that it increases by an order of magnitude to where it would exceed that particular threshold.

JUDGE KENNEDY: Is it possible to measure the dissolved oxygen during a transient? I mean, is this being monitored continuously? Would the system be able to pick up that difference?

MR. COX: It's monitored at a point. I don't know that we see any changes during transients. It's monitored at one point in the system. The other I'd like to point out, there's a difference in BWRs and PWRs here.

In a PWR, you run with a hydrogen over pressure so that scavenges the available oxygen. That's what allows us to keep the numbers as low as they are. In a BWE, your primary system goes into, turns into steam, goes through the condenser. You can't fill your condenser with a bunch of non-condensable hydrogen gas. So you don't have that ability to control oxygen with hydrogen.

So it's a completely different scenario. In the BWR world, there is an EPRI program that's used to calculate the oxygen at different points in the system. Because it does change much more drastically than it does in a PWR.

JUDGE KENNEDY: Anything from anyone else on the Entergy side?

MR. AZEVEDO: This is Nelson Azevedo. Just to add to your question, Your Honor. We monitor the oxygen about ten times a day. They'll have a data sheet here in front of me. I guess we could monitor more often but that's how often we monitor now. So it's monitored pretty often and we have actual values.

JUDGE KENNEDY: Do the values display much variation through the day? This is an example.

MR. AZEVEDO: No. They're obviously different when we are shut down. But once we start up, we add the hydrogen and the hydrazine to the primary side which essentially scavenges all the oxygen. And then from there on, until we open up the system again as Mr. Cox said, it's about five ppd.

JUDGE KENNEDY: How would --

CHAIRMAN MCDADE: Is this all part of that water chemistry AMP we discussed the other day?

MR. AZEVEDO: That's correct.

JUDGE KENNEDY: If I understand what Dr. Hopenfeld's saying, there's a recommendation on the table from EPRI or Argonne or both that indicates if you don't know the dissolved oxygen during a transient, a value of .4 would be applicable. Is this a case that's, should you be using .4 for Indian Point?

MR. AZEVEDO: This is Nelson Azevedo again. Mr. Gray or somebody can jump in. That is when you don't have actual numbers. We have actual numbers, measured numbers. And again, as Mr. Cox said, during a transient, oxygen does not spontaneously generate in the reactor coolant system.

So we feel that we're very conservative. In fact, an order magnitude higher than what we're measuring.

JUDGE KENNEDY: Mr. Gray?

MR. GRAY: This is Mark Gray for Entergy. The reference in new reg CR6909 on Page A5 says that the dissolved oxygen values obtained from each transient constituting the stress cycle for carbon and low alloy steels, the dissolved oxygen content, DO, associated with the stress cycle is the highest oxygen level in the transient, et cetera.

That last sentence says a value of .4 ppm for carbon and low alloy steels and .05 ppm for Austenitic steels can be used for the DO content to perform a conservative evaluation. So that implied that when you don't know the value, when you have nothing to go by, that's the conservative input to the equation.

They operate the plant according to a spec that gives a maximum value for dissolved oxygen. And I won't reiterate what these gentlemen have already said.

The other important thing to recognize though that may have been mischaracterized is the new regs from Argonne have repeatedly said, not just 6909, that in order to have this environmental effect, that you have to have a combination of the parameters to be above their threshold limits to have this environmental effect.

We refer to that in our answer -- sorry, I have to put my glasses on. On our answer 184 in our testimony. In new reg CR6815, for example, that's Entergy 225 where the new reg says that it's the product of the transformed strain rate oxygen and temperature values is based on experimental data.

And we quote that new reg that says it's significant. The environmental factor is significant only when four conditions are satisfied simultaneously. When the strain amplitude temperature and dissolved oxygen and water are above certain threshold values, and the strain rate is below a threshold value.

So going back to the point that was made before, when the temperature is below it's threshold value, even if I use this maximum DO value, the Fen is still at its threshold value. The equation that they've given us to use in the new reg reinforces this statement that is made in the new reg.

That unless the product of those parameters is non zero, I don't get a higher Fen.

JUDGE KENNEDY: Thank you. Maybe Mr. Stevens or someone from the NRC, any concerns with the application of the dissolved oxygen factor for Indian Point?

MR. STEVENS: This is Gary Stevens for the staff. No, Your Honor. In general, I agree with what Entergy has testified and how they characterized the statement in new reg CR6909.

JUDGE KENNEDY: All right, thank you. Dr. Hopenfeld, the final word?

MR. HOPENFELD: My final word is that they disregard the guidelines that both -- the NPR47 I believe.

JUDGE KENNEDY: Could you say that again? I missed that last --

MR. HOPENFELD: NPR 47, it's EPRI guidelines also indicated that you have to input into your equation the maximum oxygen, the oxygen during the maximum -- the maximum amount of oxygen during the transient.

But all they are talking about is steady state. And EPRI made it very clear that this has nothing to do with what we are talking about. The oxygen during the transient is not what they are talking about.

Again, I was going back to this little test. That little test is a measure value of oxygen that really happens at the surface. He's talking about adding hydrazine as a catalyst. You have tons and tons of material. You've got all kind of reactions going on in there. You don't know what it is.

You cannot use this analytical equation to tell me that it predicts what the oxygen is in the plant. That's what they say.

MR. STEVENS: Your Honor, may I?

JUDGE KENNEDY: Go ahead Mr. Stevens.

MR. STEVENS: Gary Stevens, NRC staff. I'll comment on NRP47 because I was a co-author of that document. And I'll just say that in there, there are some guidelines for treating dissolved oxygen on a time averaged approach. And I'll just say that from the testimony I've heard and read, that Entergy's approach is consistent with that.

Second thing, I think we need to correct a few things for the record that were stated here. I had some difficulty understanding

Dr. Hopenfeld but there was a lot of discussion regarding the experimental set ups that Argonne National Laboratory used to collect this information.

And I heard some mention that dissolved oxygen was measured at the surface of specimens and its relevance or lack thereof to components. And that's not true. One of the -- in New York State 356, there's a good discussion of the experimental setup and tests in Section 2 of new reg CR6583 which is New York State Exhibit 356.

And what you'll see in there very clearly is that, that would be a very difficult achievement to measure dissolved oxygen at the surface of a component. It's measured, the bulk dissolved oxygen content of the fluid in the circuit is measured in those tests. There's a figure that shows that in that section and a nice write up on how those tests are conducted.

And that's entirely consistent with how dissolved oxygen measurements are taken in the plant. So there shouldn't be any concerns about inconsistencies with dissolved oxygen measurements between test setups and plant measurements.

JUDGE KENNEDY: All right. Thank you Mr. Stevens.

CHAIRMAN MCDADE: It might be appropriate, we're approaching 6:00, we've been going for a while. It might be appropriate to break until tomorrow morning. I would propose that we start at 8:30. Does that pose any problems?

MR. HARRIS: No, Your Honor.

MR. SIPOS: No, Your Honor.

MR. ROTH: No, Your Honor.

CHAIRMAN MCDADE: Okay. I believe we had one homework assignment. I guess Mr. Gray identifying documents about the way Entergy's WESTEMS handles the coupling, thermal couple data.

DR. LAHEY: I understand that to mean how we treated the thermal couple data in the development of the transients.

CHAIRMAN MCDADE: Okay. That said, we are in recess until 8:30 tomorrow morning. Thank you.

(Whereupon, the above-entitled matter went off the record at 5:45 p.m.)