RAS M- 184

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Entergy Nuclear Vermont Yankee

50-271-LR; ASLBP No. 06-849-03-LR Docket Number:

Location:

Newfane, Vermont

Date:

Tuesday, July 22, 2008

DOCKETED USNRC

August 15, 2008 (4:00pm)

OFFICE OF SECRETARY RULEMAKINGS AND ADJUDICATIONS STAFF

Work Order No.: NRC-2296

Pages 880-1177

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2	NUCLEAR REGULATORY COMMISSION
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4	ATOMIC SAFETY AND LICENSING BOARD
5	HEARING
6	
7	In the Matter of:
8	ENTERGY NUCLEAR VERMONT
9	YANKEE, LLC Docket No. 50-271-LR
10	and ASLB No. 06-849-03-LR
11	ENTERGY NUCLEAR OPERATIONS,
12	INC. (Vermont Yankee Nuclear
13	Power Station)
14	
15	Tuesday, July 22, 2008
16	
17	Windham County Superior Court
18	7 Court Street
19	Newfane, Vermont
20	
21	BEFORE:
22	ALEX S. KARLIN, Chair, Administrative Judge
23	RICHARD E. WARDWELL, Administrative Judge
24	WILLIAM REED, Administrative Judge
25	
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PROCEEDINGS

2	8:30 A.M.
3	JUDGE KARLIN: Good morning and welcome to
4	the second day of hearings of the Atomic Safety and
5	Licensing Board proceeding in the Vermont Yankee
6	application for license renewal. I'm not going to go
7	through the long introduction of yesterday and
8	hopefully that will suffice, but I did want to mention
9	a couple of things before we get started.
10	First is a housekeeping matter. Just
11	please remember to turn off your cell phones and those
12	sort of things so they don't interrupt as we're going
13	along.
14	Second, I would hope that we all try to
15	speak clearly and loudly for the audience, for the
16	public to hear and that the witnesses will also speak
17	clearly and loudly and slowly. We're going to try to
18	ask clear questions and hopefully elicit pretty direct
19	and short answers, except where we ask for a little
20	bit longer explanation and we'll ask for that when the
21	time comes.
22	We were looking Dr. Hopenfeld, I don't
23	know if you can move down a little bit further. The
24	reason we wanted you over there is for the line of
25	sight so the Judges could see you more clearly.
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That's helpful. Thank you.

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One thing we might also mention is we asked the press and some of the parties might not have been aware of this and I'm not sure how much it will be an issue today, to try to conduct or to conduct any interviews they want to do outside of the hearing room, outside of the courtroom here, the idea being if we have a 10-minute break and come back in at 10 minutes and the media are doing an interview with somebody in the back of the room it kind of messes things up. So if you could encourage them and if they're asking you some questions, maybe you could step outside for that. That will help. So we're not going to have any interviews in the courtroom as it were.

The one other thing to mention this 16 17 morning is I want to -- we're going to continue on 18 asking questions about the metal fatigue contention of 19 the witness panel. And we might get done today on that. I don't know. But when we do at the juncture 20 21 when the Board is finished asking questions, we're 22 going to take a break, 15 minutes or so and to think about it ourselves, if we thought we've missed any 23 24 questions we thought we'd want to ask and also that's 25 the time as we reconvene after the 15-minute break for

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the parties to suggest if they have any other areas where they think we should have asked questions or it's important that something needs to be brought out. And so while we're going on today, hopefully you'll be taking your notes and think about those things, because you're not going to have much time when we take the break, a 10 or 15-minute break to start scratching your head and think about additional questions.

Once you give us suggestions, if you do, you can either do it in writing which is going to be pretty fast, handwritten or whatever. If you don't want the other side to know about or you can just do it in the open and say we think you ought to ask them about whatever, but then we will either take another quick adjournment or from the bench confer to decide whether we want to ask, we think we need to ask those additional questions or not.

So the main point is as we go along today, be thinking about it if you think we may have missed something important so that when that 15 minutes comes, you can be pretty crisp about it and we can proceed. So anyway we hope we'll get done today on contention 2, but we may not either. We've got a lot of questions today.

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With that, I just want to remind the witnesses that you're still under oath and so you acknowledge that you're -- you recognize that. And with that we will proceed with questions.

I believe Dr. Reed was doing the questioning mostly as we ended yesterday.

JUDGE REED: I would like to continue along the lines of trying to understand better exactly how these CUFen calculations were done. I think we made a lot of progress yesterday and I thank you all for helping us to understand that.

But what I would like to do this morning 12 13 is to understand exactly the sequence of calculations that were done, moving from the original calculations 14 in which the CUFens were calculated and reported to 15 be, some of the CUFens were reported to be over one. 16 And then you did a series of refined calculations in 17 which all the CUFens were less than one for the nine 18 components. And then you did a confirmatory 19 calculation of a single component and what I would 20 21 like to do is to ask, I guess this question should go to Mr. Stevens. 22

Could you help us understand first how you did the original calculations and then what was the change from that methodology to the refined analyses

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and why did those numbers go down so substantially? 1 MR. STEVENS: I am structural integrity 2 3 and did not perform the first calculations so with 4 respect to that part I think Mr. Fitzpatrick would be 5 best to answer and then I can carry on for the refined and confirmatory calculations. б 7 JUDGE REED: I'd be happy to pose the 8 question to Mr. Fitzpatrick. 9 MR. FITZPATRICK: The license renewal 10 application existing design reports, the CUFs in the 11 design reports we used --JUDGE REED: Please speak up. 12 It's hard 13 to hear. 14^{-1} MR. FITZPATRICK: For the original license application, the CUFs in the design reports we used --15 16 JUDGE REED: What are the design reports? 17 MR. FITZPATRICK: When the plant was designed, an ASME 3 stress analysis was done and --18 19 JUDGE REED: So you're going back 35 years for this? 20 MR. FITZPATRICK: Some of them. GE did an 21 22 update on the CUFs for power uprate and those were the 23 CUFs used in Table 431 of the application. 24 JUDGE WARDWELL: Who did that again? 25 MR. FITZPATRICK: The GE report assessing **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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the effects of power uprate on the CUFs.

JUDGE WARDWELL: What date was that report?

MR. FITZPATRICK: 2003.

JUDGE KARLIN: General Electric. GE.

MR. FITZPATRICK: General Electric.

JUDGE KARLIN: That's people who built the

reactor.

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MR. FITZPATRICK: Designed it.

JUDGE KARLIN: Designed it.

JUDGE REED: Were those calculations done specific to Vermont Yankee or were there some generic calculations?

MR. FITZPATRICK: It was specific things in the table for Vermont Yankee and for the locations that were identified in NUREG 6260 we used 6260 values and there's a footnote on each one of those that we didn't have plant specific, specifically the piping, the original plant design, the B31 piping and piping code. That didn't require explicit fatigue analysis. Later plants are designed to ASME 3 and the Class 1 piping has its specific capabilities.

DR. REED: I'm still puzzled by some of these statements. In the design reports the plant was originally designed for 40 years and now we're looking

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1	at CUFens for 60 years, so you must have made some
2	adjustments to account for the additional 20 years.
3	MR. FITZPATRICK: If you look at the
4	application, the number cycles in the original
5	application did not change. Table 421, 431 and 432
6	has the same number of cycles as the original design
7	and showed the projections that we wouldn't exceed the
8	original design cycles in 60 years.
9	JUDGE REED: So your original application
10	for the license renewal assumed the same number of
11	cycles as the original design and it was your
12	expectation you would not exceed that?
13	MR. FITZPATRICK: That's correct.
14	JUDGE REED: Weren't there many CUFs
15	greater than one in your analysis?
16	MR. FITZPATRICK: Not CUFs, CUFen with the
17	Fen factors applied.
18	JUDGE REED: Fine.
19	MR. FITZPATRICK: And below that table,
20	statements, we have the option to refine those
21	analysis and do an inspection program or repair or
22	replace over time. We knew we would have to do the
23	CUF analysis.
24	JUDGE WARDWELL: You've confused me more
25	than helped me. During the original design cumulative
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1	use factors were calculated?
Ż	MR. FITZPATRICK: For some components on
3	the reactor vessel, yes. Not for the piping.
4	JUDGE WARDWELL: So then you did the
5	additional analyses required for those that hadn't
6	been done during the original design?
7	MR. FITZPATRICK: We engaged spectral
8	integrity to do the CUF analysis.
9	JUDGE WARDWELL: So Mr. Stevens, you are
10	able to testify in regards to the Fen analysis
11	associated with the original, the initial calculations
12	in the license renewal application, yes or no?
13.	MR. STEVENS: No.
14	JUDGE WARDWELL: Mr. Fitzpatrick, please
15	clarify for me.
16	MR. FITZPATRICK: The CUF used the
17	original design CUFs on NUREG 6260 CUFs in the license
18	renewal application.
19	JUDGE WARDWELL: Speak up. It's really
20	hard to hear you.
21	MR. FITZPATRICK: We used the original
22	design CUFs for NUREG 6260 CUfs in the original
23	license renewal application. The Fens were calculated
24	based on the NUREG by Entergy and the results did come
25	over one and it was presented in the application.
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JUDGE WARDWELL: Thank you.

OODOL WARDWELL. IIIaink you.
JUDGE REED: Okay, so in the FSER which is
what exhibit is it, it's Staff Exhibit No. 1, if I'm
not mistaken on page 4.32, it's reflected that seven
of the nine components evaluated have an
environmentally adjusted CUF of greater than one. So
your initial as I would call it, the initial CUFen
analysis with the license application, the reanalysis
 in 2007 and then the confirmatory analysis in 2008 on
one nozzle.
The initial CUFen analysis you did for
this license renewal application showed seven of nine
 locations exceeding the unity or exceeding one
MR. FITZPATRICK: Yes.
JUDGE REED: Okay, I'm with you so far.
JUDGE WARDWELL: Is there any technical
reason you could not at that point have gone on and
performed what was later to be called the refine
calculations once you obtained your results that they
were over one for seven of the nine components?

21 MR. FITZPATRICK: No, we could have done 22 it at that time. Another group at Entergy was 23 preparing the application and we submitted it that 24 way.

Keep in mind at the time we had six years

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we spent in operation.

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JUDGE REED: Ökay, so I guess we rather crudely understand how you came up with your original set of numbers and maybe it would be useful now to turn to Mr. Stevens and ask if -- how the refined numbers came into being.

I'm guessing that you're going to tell us that basically we heard that yesterday, but the refined calculations, tell us briefly how those were calculated.

MR. part of what Mr. STEVENS: So Fitzpatrick said that I can't testify to is now we have a set of results that were initially developed that comes to me with the request to do some refined analysis. I think a couple of things are important to help clarify that initial set. We have, as Mr. Fitzpatrick just testified, we have several of the locations that show unacceptable results that we're now going to be doing refined analysis on. And another key part of that is for the piping locations, they assumed generic values that are not specific to VY. And as Mr. Fitzpatrick testified, that was because of the piping code used which does not require that CUFs be calculated.

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So another important thing that we need to

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do is to come up with some values for those piping locations that are specific to VY. So we really have two objectives. One is to come up with specific CUFs for all locations, CUFens, as well as to do some refined evaluations.

Another important point is the objective of design analyses, those done originally and those done by General Electric for EPU is to show acceptability, not margin. Acceptability, as I discussed yesterday, is a cumulative usage factor of one. So once an analyst has shown the usage factor is less than one, he has demonstrated acceptability and he can stop his analysis.

So a lot of these analyses are done with simplifications and conservatisms put in and if the answer comes out acceptable, that's an acceptable result and an acceptable method. It does not indicate that the usage factor could not be lowered.

JUDGE REED: Let me take a small amount of time here to ask you some questions about the number one.

You said just now that if you come up with a number that's one or less that that's acceptable. So in your opinion calculating a CUFen of .99 would be acceptable. Is that correct?

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895 1 MR. STEVENS: That's correct. 2 JUDGE REED: So you feel that there's no 3 margin required to this failure point of one? MR. STEVENS: I wouldn't characterize it 4 5 that way. I would say that the 1.0 has margin in and of itself because of the methodology and the criteria 6 7 that are being applied. We talked about safety 8 factors --9 Let me contest that point. JUDGE REED: 10 Now the number 1.0 has no margin associated with it at 11 all, but that omission of CUFen, if you literally read 12 those definitions it's the number of cycles that you 13 expect to occur divided by the number of cycles it would produce failure. Isn't that the definition of 14 · 15 CUFen? 16 MR. STEVENS: That's the definition, but .17 I guess I would ask you to clarify --18 JUDGE REED: Let me continue. If that's 19 the definition, doesn't it imply that if you made your best calculation of CUFen that if you calculated a 20 21 CUFen equal to one you would expect failure to occur? 22 MR. STEVENS: No, sir. 23 If you do your best job of JUDGE REED: 24 calculating what happens -- statistically, I realize 25 there's some variation here, but wouldn't you expect **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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failure to occur when a CUFen equals one? 1 2 MR. STEVENS: No, sir. JUDGE REED: Isn't that the definition of 3 CUFen? 4 MR. STEVENS: No, the definition is it's 5 a criteria. It's an allowable value. It does not 6 7 indicate failure. Failure of test data in the laboratory with factor -- adjustment factors applied 8 to it is a criteria. It is not failure. 9 10 JUDGE REED: Well, I put it to you that we just discussed the definition of accumulative use 11 factor and it's a ratio of number of cycles that you 12 expect to occur divided by the number of cycles that 13 14 are required to produce failure of the component. But if that number is one by the definition you would 15 16 expect failure to occur. 17 MR. STEVENS: Let me see if I can state it another way. If the failure curve we used was in fact 18 19 a failure curve without adjustment factors, then I 20 would agree with your statement. 21 JUDGE REED: But that's what I asked you 22 to postulate, that you were not taking into account 23 any conservatisms in the calculation. 24 MR. STEVENS: I'm sorry, I misunderstood. 25 I interpreted conservatisms and calculations as I **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

897 1 don't have the option of changing that curve, 2 therefore it's not a part of my calculations. But if 3 that's what you allow me to do, then I agree with your 4 statement. 5 JUDGE REED: Okay, so you're saying that the failure curve and this is an ASME number or -- is 6 7 that right? This is coming from some report, has 8 conservatisms built into it? 9 MR. STEVENS: That's correct. 10 JUDGE WARDWELL: And these curves are in the NUREG 6260 and 5783, is that correct? 11 MR. STEVENS: No, sir. The curves that 12 13 we're using are in ASME code. 14JUDGE WARDWELL: Thank you. 15 JUDGE KARLIN: These are what we refer to 16 as the air curves. They're not environmentally adjusted. They're just what ASME calculated as how 17 much stress this particular component would endure, 18 19 how many times, and there is a scattering of data 2.0 across the chart and you have to draw a curve that 21 tries to capture what that data reflects. 22 MR. STEVENS: Yes, sir. We call it the 23 design curve. It's an air curve through the data with 24 adjustment factors applied to account for certain 25 things and the resulting curve that's been adjusted is NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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a design curve. That's the one in the ASME code that 1 2 we use. 3 JUDGE KARLIN: Okav. 4 JUDGE REED: Can you speak to how conservative it is? Is it at the 95 percent limit? 5 6 Are there some data points on the other side of the 7 curve or is it -- does it completely bound all of the data? Am I making sense in my question to you? 8 9 MR. STEVENS: It's a good question. Ι 10 think Mr. Fair is a better one to answer that. MR. FAIR: Yes, if I can try to answer 11 12 that question. I agree with the statement that the 13 fatique curve --. 14 JUDGE REED: What curve? 15 MR. FAIR: The ASME design fatigue curve. JUDGE REED: Fatigue. 16 MR. FAIR: Is based on test data on small 17 specimens that have been adjusted to account for the. 18 19 difference between small specimens and actual 20 components and for the scatter of the data. In the NUREG report in 6583, there is 21 fatigue crack 22 assessment of the probability of initiation giving a CUF of 1 and in that it estimates 23 24 that the probability of initiating a fatigue crack is 25 somewhere between 1 and 5 percent which is logical **NEAL R. GROSS**

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. 1.	given that you adjusted the data down to try to bound
2	the test data.
3	So the second aspect of it
4	JUDGE REED: I'm sorry, you said adjusted
5	the data down
6	MR. FAIR: I'm sorry, I misspoke.
7	Adjusted the curve down to bound the test data.
8	JUDGE REED: Okay, so with the curve
9	bounds the test data. There is no data on the other
10	side of the curve. It's that conservative. Is that
11	what you're saying?
12	MR. FAIR: The original design curve
13	bounded the data as it existed at that time. And
14	based on the data scatter from the test data, Argonne
15	developed a model with a standard deviation and used
16	that model to estimate the probability of initiating
17	fatigue crack at the ASME code limit of 1.0. And that
18	data is discussed, that evaluation is discussed in the
19	NUREG 6583. It's also discussed a little bit in the
20	6909, the latest NUREG which used the 95/5 basis for
21	developing a new air design fatigue curve. If you go
22	back and look at this new air design fatigue curve,
23	it's slightly above the original ASME fatigue curve
24	for carbon and low-alloy steels which shows that
25	original adjustment was somewhat conservative compared

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900 to this criterion 6909. 1 2 The other aspect --3 JUDGE KARLIN: And with regard to 4 stainless steel? 5 MR. FAIR: With regard to stainless steel, it's mixed. 6 7 JUDGE KARLIN: The NUREG 6909 curve as 8 compared to the ASME curve is mixed. Sometimes it's above and sometimes it's below. 9 MR. FAIR: Sometimes it's below. 10 JUDGE KARLIN: Sometimes it's more 11 conservative. Sometimes it's less. 12 MR. FAIR: That's correct. 13 JUDGE KARLIN: And 6909 and Reg. Guide 14 15 1.207 combined to basically say the NRC should be using, the staff should be using these new air curves 16 from 6909 for new reactors? 17 MR. FAIR: That's correct. 18 19 JUDGE KARLIN: Okay. MR. FAIR: The other aspect I wanted to 20 21 point out in -- that's discussed in these NUREGs is that when you do initiate a fatigue crack what you're 22 23 initiating is a crack that's three millimeters deep. 24 It's not failure of the component, but it's a three 25 millimeter deep fatigue crack based on the size of the **NEAL R. GROSS**

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1	test data that was used in the fatigue testing.
2	JUDGE KARLIN: So if I understand what
3	you're saying on the ASME has a CUF
4	MR. FAIR: That's correct.
5	JUDGE KARLIN: Cumulative use factor and
. 6	first they start with a bunch of tests and that's data
7	on a chart, right? Please speak, they don't capture
8	a nod on the recording.
. 9	MR. FAIR: Yes.
10	JUDGE KARLIN: So there's data on a chart
11	and then they draw a curve through that chart to
12	and as I understand what you're saying that curve
13	showed that 95 percent of the dots are above the curve
14	and only 5 percent are below the curve. Is that
15	right?
16	MR. FAIR: For the new curve in 6909,
17	that's the estimate.
18	JUDGE KARLIN: Okay, for the ASME curve
19	are they all dots above the line or
20	MR. FAIR: For the ASME curve, the
.21	estimate was about a 1 to 5 percent probability of
22	crack initiation which would mean 1 to 5 percent could
23	fall below the line.
24	JUDGE KARLIN: One to 5 percent?
25	MR. FAIR: Right, depending on the stress
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902 1 level. 2 JUDGE KARLIN: So there's 95 percent 3 chance they're going to be above, and 5 percent 4 they're going to be below? MR. FAIR: That's correct. 5 JUDGE KARLIN: And when we say below the 6 7 line or the line -- what they're calibrating or what 8 they're testing is whether there will be a three 9 millimeter crack. Initiated, that's correct. 10 MR. FAIR: JUDGE KARLIN: In the metal. 11 MR. FAIR: That's correct. 12 JUDGE KARLIN: Not necessarily the whole 13 thing breaks in half or something. 14 MR. FAIR: Correct. 15 JUDGE KARLIN: So that failure or whatever 16 the criterion is is a three millimeter crack? 17 MR. FAIR: That's correct. 18 JUDGE KARLIN: And there's a 95 percent 19 chance that there will be no 3 millimeter cracks? 20 MR. FAIR: That's correct. 21 22 JUDGE KARLIN: And that's when you get a 23 1 to 1, 100 percent? 24 MR. FAIR: Right. 25 JUDGE KARLIN: Okay. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

903 JUDGE WARDWELL: So at a CUF of 1 for your 1 2 initial analysis that meant there is a 1 to 5 percent 3 chance that a small crack could have formed? 4 MR. FAIR: That's correct. 5 JUDGE WARDWELL: What is the CFU value was -- what are some of your higher values? 6 Do you 7 remember, Mr. Fitzpatrick? 8 MR. FITZPATRICK: CUF? 9 JUDGE WARDWELL: The environmentally corrective ones, what were those --10 11 MR. FITZPATRICK: On the initial --12 JUDGE WARDWELL: Initial analysis, the 13 highest one. MR. FITZPATRICK: Highest one. 14I think 15 around 10, 11. JUDGE WARDWELL: If you had a CUFen -- how 16 17 are we going to call that? 18 MR. FITZPATRICK: We usually call it C-U-19 F-E-N. JUDGE WARDWELL: It can't be simpler than 20 2.1CUFen of 10, is there any indication of what that. 22 the probability of that crack being formed is? 23 MR. FITZPATRICK: It would be pretty high. 24 There are some plots in NUREG 6583 that essentially 25 for a given stress and it's dependent upon the level **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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904 of stress, and that's an artifact of the statistical 1 2 evaluation that Argonne did. It will give you a 3 probability of initiation versus CUF. There are some 4 tables. 5 JUDGE WARDWELL: If NUREG 6260 and 5783 are used which I believe they were used for all your б '7 analysis, both the initial refined and the 8 confirmatory, this same 1 to 5 percent chance 9 probability with a CUFen at 1.0 would exist for all 10 those analyses, is that correct or not? MR. FAIR: That would not be correct 11 12 because the original evaluations in 6260 used some 13 interim fatigue curves developed by Argonne prior to the development of the NUREG 6583 and 5704. I don't 1415 believe there was a statistical evaluation done to estimate the probabilities using those preliminary 16 17 curves. JUDGE WARDWELL: And the subsequent 18 19 analysis used which NUREGs now? 20 MR. FAIR: The subsequent analysis has 21 6583 and 5704. 22 JUDGE WARDWELL: Thank you. 23 JUDGE KARLIN: By subsequent analysis you mean the 2007 re-analysis? 24 25 MR. FAIR: I was talking about the NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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subsequent evaluation of the data.

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25	you're using to calculate the CUFens, you again feel
24	conservatism built into the actual fatigue curves that
23	JUDGE REED: So since you have this
22	in the NUREGs.
21	MR. FAIR: I believe that's also reported
20	JUDGE REED: Okay.
19	of 2 to 2.5.
18	the mean and the lower bound is about 2 to 2.5, factor
17	MR. FAIR: The estimated variation between
16	points?
15	there a lot of statistical variation in these failure
14	JUDGE REED: Yes. And so there's is
13	used the actual data unadjusted, yes.
12	MR. FAIR: That would be the curve if you
11	Is that correct? Do I have that mentally wrong?
10	on another axis and the point is the failure point.
9	frequency on one axis and a strain stress or strain
8	a series of data points where you're plotting
7	idea of a fatigue curve, correct me if I'm wrong, is
6	conservatism built into these fatigue curves. Now my
5	understanding is that there's considerable
4	the points that you've made. So basically what I'm
3	JUDGE REED: Okay, so I think I understand
2	JUDGE KARLIN: Okay, I'm sorry.

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. 1	that a limit of 1.0 is an appropriate limit, that you
2	don't need to set a limit of .5 or some lesser number?
. 3	MR. FAIR: That's correct.
4	JUDGE REED: Basically, you're accounting
<u>.</u> 5	for all of the conservatisms in yourin the
6	methodology by which you calculate the CUFens. You
7.	don't need any conservatism on the limit of 1.0?
- 8	MR. FAIR: That's correct.
. 9	JUDGE WARDWELL: Has anyone tried to
10	quantify that in regards to how much error there is in
11	the resulting CUFen calculation? That being we
12	calculate a CUFen of 1.0, what is the error bar around
13	that calculation? It is calculated within .001 or is
14	it calculated within .5?
15	MR. FAIR: I'm not aware of any attempt to
16	estimate the uncertainty in the calculation.
17	Generally, the calculations are done with conservative
18	inputs and no attempt to quantify the exact level of
19	conservatism , but to try to use a conservative input
20	when you're doing the calculation itself.
21	JUDGE WARDWELL: But as you go ahead and.
22	then refine the calculation, isn't part of that
23	sharpening the pencil in regards to applying it to
24	site-specific things and in essence you are also in
25	the process reducing some of that conservatism. Isn't
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that correct?

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MR. FAIR: That is correct.

JUDGE WARDWELL: How do you know how far you can go before you've gone too far without this uncertainty analysis performed on the CUFen calculation itself?

MR. FAIR: Well, it's up to the analyst to maintain the input parameters as conservative values, not to use a nonconservative input.

JUDGE WARDWELL: Mr. Stevens, would you like to comment on that question on how you, as a company, do your analyses and comfort yourself that you're not broaching on the conservatism too much to make it too close to being the actual creation perhaps as opposed to having these inherent conservatisms built in?

MR. STEVENS: Yes, sir. I agree with what 17 18 Mr. Fair just said and it's important that -- and we 19 pointed to four items in my testimony or our testimony 20 yesterday about four conservatisms inherent to the There's other subtleties as far as heat 21 analysis. 22 transfer coefficients that we calculate as a function 23 of flow rate that we bound the flow rates of these 24 transients and all that. But it's important that in 25 the transient definitions, the number or cycles, the

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temperatures and pressures and flow rates used, and all those definitions that we are able to demonstrate they are conservative.

In addition, we maintain the methodology and guidance of the ASME code which from a consensus body has been defined as a proper and conservative methodology for us to use and much of our work we attest to the fact that we have maintained that methodology.

JUDGE KARLIN: Let me focus on that. Isn't it -- I thought there was something in the record that reflected that the ASME was having a problem with regard to recalculating its air curves and that the NRC has asked them to do that and they had not been able to reach a consensus.

16 Mr. Fair, do you recall something like 17 that in the record?

18 MR. FAIR: Yes, there was. I don't recall . where it was in our record, but the fact is correct. 19 There was a discussion, a long discussion on the air 20 21 curve for stainless steel and there was a concern by 22 some individuals that the adjustment on the stainless 23 steel in the high frequency range which was supposed 24 to be a factor of two was somewhat less than a factor 25 of two.

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1 So that was one of the changes we made in 2 the 6909 NUREG was we put the adjustment in with the 3 factor of two which results in the lowering of the stainless steel repeat curve in the high frequency 4 5 range. JUDGE KARLIN: Right -- go ahead. 6 7 And there's a number of MR. FAIR: 8 individuals within the ASME that don't agree with what 9 we did on the stainless steel curves. They think 10 we're too conservative. 11 JUDGE KARLIN: And I think -- tell me 12 about Req. Guide 1.207? Was it -- that was at the 13 context where the staff decided to recommend as 14quidance to use the air curves from 6909, correct? 15 MR. FAIR: That is correct. JUDGE KARLIN: In lieu of using the ASME 16 air curves? 17 18 MR. FAIR: That's correct. Well, we would 19 accept the use of the carbon and low-alloy steel air curves which would be conservative, but we requested 20 21 them to use the new air curve in 6909. 22 JUDGE KARLIN: And are you familiar with 23 the draft guidance, was it 1144 that preceded Reg. 24 Guide 1.207? 25 MR. FAIR: Yes.

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JUDGE KARLIN: In that context, did they 1 not discuss the difficulties that ASME was having or 2 3 there was question and doubt about ASME's curves? MR. FAIR: Yes. There was a discussion of 4 -- if you're talking about within the NUREG, yes. 5 JUDGE KARLIN: And so the staff decided, 6 7 had several options. One was to continue to use the 8 ASME air curve. 9 That's correct. MR. FAIR: JUDGE KARLIN: And the other was to come 10 11 up with its own air curve for new reactors. MR. FAIR: That's correct. 12 And the staff decided JUDGE KARLIN: 13 because of the debate within ASME about its air curves 14that it would -- the staff decided to use the new air 15 curve of 6909 for new reactors? 16 MR. FAIR: That's correct. 17 JUDGE KARLIN: Right. And still it's the 18 staff's position that none of that applies to existing 19 reactors because essentially they're grandfathered or 20 you're not going to impose that and there are other 21 conservatisms that offset this problem? 22 That's correct. 23 MR. FAIR: That's the 24staff's position. 25 JUDGE KARLIN: Okay. **NEAL R. GROSS**

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1	JUDGE WARDWELL: After the analysis that
2	was performed for this license renewal application or
3	any of the applications like this, it seems to me it
4	would make better engineering sense and more
5	consistent with engineering practice for an attempt to
6	be made to quantify the various conservatisms in some
7	fashion and then come up with an error bar that could
8	be useful to people performing these calculations so
9	that they are guided on how much conservatism there is
10	for any given calculations and the inputs that they do
11	put into it. Do either of you, Mr. Fair or Mr.
12	Stevens, know the reason why that hasn't been done for
13	analyses such as this performed for a license renewal
14	application?
15	(Pause.)
16	No is an answer.
17	MR. FAIR: No.
18	JUDGE WARDWELL: Fair enough.
19	MR. STEVENS: From our perspective, ours
20	being structural integrity, we think that such an
21	evaluation is at some level a little bit meaningless
22	if you can demonstrate that all your inputs are
23	bounding. Then you know that the result you get is a
24	conservative maximum. Any such errors would give you
25	a less number. When your criteria is acceptability,

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1	that kind of information is generally not viewed as
2	meaningful to the folks in the industry.
3	JUDGE WARDWELL: But yet we know that they
4	aren't all bounding. I mean just to start with the
5	curves have a 1 to 5 percent chance of not being
6	bounding.
7	MR. STEVENS: I was going to clarify Dr.
8	. Reed's question too on margin earlier which is now
9	getting at your question. In addition to what's in
10	the curve there are margins in the way we calculate
11	stresses to use that curve.
12	And those margins can be very significant
13	and based on the writing in the Reg. Guide 1.207 and
14	my interpretation of that and Mr. Fair, I think, can
15	clarify further, but those conservatisms are a key
16	reason why those curves were not backfit to existing
17	plants.
18	. Those conservatisms through many analyses
19	and many studies by many different organizations over
20	the course of the industry's history have demonstrated
21	that those analyses and results are very conservative.
22	JUDGE WARDWELL: Is another way of saying
23	what you've said, as I listen to you speak, that one
24	of the reasons you don't try to quantify the
25	conservatism is that the error in trying to estimate

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that conservatism may be as much or more than the actual amount that's there so that the number that you've generated somewhat meaningless as you say because it's so difficult to quantify the conservatisms for some of these behaviors that you know you inherently have, but can't actually put a number on how conservative it is?

MR. STEVENS: I think that's a fair way to say it. I might clarify it or say it a little bit differently.

11 JUDGE WARDWELL: I hope you can say it 12 simpler than I did as I was struggling through that. 13 MR. STEVENS: If I can demonstrate that my 14 number is very, very conservative and I have an error 15 of two orders of magnitude in the lower direction, 16 then I think just my answer being bounding and conservative with respect to criteria is all that 17 18 generally satisfies folks.

JUDGE REED: Okay, let's come back to the earlier point and that is we were trying to understand this progression of CUFen numbers starting from the original numbers in the application and we move to the refined calculations.

Do you have anything further to add to us about how those refined numbers were calculated? I

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think I understand that and I think I understand why the refined numbers are so much less than the original numbers.

JUDGE WARDWELL: Could you say that again then, exactly why they are less, the components that contributed to the fact that they are less?

MR. STEVENS: Yes. Again, there was -remember, we have some locations that did not have Vermont Yankee specific analyses performed so that was a key to starting some of the refined analyses. We wanted to replace those generic 6260 CUFens with plant-specific values. So that was one key.

Another thing, if I may, take you back to Judge Karlin's paper clip example yesterday which is really an excellent example of how to help explain some of this. And you recall I was talking about how we might for one component have 20 transients to evaluate. One simplification, conservatism an analyst may do to make his analysis lie simpler is he may choose the worst of those 20 transients, analyze that one and pretend all the other transients look just like it. It's a very bounding assumption.

So if the analyst did that and he analyzed one transient that was the worst one in a quantity that is the sum of all 20, and he showed acceptable

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results, that's an acceptable analysis, a lot of conservatism, and he's completed his evaluation.

In that sense, the result he achieved in terms of CUFen, it might be .99 as you suggested, Dr. Reed, which is acceptable. But obviously, if I were to take the time to analyze all 20 of those transients, I would get a much lower result. So my point here is that the usage factor from an analyst analyzed all 20 transients as one that very conservatively and had he done that and achieved a usage factor like 11 as Mr. Fitzpatrick said was in the original license renewal application, there's clearly other things I can do to show acceptability which is what we call refined analysis.

Remember that his objective was to -- the analyst's objective was to demonstrate acceptability, not margin. So that gives me some leeway as an analyst to go back and refine that calculation further to show acceptability before I give up and say the result is unacceptable.

And that, I think, what I'm trying to characterize is the input given to structural integrity with unacceptable CUFen results and now what I can do as a first step to try and demonstrate acceptability. I can go refine those calculations by

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1	removing some of the excess conservatisms that were
2	put into the analysis originally by another analyst.
3	And that's, in fact, what we did.
4	JUDGE WARDWELL: Do you remember when you
5	were tasked to do this and when you finished this
6	analysis?
7	MR. STEVENS: Yes, sir.
8	JUDGE WARDWELL: Would you care to share
9	that with us?
10	MR. STEVENS: We my recollection is we
11	started discussions with Entergy in late, very late as
12	in November, December 2006 to understand a scope and
13	we began calculations in the spring of 2007,
14	approximately May time frame and that initial set was
15	completed in July of 2007, drafted for review.
16	JUDGE WARDWELL: I think yesterday you
17	testified that it took somewhere in the neighborhood
18	of three persons, a set amount of time that you quoted
19	yesterday, that related to this refined analysis,
20	those numbers that you gave yesterday. Is that
21	correct?
2.2	MR. STEVENS: That referred to the
23	confirmatory evaluation of the feedwater nozzle we did
24	in January of this year.
25	JUDGE WARDWELL: About how much labor
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-1	effort was required in your refined analysis, roughly?
2	Can you estimate?
3.	MR. STEVENS: What I said yesterday was
4	three weeks, three people, about nine man weeks.
5	That's a reasonable estimate for doing these analyses
б	refined. Refined took a little bit longer because
7	some of the inputs into the confirmatory analysis were
8	identical and we did not regenerate those.
9	Reasonable estimate for doing one of these
10	refined analyses which didn't have an initial starting
11	point to work from, 12, 13, 14 man weeks. The lapsed
12	time would depend on our workload on other activities
13	at the time.
14	JUDGE REED: Clarification, please. Is
15	that per component or was that for all nine
16	components?
17	MR. STEVENS: That would be per component.
18	JUDGE REED: Per component, 12 man weeks
19	per component.
20	MR. STEVENS: And that would be more for
21	thelike the nozzle analyses that we did, piping,
22	'some of the analyses we were able to do in a more
23	simplistic fashion. They took less time, but on the
24	average for the more involved analyses, yes, you're
25	correct.
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1 土	JUDGE WARDWELL: And which more involved
2	analyses, confirmatory or the refined or both?
3	MR. STEVENS: Both. The refined, the 12,
4	13, 14 week estimate refers to the refined
5	calculation. The confirmatory would be a little bit
.6	less because some of the analyses I did for the
7	refined like building a finite element model, I could
8	make use of without dedicating time whereas in the
9	refined analysis I had to create that model.
10	JUDGE WARDWELL: And so just to be sure I
11	understand, those numbers you quoted now and quoted
12	yesterday refer to per component average?
13	MR. STEVENS: That's correct.
14	JUDGE WARDWELL: Mr. Fitzpatrick, why did
15	you task them to do that if, in fact, your plan in
16	your license renewal application was to do that in the
17	future?
18	MR. FITZPATRICK: It's part of the it's
19	part of the contention.
20	JUDGE REED: I'm having trouble hearing
21	you.
22	MR. FITZPATRICK: I'm sorry, to resolve
23	the issue in the contention.
24	JUDGE REED: To resolve?
25	MR. FITZPATRICK: Try to resolve.
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1 JUDGE REED: To resolve. Thank you. 2 I want to ask, if I may, JUDGE KARLIN: 3 about -- as I understand what you're saying, Mr. 4 Stevens, that to calculate and we're talking about not 5 just CUF but the fen values also, the CUFens for the reanalysis which occurred I guess from November of '06 6 7 to July of '07. You estimate 12 to 14 person weeks per location. Is that right? 8 9 MR. STEVENS: That's correct. 10 JUDGE KARLIN: Why does it take so long? 11 Isn't it just sort of a straight-forward calculation? 12 MR. STEVENS: No, sir. It's -- there's 13 quite a bit involved. It takes -- building a finite 14 element model is on the order of a week in and of 15 itself. Running 20 transients through that finite 16 element model are whatever means are used, takes time. 17 We have the quality assurance process that all of our 18 work must be documented and verified and checked by an 19 independent reviewer as well as the project manager 20 himself. 21 JUDGE KARLIN: Okay, so --22 MR. STEVENS: A11 that together is 23 extensive time. 24 JUDGE KARLIN: But is it pretty much

mechanical or does it involve judgment, technical

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ï	analyst's judgment also.
2	MR. STEVENS: It does involve judgment.
3	JUDGE KARLIN: Okay, and with regard to
4	the single confirmatory CUFen analysis you did on the
5	feedwater nozzle, that was yesterday you said three
б	people, three weeks of work, nine person work week?
7	MR. STEVENS: Correct.
8	JUDGE KARLIN: For that. Did that also
9	involve judgment and time and effort?
10	MR. STEVENS: Yes, sir.
11	JUDGE KARLIN: So analyst's judgment was
12	involved in doing that?
13	MR. STEVENS: Yes, sir.
14	JUDGE KARLIN: Now I'm going to ask some
15	questions a little later, but maybe this gets into it.
16	On commitment number 27, it calls for Entergy to
17	conduct two additional what I'll call confirmatory
18	CUFen analyses on the core spray nozzle and the
19	reactor recirculation outlet.
20	Is that right?
21	MR. FITZPATRICK: I don't think it's in
22	commitment 27. That's in license condition in the
23	SER.
24	JUDGE KARLIN: Right, okay. Thank you.
25	I'll take that correction. Mr. Stevens, how long is
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1 it going to take those two confirmatory analyses on 2 the core spray and the reactor recirculation outlets 3 I quess it is. It 4 MR. STEVENS: would be timing 5 consistent with that on the feedwater nozzles, so 6 approximately nine man weeks. 7 And it would involve JUDGE KARLIN: 8 judgment calls by various technical and scientific 9 people? 10 MR. STEVENS: That's correct. 11 JUDGE KARLIN: Okay. JUDGE WARDWELL: Mr. Fitzpatrick, why 12 13 didn't you apply the same criteria you did in regards to the refined analysis to the confirmatory analysis 14 15 and just perform those additional two at this point in order to resolve this contention, help resolve this 16 17 contention? MR. FITZPATRICK: Repeat the question, I 18 19 don't understand that. 20 JUDGE WARDWELL: When I asked you why did 21 you task Mr. Stevens to do the refined calculations 22 stated you did that to help resole this you 23 contention. 24 MR. FITZPATRICK: The initial assessment 25 we took the existing fatigue analysis, applied the FEN **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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1 1	factors of NUREG 6583 and 5704 and came up with higher
2	CUFens for a number of components.
3	We knew we would have to redo the analysis
4	for the VY components that weren't plant specific and
5	listed those in NUREG 6260 combined. Such integrity
6	has the expertise to do it. We engaged them to do it.
7	JUDGE WARDWELL: That's fine. That wasn't
8	my question, but that's a good answer for another
9	question, so I'm glad you stated that.
10	My question now is why haven't you gone
11	ahead and tasked them to compete the confirmatory
12	analysis for the other two nozzles that the staff is
13	requiring you to do at some point in the future, but
14	do it now to again help resolve this contention, using
15	the same approach or philosophy that you did when you
16	tasked them to do the refined calculation?
17	MR. FITZPATRICK: At this point, we
18	believe the refined analyses are conservative. The
19.	confirmatory analysis demonstrates that. The results
20	show that there's no need to do that. We're going to
21	get similar results.
22	JUDGE WARDWELL: So with the refined
23	analysis because the CUFens were greater than one, you
24	felt the need at that point when at the time you're
25	deciding whether to task Mr. Stevens to perform a
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refined analysis, you had CUF values greater than one 1 2 that inspired you to now task them to do at this point 3 to help resolve this contention. You don't have that same situation is what you're saying with the 4 5 additional two nozzles that need confirmatory analysis because you feel they're conservative enough and below 6 7 one at this point and that that confirmatory analysis can wait for the future consistent with what the staff 8 9 is requiring of you? 10 MR. FITZPATRICK: Yes, that's exactly 11 right. 12 JUDGE WARDWELL: Mr. Stevens, did you want 13 to add something to that? MR. STEVENS: Just one other item I think 14is important is we in the confirmatory evaluation that 15 16 everyone has accepted and reviewed it, we evaluated 17 the bounding nozzle, so technically going into this we would say there's no reason to evaluate the other two 18 19 nozzles, given that we one, evaluated the bounding 20 nozzle; and two, we still believe these refined 21 analyses are conservative. 22 JUDGE WARDWELL: But didn't your value, 23 resulting value in your confirmative analysis for the 24 feedwater nozzle increase over what it was before? 25 MR. STEVENS: No, sir. CUFen went down in

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1	the confirmatory evaluation which was our objective in
2	those evaluations. It is lower.
3	JUDGE KARLIN: What went up? Something
4	went up 40 percent. What went up?
5	MR. STEVENS: The CUF went up.
6	JUDGE KARLIN: By?
7	MR. STEVENS: Approximately 40 percent.
8	JUDGE REED: I'd like to ask Mr. Fair to
9	state his opinion of what we just heard in light of
10	the fact that the staff is requiring that two
11	additional calculations be done. Is it the staff's
12	view that this calculation was bounding, this
13	feedwater?
14	MR. FAIR: Yes, it is. It was the highest
15	CUF going into the analysis. The reason that the
16	staff requested the other confirmatory analysis was
17	that the CUF analysis was not bounding, although the
18	CUFen analysis was bounding.
19	The staff couldn't make a judgment. The
20	reason that the CUFen analysis went down was there was
21 .	some refinements that were made in the confirmatory
22	calculation on the Fens for each transient which
23	instead of using a bounding Fen that covered all the
24	transients, they had a specific Fen for each
25	transient.
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925 1 The staff was unable to make a judgment 2 that the same level of reduction would apply to these 3 other two nozzles and that's why they requested that 4 they do the additional confirmatory analyses. 5 JUDGE REED: I thought I read in some of your testimony or somewhere here that the staff made 6 7 a pretty clear statement that they did not believe that this was bounding. I thought you used that word. 8 9 Am I mistaken? 10 I think the staff and the SE MR. FAIR: 11 did say they thought the feedwater nozzle was 12 bounding. 13 JUDGE REED: It's not so much that the 14 feedwater nozzle was bounding, but that the 15 confirmatory calculations were not bounding. I would 16 have to study here for a few minutes --17 JUDGE WARDWELL: Let me help you here. In 18 a February 14 OA audit, the staff concluded that the use of Green's function could under estimate the 19 cumulative use factor and therefore cannot be the 20 21 analysis of record. Isn't that correct? 22 MR. FAIR: That's correct.

JUDGE WARDWELL: And so that's the motivation for why you're requiring the other nozzles to also be analyzed. Is that correct?

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·1·	MR. FAIR: That's correct.
2	JUDGE WARDWELL: Why doesn't that also
3	apply to the other locations?
. 4	MR. FAIR: Because the other locations
5	weren't based on the Green's function evaluation.
б	JUDGE KARLIN: I thought we heard
- 7	yesterday that it was. Mr. Stevens maybe can answer
8	that.
· 9	MR. STEVENS: Just the three nozzles, core
. 10	spray nozzle recirculation nozzle, feedwater nozzle.
· 11	The other six locations of the nine were not evaluated
12	with that methodology with the Green's function that
13	you referred to.
14	JUDGE WARDWELL: Why weren't they?
15	MR. STEVENS: They were done with other
16	more conservative methods.
17	JUDGE WARDWELL: Do those methods, those
18	conservative methods all relate to how the stresses
. 19	are analyzed and the number of stress component
20	tensers that are used in the field?
21	MR. STEVENS: Yes.
22	JUDGE WARDWELL: And are those other
23	locations such that they are more one dimensional if
24	you will that allow you or the flow is one
25	dimensional so that you ignore any of the small shear
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1	stresses that might develop that would require more
2	than one stress tenser to be analyzed?
3	MR. STEVENS: No, sir. For example, the
4	piping locations, feedwater piping recirc RHR piping
5	were evaluated with ASME code NV3600 formula
6	methodology for piping which accounts for all of that
7	in a conservative fashion.
8	JUDGE WARDWELL: When is the Green's
9	function used, let me ask you that?
10	MR. STEVENS: I'm sorry, did you say when?
11	JUDGE WARDWELL: Yes, when let me back
12	up quickly on that. There's the simplified Green's
13	function and I assume there's a complex or a normal
14	Green's function. Is that correct?
15	MR. STEVENS: No, there's really I
16	would say there's just one Green's function.
17	JUDGE WARDWELL: It's been called the
18	simplified Green's function in much of the testimony.
19	MR. STEVENS: Right, and this has been the
20	source of a lot of confusion in the discussion on this
21	topic. It's not really the Green's function that
22	parties haveare again disagreeing over. The
23	Green's function is a well-documented mathematical
24	technique that's understood and is very accurate.
25	What'swhere the single stress term idea comes in
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·· Ì	and taking the results from using the Green's function
2	and what you do with that result.
3	JUDGE WARDWELL: And when you did that,
4	what did you do? How did you apply that?
5	What did you do to the results of the
6	Green's function to simplify that or however you want
. 7	to word it?
8	MR. STEVENS: We took a single stress term
9	result from the Green's function, if you will, a
10	stress difference and utilized that to generate stress
.11	different histories for all transients.
12	JUDGE WARDWELL: And that's what made the
13	analysis for all those other components besides the
14	three nozzles a quicker analysis or less complex
15	analysis or
16	MR. STEVENS: Well, again, this Green's
17	function technique we're talking about was only used
18	for the three nozzles in the refined analysis. So it
19	was a simplification made for just those three nozzles
20	and what I call the second tier of the refined
21	analyses that were performed.
22	JUDGE WARDWELL: Say again then why were
23	the other locations able to be analyzed without the
24	Green's function?
25	MR. STEVENS: It really goes back to my
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discussion of what an analyst may do once he shows acceptability. He's finished. The other evaluations for the other components lended themselves to not having to make those simplifications or refinements to the analysis to show acceptability.

Some of the locations we use stresses that were generated in the original stress report, for example, that did not use Green's function, that were done consistent with using six stresses and we used those and were able to show acceptability. There was no need to go to a Green's function approach or a more refined approach.

JUDGE KARLIN: If I may, while we're on the Green's function, it references you to the FSER page 4.38. Could you all pull that out? That's where the discussion -- there's a four-page, I think, three or four page discussion of the Green's function in the staff's final safety evaluation report.

Page 4-38 of the FSER.

MS. BATY: Your Honor, I just wanted to supply our witness a copy.

JUDGE KARLIN: Yes.

MS. TYLER: Judge Karlin, will you state the exhibit number again, please?

JUDGE KARLIN: The exhibit number is Staff

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1	Exhibit No. 1, I believe. Staff Exhibit No. 1. I
2	believe that's the FSER. Let me double check.
3	(Pause.)
4	Is that right, Ms. Baty?
· 5	MS. BATY: Yes.
6	JUDGE KARLIN: Yes, Staff Exhibit No. 1,
7	final safety evaluation report, page 4-38. It's a
8	discussion of Green's function.
· 9	Perhaps this would go to Mr. Stevens.
10	Help me here. As I understand it, are you all saying
11	there's nothing wrong with the Green's function per
1.2	se. The problem in how it occurred here was that
13	there was simplified input into doing the Green's
14	function calculation. Is that right?
15	MR. STEVENS: Simplified input as well as
16	simplified use of the output.
17	JUDGE KARLIN: Yes, okay.
18	JUDGE WARDWELL: For only the three
19	nozzles.
20	MR. STEVENS: That's correct.
21	JUDGE KARLIN: So on the last paragraph on
22	page 4.38, there's a discussion of the staff's review
23	and the second sentence says "the applicant's
24	implementation of the Green's function input to the
25	software assumes that shear stress analyses are
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negligible."

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And then it goes on, "this implementation
may not be valid for those locations with geometric
discontinuity or non-axis symmetric load cases. So
therefore the applicant's implementation for
calculating a stress intensity cannot be validated,
page 2.39, therefore the staff could not conclude the
refined fatigue analysis is valid."
As I understand what they're saying,

there's nothing wrong with the Green's function per se, but you've got -- the input has got to be done right and there was a simplified input. Only one input as opposed to six inputs. Is that right?

MR. STEVENS: Yes, sir.

JUDGE KARLIN: And you all corrected for that at the staff's request in doing the confirmatory analysis for the feedwater nozzle?

MR. STEVENS: Yes, sir.

JUDGE KARLIN: Right. And as I understand what you're saying when you ran through this analysis the confirmatory analysis showed a CUF that was 40 percent higher than what it had been before, but with the addition of the Fen the CUFen was lower than what it had been before.

MR. STEVENS: That's correct.

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1.	JUDGE KARLIN: Okay. Now in your proposal
2	the license condition, Mr. Fair, that's being proposed
3	by the staff is that they do that same analysis for
4	these two other locations.
5	MR. FAIR: That's correct.
_ 6	JUDGE KARLIN: And the proposed license
7	condition or commitment 27 would say that Entergy
8	would do this within two years prior to the start of
9	the period of extended operations, right?
10	MR. FAIR: I believe that's correct.
11	JUDGE KARLIN: Okay, and the period of
12	extended operations begins in 2012, right?
13	MR. FAIR: Again, I do not know the exact
14	dates.
15	JUDGE KARLIN: March 2012, the current
16	license would expire, so the period of extended
17	operation would be March 2012, so the commitment or
18	the license condition as proposed, the recalculation
19	of those two CUFens would have to be done by and
20	completed and submitted to staff by March of 2010.
21	Are you with me, Mr. Fitzpatrick, is that right?
22	MR. FITZPATRICK: Yes, sir.
23	JUDGE KARLIN: Have you started doing it
24	now?
25	MR. FITZPATRICK: No, sir.
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You haven't asked Mr. JUDGE KARLIN: 2 Stevens' firm to start working on it yet? MR. FITZPATRICK: No, sir. 3 JUDGE KARLIN: Okay. Let me ask another 4 5 angle on this. Under the recalculation under 6909, Mr. Stevens, perhaps, you said you did that in four 6 7 hours over the weekend, right? 8 MR. STEVENS: Two of us, so I guess that would be eight hours. 9 JUDGE KARLIN: Okay. 10 And does that involve judgment and -- why was that so much quicker 11 12 and the rest of it was you know, many, many weeks and 1·3 man hours? STEVENS: Again, we 14 MR. from my - -15 description yesterday; the finite element analysis, 16 analysis of all these transients and stress 17 accounting, how they pair with each other and all that 18 doesn't factor into the calculation you're asking 19 about now. So we did not have to do all that. We did the very, very tail end of the analysis which is given 20 the stresses and the number of occurrences, we can use 21 22 the 6909 fatigue curve to give allowable cycles, 23 recompute cumulative usage factor and Fens. That's a 24 relative short process.

JUDGE KARLIN: Okay. Maybe I'll ask Dr.

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1	Hopenfeld at this point.
2	With regard to the confirmatory analysis,
3	I understand part of the reason that was done to
4	correct for this Green's function simplified input
5	problem. Are you satisfied that the confirmatory
6	analysis at least deals with the and eliminates the
7	Green's function simplification problem that was
.8	perceived?
9	MR. HOPENFELD: Well, the two nozzles
10	stated on the record are still subject to the Green's
11	function analysis.
12	JUDGE KARLIN: Let me ask this with regard
13	to the feedwater nozzle, the one that they did it for,
14	are you okay
15	MR. HOPENFELD: . With respect to that
16	aspect, yes, because they took the Green's function
17	out.
18	JUDGE KARLIN: Okay.
19	MR. HOPENFELD: But important, we
20	constantly hear these words conservatism. I mean to
21	say conservatism without quantifying it is not very
22	conservative.
23	My point is in the two items here, one
24	go back to the different issue
25	JUDGE KARLIN: Dr. Hopenfeld, we
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understand. You have testified and we probably will ask some questions about how you don't agree with some of these conservatisms, particularly --

MR. HOPENFELD: It's not the question -at this point, it's not the question of the mindset that something is conservative.

I make a certain assumption that may have no justification whatsoever. Now the results become conservative. I convince myself it's conservative. That's the problem. Because now we -- and the same thing with the definition that you ask, is something going to fail? And I can answer that question very quickly. You see, it goes to the definition and how people run tests prior to 30 or 40 years ago --

JUDGE KARLIN: Okay, well -- one of the things I think we might want to get back to is there was a discussion and Mr. Stevens, Mr. Fair was talking particularly about well, why don't you calculate the uncertainty associated with these of range calculations? They're saying it doesn't need to be done because it's conservative. And I understand that your testimony is and you've submitted that you think uncertainties should be calculated those and determined. I know you disagree with what they've said and we've got your testimony.

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MR. HOPENFELD: I said the mindset and Mr. Stevens kept saying conservatism and you'll be convinced it's conservative.

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JUDGE KARLIN: Right. Right, okay. But you are happy with the way they fixed the Green's function for the feedwater nozzle --

MR. HOPENFELD: I have no problem with the CUF with the exception of the bounding conditions to how to calculate it. The bounding condition for the Green's function and the bounding condition for the Fen under NV 32, they're considered the same. The consequences are different. I think they are under misconceptual of what the consequences are, but the bounding conditions for the Fens as far as how they use that is a contention, yes. But as far as getting rid of the simple aspects of the Green's function as a simplified method of reducing the amount of work, yes, I'm satisfied with that.

JUDGE KARLIN: Okay. One thing at a time and I just wanted to see if you were satisfied with that.

MR. STEVENS: May I add one piece of clarification?

JUDGE KARLIN: Okay.

MR. STEVENS: And I know we didn't say

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1 this explicitly in this discussion, but the discussion 2 up to now about the 40 percent increase in CUF, we 3 focused on Green's function and the use of these inputs, single stress term. Yet, we need to keep in 4 5 mind that our objective in the confirmatory analysis was not to reproduce the refined analysis. It was to 6 7 address several items that had been brought up as 8 potential issues with the analyses and to redo that 9 analysis independently, completely with satisfactory 10 compromises on all of those that would satisfy all parties and we agreed to do that with the staff to help them with their review process. 12 13 There are many factors that could have led to the 40 percent increase and I think some of the

1415 documented responses to the staff last fall from 16 Entergy indicated that the Green's function and the 17 single stress term was not the cause of that increase, 18 the bulk of that increase or a significant portion of 19 that increase. And that's why we still believe those refined analyses are bounding for --20

21 JUDGE KARLIN: What was the cause of the 22 40 percent increase or the major factors? 23 MR. STEVENS: There was approximately 20

-- what we characterized as 20 differences in the analyses, processing of the inputs. An example would

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be there were a few transients, the way they were estimated with the Green's function, the inputs were changed in the confirmatory analysis because we did not have to make those assumptions.

We changed material properties in the sense -- we used the same material properties, but the Green's function assumes the properties are constant because that's a condition of a linear integration. In the confirmatory evaluation, we -- material properties varied with temperature. There were many differences that were put into the confirmatory analysis any one of which could have contributed to the 40 percent increase.

JUDGE KARLIN: Well, okay. Let me refer 14 15 you to the Staff Exhibit 1, the SER, again on page 4-16 42. We're talking about this 40 percent increase and 17 I'm trying to find it referenced, if it is, in the 18 FSER and on page 4-42 at the bottom of the page, there 19 is a sentence that goes "with the maximum Fen value 20 used, the new EAF-CUFen is 0.893 which is greater than 21 the previous value of 0.639 reported by using the 22 Vermont Yankee Green's function application. Is that 23 the 40 percent difference? What is that?

JUDGE REED: If I may make a correction, the numbers I have is not zero point, but .089 and

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1	.064.
2	JUDGE WARDWELL: That's not what's in the
. 3	SER.
4	JUDGE KARLIN: What are those numbers?
5	I know what the numbers are in the FSER. They are
6	0.839 which is the EAF-CUF and the previous value of
7	0.639. Is that a 40 percent increase?
8	JUDGE REED: And my numbers come from
. 9	paragraphs 20 and 21 of your initial statement
10	position.
11	JUDGE KARLIN: Well, let me stick with
12	this one first. What do these numbers in the FSER
13	mean? Maybe Mr. Fair can help us?
14	MR. FAIR: Yes. I wasn't the reviewer.
15	JUDGE KARLIN: I understand.
.16	MR. FAIR: I believe that the .893 is the
17	application of the confirmatory analysis with the
18	constant FEN, that same FEN that was used in the
19	original analysis.
20	Then the Applicant further refined that
- 21	analysis, that confirmatory analysis, developing an
22	Fen for each transient which then lowered it below the
23	original
24	JUDGE KARLIN: No, I don't think so. Look
25	at the sentence. It says with the maximum Fen value
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1	used, the new EAF-CUFen is 0.893 which is greater than
2	the previous value of 0.639. So the previous value
3	the first earlier one in time was the .6 and the new
4	one is the .8, so something is going up.
5	Mr. Stevens?
6	MR. STEVENS: The numbers that Dr. Reed
7	was referring to are CUF values prior to FEN
8	evaluation and are the values that reflect the 40
9	percent.
10	JUDGE KARLIN: Okay, now where do they
11	derive from, where are they found if I wanted to find
12	them?
13	JUDGE WARDWELL: If you tried 40, page 21
14	they may be on that of his testimony.
15	JUDGE REED: That's 20 and 21 of Entergy's
16	initial statement of position.
17	JUDGE KARLIN: Okay, so are they in the
18	FSER? Mr. Fair, Mr. Stevens?
19	MR. STEVENS: I don't recall.
20	JUDGE KARLIN: I mean don't you think the
21	FSER should say that this the CUF went up 40 percent?
22	JUDGE WARDWELL: That's just the CUF, not
23	the CUFen, correct?
24	JUDGE KARLIN: Right, right.
25	JUDGE WARDWELL: The CUFs are .064 and
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1	0.89 as you change from the refined to the
2	confirmatory. Is that correct?
3	MR. STEVENS: Yes, the values in the FSER
4	are taking the values that Dr. Reed identified, I
5	believe it was you stated in the NRC initial statement
6	of position which are the CUF values. And that these
7	are the CUFens applying the same Fen value that was
8	determined in a refined analysis to both of those
9	results.
10	JUDGE KARLIN: Okay, all right. stop right
11	there. So the Fen is a constant value in this
12	calculation and the CUF is a differential value. And
13	it's going up. It went up from .6 to .8 and Fen is a
14	constant, right? Isn't that a 40 percent increase?
15	I thought you said if you use a
16	constant Fen, the CUFen would have gone up 40 percent
17	by fixing the Green's function?
18	MR. STEVENS: Yes.
19	JUDGE KARLIN: But you didn't use a
20	constant Fen.
21	MR. STEVENS: No.
22	JUDGE KARLIN: You used a more specific or
23	particularized Fen.
24	JUDGE WARDWELL: And that came up to a .3
25	of CUFen, is that correct?
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1	MR. STEVENS: That's correct.
. 2	JUDGE KARLIN: So the CUF went up and Fen
3	went down and the total result you conclude went lower
4	than the prior one.
5	MR. STEVENS: That's correct.
6	JUDGE WARDWELL: And your constant Fen is
. 7	either 10 or .1. I don't know which why it applies.
 8.	JUDGE KARLIN: So and in fact this would
9.	be directly, I guess, well, Dr. Hopenfeld?
10	MR. HOPENFELD: I would like to help them
11	to give you I'll tell you where the reference where
12	we can find the CUF and it's the last one. I can
13	go back and find it.
14	If you look at NEC JH-21 and I think page
15	7 of 7. There's a table there where you can see how
16	they've done that.
17	JUDGE WARDWELL: Wait, bear with us while
18	we find those first.
19	JUDGE KARLIN: NEC JH-21. And that is
20	structural integrity?
21	MR. HOPENFELD: Correct, and I think it's
22	page 7 of 7. And you'll see a table there. I think
23	it's dated it's a revision. I think it was given
24	to us at the beginning of January. And you'll see
25	there they have the user factor for all the transients
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and then you see how they corrected it. I think this ī 2 was done for the exact analysis and they have similar like that for other tables, but you asked about where 3 to see the user factors before the correction and 4 5 that's where it is. 6 JUDGE WARDWELL: This is page 7 of --7 MR. HOPENFELD: Page 7 of 7. JUDGE WARDWELL: And you can read that 8 ġ thing? 10 MR. HOPENFELD: I need a magnifying glass. 11 JUDGE KARLIN: Do you agree with that, Mr. 12 Stevens? 13 MR. STEVENS: No, I'm not finding -- I'm a little cross wired on the commonality of the 1415 exhibits. 16 I had JH-21 as being the equivalent of 17 Entergy Exhibit E-227. Is that correct? 18 JUDGE KARLIN: I do not know. Maybe Ms. 19 Carpentier, do you have that? 20 (Off the record.) 21 JUDGE KARLIN: E-227. 22 MR. STEVENS: E-227 specifically is 23 Entergy calculation VY19Q303. That would be the 24 fatigue results for the confirmatory evaluation of the 25 feedwater nozzle. It reports one value. I'm not **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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seeing a comparison to any others. ĺ 2 JUDGE KARLIN: Dr. Hopenfeld? MR. HOPENFELD: Yes, the table that I was 3 referring to gives you the usage factor without the 4 5 correction and with the correction. It's unfortunate 6 7 JUDGE KARLIN: It's just one of the 8 values. MR. HOPENFELD: It's the latest one. It's 9 the latest one. It's the one that you get the final 10 answer to form .897, but you can see what the 11 12 differences are between. Before correction and after correction and all the usage factors. 13 JUDGE KARLIN: Mr. Fair, Mr. Stevens, I'll 1415 go back to the FSER on page 4-42. The new EAF-CUFen is 0.893. The previous value is 0.639. Unquote from 16 17 the FSER. You're saying that's the revised CUF and a 1.8 constant Fen value, is that right? 19 MR. FAIR: That's correct. JUDGE KARLIN: Okay, perhaps you can then 20 21 show me -- let's go on in the FSER and tell me where 22 the ultimate CUFen value which with the Fen changed is 23 reflected in the SER, is it? 24 (Pause.) 25 Well, I didn't understand. I was confused **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

by that. Is the final CUFen value that Entergy has
presented by the confirmatory analysis reflected in
the FSER, the number put in the FSER?
MR. FAIR: Give me a moment. I thought it
was in there. I'm looking for it.
JUDGE KARLIN: Okay.
(Pause.)
JUDGE KARLIN: Well, let's read the next
sentence. "This indicates the results of the Green's
function application using the specific software could
under estimate the CUF and therefore cannot be the
analysis of record."
Then the next sentence says "however, the
updated analysis, whether using the maximum Fen or
appropriate Fen yields CUFs lower than the code
allowable. The staff concludes that this updated
analysis is the analysis of record for the feedwater
nozzle. When it says "this updated analysis" what is
that? Is that the analysis with the revised Fen?
MR. FAIR: Yes, that's what is referred
to.
JUDGE KARLIN: But that value is not
MR. FAIR: Yes, appears not to be in
JUDGE KARLIN: And what is that value, Mr.
Stevens?
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1	MR. STEVENS: It's .3531.
2	JUDGE KARLIN: Point 3531 and where does
3	that come from? I mean is there an exhibit that tells
4	us that? Is that this exhibit that Dr. Hopenfeid has
5	pointed us to?
6	MR. STEVENS: Yes, sir.
7	MS. BATY: Your Honor, it's Entergy
8	Exhibit E-228 also has a table with just these
9.	critical numbers in it on page 6.
10	JUDGE KARLIN: E-228. All right. Let's
11	focus on the exhibit NEC JH-21, page 7. It's also
12	Entergy Exhibit E-227, as I understand it. Where is
13	this new value on this tiny little chart? Where
14	where can I find it?
15	MR. STEVENS: If you go to Table 1 on page
16	7 of 7.
17	JUDGE KARLIN: Yes, sir.
18	MR. STEVENS: And upper half, far right.
19 [°]	JUDGE KARLIN: All right.
20	MR. STEVENS: With my glasses on, I can
21	see that it reads "total U60-ENV equals .35306."
22	JUDGE KARLIN: Okay. There it is. There
23	it is. I see it. Which equates to .3531.
24	I wish the FSER had had that in there.
25	JUDGE WARDWELL: Mr. Fair, can I ask why
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did you ask -- it appears based on the statements in the FSER that this was asked of them to calculate later on because it has parentheses, "this value was verbally provided during the audit."

Why did you ask for that calculation when in fact what they considered to be the appropriate calculation included the variation in the Fen value for each of the different transients?

MR. FAIR: I would have preface this that I'm not the reviewer, but my understanding of why it was asked at that time was the intent was feedwater analysis confirmatory analysis was going to be used to show that all three nozzles were appropriately conservative.

When Dr. Chang reviewed this confirmatory analysis and noticed that there were different Fen factors used in the confirmatory analysis, it couldn't make a conclusion that this same level of conservatism would exist in the other two nozzles that would allow you to drop that CUF down and that's why they were asked to do the analysis of the other two nozzles.

So although the feedwater nozzle analysis is acceptable, they couldn't make a judgment that the other two nozzles had the same level of conservatism in them that would come out and give a lower result.

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1	JUDGE KARLIN: You could or could not?
2	MR. FAIR: Could not.
3	JUDGE KARLIN: Could not, and therefore
4	MR. FAIR: Requested the other two nozzles
5	be evaluated.
6	JUDGE KARLIN: Okay.
7	JUDGE WARDWELL: In the pause, I'll ask
8	again, Mr. Stevens, to refresh my memory on earlier
9	testimony this morning on why does not the same
10	approach need to be applied to the other components
11	besides the nozzles?
12	MR. STEVENS: Because the other components
13	were demonstrated to be acceptable using other
14	analytical techniques that don't have these issues
15	included in them, Green's function issues. So we were
16	able to use existing conservative analysis that did
17	not rely on Green's functions that estimate stresses,
18	conservatively demonstrate the CUFens were less than
19	one. We met criteria and our evaluation is complete.
20	(Pause.)
21	JUDGE WARDWELL: Saying it another way,
22	for the refined analysis, when you analyzed the
23	nozzles, you had to or chose to use the Green's
24	functions to analyze the stress conditions on it that
25	ultimately resulted in demonstration of meeting the
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criteria? 1 2 MR. STEVENS: Yes, sir. 3 JUDGE WARDWELL: Okay, I understand. It's been going about an JUDGE KARLIN: 4 5 hour and a half now and you all have been very good in trying to answer our questions. I think it's probably 6 7 good to try to take a break. I have 10 o'clock. Whv 8 don't we reconvene at 10:15. So we'll stand adjourned until 10:15. 9 (Off the record.) 10 JUDGE KARLIN: We'll go back on the 11 12 record, Mr. Reporter. And let me remind the witnesses that .13 14 you're still under oath. We are continuing with questioning related 15 to metal fatigue contention, and I believe Dr. Reed 16 17 can start us off again. 18 JUDGE REED: Okay. Just a quick follow-up on a statement Mr. Fair made. I'd like to ask you to 19 20 please open up your initial statement of position, the 21 staff's initial statement of position, and look on 22 page 17. 23 Now, what do you mean by the MR. FAIR: 24 initial statement of position? 25 JUDGE REED: I don't have the exhibit **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

ĺ number. 2 JUDGE KARLIN: It's not an exhibit. It 3 would be the pleading presumably. JUDGE WARDWELL: Dated May 13th. 4 5 MR. FAIR: I think I have it. JUDGE REED: Okay. If you would look at 6 7 the bottom and read that paragraph on the bottom, please, starting "although the confirmatory analysis." 8 9 Well, maybe I'm not on the MR. FAIR: 10 right -- did you say page 13? 11 JUDGE REED: No, 17. Sorry. 12 MR. FAIR: Oh, I'm sorry. And again, 13 which? 14 JUDGE REED: The bottom paragraph. ·It 15 starts with the word "although." 16 MR. FAIR: All right. Somehow I don't seem to have the -- oh, I'm sorry. I'm turning to the 17 18 wrong (pause) -- thank you so much. 19 I have it. Sorry about the delay. 20 JUDGE REED: No problem. 21 MR. FAIR: "Although the confirmatory 22 analysis was acceptable to the staff and the CUF with feedwater nozzle was less than 1.0. The CUF produced 23 24 by the confirmatory analysis was greater than that 25 produced by the September 2007 analysis and thus not **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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bounding. SER (Staff Exhibit 1 at 442 to 443, Staff Exhibit 2 at 820). Therefore, the staff requested that Entergy make the confirmatory analysis, the analysis of record for the feedwater nozzle. SER (Staff Exhibit) --

JUDGE REED: You can skip those references. And then the final sentence is?

8 MR. FAIR: "Also, because the September 2007 analysis was not bounding for the feedwater 9 10 analysis, the staff proposed a license condition requiring that Entergy preform ASME code analysis for 11. 12the core spray in the reactor recirculation outlet 13 nozzle at least two years prior to the period of extended operation and make those analyses 14 the 15 analyses of record for the core spray in the reactor recirculation outlet nozzle. 16

JUDGE REED: Thank you.

So earlier I asked you if the staff's position was that this confirmatory analysis was bounding or not, and it was my understanding that you said that you believed that it was bounding, and so in light of this testimony that you just read or this initial statement of position, were we simply confused or --

MR. FAIR: Well, I may have been confused

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1 1	as to what the intent of your questions are. What I
2	meant when I said it was bounding, I meant it was
3	bounding for the other two nozzles. The reactor
4	feedwater nozzle had a bounding CUF.
5	JUDGE REED: Okay, but again, in the sense
6	of this, the staff's position is that that analysis is
.7	not bounding and that is hence why you are asking for
8	these two additional analyses to be performed; is that
9	not correct?
10	MR. FAIR: That's correct.
11	JUDGE REED: Okay. I just wanted to clear
12	that up.
13	Okay. I would like to change gears
14	slightly, and I'd like to talk now more particularly
15	about the Fen values. I observed earlier that there
16	seems to be quite a large variation in Fen values
17	ranging from one to I think I've seen numbers as high
18	as 70 or 90. So clearly fatigue cracking can be very
19	sensitive to environmental factors; is that correct,
20	Mr. Stevens?
21	MR. STEVENS: Yes.
22	JUDGE REED: So could you state for me
23	what environmental factors you believe fatigue
24	cracking is most sensitive to?
25	I know there are a large number of these
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1	factors, but if we could pick out the five or six that
2	you think are important.
3	MR. STEVENS: The laboratory data that
4	Argonne evaluated would indicate that strain rate,
-5	dissolved oxygen, temperature, and where appropriate
6	it
7	JUDGE REED: Temperature of what?
8	MR. STEVENS: Fluid temperature.
9	JUDGE REED: Fluid, not steel temperature?
10	MR. STEVENS: Correct. They're assumed to
11	be the same.
12	JUDGE REED: Okay.
13	MR. STEVENS: And where appropriate,
14	material sulfur content.
15	JUDGE REED: And is that sulfur content in
16	the water?
17	MR. STEVENS: That would be in the
18	material itself.
19	JUDGE REED: In the material. Anything
20	else?
21	MR. STEVENS: Those are the dominant ones
22	in the relations. There are other effects like strain
23	amplitude, how much you what level you stress a
24	component to that could indicate a threshold below
25	which you would not have to consider the other
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1	variables, but those are the dominant ones.
2	JUDGE REED: Well, let's talk for a minute
3	about one of these. Let's pick oxygen concentration
4	and talk about that for a moment. So can you tell us
[`] 5	a little about how you've accounted for oxygen
6	concentration in your calculations?
7	MR. STEVENS: Yes, sir. Entergy provided
8	structural integrity with oxygen values that are
9	representative of plant operations, and we looked at
10	those values and took a bounding value that would have
11	been seen in plant operation and used those in the
12	formulas to estimate the Fen appropriately.
13	JUDGE REED: Now, this is a single
14	constant number you used for all transients for all
15	time?.
16	MR. STEVENS: No, sir. We took bounding
17	values, but with the implementation of hydrogen water
18	chemistry, I don't recall exactly the year that was
19	implemented, but it was well after plant start-up. It
20	has a significant impact in some areas of the reactor
21	on dissolved oxygen levels.
22	JUDGE REED: Exactly what is meant by
23	hydrogen water chemistry? I don't know that.
24	MR. STEVENS: Hydrogen water chemistry is
25	a method to bring under control water chemistry in the
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JUDGE REED: So this reduces the dissolved oxygen.

MR. STEVENS: It reduces the dissolved oxygen in some areas of the reactor, yes.

JUDGE REED: So a higher concentration of dissolved oxygen is detrimental to fatigue cracking or it tends to worsen fatigue cracking?

MR. STEVENS: Generally speaking it's dominant for carbon and low alloy steels, that the higher the oxygen the more detrimental on fatigue. In a case of stainless steels, at least the relationships that we use for austenitic from the NUREG CR-5704 that indicates that lower oxygen is a bit more detrimental than higher oxygen levels, forced austenitics.

JUDGE REED: What type of steel are we talking about for the feedwater nozzle?

MR. STEVENS: The feedwater nozzle calculations are based on ferritic, carbon low alloy. JUDGE REED: Carbon low alloy. There was some mention of a -- you'll have to forgive me. Maybe I should ask you to describe the feedwater nozzle very briefly. Geometrically what does it look like?

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And I know there are two locations that you're concerned about. So you might help us understand a little bit about what it looks like and why you're analyzing two different locations on that nozzle.

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MR. STEVENS: The feedwater nozzle is basically a component where the feedwater piping which brings back condensed fluid to the reactor, joins the reactor pressure vessel. Very simplisticly, that's two intersecting cylinders, an incoming pipe into a larger cylindrical reactor pressure vessel.

The nozzle itself is a very large forging that transitions in thickness from the thick reactor pressure vessel to the thinner feedwater pipe. There is a component called a safe end in between the nozzle forging end of pipe that is another transition piece to transition from the pipe to the nozzle.

JUDGE REED: Okay. There was some mention of the installation of a thermal shield. I believe I have the terminology correct.

21 MR. STEVENS: Thermal shield or thermal 22 sleeve is the more commonly referred term.

JUDGE REED: Thermal sleeve.

MR. STEVENS: Thermal sleeve is inside the -- it connects or it touches to the safe end and

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channels the flow through the nozzle into the reactor vessel and is connected to what's called a sparger. The sparger distributes the feedwater flow evenly into the inside of the reactor vessel. The thermal sleeve acts as a shield to the feedwater nozzle forging and connection to the reactor pressure vessel to help channel the flow and also minimize thermal cycling on the nozzle itself.

JUDGE REED: So the thermal sleeve is helpful with regard to fatigue in that it reduces the stress on the feedwater nozzle due to temperature changes; is that correct?

MR. STEVENS: Yes, it's very beneficial in that it protects or greatly reduces the severity of transience on the nozzle itself.

JUDGE REED: And did you account for the presence of this sleeve in your analyses?

MR. STEVENS: Yes, sir.

JUDGE REED: But that sleeve was a recent addition; is that correct? MR. STEVENS: Can you clarify your

22 question?

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plant was --

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the sleeve -- has the sleeve been in position sine the

JUDGE REED: It was my understanding that

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1	MR. FITZPATRICK: The feedwater nozzle has
. 2	always had a thermal sleeve in it.
3	JUDGE REED: Yes.
4	MR. FITZPATRICK: The design was changed
5	in 1976 with a sleeve that had a tighter seal than the
6	original.
7	JUDGE REED: In '76?
8	MR. FITZPATRICK: '76.
9	JUDGE REED: So I had misread some
10	document actually. So these analyses have always
11	assumed the presence of a thermal sleeve.
12	MR. FITZPATRICK: Yes.
13	JUDGE REED: So let's go back to the
14	question of dissolved oxygen. So there is an
15	allegation by NEC that, in fact, fatigue is not really
16	sensitive to dissolved oxygen, but is sensitive to
17	something else called the electrochemical potential.
18	Could you respond to that?
19	And maybe you're not the right witness to
20	do that, but
.21	MR. STEVENS: I think Mr. Fair would have
22	a better answer to that than I would.
23	JUDGE REED: Mr. Fair.
24	MR. FAIR: Yes. There has been some
25	recent data that's indicated that electrochemical
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potential is a significant contributor 1 to the 2 environmental fatigue. Argonne looked at that data 3 and determined that based on some of the testing that they had done, it took a certain amount of time to get 4 5 a proper soak, heat soak in the material so that that was not a concern. It would stabilize. б 7 JUDGE REED: I didn't understand what you 8 said. A proper heat? 9 MR. FAIR: Yes. Well, I'm sorry. Ι′d like -- I used bad terminology. 10 JUDGE REED: It's just I can't hear you 11 12 from across the room. 13 JUDGE WARDWELL: Could you explain what electrochemical potential is in these situations that 1415 is of concern? MR. FAIR: Well, it's just the potential 16 17 electrical field that's set up that could have an 18 impact on the fatigue -- on the environmental effect, 19 and the data that we have for environmental is basically measured oxygen content, and we do not have 20 21 measurements on ECP. 22 When Argonne took a look at this issue, 23 they determined it took a while for the ECP to 24 stabilize at a given oxygen content so that there may 25 be some period of time, a short period of time where **NEAL R. GROSS**

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the ECP could have an effect.

JUDGE REED: So let's cut to the bottom it dissolved oxygen or electrochemical here. Is potential that should be the controlling factor? MR. FAIR: That issue has not been totally settled in the industry. Again, the data that we have for the environmental effect is all based on dissolved oxygen with very small amount of data that actually has ECP measures. JUDGE REED: Let me turn to Dr. Hopenfeld. This is your issue. Could you please state what your concerns is regarding dissolved oxygen? DR. HOPENFELD: First of all, T would like to comment that this is not a major concern. JUDGE REED: This is not what? DR. HOPENFELD: This is not a major concern, but it is an item that is important to understand. JUDGE WARDWELL: Don't you testify that it's a controlling parameter? DR. HOPENFELD: Yeah, I'm saying, but a major -- a major factor compared to all the others,

why that is an important factor. I mean, you should use ECP or you should use the electrochemical potential instead of concentration. It comes through

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1	the uncertainties of calculating the Fen and looking
. 2	elaborately on that.
3	But like I said, compared to others this
4	is not high on the priority, but let me explain.
5	JUDGE REED: Let me just observe that when
6	I asked Mr. Stevens for a list of controlling
7	parameters, the most significant parameters that
8	affect fatigue, environmental parameters that affect
9	fatigue, dissolved oxygen
10	DR. HOPENFELD: Yes, that's correct.
11	JUDGE REED: was number two.
12	DR. HOPENFELD: Well, oxygen is important.
13	JUDGE REED: So are you saying that you've
14	been down around number ten?
15	DR. HOPENFELD: Let me explain what I come
16	from on this. The basic mechanism of a crack
17	propagator is not 100 percent understood, but oxygen
18	creates an important part of it, but the driving force
19	is ionic dissolution. In the case of anodic
20	dissolution you have an anode and you have a cathode
21	and you have electrochemical potential to drive the
22	reaction.
23	The reason behind the electrochemistry,
24	and you write the equation for an electrochemical
25	potential, it's the activity that comes as a basic
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coreometer, not the concentration. But dilute concentrations you can sometimes say, yes, the activity coefficient is not very important and you can just go directly and right to potential in terms of concentration.

Now, why is that important? It was one item in the table that I provide you, and the reason it comes in, because it is an electrochemical parameter, and you're going to basic mass transfer between electrodes. You'll find out the conductivity. The ionic conductivity of the water also plays a part in the anodic dissolution, and I think Argonne discussions this and goes into the one parameter that is important.

15 In that context I was saying it's more important to use the -- I just want to make sure that 16 17 the science is correct. As you understand, the basic parameter, if you look in every textbook you'll see 18 what defines electrochemical potential 19 in your battery, in your anywhere in certain terms of 20 21 activity. That's the basic thermodynamic parameter, not concentration. 22

However, it's difficult to measure
absolutely. it should be measured by the potential,
but that's why people are talking concentration, but

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you have to understand that was the purpose of it. 1 2 When you have an uncertainty, and Argonne alludes to 3 the fact that different conductivity affects the 4 fatigue produced. And that's where I was trying to 5 explain. JUDGE WARDWELL: Did you not state at your 6 7 Exhibit 64, page 427 and 28 that EPRI also believes that this --8 9 DR. HOPENFELD: Oh, yes, yes, they did. They did. 10 JUDGE WARDWELL: -- chemical naturally is 11 12 a controlling parameter? 13 DR. HOPENFELD: Yes, yes, sir, and if you 14wish, if you go to -- let me see if I can find the 15 exact page where it's stated. 16 JUDGE WARDWELL: Four, twenty-seven. DR. HOPENFELD: 'It should be -- to be 17 18 considered is the electrochemical potential. They 19 stated that very clearly. 20 Now, I did see some of the testing that 21 they've been talking about, but I haven't seen -- I 22 haven't analyzed the work. It's hard to get because 23 this is not the number priority on one the 24 uncertainties here. 25 JUDGE WARDWELL: Well, that's why I want **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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to focus on why it isn't the number one priority. Are 1 2 you saying that representing this electrical-chemical 3 potential or at least the effects of it can be approximated by just having the concentrations of 4 dissolved oxygen represented at the --5 DR. HOPENFELD: That is --6 7 JUDGE WARDWELL: Let me finish. Okay? 8 Because then I can hear you if you would let me finish 9 my question. 10 DR. HOPENFELD: Right. 1.1 JUDGE WARDWELL: Let me start it again. 12 Are you saying that this electrical-chemical potential can be represented by a dissolved oxygen concentration 13 in regards to its effect on fatigue we're trying to 14 15 analyze? DR. HOPENFELD: That is correct, except --16 JUDGE WARDWELL: Now I'll let you explain. 17 18 Elaborate more if you wish. DR. HOPENFELD: Yes, it is correct, but --19 20 JUDGE WARDWELL: Okay, but it's your 21 position that a more accurate way to do it would be to 22 measure the electrical potential precisely. 23 DR. HOPENFELD: -- not from immediately --24 any electrochemist will tell you that. 25 JUDGE WARDWELL: How could that be done? NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.neairgross.com

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1.	DR. HOPENFELD: Well, you measure the
2	electrochemical potential.
3	JUDGE WARDWELL: How?
4	DR. HOPENFELD: I don't know practically,
5	but in the plant you probably don't do it, but in the
6	laboratory they do.
7	JUDGE WARDWELL: Well, practically how can
8	you do it in a plant?
9	DR. HOPENFELD: You can't.
10	JUDGE WARDWELL: So why are you bringing
11	this so isn't the only alternative available is to
12	use dissolved oxygen?
13	DR. HOPENFELD: In the plant, yes, but the
14	point is
15	JUDGE WARDWELL: Thank you.
16	DR. HOPENFELD: sir, what I'm trying to
17	say when you hear that everything is conserved, what
18	I'm trying to tell you, that there are parameters in
19	here that come into play. I think Dr persons at
20	Argonne I can mention about the factor of one to
21	two conductivity in the plant. That's where it comes
22	in.
23	JUDGE WARDWELL: And did Argonne show that
24	the measurement of dissolved oxygen always
25	underestimated the potential that might
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1 DR. HOPENFELD: No, I don't --2 JUDGE WARDWELL: -- the potential impact 3 associated with the electrochemical potential? 4 DR. HOPENFELD: No, I don't think they got into that detail, except that, you know, the whole --5. WARDWELL: 6 JUDGE So, in fact, the 7 dissolved oxygen may over estimate the impact 8 associated with this parameter. DR. HOPENFELD: It could be. I don't know 9 10 the exact kinetics. I mean, I don't think anybody knows what they are, but kinetics is going on in that 11 12 when the crack propagates. These are theories, which 13 is not exact science. The basic parameters and, therefore, the people at EPRI said -- a lot of people 14 15 and they're really talking believe, from the 16 perspective of the scientist or the perspective of the 17 people who do tests in the laboratory, who can do 18 that. They're not talking in terms of scientists at-19 the plant. I never meant to. 20 JUDGE WARDWELL: In Entergy --21 DR. HOPENFELD: All I was just trying to tell you is there's an uncertainty, and I don't want 22 23 to tell you the uncertainty comes from nowhere. Ι'm 24 just trying to say where it comes from, and that 25 uncertainty very well might --

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1	JUDGE WARDWELL: And it could be on either
· 2	side of the estimation of its impact.
· 3	DR. HOPENFELD: Yes.
4	JUDGE WARDWELL: Entergy's statement of
5	position, Answer 33 on page 16 said it considered
6	oxygen values and water chemistry excursions in its
7	CUF analysis. Doesn't that resolve this issue?
8	DR. HOPENFELD: Absolutely not.
9	JUDGE WARDWELL: Why not? It's also using
10	not only oxygen but also water chemistry.
11	DR. HOPENFELD: Could I refer you, sir to
12	NUREG 6583 and NUREG 6909?
13	JUDGE WARDWELL: And what's the
14	DR. HOPENFELD: Well, in Entergy's
15	documentation it's just called NUREG 69 6583.
16	JUDGE WARDWELL: What's the exhibit? We
17	need the exhibit number to find it.
18	JUDGE KARLIN: The exhibit number for
19	NUREG 6909 is, among others, Entergy 2-30. That's
[.] 20	6909, and the other one you referred is NUREG 6583, is
21	Entergy Exhibit E-206, as I have it.
22	DR. HOPENFELD: This is extremely
23	important, and I would like to read it because this
24	is
25	JUDGE WARDWELL: Where are you at?
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1		DR. HOPENFELD: I'm sorry?
2		JUDGE KARLIN: What page of which exhibit?
3		DR. HOPENFELD: NUREG 6583.
. 4		JUDGE WARDWELL: Wait, wait. Got to find
5	it. You ha	ve to bear with us. Sixty-five, eighty-
6	three?	· · · · · · · · · · · · · · · · · · ·
7		DR. HOPENFELD: At 78.
. 8		JUDGE WARDWELL: At 78.
. 9		JUDGE REED: Fage 78?
10		DR. HOPENFELD: Correct.
. 11		JUDGE WARDWELL: And did you say 6583?
12		DR. HOPENFELD: Sixty-five, eighty-three.
13	I have this	Exhibit 204. I need 204.
14		JUDGE KARLIN: Here it is. Okay. Sixty-
15	five, eighty	y-three. On what page, sir?
16		DR. HOPENFELD: On page 78.
17		JUDGE KARLIN: Seventy-eight.
18		DR. HOPENFELD: Can I read it?
19		JUDGE WARDWELL: Yeah. Is everyone set?
20		DR. HOPENFELD: The value of the
21	temperature	
22	-	JUDGE WARDWELL: Now, where are you
23	reading? I	m sorry.
24		DR. HOPENFELD: End is oh, can I read?
25		JUDGE KARLIN: What part of the page? The
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1	first paragraph, second
2	DR. HOPENFELD: I don't have paragraph.
3	JUDGE KARLIN: All right.
4	DR. HOPENFELD: I didn't I don't have
5	the thing.
6	JUDGE KARLIN: It's a long page.
7	DR. HOPENFELD: Yeah. Let me read it to
8	you. It's only one sentence.
9	JUDGE KARLIN: Please read it, yeah.
10	DR. HOPENFELD: The value of the
11	temperature and dissolved oxygen may be conservatively
12	taken as the maximum value for the the same wording
13	were given to us this week by Entergy when they passed
14	out, and I don't know if you have it in evidence, when
15	they passed out in slides that they wanted to talk
16	about it.
17	This is the instruction. These are the
18	specifications in NUREG 6583 as to how to use that
19	equation. What you heard from Mr. Stevens before, he
20	was talking about steady state operation. These
21	equations when you look at the equation itself, in the
22	exponent you have temperatures, oxygen, sulfur. You
23	have strain weight. These are to be determined during
24	the transient at the surface during that time.
25	These are not the parameters for oxygen in
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970 your sample somewhere in the plant once a week. This 1 2 is not the value, the intention you formulate in 3 dividing these equations. That's not the purpose of 4 Argonne to specify that you can use the steady state. 5 Now, let me go and take another document -б 7 JUDGE WARDWELL: Wait a minute. DR. HOPENFELD: what's extremely 8 9 important. 10 JUDGE WARDWELL: I've got to slow you 11 down. 12 DR. HOPENFELD: Sure. 13 JUDGE WARDWELL: This seems to me different discussion than the electrical-chemical 14 discussion. You are now saying if I am hearing you 15 16 correctly that you're arguing that they're using 17 dissolved oxygen values from steady а state operational condition and not for the transients, and 18 19 that's what-you're objecting to; is that correct? 20 DR. HOPENFELD: That's correct, but I was 21 trying to answer your question. Why is oxygen 22 important? The oxygen concentration, that's what the 23 question is about. That was my response. 24 JUDGE WARDWELL: I'm sorry. I did not 25 mean to ask that question. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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DR. HOPENFELD: Well, that's what I was 1 2 responding sir. I wasn't responding in the context 3 of electrochemical potential. There is more than a 4 cutorial kind of thing. Look. This is the --5 JUDGE WARDWELL: Just to make sure we're not wasting time -б 7 DR. HOPENFELD: Right. JUDGE WARDWELL: -- I'm sorry if I 8 interrupt you, but if hear that I haven't made myself 9 clear, I don't want to waste everyone's time --10 DR. HOPENFELD: Absolutely. 11 12 JUDGE WARDWELL: -- nor your efforts 13 associated with this. I think the last question and what I 14 intended to try to resolve was whether or not 15 Entergy's fact that they or testimony I should say 16 17 that they consider oxygen values and water chemistry excursions in a CUF analyses does not resolve this 18 19 issue of best representing anything associated with these parameters and their impacts on this phenomenon 20 21 we're trying to address. 22 And what is your response to that? 23 DR. HOPENFELD: My response is that's 24 incorrect, and that's what I started reading this. 25 Because you see, they're talking about excursion. If **NEAL R. GROSS**

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972 I understand correctly, they probably talk about 1 2 excursion through the crane, okay, or after heat-up 3 some time because maybe the system was opened up. But what the excursion --4 5 JUDGE WARDWELL: I'll ask them what they 6 meant. 7 DR. HOPENFELD: Right. If you tell me what they mean by "excursion" --8 9 JUDGE WARDWELL: So Mr. Fitzpatrick and 10 Mr. Stevens --11 DR. HOPENFELD: -- I've got to make sure 12 and I tell you what I understand. 13 JUDGE WARDWELL: Right. So what did you 14 mean by "excursions"? The oxygen values in law of 15 chemistry excursions in your analysis. 16 MR. FITZPATRICK: Could you point to where 17 you're speaking? 18 JUDGE WARDWELL: I was looking at your statement of position, Answer 33 on page 16. 19 20 MR. FITZPATRICK: Thirty-three. 21 JUDGE WARDWELL: I haven't typed it. MR. LEWIS: Point of clarification. Are 22 23 you referring to the testimony, the post -- statement 2.4 of position? Because if it's A-33, it's our 25 testimony. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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973 JUDGE WARDWELL: could be 1 It the 2 testimony. 3 JUDGE KARLIN: Yeah, it's Answer 33 on page 16. Is that where we are? 4 5 (Pause in proceedings.) MR. FITZPATRICK: Is that Question 56 on 6 page 33? 7 JUDGE WARDWELL: I have Answer 57 on page 8 33, and I think it's also on 56, page 32. 9 I was trying to look at the other one also. And both of 10 those answers, 56 and 57. 11 12 JUDGE KARLIN: And now we're referring to 13 what was formerly Entergy Exhibit 2.82.01 on pages 32 and 33, which is now no longer an exhibit. 14 15 JUDGE WARDWELL: But as I interpret what you were saying there, the oxygen values in the water 16 17 chemistry excursions were included in your CUF 18 analysis. Is that correct or is it not? MR. FITZPATRICK: Yes. We get the single 19 20 value for oxygen, all the transients. That value 21 represented 13 years of measurement data including start-ups and shutdowns, and that was an average plus 22 23 one standard deviation. JUDGE WARDWELL: Okay. So you took the 24 25 average of a transient DO levels -- say that again. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.neairgross.com

1 MR. FITZPATRICK: The oxygen measurements 2 I used to take at least twice a day. It's either 3 daily or twice a day. I always took it more during 4 this time when I tried to get this system down. That 5 data, we took a statistical average of it, and we added the standard deviation. So the expressions in 6 7 the planning office are based on 50 ppp feedwater 8 oxygen, will typically run 36 to 40, in there. 9 JUDGE WARDWELL: How much does it vary during the transience? 10 MR. FITZPATRICK: During the transient, I 11 12 don't think it varies that at all during a transient. 13 During a transient, that would be an injection. 14 Were the vessels hot? Once the 15 hydrochloric chemistry and the oxygen injection system. is stable, that doesn't change unless the system goes 16 off line. But there is no direct correlation between 17 18 the transient -- the oxygen injection, the hydrogen 19 injection system, and a transient. 20 JUDGE WARDWELL: Dr. Hopenfeld, do you 21 agree with that? 22 DR. HOPENFELD: No, absolutely not. Ιf 23 you look, please, at JH-65. 24 JUDGE KARLIN: Give us a moment to find 25 it. That's okay.

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1	DR. HOPENFELD: I think the pages are
2	there. Do you see there
3	JUDGE WARDWELL: What are you referring
4	to?
5	DR. HOPENFELD: JH-65.
6	JUDGE WARDWELL: I know, but where in
7.	that?
8	DR. HOPENFELD: It's on the there are
· .9	two pages in there. One pages shows you the date on
10	the second page showing the oxygen.
11	JUDGE WARDWELL: So Figure 1?
12	DR. HOPENFELD: Yeah, it's only one.
13	JUDGE WARDWELL: Page 53.
14	DR. HOPENFELD: Right. Two, fifty-three,
15	is that what it is?
16	JUDGE WARDWELL: I'm looking at the
17	exhibit. You tell me what you're looking at.
18.	DR. HOPENFELD: Yeah. Well, I thought I
19	did. It's 10ECJ865. There are only two pages in that
20	exhibit. I'm talking about the graph, the graph that
21	gives you oxygen concentration in ppm versus
22	temperature in degrees C. Only two pages, unless
23	you're looking at a different
24	JUDGE WARDWELL: I have three pages.
25	DR. HOPENFELD: Okay.
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1 JUDGE WARDWELL: But you're referring to 2 Figure 1 --3 DR. HOPENFELD: Correct, correct, right. It's only one figure. 4 Correct. 5 You can see in that oxygen concentration either hydrogen chemistry or normal state chemistry 6 7 goes up by an order of magnitude during that trend, up 8 and down. Another word I'd like to say is counting on 9 that gases have a negative solubility coefficient. So 10 as the temperature goes down, the oxygen concentration 11 goes up an order of magnitude. 12 Furthermore, if you will now permit me to 13 finish my line of thought, if you're going out to NUREG 6909, and again, this is a very important --1415 it's important you understand it, and this kind of 16 misunderstanding about what we're talking about was 17 excursion because you can have excursion and do steady 18 state, too. 19 JUDGE KARLIN: What page? Sixty-nine, oh, 20 nine? 21 DR. HOPENFELD: A-5. 22 JUDGE KARLIN: A? 23 DR. HOPENFELD: A-5. 24 JUDGE KARLIN: A-5. 25 DR. HOPENFELD: NUREG 6909. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	JUDGE KARLIN: A-5. This is the Appendix
2	5.
3	DR. HOPENFELD: A-5, right. Sir, you
. 4	asked what is the difference between these two NUREGS,
5	and you didn't get the answer.
6	JUDGE KARLIN: Okay. It's NUREG 6909,
. 7	page A-5.
8	DR. HOPENFELD: Can I read it?
9	JUDGE KARLIN: Yes, sir.
10	DR. HOPENFELD: The dissolved oxygen value
11	is obtained from each transient constituting the
12	stress cycle. For carbon and low alloy steel the
13	dissolved oxygen content, DO, associated with stress
14	cycle is the highest, highest oxygen content level in
15	the transient. And for us ferritic steel is the
16	lowest.
17	A value of .4 ppm. It's4 ppm. It's
18	400 parts per billion is recommended. This is the
19	instruction with the package. What was passed to us
20	the other day was the same wording that said you
21	should value the oxygen at the highest concentration,
22	the highest concentration due to the transient, both
23	in NUREG 6583, but they didn't say that their
24	recommendation, that specification is 400 parts per
25	million.

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Now, if you take this together with what you see, the EPRI data, then your next step is to make the calculation, and I would like to make the same calculation to show you the result of my calculation, about the same time that Mr. Stevens did, and I'd like. to read you those numbers so we can compare what those Fen values are for only that one uncertainty, which is the oxygen content.

Can I do that?

JUDGE KARLIN: Well, didn't you put that in your testimony?

DR. HOPENFELD: No, I did not. I just calculated it about the same time he did.

JUDGE KARLIN: Well --

DR. HOPENFELD: I did put some of the testimony -- I gave you the order of magnitude, yes.

In the table, I think it was Item 10, I

said use --

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JUDGE WARDWELL: Item 10 of what? DR. HOPENFELD: The table, the table that

I provided.

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JUDGE KARLIN: Ah, your table in your rebuttal testimony?

24 DR. HOPENFELD: Yes. I'll give you the 25 number of the table.

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1	JUDGE KARLIN: Table 13
2	DR. HOPENFELD: Just a second and I'll
3	give you the table number.
4	JUDGE WARDWELL: Table 1.
5	DR. HOPENFELD: JH-63, there's a table
6	there.
7	JUDGE WARDWELL: Page 4?
8	DR. HOPENFELD: Yes, I believe it is page
9	4, yes. On Item 10 there, I told you the oxygen
10	count, and if you put a factor of five in there it
11	increases the Fen by I don't know a factor of 50
12	or something, a factor of 55.
13	Do you see down there?
14	JUDGE WARDWELL: And that's with a
. 15	factor
16	DR. HOPENFELD: Right.
17	JUDGE WARDWELL: That's with a factor of
18	four in the oxygen.
19	DR. HOPENFELD: Correct, correct. Because
20	you see, it's an exponential which is being amplified
21	by the you take the exponential and you see how
22	sensitive it is to the oxygen. You know, if you take
23	DF, DO to give you the sensitivity, the derivative
24	will give you sensitivity, the parameter.
25	You see how what it is, it makes a big
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980 difference because now you have it back here, and 1 2 that's why I gave you an order of magnitude. I told 3 you what the problem is, and all I'm trying to tell 4 you, I went through the same thing and I tried it by 5 pencil over the weekend, and I'd like to give you - б those numbers. Sure, all right. 7 JUDGE KARLIN: 8 DR. HOPENFELD: Okay. 9 JUDGE KARLIN: Tell us what they are. DR. HOPENFELD: You'll have something to 10 11 compare one to one. It's number one; it's component 12 number one, between .6, .8. This is the CUFen, that 13 only due to the interest of the oxygen. There are other parameters. I'm just talking about 01, which 1415 hopefully we'll get to others. 16 JUDGE WARDWELL: We understand. 17 DR. HOPENFELD: But 01, the oxygen, okay? 18 One, I can repeat the number, .6 to .8. Two, 4.5 to 6. 19 20 Three, 6.7 to 8.9. 21 Four, which is stainless steel, they're 22 doing the right thing. They used the lowest oxygen. 23 That's NUREG 6909, but you cannot use -- you see, the 24 accident is because the mechanism of crack 25 The theory is that the oxygen operates propagation. **NEAL R. GROSS**

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. 1 .	differently through the
, 2 .	JUDGE KARLIN: Keep giving us the values.
3	What are the values?
4	DR. HOPENFELD: Yeah. I was just going to
5	tell you I didn't calculate it.
6	JUDGE KARLIN: Oh.
-7	DR. HOPENFELD: I didn't calculate it
8	because their numbers I agree with it.
9	JUDGE KARLIN: Oh. okay.
10	DR. HOPENFELD: I agree with it with
11	respect to that aspect alone, not others.
12	JUDGE KARLIN: Okay, fine.
13	DR. HOPENFELD: But I keep qualifying
14	myself. Just remember I'm talking about the effect of
15	oxygen only. They did it correctly.
16	Five, I couldn't find some data. So I
17	just skipped that one. I couldn't find it over the
18	weekend, but it's more than one definitely, but I just
19	couldn't do it exactly.
20	Seven is one and 1.2.
21	Eight is 1.2 to 1.6.
22	Nine is 7.2 to 10.3.
23	And ten is 2.5 to 3.5.
24	JUDGE WARDWELL: To clarify
25	DR. HOPENFELD: Yes.
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. 1	JUDGE WARDWELL: what was the value of
2	oxygen that they used or what was the value that you
3	used?
4	DR. HOPENFELD: Okay. That's what the
5	reason that you had two numbers here
6	JUDGE WARDWELL: What was the value that
7	they used and what was the value that you used?
8	DR. HOPENFELD: They okay. Very good.
. 9	Let me just tell you what I got. I took their
10	equation, the numbers that they used. They used
11	between, depending on the component, between 50 to 100
12	on the average.
13	JUDGE WARDWELL: Parts per million.
14	DR. HOPENFELD: I couldn't go to that
15	exact because
16	JUDGE WARDWELL: Parts per million.
17	DR. HOPENFELD: they average. They had
18	96 on one side, your normal operation. The hydrogen
19	is 150. I just didn't want to do
20	JUDGE WARDWELL: Is that ppb or ppm?
21	DR. HOPENFELD: I did it over the weekend
22	I'm sorry?
23	JUDGE WARDWELL: Was that ppm or ppb?
24	DR. HOPENFELD: Ppb.
25	JUDGE WARDWELL: Okay. B.
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DR. HOPENFELD: So I just took their 1 . 2 numbers, plugged the thing back into the equation, 3 pulled out the appropriate factor, and plugged my number. Now, you have to realize the equation is 4 5 written in such a way that if you go about 500 parts per billion, it doesn't make any difference because б that's constant. It's a number. It's a log of 12.5. 7 If you look at the -- you see it doesn't make any 8 9 difference. So once you get out of the 12.5, it 10 doesn't matter. JUDGE WARDWELL: So for carbon steel and 11 12 low alloy steel --DR. HOPENFELD: Correct. 13 -- the higher 14 JUDGE WARDWELL: the concentration of dissolved oxygen, the higher the Fen 15 value. 16 DR. HOPENFELD: Absolutely. Now, let me 17 1.8 tell you one more thing if I may. I gave you three reasons why that's so. I'd like to give you another 19 20 one, and the only reason I'm doing it, well, I'm 21 probably getting excited here, but the problem is when I do this conservative and everything is conservative, 22 23 and we get to this mind --JUDGE WARDWELL: We understand that. Curb 24 25 your enthusiasm and let's go --**NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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DR. HOPENFELD: But what -- but let--JUDGE WARDWELL: Is that all you wanted to

DR. HOPENFELD: No, no, no, no. What I want to say, you certainly can check on what I'm saying, what I'm telling you here. And the incentive check, you take a look at EPRI. Okay? Take a look at what EPRI does about that. They realize; they realize that this whole concept of Fen is work in progress. They say these work. It's a work in progress. I can quote you the number where they say that.

Now, many uncertainty, many loose ends. The bottom line is you define the people who are the analysts. You make sure they understand what's behind that. That's what it is. The whole thing is not ready for the market yet. That doesn't mean you go home and don't do anything. What you do is in the back of your mind you say, "Well, I'm going to do I'm going to use a conservative number. this. I'm going to use the upper bound, but I want to make sure I run it, I check it by somebody that these are real numbers, just because I decided it's not а conservative number."

> JUDGE WARDWELL: We are --DR. HOPENFELD: Let me just give you the

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say?

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1	figure that I was going to provide you because that
2	figure is NEC JH-84.
3	JUDGE KARLIN: It must be in the
4	rebuttal.
5	DR. HOPENFELD: Yeah, it is in the
6	rebuttal, right, and you see that
7	JUDGE KARLIN: Oh, no, we don't see
8	anything yet.
9	DR. HOPENFELD: Oh, okay. I have to go
10	and get it myself. I could say the time table is the
11	result if you want to, but
12	JUDGE KARLIN: Hold on a second.
13	MS. TYLER: Tell me the title of the
14	document. He doesn't have an Exhibit 84. What's the
15	title of the document?
16	DR. HOPENFELD: Yeah, it's NEC JH-64.
17	MS. TYLER: Sixty-four.
18	JUDGE KARLIN: Yeah.
L9	DR. HOPENFELD: Sixty-four, and it's page
20	418. Oh, did I say
21	JUDGE KARLIN: You said 84.
22	DR. HOPENFELD: I'm sorry. I'm sorry.
23	It's 64. I apologize.
24	JUDGE WARDWELL: Well, I'm glad I have
25	never made a mistake either.
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	986
1	(Laughter.)
2	JUDGE WARDWELL: I'm with you. I know how
3	this is when you know where you are. Okay. What page
4	are you on?
5	DR. HOPENFELD: Page 418. See at the
6	bottom carbon steel, Fen?
7	JUDGE WARDWELL: Yes. Is everyone with
8	you? Yeah.
9	DR. HOPENFELD: Are we on the same page
10	now?
11	JUDGE WARDWELL: Yeah.
12	DR. HOPENFELD: Okay. You see that my
13	numbers, according to the numbers, I didn't give you
14	the Fens, but roughly they're on the order of
15	magnitūde I can give them to you, but they are
16	between 80 to 100. That's the final CUFens.
17	If you look here you see what EPRI has is
18	they have F 550. I think that's about the temperature
19	we're talking about. Do you see the upper bound is
20	80? And this is not my calculation. It's sort of an
21	independent checking. So you see my number is
22	consistent with EPRI. EPRI numbers show that the
23	numbers in this area are something on the order of 80.
24	Now, the slides that were given to us by
25	Entergy were titled maximum Fen. I think they should
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1	revise this and call it minimum.
2	MR. STEVENS: May I clarify?
3	JUDGE WARDWELL: In a second. I just want
4	to ask a couple more fixing points and then I'll get
5	back to you. I'll get back to Entergy to respond.
6	So in conclusion, it's your position that,
7	in fact, they are not conservative in regards to the
8	value they selected for dissolved oxygen for carbon
9	steel and low alloy steel.
10	DR. HOPENFELD: (Unintelligible.)
11	JUDGE WARDWELL: It's your position that
12	their analysis for stainless steel in regard to
13	dissolved oxygen alone is adequate.
14	DR. HOPENFELD: Yes.
15	JUDGE WARDWELL: Thank you.
16	What is your response to everything he has
17	just said, Mr. Stevens.
18	MR. STEVENS: Where do I start? Let's
19	start with the NEC JH-64 document, otherwise known as
20	MRP-47, Rev. 1. I think I can comment on that because
21	I was the primary author of that document.
22	JUDGE WARDWELL: So this is the EPRI
23	document.
24	MR. STEVENS: This is the EPRI document.
25	Let's start with the figure on page 418. What that
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figure is showing is Fen is a function of temperature under various oxygen and strain rate loads. The top curve, the range of these are trying to show to individuals, given the range of the parameters defined by these equations, how Fen can vary.

There's several variables. So you have to take several graphs to show people the variance on any of these variables. This one here is trying to show as a function of temperature when you apply the different oxygen levels how the Fen would apply. Ιt doesn't indicate in any way that those indications are valid for Vermont Yankee or any other plant. It's just merely demonstrating to you the variation in Fen as a function of temperature under those variations.

15 The top curve, I think I even said this 16 yesterday in response to one of Dr. Reed's questions. The Fen can be as high as 140 as indicated by that 17 18 figure, but that's under oxygen levels greater than 19 500 ppb and very low strain rate.

20 Those conditions don't exist at Vermont Yankee, and whereas I would agree that that would be 21 22 a very conservative assessment, it's also very 23 unrealistic.

JUDGE But WARDWELL: have you not 25 characterized all of your analyses as being very

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conservative and very bounding? Is it fair to say then that, in fact, your dissolved oxygen -- your selection of dissolved oxygen in your analysis is more realistic than it is bounding?

MR. STEVENS: I would characterize it, sir, as being bounding for the conditions we have as info, which are for the Vermont Yankee plant. They were labeled as maximum Fens as applied to Vermont Yankee, not as applied to the maximum you could possibly achieve through these relationships.

JUDGE WARDWELL: How would -- and if I'm wrong in remembering this -- if I understand it correctly, you selected a value that is an average plus one standard deviation, and that average included all operational conditions with the transients included in it, but wouldn't that value, in fact, be very biased towards normal operational conditions?

MR. FITZPATRICK: Yes.

JUDGE WARDWELL: Is that an appropriate conservative value or would the transients dominate the potential failures that we're trying to evaluate in this contention?

MR. FITZPATRICK: In relation to the oxygen levels in the transients, your higher oxygen during start-up, which is a very slow, and sometimes

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a cycle which is a gradual cool heat-up with a gradual cool down. The contribution to the CUF from the start-up is very small compared to the contribution from an injection from HIPSI or the feedwater.

JUDGE KARLIN: Could you speak up, Mr. Fitzpatrick?

MR. FITZPATRICK: The contribution to the CUF from a start-up or a shutdown transient when the oxygen data shows that status for the system, you're going to higher oxygen when you're starting up the plant as the systems come on line. That fatigue contribution from that start-up is a very small contribution to the total CUF.

The primarily contributors are when the plant is running and something happens, when you get the injection of the plants, when you're getting a steady state. Also there's no direct correlation of a higher oxygen content from any measurement we've seen over there. The oxygen went up for this transient. It just the transients occur very quickly. There's nothing to change the oxygen.

JUDGE WARDWELL: But wouldn't it be more appropriate to use just the oxygen levels that were observed at the 20-some transients, or whatever it was, that we were talking about yesterday -- I forgot

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1 -- that we're --2 MR. FITZPATRICK: Those are design 3 transients. JUDGE WARDWELL: analyzing as the 4 - cumulative effects on this bending of the paper clip? 5 6 MR. FITZPATRICK: Those are the design transients. There is no measured -- the measured data 7 that we've taken over time, we will shut the plant 8 9 down, show that there is no real change. Say that on 10 plant trips -- I have to look it up. For an example, 11 if a plant trips, the O2 data is carried, still measured the same frequency, and you don't see any 12 13 change until later on. You don't see any change to the transient. 14 MR. STEVENS: May I clarify? The oxygen 15 measurements that Mr. Fitzpatrick is referring to are 16 indicative of what they would be during transients 17 that cause dominant fatigue. 18 The other response I was going to make 19 20 with Exhibit NEC JH-65, which was this paper from --21 JUDGE WARDWELL: Before you go to that --I'm sorry to interrupt, but I just want to make sure 22 I understood what you just said. Would you repeat 23 that? I don't know what you're referring to -- the 24 25 comment.

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992 1 MR. STEVENS: Mr. Fitzpatrick said that 2 the oxygen levels are monitored once or twice daily on 3 a continuous basis. 4 JUDGE WARDWELL: Right. 5 MR. STEVENS: And those oxygen levels --6 because of the water chemistry control and all of that 7 during plant operation are indicative of what they would be if a transient occurred during that period, 8 9 in between reads if you will --10 JUDGE WARDWELL: Can I stop you right 11 there with a promise I'll get back to you? 12 MR. STEVENS: Yes. 13 JUDGE WARDWELL: Dr. Hopenfeld, what 14 indication do you have, or evidence do you have, that 15 the oxygen levels could be as high as what you use in 16 your analysis at Vermont Yankee? 17 DR. HOPENFELD: Well, for one thing, it's 18 plain physics. If I didn't know anything else, I 19 would tell you that the temperature goes -- as the 20 temperature goes down, the oxygen concentration goes 21 up, you saw the --22 JUDGE WARDWELL: Sorry. Say that again. 23 It's hard to --24 DR. HOPENFELD: As the temperature -- the 25 solubility of gases is inversely proportional to the **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

temperature, which is by Henry's Law, whatever. When the temperature goes down, the oxygen concentration goes up. The equation that you have to resolve here, or solve, are -- those require you to find out what the oxygen concentration is during the transient at . the surface, not somewhere else. And EPRI makes the point very, very clear in their writeup. I can't -- I don't know if I can find the page. Maybe someone can find it for me. They say that oxygen is unknown in the transient. It's completely opposite, so Mr. Stevens said. He says he knows it.

I'd say I don't understand the issue. I think maybe they weren't that careful or maybe they didn't understand it to that degree, or for whatever reason, when they wrote 6583 they told you to calculate the oxygen at its maximum boundary to the transient. In 6909 they specified 400, not only the shutdown -- not only during the startup/shutdown, but let me answer about the shutdown, and let me --

21JUDGE KARLIN: Dr. Hopenfeld, may I just22interrupt? This is strange, if we go -- you're citing23at the EPRI document, NEC Exhibit JH-64, right?24DR. HOPENFELD: Yes.

JUDGE KARLIN: And it's EPRI materials

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reliability guidelines for addressing fatique Ţ 2 environmental effects in а license renewal application, MRP-47. This is the -- EPRI's guidance 3 on this issue. And if we go to page iii of the 4 5 matter, it says that the author of that document is Gary Stevens, who is sitting right there next to you. 6 7 And so I'm very -- I have a difficult time with Dr. -when Mr. Stevens tells me that -- what they say, and 8 9 you're saying that it's directly opposite. I mean, he 10 wrote the report. 11 DR. HOPENFELD: What I'm saying is the 12 numbers that I have calculated, according to their 13 equation, their values --14JUDGE KARLIN: Yes. -- substituting their 15 DR. HOPENFELD: 16 oxygen content, which was 50 to 100 -- whatever it was 17 -- with my numbers, which are -- which were prescribed 18 by NUREG-6909, which says all transients use 400 parts. 19 per billion. That's what they recommend to use with 20 those equations during transient. 21 JUDGE KARLIN: And let me ask, in this case as I understand it, the dissolved oxygen value 22 23 that was used was 50 parts per billion, is that right? DR. HOPENFELD: 50 to 100, depending on 24 25 the component. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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JUDGE KARLIN: Okay. Let me ask Mr. 1 2 Fitzpatrick on that. What dissolved oxygen value was 3 used in calculating these Fens? 4 MR. FITZPATRICK: So let me ask --JUDGE KARLIN: I read somewhere that it 5 was 50 parts per billion based on this 13 years and 6 all that other stuff. 7 8 MR. FITZPATRICK: That's the feedwater 9 line on the feedwater safe end, dissolved oxygen 10 concentration. JUDGE KARLIN: Okay. 11 MR. FITZPATRICK: Inside the reactor, the 12 oxygen concentration varies due to radioelectrolysis 13 14 with chemistry going on inside the core. Most of the -- when the water goes through the core, it creates 15 steam. A lot of the oxygen goes out. 16 17 Throughout the circuit, EPRI has a program that determines oxygen levels around the circuit. So 18 each section of the lesson there are values for 19 20 dissolved action. JUDGE KARLIN: So do you agree with what 21 Dr. Hopenfeld just said, that you -- that Entergy used 22 23 values from 50 to 100 parts per billion ---24 MR. FITZPATRICK: Even higher than that. 25 JUDGE KARLIN: -- oxygen. NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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1		MR. FITZPATRICK: Even higher than that.
2		DR. HOPENFELD: On the average.
3		JUDGE KARLIN: Okay. On the average.
4		DR. HOPENFELD: We really
5		JUDGE KARLIN: Well, what size did you
6	use? I mea	n
7	- · ·	MR. FITZPATRICK: Exactly?
8		JUDGE KARLIN: Well, if you can
9		JUDGE WARDWELL: If you've got them handy,
10	yes.	
11		JUDGE KARLIN: Yes.
12		MR. FITZPATRICK: It's E-212.
13		JUDGE KARLIN: E?
14	· · ·	MR. FITZPATRICK: E-212. Table 1.
15		JUDGE KARLIN: E-212. What was the page?
16		MR. FITZPATRICK: Page 14.
17	-	JUDGE KARLIN: E-212 is? Could you
18	identify that	at?
19		MR. FITZPATRICK: It's the EPRI
20	calculation	for VY 16Q-303.
21	· ·	JUDGE KARLIN: Okay. Dated?
22		MR. FITZPATRICK: It's dated 7/5/07.
23		JUDGE KARLIN: Okay. We're with you. And
24	what page?	
25		MR. FITZPATRICK: Page 14.
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997 JUDGE KARLIN: Page 14. All right. 1 And 2 what is that we're looking at? 3 MR. FITZPATRICK: All right. Those are 4 inputs --5 JUDGE KARLIN: Are those your dissolved oxygen levels that you used? 6 7 MR. FITZPATRICK: Dissolved oxygen levels 8 from each of the components evaluated in the analysis. JUDGE WARDWELL: How do you reconcile that 9 with the recommendation in 6909 that we should be 10 11 using 400 parts per billion? 12 MR. FITZPATRICK: He misquoted the last 13 sentence in the appendix on 6909, on page A-5. JUDGE KARLIN: All right. Hold on. 14 15 MR. FITZPATRICK: It's the bottom 16 sentence. 17 JUDGE KARLIN: We're at Exhibit --MR. FITZPATRICK: 6909, Exhibit --18 19 JUDGE KARLIN: A-230 at page A-5, is that 20 right? 21 MR. FITZPATRICK: That's correct. 22 JUDGE KARLIN: Okay. The last sentence on 23 that page? 24 MR. FITZPATRICK: The sentence says, "A 25 value of .4 ppm for carbon and low-alloy steels and **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	0.05 ppm for austenitic steels can be used to perform
2	a conservative evaluation."
3	JUDGE KARLIN: Okay.
4	MR. FITZPATRICK: It's not prescriptive.
5	JUDGE KARLIN: Not prescriptive, all
6	right.
7	MR. FITZPATRICK: It says "can."
8	JUDGE KARLIN: And since you wrote it, Mr.
9	Stevens, what did you mean by "can"? No, I'm sorry,
10	you didn't write this one. This is 6909. I'll
11	withdraw the question.
12	Is there any place well, that seems to
13	be is there any other indication in 6909 that some
14	other value can be used? I mean, are they just sort
15	of throwing that out there?
16	MR. FAIR: If I could help?
17	JUDGE KARLIN: Yes, Mr. Fair.
18	MR. FAIR: This was put in there in case
19	somebody that's using this procedure does not have
20	dissolved oxygen to input.
21	JUDGE KARLIN: Doesn't have the actual
22	values.
23	MR. FAIR: That's right.
24	JUDGE WARDWELL: That it would be
25	permissible to use this
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1	MR. FAIR: For a
2	JUDGE WARDWELL: and still meet the reg
3	guide, if that's what I mean
4	MR. FAIR: That's correct.
5	JUDGE WARDWELL: the NUREG, if that was
6	of interest
7	MR. FAIR: I
8	JUDGE KARLIN: Dr. Hopenfeld, would you
9	agree with that?
10	DR. HOPENFELD: I would. I would agree
11	with that, to the extent they had a they had a
12	instrument sitting at the surface of each of those
13	components measuring the oxygen. During their
1′4	training they don't have anything like that.
15	JUDGE KARLIN: All right. So let me stop
16	you there. So
17	DR. HOPENFELD: And that is what is
18	recognized. I think this what Mr. Fair said, he
19	reads what Argonne could have thought about it, and
20	then the definition is, you know, what chem is? I
21	don't know what
22	JUDGE REED: Do you believe that the
23	oxygen concentration at the surface of these
24	components is larger than the bulk oxygen?
25	DR. HOPENFELD: Simply use applied
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- _ 1	physics. There is about
2	JUDGE REED: Applied physics.
3	DR. HOPENFELD: It increases by an order
4	of magnitude going from 50 to 100.
5	JUDGE REED: But is that first of all,
· 6	I don't understand the physics, and I'm not sure we
7	should take the time to delve into it. But is that
8	the assumption in which these curves were generated?
9	MR. FAIR: Yes, it was the
10	JUDGE REED: Was it the local right next
11	to the
12	DR. HOPENFELD: Yes.
13	JUDGE REED: How did you measure that,
14	then? I don't believe that.
15	DR. HOPENFELD: The assumption, that those
16	things were generated in a laboratory, temperature
17	uniform, oxygen uniform, measured everything was
18	measured accurately. Then, I am taking this and
19	trying to apply it to
20	JUDGE REED: If the curves are correlated
21	against the bulk oxygen content, that's what you have
22	to use, not the content adjacent to the surface of the
23	metal, because that's not how the curve is run.
24	DR. HOPENFELD: They're the same. The
25	two
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JUDGE REED: Pardon me? 1 2 HOPENFELD: In a case of -- where the DR 3 curves were used, they are the same. 4 JUDGE REED: They're the same in the 5 lower -- they're the same in the lab, but not in the 6 reactor. DR. HOPENFELD: They were not writing the 7 train. They were writing the steady-state. 8 9 JUDGE WARDWELL: Let me see if I can help clarify, at least for me. It may not for you, Mr. 10 Reed, but -- Mr. Fitzpatrick, do you dispute the fact 11 that solubility changes dramatically with temperature? 12 MR. FITZPATRICK: No. That's physics. 13 14JUDGE WARDWELL: During transients, how 15 does the temperature vary in these components? MR. FITZPATRICK: Measure each transient, 16 which will go from operating down to 100 degrees 17 18 Fahrenheit for a certain transient. JUDGE WARDWELL: That's a pretty drastic 19 20 temperature change, isn't it, for that component. MR. FITZPATRICK: Yes. 21 22 JUDGE WARDWELL: Would you not expect the 23 dissolved oxygen to increase by several factors, if 24 not orders of magnitude? 25 MR. FITZPATRICK: It depends on the **NEAL R. GROSS**

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1002 timing. If the transient is very rapid, I don't think 1 2 it could -- in order for the chemistry to happen, to 3 occur, I --4 JUDGE WARDWELL: What was --5 MR. FITZPATRICK: I didn't get to that level of chemistry, but the phenomenon is there. б 7 JUDGE WARDWELL: Mr. Stevens, what was the 8 basis for your selection of those values we were 9 looking at in the previous exhibit? E-212 VY, page 14. We look at DO values, as you said, between 50 and 10 100. 11 MR. STEVENS: Those values were provided 12 13 to us by Entergy, consistent with what Mr. Fitzpatrick 14had testified earlier. JUDGE WARDWELL: And, Mr. Fitzpatrick, 15 which of those -- what is the basis for those in 16 17 regards to how you incorporated the change in 18 dissolved oxygen associated with а change in temperature for each of those components and the 19 20 resulting change in solubility of dissolved oxygen? 21 MR. FITZPATRICK: It wasn't evaluated to 22 that specific level. The oxygen levels given were 23 based on an EPRI model reactor with different 24 operating conditions -- normal water chemistry and for 25 hydrogen water chemistry at different power levels. NEAL R. GROSS

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And there is representative steady-state at those 1 2 power levels. It's only during the 3 JUDGE WARDWELL: transients that these cumulative use factors are 4 5 evaluated, correct? MR. FITZPATRICK: If you don't have a б .7 transient, you don't have any usage, yes. JUDGE WARDWELL: And as I'm hearing now, 8 that change in temperature of that component is very 9 10 influential in determining the dissolved oxygen that's available at that transient. 11 MR. FITZPATRICK: Yes. And it -- that's 12 one part of the Fen expression. If the transient 13 14 occurs very fast, you have a strain rate component, which cancels out that content. 15. MR. STEVENS: May I add some clarification 16 17 for you? JUDGE KARLIN: Sure, go ahead, sir. 18 19 MR. STEVENS: I'm going to try and clarify where -- your oxygen questions. We have talked about 20 a variety of inputs here. We have talked about an old 21 EPRI paper from 1983. We have talked about 22 temperature. I'm going to go back to NEC JH-64, which 23 24 is the --25 JUDGE WARDWELL: Is this back to the last **NEAL R. GROSS**

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1	time I promised I'd get back to you and I haven't
2	gotten back to you?
3	MR. STEVENS: That's kind of where we are,
4	yes.
5	JUDGE WARDWELL: I'm off the hook for
6	that.
7	MR. STEVENS: This is the MRP guidance for
8	license renewal that I authored. And we in the
9	last 45 minutes or so, we have talked about ECP, we
10	have talked about oxygen, we have talked about
11	temperature. And this document identified that these
12	are some issues. And as Mr. Fair testified, there
13	have been some other observations and data taken on
14	these.
15	But what this document basically says is
16	what we have is the best the best method based on
17	what we know today. And this identifies things like
18	ECP and how some of the experts have said maybe that's
19	a better parameter. It talks about time history,
20	variation of things during transients, and then it
21	makes a recommendation that's based on all of these
22	best practices and knowledge of the industry on what
23	to do.
24	That discussion, for example, on analysis
25	issues on oxygen is contained on page 4-27 of that
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-1	document. And at the bottom it makes a recommendation
2-	on what to do, and it points at a section in this
3	document 425 and says, "This is what you should
4	do." And what it says you should do for oxygen is
5	exactly what we did for the Entergy evaluation.
б	And what this document says is, given all
7	of these inputs and issues that have been identified,
8	that is the best way to evaluate this particular
9	issue. And what it would say is to take the
10	measurements in the plants, the bulk levels, and it
11	would say to take those and time-average them, and use
12	those inputs into your analysis. And that's what we
13	did.
14	And, in addition, we to the average we
15	took a one sigma deviation on those to make sure we
16	bounded some of these variations that occurred over
17	the time in the plant. So we are following the
18	guidance and the methodology that has been defined to
19	us based on all of the information we have at this
20	point.
21	On the 1983 EPRI paper that shows very
22	high oxygen content, the Figure 1 of NEC JH-65, we
23	don't know where these measurements were taken. We
24	don't know what plant they were taken. We have no
25	reason to know whether they're applicable at all to

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What we might be able to infer from some of the wording in here is that these are related to BWR startup events. It does say that in the text, although it does not say specifically that that's where this data was taken.

So there's a couple of observations we can make on that. First off, at least half of the data or more is below 150 degrees Centigrade, which is a threshold temperature below which environmental effects don't apply or Fen is one.

And, secondly, we know from our analysis, as well as 40 years of experience with doing these analyses, startup events contribute insignificantly to fatigue. So, and then, the fact that this paper is 25 years old aimed at stress corrosion cracking issues, you know, we have to be careful on how we apply that to environmental fatigue analyses today.

So my point would be how we evaluated oxygen and put it into the relationship is exactly consistent with all of the guidance out there by EPRI and the industry.

JUDGE WARDWELL: Well, I think we've got the picture on DO and ECP as best we can. Would you like to add anything else?

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1007 DR. HOPENFELD: I'd like to add a couple 1 2 For one, with regard to the word "can," of things. 3 I'm not --JUDGE KARLIN: I'm sorry, I didn't hear 4 5 that. DR. HOPENFELD: That the mention of the 6 word "can," I mean, Mr. Fitzpatrick said that you 7 don't really have to do it because it says "you can 8 9 use it." I don't think the intent behind that --10 they still don't measure the because oxygen concentration during the transient at the surface. 11 And the data was looked at under steady-state 12 13 conditions. 14Dr. Chang, when he went to the ACRS, he told them, because the question about oxygen came up, 15 16 obviously. And he told them, "Yes, well, I'm not sure they're using bounding values for oxygen." But then 17 he said -- well, Mr. Stevens said that the usage is 18 19 very small. Well, I went and looked for the transients 20 going up and down for the startup and the 300 --21 startup transients and the 300 shutdown transients. 2.2 And I went to the table that I mentioned to you before 23 24 -- I think it's NEC JH-21 -- and I looked at those 25 transients, and I edited out under 300 -- for the --

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1008 I can give them to you -- and each transient was very 1 -- the usage factor is very, very small. But there 2 are 300 of them, so -- 600 of them, and they add up to 3 4 50 percent of the total. 5 Now, if this is so small, why -- why do you even include shutdown? Why do you -- it's going. б 7 to cost more money to run more transients if it's nothing. 8 I was trying -- I was surprised Dr. Chang 9 comes in, and ACRS probably made some decisions based 10 on what -- his testimony. He comes in and he says 11 they used -- there is no usage here at all. And they 12 -- because he --1.3 JUDGE KARLIN: Can I stop you there? Dr. 14 Chang's testimony before the ACRS on what date? Was 15 this February --16 DR. HOPENFELD: I have to check. I don't 17 18 have it in front of me. I can give you his testimony also in this proceeding. I can give you the page 19 20 where that --JUDGE KARLIN: Well, let me just ask 21 counsel for NEC if they could find that, and at some 22 23 later point give us that citation to that testimony 24you're referring to. 25 DR. HOPENFELD: On the ACRS. But that **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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1009 particular ACRS paper I got from Entergy. It was 1 2 attached to -- it was one of their exhibits. 3 JUDGE KARLIN: Which exhibit and what's 4 the page? 5 DR. HOPENFELD: Yes. JUDGE KARLIN: Ms. Tyler, if you could 6 7 help us with that, either now or later. DR. HOPENFELD: But in the same context, 8 9 I would like to give you that -- the -- Dr. Chang's testimony on page 10 -- for page 12, NRC testimony. 10 JUDGE KARLIN: Page 12 of --11 12 DR. HOPENFELD: It's page 12 of his testimony. 13 JUDGE KARLIN: Oh, okay. Hold on a second 14 15 while we --. JUDGE KARLIN: And then, it was repeated 16 in a different form to the ACRS. 17 18 MS. BATY: Let me point out for the record that this exhibit -- that this testimony has not been 19 -- the Board has yet to rule on the admissibility of 20 21 this testimony, and there is a pending motion to 22 withdraw the testimony before the Board. JUDGE KARLIN: All right. So noted. What 23 24 page? 25 DR. HOPENFELD: Page 12, on the bottom of **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1	the page. This was my notes. I don't have it's
2	NRC. I don't remember which number which exhibit.
3	JUDGE WARDWELL: It's Dr. Chang's
4	testimony?
5	DR. HOPENFELD: Yes.
6	JUDGE WARDWELL: Okay. That's Staff 2.
7	DR. HOPENFELD: I don't have
8	JUDGE WARDWELL: NEC
9	DR. HOPENFELD: He said they did not use
10	bounding numbers, with the exception of the of the
11	heatup. He used the word "heatup."
12	JUDGE WARDWELL: You said you're referring
13	to page 12?
14	DR. HOPENFELD: Yes, on the bottom there
15	somewhere. That's what my note said, on page 12 on
16	the bottom. Dr. Chang agreed this occurred through
17	heatup of usage factor is negligible. He didn't
18	quantify either one of them.
19	JUDGE WARDWELL: I'm looking at one
20	sentence here that says the DO values used in the Fen
21	calculations are the average DO values plus one
22	standard deviation, which bounds almost all of the
23	data points in normal plant operation.
24	DR. HOPENFELD: That's what he said, yes.
25	And he also said that this would not he also used
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1 the word -- he said that the oxygen occurred during 2 heatup. 3 The staff noted JUDGE WARDWELL: Yes. 4 that --5 DR. HOPENFELD: The usage factor is б negligible. 7 JUDGE WARDWELL: And this is one -- the 8 staff noted that excursions where oxygen content 9 increases do occur during heatup. However, no 10 significant thermal transients occur during this period, so that practically no fatigue usage factor is 11 12 accrued during this period. 13 DR. HOPENFELD: He didn't quantify it. And I tried to quantify it. My usage factor doing 14 15 those things comes to about 50 percent of the -- both 16 heatup and cooldown. And he also didn't say -- he 17 just made the statement -- I would like for him to 18 testify, so we can find out. 19 JUDGE KARLIN: Can I ask a question here? 20 we've spent an hour or something talking about 21 dissolved oxygen and the electrochemical potential. 22 And you have a chart, Dr. Hopenfeld, on page -- the 13 23 factors ---24 DR. HOPENFELD: Yes. 25 JUDGE KARLIN: your rebuttal on **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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1	testimony.
2	DR. HOPENFELD: Yes.
3	JUDGE KARLIN: Is dissolved oxygen one of
4	your major concerns and problems here?
5	DR. HOPENFELD: It was one of them. It
6	was not it was one of them. I basically
7	JUDGE KARLIN: Okay. It was one of them.
8	DR. HOPENFELD: One of them. It is a
9	major input, yes.
10	JUDGE KARLIN: It's one of the 13.
11	DR. HOPENFELD: Very important.
12	JUDGE KARLIN: But of the 13, what are
13	your top three problems with regard top three.
14	DR. HOPENFELD: Top three?
15	JUDGE KARLIN: The biggest three problems.
16	DR. HOPENFELD: The one that bothers me
17	the most has to do with again, you talk in terms
18	you have to put yourself in the mind-set as you have
19	these
20	JUDGE KARLIN: Just what they are, just
21	what you've got 13.
22	JUDGE WARDWELL: Just give us three of
23	them.
24	DR. HOPENFELD: Oh, you mean an example?
25	Okay.
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1	JUDGE KARLIN: You've got 13 factors.
2	DR. HOPENFELD: I'm sorry. The factor
3	about the cracks in the cladding.
4	JUDGE KARLIN: Cracks in the cladding.
5	JUDGE WARDWELL: That's number one?
6	DR. HOPENFELD: Yes, I would say this is
7	number one. Surface roughness.
8.	JUDGE KARLIN: Okay.
9	DR. HOPENFELD: And I already said the
10	what was that one that I said?
11	JUDGE KARLIN: Oxygen.
12	DR. HOPENFELD: Yes, and
13	JUDGE KARLIN: You think oxygen is in the
14	top three?
15	DR. HOPENFELD: Yes. Oh, absolutely.
16	JUDGE KARLIN: Okay.
17	JUDGE WARDWELL: It's number 2, surface
18	finish?
19	DR. HOPENFELD: I would say number
20	JUDGE WARDWELL: No, no. I mean, I'm just
21	you said surface roughness. I'm saying that your
22	number 2
23	DR. HOPENFELD: Yes.
24	JUDGE WARDWELL: of your table, surface
25	finish is one of them.
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. 1	DR. HOPENFELD: Yes.
2.	JUDGE WARDWELL: Number 10, oxygen, is the
3	other one of your top three.
4	DR. HOPENFELD: Right.
5:	JUDGE WARDWELL: And then, number 13,
6	existing surface cracks?
7	DR. HOPENFELD: Correct.
8	JUDGE WARDWELL: Is the other
	DR. HOPENFELD: Correct.
10	JUDGE WARDWELL: another one.
11	DR. HOPENFELD: Now, in terms of
12	importance, I can't say this is higher than that. I'm
13	just saying
14	JUDGE WARDWELL: No, that's why
15	DR. HOPENFELD: those are those
16	three are very important. Not that there are nine
17	more, and you have to evaluate each one of them. I
18	don't have data a lot of them. Nobody does. But
19	what you have to know, which I believe they do not,
- 20	they believe because the it states conservative,
21	conservative, conservative, he believes it. When you
22	look to those all of these 13 factors.
23	JUDGE KARLIN: But, Dr. Hopenfeld, let me
24	ask isn't it true that they calculate these CUFens
25	for every nuclear powerplant that that's being used
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in the United States? It's a common thing -- the 1 calculation of CUFens. 2 DR. HOPENFELD: Well, I don't know. 3 The 4 whole concept of this methodology, and I -- I was 5 going to read to you, when Mr. Stevens said that he was involved in this -- writing this report. I'm sure 6 7 that many people wrote this report, and I don't know what part he had --8 JUDGE KARLIN: Well, but let me ask -- I 9 10 just want to get back --11 DR. HOPENFELD: No, no. JUDGE KARLIN: -- is calculation of CUFens 12 13 a normal thing that's done for all nuclear powerplants 14in the United States? 15 DR. HOPENFELD: I don't know. 16 JUDGE KARLIN: You don't know. 17 DR. HOPENFELD: I really cannot testify to 18 that, because I don't know. And I was trying to get --19 20 JUDGE KARLIN: Is it unique here? Have 21 you ever seen it done before? Are they doing it at 22 Indian Point? 23 DR. HOPENFELD: I'm sure they do, because 24 as soon as they see the data, the NRC tells them to do 25 that, they would do that. However --**NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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1016 JUDGE WARDWELL: Mr. Fair, is this -- as 1 2 far as staff experience is concerned, is this a common calculation that is done at various -- at numerous 3. 4 plants? DR. HOPENFELD: For reactors that have --5 JUDGE WARDWELL: I'm asking Mr. Fair. 6 7 DR. HOPENFELD: It's only for those that -- if it's fair? 8 9 JUDGE WARDWELL: I'm asking Mr. Fair 10 because --DR. HOPENFELD: .Oh, oh. 11 12 JUDGE WARDWELL: -- you didn't know. Ι was asking Mr. Fair whether or not it is a common ---13 14 .MR. FAIR: It's common for all plants 15 undergoing license renewal. JUDGE WARDWELL: And it's -- how is it for 16 17 the other plants that aren't going through license 18 renewal? MR. FAIR: The staff I know -- I'm afraid 19 20 to use the terminology, but the staff did a study back in about 1995 to determine whether we should have 21 existing operating plants evaluate their components 22 for environmental effects. 23-24 But part of the evaluation involved a risk 25 assessment. As a result of the risk assessment, the NEAL R. GROSS

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1017 1 staff determined that they could just justify 2 backfitting this to existing operating plants because 3 of the low risk. JUDGE KARLIN: Well, let me ask you about 4 5 that, then. 6 MR. FAIR: Okay. 7 JUDGE KARLIN: The requirement to do a 8 CUFen analysis is applied to all plants that are 9 looking for a license renewal. Is that what you're 10 saying? 11 MR. FAIR: That's correct. 12 JUDGE KARLIN: Okay. And in -- but it's not applied to existing plants that are not looking 13 14 for a renewal. 15 MR. FAIR: That's correct. JUDGE KARLIN: And the CUFen analysis 16 17 that's imposed upon license renewal applicants is 18 NUREG 5704 and 6583. 19 MR. FAIR: Correct. 20 JUDGE KARLIN: And the -- but a totally 21 different CUFen analysis is imposed upon new reactors, which is 6909. 22 23 MR. FAIR: That's correct. 24 JUDGE KARLIN: So neither one of them is 25 a backfit. Nothing is applied to existing plants at **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	all, is that right?
2	MR. FAIR: Yes.
3	JUDGE KARLIN: Unless they are looking for
. 4	renewal or a yes, unless they're looking for
5	renewal.
6	MR. FAIR: That's correct.
7	JUDGE WARDWELL: And is it fair to say
8	that the low risk came about under the assumption they
9	were going to be closing down also within a short
10	period of time, and knowing that the amount of
11	cumulative use factors are not likely to be exceeded
12	in the future. Is that where the low risk came in?
13	MR. FAIR: No. The low risk came in from
14	an evaluation of the probability of initiating a
15	fatigue crack if you have a CUF greater than one,
16	coupled with the probability of then running that
17	fatigue crack through the component to get leakage,
18	and the probability of once you ran the crack through
19	the component you would get a failure of the
20	component.
21	That total risk was determined to be low.
22	So the you know, there are several factors that
23	went into the risk assessment. The probability of
24	initiating a crack, the probability that the crack
25	goes through the component, the probability that
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causes a component to fail, and the consequences if the component failed of what would happen to the plant.

JUDGE WARDWELL: How many metal fatigue failures have occurred nationwide at plants?

MR. FAIR: I don't believe that there is any failures that occurred. I think there has been several cases of leakage due to unanticipated thermal loading.

JUDGE WARDWELL: And are those -- were those leakages detected in readily accessible areas, or were some in areas that could have gone unnoticed for even longer periods of time, such that more drastic failures could have occurred, do you know?

MR. FAIR: That I can't answer.

JUDGE REED: So, Mr. Stevens, I believe I heard you some time ago state that the Fen values for situations with temperatures below 150 degrees C, the Fen values are one in that case. Did I hear that correctly?

MR. STEVENS: Yes, sir.

JUDGE REED: Okay. I also believe that it's NEC's position, or that NEC asserts, that they believe the decrease in light of up to a factor of two is possible in this temperature range. Do I have that

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correct, Dr. Hopenfeld?

DR. HOPENFELD: That is correct. And that's a direct quotation of Dr. -- the author of that Argonne report, the guy who developed these equations. That's the part between the ACRS -- to the ACRS, and he said -- I mean, the question came up, "What about the temperature?" And he said, "Well, you know, on the average about 150. Most of the data falls apart above that." But if you go below the 150, you could have -- it's not necessarily zero. But when you put the Fen in statistical correlation, it exponentially drops out at zero. That's one.

And they also said, if you look at the data, if you go back to the original raw data, all you see -- what you will see, you will see there is only one point -- one data point at the very low -- at the 50 to 40 -- 50 to 40 parts per billion. In other words, there's a lot of weighing to be put in there on that -- on that very -- one data point.

He said, "Well, even there it's not 100 He said, "Well, even there it's not 100 percent sure when you go to the lower accident that you don't have some" -- so this is a statistical correlation. It's the best correlation you can come up with. I'm not questioning that. But you have to realize that this -- they say that this is -- the data

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that -- the answer comes to 2.9999, and that's correct.

JUDGE REED: I'm sorry. I'm not following 3 4 it your point that statistically the you. Is 5 statement that Dr. Stevens made is correct, that the Fen is one below 150, but there is some statistical 6 7 fluctuation around that, and there is some possibility? I didn't really follow what you said. 8 9 DR. HOPENFELD: No. I'm saying that Dr. 10 -- the person who developed these equations -- not me -- he said if you look at his equation it may be when 11 we go to the indication -- below 150, whatever the 12 13 requirement is -- I think it was 150 -- it's zero. 14But it really isn't. It's -- it could be as much as 15 a factor of two. 16 JUDGE REED: I'm sorry. You said it is zero, and I didn't --17 DR. HOPENFELD: Well, the exponential term 18 19 drops out. 20 JUDGE KARLIN: Well, let me just stop you, 21 Dr. Hopenfeld. Let's pull out the relevant NUREG, and 22 you can point us to where --23 DR. HOPENFELD: Okay. 24 JUDGE KARLIN: -- Mr. or Dr. Chopra, who wrote these NUREGs -- from Argonne wrote --25 **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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1 DR. HOPENFELD: Okay. 2 JUDGE KARLIN: Cite us to the page that he 3 talks about this matter. I remember seeing something 4 about that, and so --5 DR. HOPENFELD: Yes, I think --JUDGE KARLIN: I just can't find it. 6 7 DR. HOPENFELD: It's NUREG --8 JUDGE KARLIN: Is it 6909? Is that what 9 we're talking about? 10 MS. TYLER: If you go to page 26. JUDGE KARLIN: 26? 11 12 MS. TYLER: Yes. 13 JUDGE KARLIN: Yes, okay: That's it. 14Yes. And is that also E-230? We're talking about 15 NUREG-6909. 16 MS. TYLER: Yes, E-230. 17 DR. HOPENFELD: You can go to any one of 18 those equations and see --19 JUDGE KARLIN: On what page? 20 DR. HOPENFELD: Okay. Okay. That's --21 I'm looking at the equations. Let me find the 22 equations where the temperatures were in there. 23 Actually, we probably -- we talked about -- that 24 equation was brought into evidence this morning, the 25 Fen equals T. I'm looking for it, but -- oh. Just a **NEAL R. GROSS**

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1	minute. I'll get it in a minute.
2	JUDGE KARLIN: Take your time. 6909 is a
3	long document.
4	DK. HOPENFELD: Let me while I'm
5	looking at it, let me talk about the equation was
6.	brought up oh, here I think it is. Yes.
7	JUDGE WARDWELL: How do you spell his
8	name?
9	DR. HOPENFELD: The person who wrote this?
10	JUDGE KARLIN: Chopra, that's C-H-O-P-R-A.
11	DR. HOPENFELD: Just a minute. I have to
12	spell it out.
13	JUDGE KARLIN: Okay. Chopra.
14	DR. HOPENFELD: I think it's Dr. Chopra.
15	Yes, here it is. Chopra and W.J. Shack. I think that
16	Mr. Shack Dr. Shack is a member of ACRS.
17	If you go to let me see what find
18	the Fen equations here. Okay. If you go to on
19	page 38, okay, you'll see there's an equation there,
20	Fen is a fraction of is a function of .6 the
21	first term says the constant drops out.
22	The next one you see there's a T star
23	there, and that T star is really is a normalized T.
24	It's T minus some reference value, which I think is
25	150 I don't remember that calculation. I believe
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1	it's 150. And so the whole term at the lower
2	temperature drops out. It becomes what you have is
3	constant, because you see the term on the right hand
ų.	is zero. And what you wind up with is a constant.
5	JUDGE KARLIN: Well
6	DR. HOPENFELD: If T star is zero, the
7	rest is
8	JUDGE KARLIN: But, Dr. Reed, could you
9	restate your question? It was about 150 degrees and
10	it
11	JUDGE REED: Well, there seems to be a
12	difference of opinion between the two parties as to
13	whether temperatures below 150 degrees what the
14	environmental factor is. There's an assertation by
15	Entergy that at below 150 degrees the Fen value is
16	one. Dr. Hopenfeld believes that it may be as large
17	as two.
18	JUDGE KARLIN: And there's something on
19	this page 38 that supports what you just said?
20	DR. HOPENFELD: On page 38, I'm explaining
21	where it comes from. When you see the equation there,
22	it says a constant, and then you have an exponential
23	to times the
24	JUDGE KARLIN: Which equation? 26, 27, or
25	28?
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10251 DR. HOPENFELD: Take any one. Take 28. 2 JUDGE KARLIN: All right. 3 DR. HOPENFELD: And you will see it's 4 sulfur times temperature. Notice it is not the real 5 temperature. It is a reduced temperature. It's a T 6 minus T8 -- 28. 7 JUDGE KARLIN: Where does it say that 150 8 degrees is not one? 9 DR. HOPENFELD: Okay. 10 JUDGE KARLIN: This calculation says it? 11 DR. HOPENFELD: No, no. The -- where it says it isn't one was in the testimony of Dr. Chopra. 12 13 at the ACRS. JUDGE KARLIN: Oh, okay. 14 15 DR. HOPENFELD: We do have that as an 16 exhibit. 17 JUDGE KARLIN: All right. 18 DR. HOPENFELD: I just didn't know the 19 number of that exhibit. It's an ACRS --20 JUDGE WARDWELL: It also says it right 21 there in the following paragraph below 28 -- one, two, 22 three, four, five, six, seven -- seven lines down, that within the threshold of this is -- Fen is equal 23 24 to one. 25 DR. HOPENFELD: Yes, correct. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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1	JUDGE WARDWELL: Is that not correct?
2-	Where does it say the Fen should be two under other
3	circumstances?
4	DR. HOPENFELD: No, it's not just for
5	it was a factor of two higher than the equation would
Ġ	predict.
7	MR. STEVENS: May I clarify?
8.	JUDGE KARLIN: Well, just in a moment,
. 9	but I agree with what Dr. Wardwell just the
10	threshold strain amplitude is also defined, below
11	which lightwater reactor coolant environments have no
12	effect on fatigue life, i.e. a Fen of one. And is
13	that what you're saying, Mr. Stevens, is 150 degrees?
14	MR. STEVENS: Yes, but I I need to
15	clarify, because in all the confusion I might have
16	confused you further. I was I thought the
17	discussion was referring to carbon and low-alloy
18	steels. There is a similar effect, although not one,
19	for austenitics. And I
20	JUDGE KARLIN: Okay.
21	JUDGE WARDWELL: Austenitics?
22	MR. STEVENS: May I clarify now?
23	JUDGE KARLIN: Yes.
24	MR. STEVENS: I hesitate to do this, but
25	I'll refer you to NEC JH-64 again. This is the EPRI
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1027 1 MRP report, page 4-18. 2 JUDGE KARLIN: You're citing yourself again, is this what we're doing? 3 4 (Laughter.) 5 MR. STEVENS: Yes, sir. There's two figures on this page that show Fen as a function of 6 7 temperature. 8 JUDGE WARDWELL: I'm sorry. And the page 9 again? MR. STEVENS: 4-18. Two figures on this 10 page, top one being for stainless steel, bottom one 11 12 being for carbon steel. My earlier statement of Fen 13 is one below 150 was referring to the carbon steel, and you can see by that graph that the Fen goes down 14 15 to one at lower temperatures. 16 The upper graph for austenitics shows that 17 the Fen for stainless steel at lower temperatures is 18 approximately two. So I recognize the adjustment can 19 be a factor of two at lower temperatures for Yes, that's true by these 20 austenitic material. 21 equations. 22^{-1} JUDGE KARLIN: So is that -- do you agree 23 with that, Dr. Hopenfeld? 24 DR. HOPENFELD: Well, I thought -- if I am 25 wrong, correct me. I was really -- I did check that, **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1028 but I went by the testimony of Dr. Chopra before the 1 ACRS, and I don't remember him saying -- making a 2 3 distinction between stainless steel and carbon. 4 JUDGE KARLIN: So do you agree, disagree, 5 or don't know? DR. HOPENFELD: I don't know. 6 You don't know. 7 JUDGE KARLIN: Okay. That's fair enough. 8 DR. HOPENFELD: If Mr. Chopra was here, I 9 would find out, but I -- I would say given --10 physically speaking, it doesn't cut off right there, 11 because it's 150 degrees. 12 13 JUDGE KARLIN: Okay. JUDGE REED: Mr. Stevens, in the cases 14 where the components you're analyzing were stainless 15 steel, did you use the correct value? Ιf the 16 temperatures fell down to 150 degrees, would you have 17 18 used --MR. STEVENS: - Yes, sir. 19 JUDGE REED: But in the cases where it's 20 -- like the feedwater nozzle where it's not stainless, 21 you would have used an appropriate value. 22 23 MR. STEVENS: That's correct. JUDGE REED: Which might be one. 24 25 MR. STEVENS: That's correct. NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	JUDGE REED: Okay. Dr. Mr. Fair
. 2	MR. FAIR: Could I try to help clarify a
3	little bit? I think there might be a little confusion
4	on the calculation.
5	JUDGE KARLIN: All right. If you can make
6	it relatively quick.
7	MR. FAIR: I will.
8	JUDGE KARLIN: We think we're
9	MR. FAIR: If you have the NUREG/CR-6909,
10	and go to the procedure A-1, page A-1 near the back of
11	it
12	JUDGE KARLIN: That's the Appendix 1.
13	Okay. I'm with you.
14	MR. FAIR: And if you go to the equation
15	A-2, which is one of the Fen inspections.
16	JUDGE KARLIN: Yes.
. 17	MR. FAIR: If you go down to the variables
18	in A-5 with a T less than 150 degrees C, this T star
19	is equal to zero. So while I think it that they're
20	referring to the expression in A-2 that includes T
21	star goes to zero at below 150 degrees, and you are
22	left with an Fen as the exponential of that constant.
23	So there is a value above one, but it's something
24	close to two.
25	DR. HOPENFELD: That's correct.
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1030 1 JUDGE KARLIN: Okay. 2 DR. HOPENFELD: That's what I was talking 3 about. 4 JUDGE KARLIN: That seemed to be helpful. 5 MS. TYLER: Judge Karlin, I have located the discussion in the transcript, if that would be 6 7 helpful. 8 JUDGE KARLIN: Yes. Is that an exhibit? 9 MS. TYLER: It's Exhibit NEC JH-27, and 10 the relevant discussion is on page 25. JUDGE KARLIN: Great. Thank you. We'll 11 12 take a look at that. 13 .A couple more questions? JUDGE WARDWELL: I just had a couple of 14 15 followups to get back to --JUDGE REED: I just need to understand 16 what Mr. Fair is saying. Are you saying that we were .17 18 wrong about the Fen being one below 150 degrees, that 19 it's a constant below 150 degrees, but that constant 20 is not necessarily one? 21 MR. FAIR: That's correct. 22 JUDGE REED: Okay. 23 JUDGE WARDWELL: Just a couple of 24 followups that we've got. We blew by it, and I just 25 -- they are just quick fixes again, and that deals **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701 (202) 234-4433 www.nealrgross.com

	1031
1	with the hydrogenated water. Where in the plant I
2	think, Mr. Fitzpatrick, you said that not all of the
3	plant contains the hydrogenated water. Or it's only
4	contained in certain parts of the plant.
5	MR. FITZPATRICK: The hydrogen is injected
6	at the suction of the feed pumps. The feedwater
7	stream in the reactors it's fed into the reactors.
8	JUDGE WARDWELL: And in that hydrogenated
9	water, the oxygen levels are lower, is that correct?
10	MR. FITZPATRICK: It depends on where
11	are you comparing the two values in the chart? The
12	oxygen is measured in the same area. That's right.
13	The oxygen values are measured in the same area, and
14	the hydrogen is injected in a similar system same
15	system in a different location, and in the reactor.
16	So the data is taken on the piping, we get
17	the EWR BIA program, determine the oxygen level at
18	different locations in the reactor, and we have that
19	for hydrogen injection and prior to hydrogen
20	injection.
21	JUDGE WARDWELL: One other point that you
22	brought up that I'd like to just touch upon, and if it
23	it will probably get lengthy, so we'll continue
24	after lunch. I just want to know whether we if
25	it's going to be lengthy or not. But we were
11	

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discussing the relationship between solubility and 1 2 oxygen and temperature. You implied that the effects 3 of low temperature and the resulting increase in dissolved oxygen would be compensated for in a 4 5 transient based on strain rate. At least that's how 6 I interpreted what you were about to say. 7 MR. FITZPATRICK: In reality, yes. JUDGE WARDWELL: That probably is going to 8 9 be a longer discussion, is it not? MR. FITZPATRICK: Yes. 10 And --JUDGE WARDWELL: Well, good. Let's just 11 12 wait until after lunch, because it's on my list that I -- we'll do that, because Dr. Hopenfeld has that on 13 14 his list and it will be one of those parameters we'll 15 talk about after lunch. 16 DR. HOPENFELD: Just one comment before we I think Mr. --17 qo. JUDGE WARDWELL: Is this in response to 18 one of my questions? 19 DR. HOPENFELD: Well, it's really related, 20 because it -- no, it's not in response to --21 22 JUDGE KARLIN: All right. We'll just have it after lunch. 23 24 We're going to take а break. We 25 appreciate the witnesses responding patiently to our **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.neatrgross.com

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1	questions. It is now noon. Let us reconvene at 1:15.
2	We're now adjourned. Thank you.
3	(Whereupon, at 12:03 p.m., the
4	proceedings in the foregoing matter
5	recessed for lunch until 1:19 p.m.)
6	JUDGE KARLIN: We'll go back on the record
7	at this point. I apologize that we're a couple
8	minutes late and appreciate your patience on that.
9.	We'll try not to do it again.
10	We'll remind the witnesses that you're
11	under oath and so please advise by that. And before
12	we start, I would like to say I'm remiss in not
13	mentioning this this morning. We have another judge
14	with us from the Atomic Safety and Licensing Board,
15	Michael Gibson, over here, most recently a partner
16	with Jones Day down in Houston and has joined us as of
17	two weeks ago and sitting in on this session because
18	it's so fascinating on technical issues. And he's
19	getting all of this, I hope. Welcome.
20	Okay. Now we're focusing on Contention
21	No. 2, the metal fatigue and who wants to go first.
22	Dr. Wardwell, I think, is
23	MS. TYLER: There was on other reference
24	that you had asked me to find.
25	JUDGE KARLIN: Great. Okay.
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MS. TYLER: This is when Dr. Hopenfeld was referring to Dr. Chang's profession of the occupant issue and that transcript was an Entergy exhibit. It's E2-36 and the relevant discussion is on page 135.

Thank you.

JUDGE KARLIN:

JUDGE WARDWELL: I think we broke right at lunch talking about, starting to talk about, the strain rate with Mr. Fitzpatrick in regards to how that affects the Fen value and to refresh everyone's memory, I think earlier on it was alluded to when we were talking about temperature effects on dissolved oxygen and how those reduced temperatures would increase the dissolved oxygen and possibly increase the Fen and I believe, Mr. Fitzpatrick, that you said that would compensated for or at least alluded to that by the strain rate. Could you elaborate more on why you feel that's correct?

MR. FITZPATRICK: It depends on the -- the 18 19 rate temperature change and temperature change of --20 the change in the stress and the strain. That's 21 hypothetical for each transient. When we were talking 22 about -- We were getting into the solubility. I was 23 talking to other consultants and engineers. I think 24 I'm corrected. The solubility may increase if the 25 temperature goes down and if the temperature goes down

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That's great.

-- I think I was in error when I said it was one way or the other before. However, for the transients we're talking about, if the temperature goes down and the vessel is still pressurized and the oxygen won't come out of solution because it was not in saturated condition -- and the vessel is still in the power -side. It won't get oxygen coming out of solution. If your oxygen does come out of solution, it's in the steam or low temperatures.

JUDGE WARDWELL: What is -- I hate to go back to oxygen. How have you incorporated strain rate into your Fen analysis?

13 MR. FITZPATRICK: We view a value of integrity that can be used for all the Fen factors. 14 15 They've used the value of strain rate that would maximize the Fen value. When you has a very rapid 16 transient and you have a very fast strain rate, there 17 is no effect. The Fen is one or low. If you have a 18 19 very slow transient, that maximizes the Fen. They 20 used the minimum strain rate which maximizes the Fen value in the instructions --21

MR. STEVENS: May I?

JUDGE WARDWELL: Would you like to elaborate?

MR. STEVENS: Yes.

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JUDGE WARDWELL: Mr. Stevens.

MR. STEVENS: The strain rate, in the Fen expressions, the strain rate, there's a value that maximizes that term. In other words, the n is for a low strain rate. The Fen goes up with decreasing strain rate.

There's a value of strain rate below which the Fen does not increase in those equations. We've 8 referred to that as a saturated value. That is it's 10 the worst strain rate you can put into the expression to yield the maximum Fen. All of our calculations for all components whether we find it confirmatory use that saturated value of strain rate.

· 14 In effect, it makes the worst case assumption and 15 takes strain rate determination out of the equation if 16 you will.

JUDGE REED: Could you please explain from a physical point of view why an environmental factor would be affected by the strain rate? I don't see the connection.

21 MR. STEVENS: I think Mr. Fair might 22 answer that clearer than I could.

23 MR. FAIR: Yes, I believe what happens 24 when we strain the component is there's an oxide layer 25 that protects the base material and you crack that

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oxide layer. So when you do it very fast you don't have much time to do much damage to the underlying material. But with a slow strain rate, you keep it exposed for a longer period of time and that maximizes especially the environment.

JUDGE WARDWELL: Wouldn't that also depend upon the magnitude of strain or is there an inherent assumption that the magnitude of strain is the same for all the transients?

MR. FAIR: No, once you -- The magnitude of the strain, there's a cutoff point where you don't crack the oxide layer and that's that strain level of which the Fen goes to one. Above that, once you crack the oxide layer you are getting the damage and that damage is a function of how long the base material is exposed before you reform the oxide layer.

And it's not dependent on the magnitude of the strain, but just how long you keep the base material exposed. The fatigue life now is a function of the actual strain level because the higher the strain the more damage you do on the fatigue cycle.

JUDGE WARDWELL: Dr. Hopenfeld, do you have any objections to what has just been said in regard to how strains handle before we get into whether or not you think it's adequate or not? Is

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1038 there anything that they've said that wasn't your 1 understanding of how they handled it? 2 3 DR. HOPENFELD: No, I understood how they handled it. I used their numbers when I came up with . 4 5 my numbers. I used exactly what they did. I just took their numbers and put -- flushed out their oxygen 6 7 and put mine there. 8 JUDGE WARDWELL: We're talking about 9 strain rate now. DR. HOPENFELD: Yes, I know. I used the 10 11 same strain because you see --JUDGE WARDWELL: So you have no dispute 12 with how they handled strain. 13 DR. HOPENFELD: Well, I used the same. 1415 No, I have no dispute of how they handled strain. 16 JUDGE WARDWELL: Okay. Thank you. 17 DR. HOPENFELD: I do have a -- I would like to comment if I may or maybe I'll comment some 18 other time regarding on the mechanism --19 20 JUDGE WARDWELL: If it doesn't deal with 21 strain rate, I don't want you to comment right now. 22 DR. HOPENFELD: Yes and no because the 23 implication here is that you -- that we really 24 understand the exact mechanism of the oxide layer, how 25 it cracks and when it cracks. There are some other **NEAL R. GROSS**

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1	theories, you know, other theories that compute things
2	physically that I'm absolutely sure I have a good
3	feeling with it, but it's something that our gang came
. 4.	up with, I don't know, within the next ten years that
5	other people say yes and there was something about
6	hydrogen It's a complex issue.
7	JUDGE WARDWELL: This is in regards to
8 .	DR. HOPENFELD: It's so over simplified
9	that my mind has been in shock.
10	JUDGE WARDWELL: So this is in regards to
11	how the oxide layer behaves which
12	DR. HOPENFELD: Right. What I'm saying is
13	this is not given what the gentleman said. He may be
14	right. This is a work in progress. So the best
15	reason to conclude that he's conservative, that's
16	where the problem comes in.
17	JUDGE WARDWELL: But you have no evidence
18	to dispute that either. It's still as you say
19	possibly a work in progress is all empirical things
20	DR. HOPENFELD: I have no dispute in
21	theory. You know, there are a lot of theories, but
22	that's not the only theory and I'm not familiar with
23	all of them, but I'm familiar with that one and it
24	makes sense. But that doesn't mean that because
25	you say the strain does this and doesn't do that and

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1.	that's what's conservative just because of this
· 2	theory. I mean, it's naive.
3	JUDGE WARDWELL: Dr. Hopenfeld, what
4	Any other questions on strain rate? Dr. Reed, any
5	questions on it?
6	JUDGE REED: No.
7	JUDGE WARDWELL: Dr. Hopenfeld, what leads
8	you to believe that the base metal of the feedwater
9	nozzle is cracked?
10	DR. HOPENFELD: Okay. In the I don't
11	know exactly the history, but I believe somewhere in
12	the `70s, late `70s or maybe mid `70s, a whole bunch
13	of BWRs, I remember, where the feedwater nozzle
14	cracked and a lot of BWRs are replaced. They remove
15	the cladding, remove the welding. From what my
16	understanding is, they haven't done so. In other
17	words, the weld metal is still there. They haven't
18	done anything with that as opposed to other plants.
19	JUDGE REED: Could we investigate that
20	point for just a moment? I'm a little confused about
21	the geometry of this nozzle. Isn't it clad with
22	stainless steel?
23	MR. FITZPATRICK: It's clad with stainless
- 24	steel in a blended use.
25	JUDGE REED: Pardon.
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MR. FITZPATRICK: In a blend rate. It is 1 2 clad with stainless steel and in '70s when they 3 replaced -- In '76 they replaced the sparger. Thev pulled the sparger out to pull the original thermal 4 5 - sleeve out of the vessel. They were doing inspection. 6 They actually did --7 JUDGE REED: When you refer to "they" you 8 mean you as Entergy. MR. FITZPATRICK: Entergy and GE. 9 GE was doing this for a lot of plants back then. 10 They replaced the spargers at the same time they inspected 11 the whole -- radius. They grouted out any indications 12 they could find with -- I think they were doing PT 13 inspections back then. People were sitting in the 14 15 vessel core heads. 16 JUDGE WARDWELL: Are you talking about at 17 Vermont Yankee? MR. FITZPATRICK: At Vermont Yankee, yes. 18 19 JUDGE WARDWELL: The owner of Vermont 20 Yankee at that time was doing what -- Your testimony 21 is that they did this. 22 MR. FITZPATRICK: Yes. 23 JUDGE WARDWELL: Okay. They inspected it and 24 MR. FITZPATRICK: 25 there was a period of inspection doing in the vessel **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

	1042
1	during the PT inspections.
2	JUDGE WARDWELL: PT?
3	MR. FITZPATRICK: Penetrant testing.
4	JUDGE WARDWELL: What is it?
5	MR. FITZPATRICK: Penetrant testing.
6	JUDGE WARDWELL: Penetrant testing, okay.
7	MR. FITZPATRICK: You put a dye into the
8	point of the crack.
9	JUDGE WARDWELL: Ckay.
10	MR. FITZPATRICK: And through the years
11	they've developed further UT techniques.
12	JUDGE WARDWELL: UT?
13	MR. FITZPATRICK: Ultrasonic testing.
14	JUDGE WARDWELL: All right.
15	MR. FITZPATRICK: Most inspection is done
16	with ultrasonic testing. They can put the probes on
17	the outside of the nozzle and investigate that the
18	geometry is including the probe to Our exhibit, we
19	have a diagram. It's a small one. E-233, we give you
20	a diagram of the head of the nozzle.
21	JUDGE REED: E-233.
22	MR. FITZPATRICK: Yes.
23	JUDGE REED: And the page?
24	MR. FITZPATRICK: There are five pages in
25	it. They are all marked 106.
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	1043
1	JUDGE REED: The very last page.
2	MR. FITZPATRICK: Yes. The last page.
3	This is a section called the nozzle looking in a
4	vertical plane and the blend rate is, if you look down
5	on the page, at section one where the radial surface
6.	is.
7	JUDGE REED: Yes.
8	MR. FITZPATRICK: That's called the blend
9	radius.
10	JUDGE KARLIN: Okay.
11	MR. FITZPATRICK: That's where the CUFen
12	is calculated.
13	JUDGE KARLIN: That's where the CUFen was
14	calculated.
15	MR. FITZPATRICK: Yes. One of the
16	locations.
17	JUDGE KARLIN: One of the locations, okay.
18	JUDGE REED: Is that called the nozzle
19	core (phonetic)?
20	MR. FITZPATRICK: Yes, that's the
21	terminology of the NRC is nozzle core.
22	JUDGE REED: Thank you.
23	MR. FITZPATRICK: And they've done
24	inspections to demonstrate the method works in
25	mockups. It's pretty much standard instrumental.
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They'll do a UT exam on the exterior of this, on the whole nozzle, to investigate these areas. The UT technique is sized to capture a maximum or minimum size flaw and we have another analysis at Section 11 that the postulated flaw in that. We have postulated a flaw in that nozzle core already and we have done a Section 11 analysis for that. That's outside the fatigue.

JUDGE WARDWELL: Section 11?

MR. FITZPATRICK: ASME Section 11. That's a service inspection and that was in response. This inspection -- There's a special inspection called augmented inspection and it's in response to the NUREG that was done in the '70s. What is it? Six-nine --I haven't got the number.

JUDGE WARDWELL: Are we looking at -- Does the feedwater go in between the lines of this nozzle or is this the cladding of the nozzle?

MR. FITZPATRICK: That represents the full thickness of the nozzle. The feedwater pipe will be here and the center line would be here. So it would be the top section of the pipe. This is the vessel wall. The pipe's coming in horizontally. This is the safe vent well down here and this is the port nozzle of these.

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	1045
1	JUDGE WARDWELL: Where is the feedwater
2	going?
3	MR. FITZPATRICK: (Indicating) This way.
4	There is the thermal sleeve that fits in there and
5	it's pressed right into the safe vent. You don't see
6	it in this diagram and the feedwater flow is in
7	through the thermal sleeve. It's a pipe within a
8	pipe. You can think of it that way. So the full
. 9	feedwater flow never really gets to this part.
10	JUDGE KARLIN: Try to describe what you're
11	pointing to so we can have something on the record
12	that will transcribe.
13	MR. FITZPATRICK: Try to describe it.
14	MR. STEVENS: May I?
15	JUDGE KARLIN: Sure.
16	JUDGE WARDWELL: Mr. Stevens please.
17	MR. STEVENS: On this picture where it
18	says "Vessel"
19	JUDGE KARLIN: Now we're referring to?
20	MR. STEVENS: We're referring to page
21	five.
22	JUDGE KARLIN: E-233 Vermont Yankee and
23	page five, the diagram. Right?
24	MR. STEVENS: That is correct.
25	JUDGE KARLIN: Okay.
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· 1	JUDGE WARDWELL: The diagram shows several
2	lines. It looks like a closed in component.
3	MR. STEVENS: Correct. So remember the
4	Recall the earlier description I gave the nozzle being
5	the intersection of two cylinders, the large vessel
6	cylinder and the incoming pipe and that's what you're
7	What you're seeing here is a cross section of that
8	intersection, one-half of that cross section. The
9	lower half of that cross section is not shown here,
10	but it would be an inverted image of this.
11	JUDGE WARDWELL: And it's a cross section
12	of a doughnut. We're seeing one-half of a cross
13	section of a doughnut type of
14	MR. STEVENS: Correct.
15	JUDGE WARDWELL: Coating, yes.
16	MR. STEVENS: Another way I've described
17	this to folks is if you took this and revolved it
18	about a center line you would have There would be
19	one difference in doing that to the real
20	configuration. The vessel portion of this would be
21	flat if you rotated that about a center line axis
22	when, in fact, the vessel is itself a cylinder. But
23	it's close. So if you do this solid revolution, call
24	it, it gives you close representation of what the real
25	component is.
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1047 JUDGE REED: Now the clad, would you 1 specify exactly what portion of this nozzle is clad in 2 this picture? 3 MR. STEVENS: Yes, the cladding is put on 4 to the vessel wall interior surface and the nozzle 5 6 forging. 7 JUDGE REED: And which part is called the nozzle forging. 8 9 MR. STEVENS: The thicker part. The part 10 that's identified as nozzle in this diagram is the forging. . 1.1 JUDGE REED: And the forging ends there on 12 where the wall becomes thin or? 13 14 MR. STEVENS: Yes. On the one side, it's the forging itself, the nozzle, is attached to the 15 vessel itself with a weld, a full penetration weld, 16 17 which is shown by the dark region between vessel and 18 nozzle. 19 JUDGE REED: Okay. MR. STEVENS: And then it's adjoined to 20 the safe end at the other end where the dark region 21 between the nozzle and safe end. 22 JUDGE REED: I didn't understand, but 23 24 those are wells. 25 MR. STEVENS: Those are depictions of NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

wells. Yes, sir. 1 JUDGE REED: Thank you. 2 JUDGE KARLIN: And when you say the 3 interior is clad also, does that mean the lower 4 horizontal line in the diagram that's over 5 the 6 interior on this? 7 Yes. The nozzle forging MR. STEVENS: itself is clad contiguously with inside the vessel and 8 then if you look at these regions that are marked 1, 9 2a, 2b and 3. 10 11 JUDGE KARLIN: Yes. MR. STEVENS: The nozzle itself is clad 12 into those regions. 13 JUDGE KARLIN: All right. 1415 JUDGE REED: Is it clad all the way down to the weld position or? 16 MR. FITZPATRICK: Some of the nozzles end-17 18 up just before the weld. 19 When you're ultrasonic JUDGE REED: 20 testing, is it able to detect cracks of the cladding even though you're testing from the outside? 21 22 MR. FITZPATRICK: It's designed to detect minimum sized flaw that is postulated in the base 23 metal weld. It's either 3/16ths or 1/4 inch. I think 24 25 it's 3/16ths. It can detect up to a 3/16ths crack in **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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the base metal weld.

JUDGE REED: Now when you say a 3/16ths

MR. FITZPATRICK: Yes.

JUDGE REED: Is that along -- Is that depth?

MR. FITZPATRICK: Yes.

JUDGE REED: So it's not opened up. I mean, it's just a microscopic opening.

10 MR. FITZPATRICK: Microscopic crack, yes. And there was another analysis that is done to support 11 12 this issue back in the '70s that has been refined a 13 few times and that crack analysis supports the 14 inspection program for that nozzle. We postulate 15 crack -- It's an analysis that shows crack erosion at 16 the time and the inspection program is designed such 17 that we've inspected prior to getting appreciable 18 crack.

JUDGE REED: So it's my understanding thatin some plants this cladding has been removed.

MR. FITZPATRICK: Yes.

JUDGE REED: Is that correct?

MR. FITZPATRICK: Yes.

JUDGE REED: And for what reason? MR. FITZPATRICK: That eliminates the

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possibility of getting cracks in base metal. The cladding actually drove -- The cladding drove the cracks because the original designed thermal sleeve allowed leakage by --JUDGE REED: What? Leakage by? MR. FITZPATRICK: Leakage. JUDGE REED: Leakage.

MR. FITZPATRICK: The original thermal sleeve, there was a gap between the inside of the pipe and the outside of the thermal sleeve and they had leakage by the thermal sleeve and that mixed with the hot reactor water and so that was the mechanism that cracked the cladding.

JUDGE WARDWELL: Do you want to clarify? MR. STEVENS: By leakage, we're not referring to leakage outside of the pressure boundary. It's a relative term to indicate leakage past this thermal sleeve.

19 I understand that. JUDGE REED: Yes. 20 MR. FITZPATRICK: When they replaced the 21 thermal sleeve, they did what's called an interference 22 fit. It's the design -- it's an -- material. They 23 froze it and rammed it into the pipe and let it heat 24 up and it gave a very rigid fit and we actually have 25 thermal couples on the outside of the pipe indicating

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if there's leakage on that or not and that's monitored 1 2 periodically. 3 JUDGE REED: So now there is not a lot of 4 leakage past the thermal couple. MR. FITZPATRICK: We tried in the analysis 5 to determine if there was an possible leakage and if 6 7 something changes with that, we will have to build a corrective action plan. 8 9 JUDGE REED: You do not believe you had cracks in the cladding prior to installation of this. 10 Now the thermal sleeve was changed a long time ago, 11 12 wasn't it? 13 MR. FITZPATRICK: Yes, and the eight cracks that were found were grounded down at that 14 time. And they would do periodic inspections of the 15 16 cladding from the inside of the vessel using PT. 17Given the exposure that these little inspectors would 18 take over time doing that, the technology advanced 19 over the years to do UT, ultrasonic testing, and it's 20 almost done on every -- I think it gets done on every 21 BWR feedwater nozzle on an -- basis. There's a second 22 program to do investigation. Every plant has their 23 own real specific program that they have. 24 JUDGE REED: With this background, what 25 can you tell us about existing cracking in either the **NEAL R. GROSS**

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1	cladding or the base metal?
2	MR. FITZPATRICK: The inspection program
3	is not showing any cracks. They haven't detected any
4	cracks in the past 20 years that are bigger than
5	3/16ths and we know that. Our Section 11 analysis
6	which goes into the protected corrective actions to be
7	found for these cracks covers that site, covers that
·8.	phenomenon.
9	The fatigue analysis
10	JUDGE REED: What analysis?
11	MR. FITZPATRICK: The fatigue analysis in
12	ASME Section 3, you don't postulate cracks in the base
13	metal in trying to determine acceptance. A fatigue
14	usage, again some acceptance of the Level 1 that
15	has an assumption there are not cracks in that ASME 3
16	analysis. Once you get into cracking, you would be
17	into the ASME Section 11 analysis.
18	JUDGE REED: So you assume no cracks in
19	your analysis.
20	MR. FITZPATRICK: It's inherently ASME
21	Section 3 analysis.
22	JUDGE REED: And that's the analysis you
23	did, that you follow. Is that
24	MR. FITZPATRICK: All Section 3 analysis.
25	JUDGE REED: But I guess what I'm asking
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. 1	is the analysis that we've been talking about is
2	Section 3 analysis.
. 3	MR. FITZPATRICK: Yes.
4	JUDGE REED: Thank you.
. 5	JUDGE KARLIN: Well, I don't know. Maybe
6	I'm cutting to the chase a little bit too prematurely.
7	But, Dr. Hopenfeld, when we look I've looked at
8	your chart of uncertainties, Table 1 in your rebuttal,
9	and you have these 13 factors listed of uncertainties
10	in the ANLE Argonne National Lab.
11	DR. HOPENFELD: Right.
12	JUDGE KARLIN: 1998 and 2007. Then
13	equations and I guess we turn to No. 13, is it, which
14	is Factor 13 or Uncertainty 13 you have as "existing
15	surface cracks." Right?
16	DR. HOPENFELD: Is it 13?
17	JUDGE KARLIN: Is that the one you're
18	talking about?
19	DR. HOPENFELD: Yes, 13. Right.
20	JUDGE KARLIN: This is what we're talking
21	about here with the crack
22	DR. HOPENFELD: Correct. Yes.
23	JUDGE KARLIN: cracked cladding,
24	cracking and all that.
25	DR. HOPENFELD: Yes.
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1054 1 JUDGE KARLIN: And you say, "Existing fatigue cracks" -- Does NUREG 6909 deal with this 2 3 issue at all? DR. HOPENFELD: No. 4 JUDGE KARLIN: No. And you say it was not 5 addressed in the Entergy analysis. Is that correct? б 7 DR. HOPENFELD: Yes. 8 JUDGE KARLIN: And your comment is 9 "Existing fatigue cracks in the cladding or base metal 10 can provide sites for accelerated corrosion, thereby, accelerate fatigue failure under cycling loads." Now 11 as a theoretical statement, I suppose -- Does anybody 12 13 challenge that as a theoretical statement? Mr. 14 Stevens, theoretically, that could be true. 15 MR. STEVENS: Theoretically, I suppose it 16 could be. Yes. I don't know if it's 17 DR. HOPENFELD: theoretical. I think it's observation. My experience 18 19 if there was an ground surface you could get a crack. JUDGE KARLIN: When I say "theoretical" I 20 21 mean existing fatigue cracks in the cladding can 22 provide sites. 23 DR. HOPENFELD: Right. 24 JUDGE KARLIN: Now the question is are 25 there any existing fatigue cracks in the cladding and NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

I guess what we're hearing is, no, there aren't any. DR. HOPENFELD: Can I answer that guestion?

JUDGE KARLIN: Yes.

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DR. HOPENFELD: First of all, I take an issue here with the statement that it was -- what 3/16th of an inch. You said it was a microscopic crack. Is that what the statement was? I don't think it's a microscopic crack. In the testing that you do -- I'm not digressing here, but we were talking this morning about clads, about life. One definition of life is crack it completely onto the reflection itself --

JUDGE KARLIN: Definition of what? Light? DR. HOPENFELD: Reflection. One definition of the life of a component, remember the big N on the bottom of the page.

JUDGE KARLIN: Okay. Got you.

DR. HOPENFELD: Remember we were doing all these -- Is fracture into the Nth. Another definition

JUDGE KARLIN: Fracture to the Nth? DR. HOPENFELD: Yes. To the --JUDGE KARLIN: To the end. DR. HOPENFELD: And under that definition

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is --

1 it's being one. That's all it is is one requirement. 2 But some other people when you test they have a definition and maybe it's convenient to some degree is 3 to run to a point which you have, what's called, an 4 5 engineering crack of about three millimeters and then you see them when you're testing the loading drops. 6 So that's a different definition. 7 What we're talking about here in the tests 8 that Argonne ran, by the time you get three millimeter 9 10 you're over the initiation process. You're 11 analygating (sic) to the proposition. So when he says it's very, very small, it's not -- Three-sixteenths is 12 not -- I can't remember what it is. 13 Well, we don't need to 14JUDGE KARLIN: 15 debate whether 3/16ths is --DR. HOPENFELD: It's not microscopic. 16 .17 Let's look at the microscope. I can feel. I know --JUDGE KARLIN: Dr. Hopenfeld, we can posit 18 19 that 3/16th is 3/16ths. 20 DR. HOPENFELD: Right. JUDGE KARLIN: The adjective "microscopic' 21 22 can be discarded. 23 DR. HOPENFELD: It's important because --24 JUDGE KARLIN: Mr. Fitzpatrick. 25 MR. FITZPATRICK: Ι didn't say **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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"microscopic" in the same sentence as 3/16ths.

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All right. JUDGE KARLIN: Let's just dispense with the word "microscopic" and say it's 3/16ths. Right?

DR. HOPENFELD: Okay. Now the reason for that, for one thing, when you do ultrasonic, it's difficult to do ultrasonic when you have a base metal and at the same time you have a clad of stainless steel and carbon. So it's difficult to distinguish between the two. Especially when you do the UT, you really get -- because you don't really know whether you've penetrated one millimeter in there or a fraction of a micron.

When GE examined a whole slew of damaged nozzles, there were some of them that cracked through the base metal. It's my understanding and I don't 16 17 know what kind of machines they are using today for UT examination, but my understanding is that we're talking about minimum detection, something like one quarter of an inch and the clad if I understand correct is a little bit less. So there is a possibility of -- at the base metal.

23 But be it as it may, take a look what the people at Argonne ran. They're in 6909 or the other, 24 25 6583. These specimens were not cladding. These were

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not cladding. This was not the same type of a test. 1 Now they've taken this and in one of their -- they 2 said, "Well, we admit. We're going to make the 3 assumption that the cladding is cracked." 4 For 5 whatever reason, NRC asked them and they said they're going to assume. 6 7 Well, if you assume something, first of all, you really cannot tell -- You have to admit you 8 9 can't tell whether it's cracked beyond the base metal 10 or not. JUDGE KARLIN: So let me stop you there if 11 12 I man. 13 DR. HOPENFELD: Okay. 14JUDGE KARLIN: You're acknowledging that Entergy has assumed that they are cracked. 15 16 DR. HOPENFELD: Yes. In one of the labs, 17 they said they assumed that they are cracked. 18 JUDGE KARLIN: They are making the 19 assumption. 20 DR. HOPENFELD: And they also -- possible that they could, in fact, propagate it through the 21 22 next 20 years. Once you've made that assumption, it 23 seems to me you should be consistent in the 24 calculation of the Fen. 25 Well, let's ask Mr. JUDGE KARLIN:

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1 Fitzpairick or Mr. Stevens. 2. MR. STEVENS: May I clarify? 3 JUDGE KARLIN: Go ahead. 4 MR. STEVENS: My comment on this issue, 5 Item 13, is it's not relevant to our CUFen analysis. Our CUFen analyses inherent in them, there's a Section 6 7 3 analysis which does not allow cracks and we're also 8 doing a calculation that demonstrates --9 JUDGE KARLIN: Wait a second. What do you mean it doesn't allow cracks? It prohibits there will 10 11 be never be a crack. 12 MR. STEVENS: Section 3 as part of 13 fabrication of vessels if there were any indications 14 it requires repair. The analysis --15 JUDGE KARLIN: So it assumes there will be 16 none. There are no cracks. 17 MR. STEVENS: That's correct. 18 JUDGE KARLIN: And if there are cracks it's invalidate. 19 20 MR. STEVENS: It would have to be repaired 21 so that there were no flaws under the Section 3 22 fabrication. 23 JUDGE KARLIN: Yes. You have to have no cracks in order for this to work. 24 25 MR. STEVENS: And the analysis we're doing **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1060 is a calculation of crack. Our criteria against crack 1 2 initiation we're showing to be acceptable. So the 3 presence of a crack is meaningless to an analysis that has to assume no crack to begin with and our criteria 4 5 Doesn't it invalidate the 6 JUDGE KARLIN: 7 analysis if there is a crack? 8 MR. STEVENS: If a crack was detected, 9 then you would be into a Section 11 program like Mr. 10 Fitzpatrick explained and what[.] we have here 11 historically is, yes, they would indicate cracks in the VY feedwater nozzle. They were repaired and a 12 complete repair was implemented that included grind 13 14 out of the cracks as well as thermal sleeve and 15 sparger replacement that restored that component to a new condition and since that time, Section 11 programs 16 17 have verified within their capability the absence of cracking as well as analysis that's been done, updated 18 19 analysis, to meet the CUF requirements of Section 3 20 which would say you would have and analyzed against 21 the presence of cracks. 22 In addition to all that, we have a belt 23 and suspenders program, a Section 11 program, that 24 continues to inspect those nozzles and, as a part of 25 that, there is the crack growth analysis tied into

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that program that Mr. Fitzpatrick alluded to. It says even if all of that might be mistaken, we're going to postulate a flaw and demonstrate the growth of that flaw as acceptable over the life of the plant. So it's a combination belt and suspenders program of acceptability and manage the fatigue in this component.

But with respect to the CUFen, cracks are not relevant. They don't factor into the analysis. JUDGE WARDWELL: And is that a better way to say it that, in fact, you have, that Entergy has, a monitoring and maintenance program that repairs all cracks such that they have no influence on the CUFens? MR. STEVENS: Yes, sir. That would be a correct way to say it.

JUDGE WARDWELL: Rather than to say it's 16 not relevant. It is relevant but you don't allow them 17 . to occur from the monitoring and maintenance program. 18 19 MR. STEVENS: Yes. If you detected a 20 crack, you would be outside of Section .3 and into 21 Section 11 and would have to correct that situation. 22 JUDGE WARDWELL: Recognize that we don't 23 understand the significance of a Section 3, a Section 24 That doesn't mean much to us. It sounds like 11 25 it's a very important thing to you people at Entergy

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1	that when you go into a Section 11 means you have to
2	do some stuff and that, of course, is a corrective
3	action thing.
4	How often do you inspect this particular
5	component to assure that those cracks are detected and
6	repaired expeditiously so that provocation would not
7	occur?
8	MR. FITZPATRICK: Right now, it's very
9	four cycles there's a 100 percent UT done on all four
10	nozzles.
11	JUDGE WARDWELL: Every four
12	MR. FITZPATRICK: Every four cycles.
13	JUDGE WARDWELL: refueling cycles?
14	MR. FITZPATRICK: Yes. Approximately six
15	years. We just finished the last one in 2007.
16	JUDGE WARDWELL: Describe if you could for
17	me a little more detail of this suspenders part of the
18	belt and suspenders and that being where you assume
19	that it's cracked. What have you done with that
20	assumption or what have you applied that assumption
. 21	to?
22	MR. STEVENS: If we have a CUF analysis
23	that indicates CUF is less than one, the indication
24	would be that there are no cracks first off. Second
25	though, because of the history of these components as
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well as Section 11 programs, they do get periodically inspected for any kind of deterioration due to fatigue and other mechanisms that might be present. Those as Mr. Fitzpatrick alluded to use typically ultrasonic techniques which have improved drastically in the last 25 years and are heavily qualified by organizations such as EPRI.

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But nevertheless those inspections do have limitations. There is a threshold below which they cannot detect cracking. In order to compensate for that, an analysis is done postulating a flaw --

JUDGE WARDWELL: And is that the 3/16ths that we were talking about before?

MR. STEVENS: Yes, sir.

JUDGE KARLIN: Okay. So that can't see a crack that's smaller than that.

MR. STEVENS: Yes, sir.

18 JUDGE KARLIN: And therefore possibly 19 there is a crack of that size in there.

20 MR. STEVENS: You postulate a flaw size 21 that may have been missed.

JUDGE KARLIN: Right.

23 MR. STEVENS: And do an analysis that 24 shows acceptability of that flaw and growth over 25 future operation.

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1064 JUDGE WARDWELL: And what type of analysis 1 is that? .2 MR. STEVENS: That is a fracture mechanics 3 4 analysis. 5 JUDGE WARDWELL: And that allows you to estimate the propagation of that crack? 6 7 MR. STEVENS: Yes. 8 JUDGE WARDWELL: Dr. Hopenfeld, what 9 evidence do you have that the feedwater nozzle 10 cladding is now cracked? DR. HOPENFELD: It now cracked. 11 No, I 12 don't have direct evidence it's cracked. I looked at their inspection reports and they state not detected 13 14which means within the detection capability of UT. It 15 was not -- As I said, 3/16th, it was my understanding one quarter of an inch, but that's not that different. 16 The point that's being missed here and 17 that's a practical engineering problem that I've seen 18 19 through all my life almost with different endeavors, nothing in the nuclear business, is when you have 20 21 cracks you just grind them out. You get rid of them. You shim them out. You don't want them. 22 That's a standard procedure. 23 24 He's talking about walking it to one 25 section to another section and that's a ASME Code. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	That's a different world. In the real world, you have
2	these things and what happens is that these are site
3	corrosion product, what those corrosion products would
4	do if the time is unknown. But, more importantly,
5	when you want to test and you want to test some smooth
6	surfaces and then you say, "I'm going to use these at
7	the end and I'm going to say these are conservative,"
8	well, he is absolutely sure that this is conservative.
9	I don't see how that is conservative when he already
10	starts with cracks because he doesn't know where they
11	are. So he does the analysis and that's because the
12	ASME asked him to an analysis. But that's a different
13	world.
14	In the real world, you have these FUM
15	(phonetic) numbers. They came in from laboratories
L 6.	for very; very smooth surfaces. I don't know.
L7	JUDGE WARDWELL: What was the wording in
L8	the inspection program that indicated that there was
19	no cracking in this nozzle?
20	MR. FITZPATRICK: No relevant indications.
21	JUDGE WARDWELL: There's no
22	DR. HOPENFELD: No relevant indications.
23	Usually you classify something like that in terms of
24	POD which is probability of detection. They don't
25	talk about that.
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1066 MR. FITZPATRICK: The SER states a quarter 1 inch crack. The analysis maybe used in a quarter 2 3 crack, too. JUDGE KARLIN: Where is that? 4 5 MR. FITZPATRICK: If you look at SER --The FSER study, the whole discussion starts at the 6 7 bottom of page 4-25. Do you have the section? JUDGE KARLIN: Are you talking about the 8 9 final safety evaluation? 10 MR. FITZPATRICK: Yes, as it were. 11 JUDGE KARLIN: Okay. MR. FITZPATRICK: It's Code 3 -- Analysis. 12 JUDGE KARLIN: Page four --13 MR. FITZPATRICK: That's at the bottom of 14 15 page 4-25. JUDGE KARLIN: Four-25. 16 MR. FITZPATRICK: Yes, and continues on to 17 4-27. 18 19 JUDGE KARLIN: This is a discussion of feedwater nozzle fatigue analysis. 20 MR. FITZPATRICK: Yes, this is -- This was 21 the section of the inspection prior to looking at EAF 22 23 Section --24 JUDGE KARLIN: Okay. 25 MR. STEVENS: May I clarify one thing on NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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JUDGE WARDWELL: Yes, go ahead.

MR. STEVENS: On page 4-26, next to the last paragraph where it's talked about a 0.25 inch flaw, that doesn't necessarily mean that's the capability of the UT system. The technical basis behind this work which I'm very familiar with says that there are certain effects that would drive a crack to one quarter of an inch that are difficult to include in the analysis. The analysis is supposed to assume a quarter inch or the capability of the UT system whichever is greater. So this value here in initial crack size may, in fact, reflect that technical basis more than it reflects the capability of the UT system.

So, in fact, Mr. Fitzpatrick's comment about 3/16ths of an inch capability may be true. But the technical basis for this work requires us to assume one quarter inch minimum because of other stress effects that would be present. My point is I don't want you to look at the quarter inch and be confused that might be a UT capability. It might be far better than that.

> DR. HOPENFELD: Can I --JUDGE KARLIN: Dr. Hopenfeld, yes, would

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you like to respond?

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-	DR. HOPENFELD: Well, not a comment on
•	that. You see, we don't When you weld something,
	you put a bead in there and that's a machine weld,
•	usually there's an uncertainty with the thickness that
	you get there and it's I went to the original
	drawings and I read it and couldn't figure out exactly
	what those differences are and we asked them to tell
	us what is "as is dimension." It was wrong if you're
	interested.

Now the cladding is -- I believe it was 11 like 5/16. So we're not talking -- I don't remember 12 13 exactly what the cladding is. But that could be 14 within the tolerances. If you're through the tolerances, you might be already within the base metal 15 16 and whether you are in the base metal or not it 17 doesn't really matter because you see the interfaces 18 is the point of stress. It's the initiation point and 19 when you put all that corrosion products, it's something that Argonne hasn't run and I can't see in 20 21 the world how that could be conservative.

> JUDGE WARDWELL: Thank you. Moving onto your third of three most important issues relating to Table 1 Uncertainties in the Fen equation dealing with surface finish, would

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1069 you like to elaborate a little bit more, Dr. Hopenfeld 1 2 DR. HOPENFELD: Sure. 3 JUDGE WARDWELL: -- on what you mean by 4 5 that or why it's so important? 6 DR. HOPENFELD: Yes. Let me get you in 7 the right direction on this. 8 JUDGE WARDWELL: We always like that. 9 MS. BIELECKI: May we show him our copy? JUDGE WARDWELL: Yes. Sure. 10 11 DR. HOPENFELD: Okay. Could you please --You're talking about the number that would be the 12 first one or the second one? 13 The oxygen or the surface? 1415 JUDGE WARDWELL: The surface. DR. HOPENFELD: The surface, right. Okay. 16 17 I have it. NEC JH-28. JUDGE WARDWELL: Twenty-eight. I'm sorry. 18 19 What is that again? NEC what JH? 20 DR. HOPENFELD: NEC at 28 page three. JUDGE KARLIN: Twenty-eight what? 21 22 DR. HOPENFELD: Page three. NEC JH-28. 23 JUDGE WARDWELL: And this is the ACRS 24 meeting? 25 DR. HOPENFELD: No. That's the -- It's my **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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. 1	presentation. Do you see a table there?
2	JUDGE KARLIN: No. NEC JH-28 is an
3	excerpt from the February 7, 2008 Advisory Committee
4	Meeting on Reactor Safeguards.
5	DR. HOPENFELD: No.
6	MS. TYLER: Dr. Hopenfeld, what's the
7	title of the document that you want to refer them to?
8	JUDGE KARLIN: Yes. What's the title?
9	MS. TYLER: What's the title of the
10	document?
11	DR. HOPENFELD: Oh, yes. I see. I'm .
12	sorry. I got screwed up. Okay. NEC Well, it says
13	JH-23 at 76. I think it's the NUREG 6909 report.
14	MS. TYLER: If it's 6909, it's JH-26.
15	DR. HOPENFELD: Yes, the 6909. Twenty-
16	six.
17	JUDGE KARLIN: So you're referring to
18	6909.
19	DR. HOPENFELD: Right. Correct.
20	JUDGE KARLIN: NUREG 6909.
21	DR. HOPENFELD: Right and I believe it's
22	page 76 that there's a table there and
23	JUDGE KARLIN: Page? What page, sir?
24	DR. HOPENFELD: Seventy-six.
25	JUDGE KARLIN: Seventy-six.
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1 DR. HOPENFELD: Right. 2 JUDGE KARLIN: There's a Table 12 on that 3 page? DR. HOPENFELD: Yes. 4 5 JUDGE KARLIN: Is that what you're referring to? 6 7 DR. HOPENFELD: Yes, sir. I'm sorry. 8 JUDGE KARLIN: All right. Let's wait for 9 everyone else to get there. 10 DR. HOPENFELD: Yes. 11 JUDGE KARLIN: Okay? What's the question? 12 JUDGE WARDWELL: Yes. Would you like to 13 elaborate more on how important that is? 14 DR. HOPENFELD: Sure. 15 JUDGE WARDWELL: And what impact does it have on the Fens? How sensitive are they to this --16 17 DR. HOPENFELD: Sure. You see on that page what you have on the left-hand side is you have 18 19 number 2, 2.5, 4 and proposed plan. These are 20 parameters and not as Mr. Fitzpatrick said, this is not a safety factor. This is an adjustment parameter 21 22 in the computer code, excuse me, ASME Code. And you notice that the surface roughness is a factor of four. 23 24 So it's pretty heavy. It's considered to be very 25 important. These things were done, I don't know, 30 **NEAL R. GROSS**

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1	or 40 or 50 years ago indicating there was clearance -
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3	JUDGE WARDWELL: What does a Section 3
4	criterion mean?
5	DR. HOPENFELD: I'm sorry.
6	JUDGE WARDWELL: What does a Section 3
7	criterion document mean?
8	DR. HOPENFELD: Well, it's what the ASME
9	Codes are based on for calculating the fatigue curve
10	as the stress versus the best cycles.
11	JUDGE WARDWELL: Yes.
12	DR. HOPENFELD: That's where it comes
13	from. That's what the calculating the stress, the
14	fatigue, level of air by the ASME Code and I think
15	there are a similar curve that was presented by the
16	NRC somewhere in one of your exhibits.
17	JUDGE WARDWELL: Right.
18	DR. HOPENFELD: Yes, it's the ASME Code
19	that the crack doesn't work by itself. The ASME Code,
20	the data in here is based on a large number of
21 [.]	experiments. Ninety-nine percent of them were
22	conducted in air, okay, in an environment, not in an
23	industrial environment. So And I've been for
24	many years. So the person who agrees in charge at
25	that time, Dr Cooper, and being a lot of people under
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us and they came up with numbers as to the various effects that you should really involve the experimental data that you got in the lab report and when you put it in the ASME Code, somebody could use it. It's still in air. Conceptually, it's probably not the same environment the same as air that you had in the laboratory. But it's air.

But realizing that factors like size and the most important one in the surface -- they put factors in it for best estimates, best guesses, they could. But those estimates were based on, the roughness of the surface was based on machine surfaces, what you leave on the machine, whatever the machine surface is. I mean, different components have different machine surfaces. You know, you grind it. You use a -- or whatever it is you use to forge it or whatever it. So you have different surfaces and they did a number before.

Okay. So now when you come to the issue of surface roughness being in water, definitely it would be like water reactive, the first question is the surface roughness here the same as the surface roughness there (Indicating). And, of course, you look at it and I believe that they did and I even believe that Argonne didn't look too far beyond that

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"Well, is they said, they're still talking about machine surfaces."

3	But what you have, a lot of these
4	components are carbon steel, low-alloy steel, that
5	have been cooking there for many, many years. Their
6	surface is corroded and we'll talk about that later.
7	The surface what you heard is not on a machine surface
8	and the corrosion corroded some of the corrosion
9	surfaces and you might have pits, ridges. These all
10	could be high stress points for crack initiation.
11	Some of the pits could be points for accumulating
12	corresion products. It is not the same thing.
13	Now Dr I don't think they went beyond
14	the point of assuming that these surfaces are really
15	machine surfaces. They haven't considered it because
16	there's no ordinary problem they've considered on
17	the surface.
18	JUDGE KARLIN: Well, let me stop you
19	there.
20	DR. HOPENFELD: Sure.
21	JUDGE KARLIN: Let me stop you there, Dr.
22	Hopenfeld. We're looking at this chart. It's on page
23	76 of the NUREG 6909. Right?
24	DR. HOPENFELD: The chart?

JUDGE KARLIN: Yes, the chart you just

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1	referred to.
2	DR. HOPENFELD: Oh, this thing. Right.
3	JUDGE KARLIN: That you referred us to.
4	DR. HOPENFELD: The table, yes.
5	JUDGE KARLIN: The table. I'm sorry. And
6	it's 6909 table and it has a parameter and the
7	parameter is surface finish. Right?
8	DR. HOPENFELD: Correct.
9	JUDGE KARLIN: On the left-hand column and
10	it says, "Section 3 Criterion Document" and by that we
11	mean the ASME document?
12	DR. HOPENFELD: I don't know. I would
13	think so, yes.
14	JUDGE KARLIN: In air. Well, they say you
15	should have a factor of 4.0.
16	DR. HOPENFELD: Right.
17	JUDGE KARLIN: And then the present
18	report, I suppose that means the 6909 NUREG, that
19	report says the factor should be less.
20	DR. HOPENFELD: Yes.
21	JUDGE KARLIN: 2.0 to 3.5.
22	DR. HOPENFELD: And I'm saying that's
23	right. That's exactly the point.
24	JUDGE KARLIN: And these are the
25	environmental factors, are they not?
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JUDGE KARLIN: But you're starting with the curve in the air and you're saying, "Why don't we adjust it by four or why don't we adjust it by 3.5?" DR. HOPENFELD: No. Let me explain. That's the reason I'm being here so that you can understand so we're talking about the same thing. JUDGE KARLIN: That's what I thought. DR. HOPENFELD: But you're right. But here is the point. They say this is not -- This has nothing to do with the Code. Remember on the righthand side it's a present report. It's when they calculated their air volume. Okay. They believe that these are the numbers that should be in there.

One reason their number is -- reason they believe is the Code is very conservative is because they said, "Well, this is one parameter that we believe is between 2.0 to 3.5. That's what he believes and that's not necessarily correct. I don't know how to work with the way this has been tested to see whether he really talks about the real surface that you have in a reactor. And then you look at the corroded surface that you have or surfaces that especially the surfaces which are carbon steel and low-alloy steel and you see that they were exposed to

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	1077
1	high accelerated corrosion, I mean, there's a
2	landscape of entirely different surfaces and I'll show
3	you those pictures in the
4	JUDGE WARDWELL: What are these numbers
5	used for if they're not Fens?
6	DR. HOPENFELD: I'm sorry.
7	JUDGE WARDWELL: What are these numbers
8	DR. HOPENFELD: These were used more or
9	less as a recommendation. If he had his choice, he
10	would have recommended a new air and detect the ASME
11	Code and replace it with his.
12	JUDGE WARDWELL: I'm sorry. I don't think
13	you understand me. I don't The question is now
14	what is the 2.0 to 3.5 versus the 4.0 you used or any
15	of these numbers you used.
16	DR. HOPENFELD: Well, the number of these
17	things, what he is trying to say here with regard to
18	the Fen, he's trying to say here that the ASME Code
19	which has their air curve in there is very
20	conservative to compare what he has. But then he says
21	that it's his judgment. He says it's between 6.0 to
22	27.4 which is a range that he gives and he said he
23	used that and that's the reason when they say, they're
24	talking about, there's a lot of conservatism. There
25	is a judgment that there is conservatism in the ASME
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1	Code. I've had people think that it's not
2	conservative.
3	JUDGE KARLIN: Can we stop you there?
4	DR. HOPENFELD: Yes.
5	JUDGE KARLIN: Mr. Fair, maybe you could
6	help us. Do you agree with his, with Dr. Hopenfeld's,
7	discussion of this chart and what it's showing us?
8	MR. FAIR: I'm not sure that I understand
9	his discussion of the chart.
10	JUDGE KARLIN: Okay. What's your
• 11	understanding of these factors and the loading.
12	history, I'm sorry, the surface finish? There's 4.01
13	for Section 3 and then there's a 2.0 What are those
14	things?
15	MR. FAIR: Yes, the numbers in the left-
16	hand column under the Section 3 Criterion Document
17	come from an original ASME criterion document that
18	they published in 1960s explaining the bases for the
19	fatigue evaluation procedure and these were the
20	assumed values they used to adjust the mean test data
21	that they used to establish the fatigue air curve
22	adjusted downwards to get the design curve.
23	JUDGE WARDWELL: So they divided that
24	curve for 4.0.
25	MR. FAIR: No. By 20 for the total.
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1079 1 JUDGE WARDWELL: No. We're only talking 2 surface now. 3 DR. HOPENFELD: No, they did it altogether 4 because --5 JUDGE WARDWELL: We're talking to Mr. Fair 6 now. 7 DR. HOPENFELD: I'm sorry. JUDGE WARDWELL: Thank you. 8 9 MR. FAIR: The right-hand column is the 10 latest assessment that was done by Argonne of the available literature to relook at those parameters to 11 see what they thought those parameters would be in 12 13 light of the current data and these were the estimates of the range of estimates they got from the literature 1415 on these parameters. JUDGE KARLIN: If I may stop you. 16 These 17 are the air curves, right, and adjustments? 18 MR. FAIR: That's right. 19 JUDGE KARLIN: And this is an example 20 where you might say -- When you said the 6909 is less 21 conservative than the old method, this is an exact example of that, is it not? 22 23 MR. FAIR: That's right because --24 JUDGE KARLIN: Because the old method was 25 at an adjustment factor of 4.0 and the new method of **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

6909 has an adjustment of 2.0 or 3.5. 1 2 MR. FAIR: Well, that wasn't the specific 3 area I was referring to because the old adjustment just put an fixed adjustment of 20. The current 6909 4 5 assumed a probability distribution with all of these parameters and then did a simulation to determine what 6 7 the adjustment factor should be and the current --8 JUDGE KARLIN: Is this the Monte Carlo 9595? 9 10 MR. FAIR: That's exactly right. And the 11 current testament based on that Monte Carlo simulation 12 was that adjustment factor could be 12 so that the 13 previous air curve was conservative in comparison to 14 the current Argonne assessment. 15 JUDGE KARLIN: Right. 16 What did you JUDGE WARDWELL: use, 17 Entergy, in your analysis? Either Mr. Stevens or Mr. Fitzpatrick. 18 19 MR. STEVENS: We used the ASME Section 3 20 fatigue curve which is represented by the numbers 21 under the Section 3 criteria document. 22 JUDGE WARDWELL: So it's represented by the 4.0 number if we are only talking about surface 23 roughness. 24 25 MR. STEVENS: Yes, sir. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433

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1	JUDGE WARDWELL: Dr. Hopenfeld, do you
2	have any indications besides just your common sense
3	that says there must be adverse surface finish beyond
4	what was assumed in the Section 3 Criterion Document.
5	DR. HOPENFELD: Yes, I think 6909 gives an
6	equation of the effect of surface roughness and if you
7	look at the surface roughness that these people are
8	talking about it's not the same surface roughness that
9	you would see in an actual plant, in an actual
. 10	component So this is an uncertainty.
11	I don't know exactly what the exact effect
12	is in effect because there is an equation in 6909
13	relating to surface roughness. But that surface
14	roughness is again a machine.
15	JUDGE WARDWELL: Let me clarify something
16	with yourself if I might.
17	DR. HOPENFELD: Yes.
18	JUDGE WARDWELL: Or let you clarify for
19	me. Entergy just testified they use a Section 3
20	criterion for this discussion that you're just
21	bringing up in regards to 6909 sugars down to a
22	recommendation herein of a value of somewhere between
23	2.0 and 3.5 of which 2.0 if you look at the asterisks
24	can be used for carbon and low-alloy.
25	DR. HOPENFELD: Yes.

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JUDGE WARDWELL: That seems to be if 1 you're using the present report half as much influence 2 3 as what was used. So they're more conservative by a 4 factor of two. 5 DR. HOPENFELD: This is the -- Yes. That 6 two was the number. But I'm saying this 2.0 to 3.5 7 was not based on actual surface. That was ---8 JUDGE WARDWELL: But where -----What evidence do you have and what are the numbers for that 9 evidence of actual surfaces? 10 DR. HOPENFELD: No evidence but based on 11 12the surface roughness of a corroded surface on the 13 pipe and you see it on carbon steel or low-alloy steel 14 is much higher than a machine surface that you get it out of --15 16 JUDGE WARDWELL: So you disagree with 17 Argonne in regards to the development of 6909. 18 DR. HOPENFELD: I doubt that it was 19 That's the reason I brought it up because -raised. 20 JUDGE WARDWELL: Who else disagrees with 21 Argonne? 22 DR. HOPENFELD: I'm sorry. JUDGE WARDWELL: Who else -- Can you quote 23 24 then reference a cite that disagrees the way you do 25 with what Argonnne has done and supplied on that? **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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1 DR. HOPENFELD: Okay. I don't know the invested issue, the specific issue, of the surface 2 3 roughness either. Δ JUDGE WARDWELL: Thank you. 5 DR. HOPENFELD: But with regard to the 6 ASME Code --7 JUDGE WARDWELL: No. We're talking 8 surface finish now. 9 DR. HOPENFELD: Yes, but the two come together. They talk about a 20 factor. They add all 10 11 these factors together. They added here 20 and they 12 added here to whatever the number of times. But if 13 you're talking about just the surface itself, okay, 14and that's what -- Let's say that a factor of -- that this reference here, the 4.0, the average number. 15 16 Let's say just for -- I'm not saying that that's 17 right. Let's say 10. Okay. Then you say, "I didn't 18 run these, didn't generate equations for a number of 19 10. We generated -- They're using actually a number 20 of four because when they multiplied their Fen which 21 is their Fen divided by -- in water divided by air, 22 they're basically using the number 4.0. But if they 23 take a number -- if their thing was really 10, then 24 you would have a different number. That's how you do 25 the surface.

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1	JUDGE WARDWELL: I understand.
2	DR. HOPENFELD: You have to extend it
3	JUDGE WARDWELL: If you had a number of
4	100, what happens?
5	DR. HOPENFELD: I'm not going Look. If
6	you want me to give you a number on this, I cannot
7	because
8	JUDGE WARDWELL: I'm asking you for a cite
9	of someone else's support of the position you're
10	taking because it seems to me you can't support any
11	other number besides what's here.
12	DR. HOPENFELD: No, I don't support this -
13	- Look. This number reflects surface which was a
14	machine, not surface that was exposed to corrosion.
15	JUDGE WARDWELL: Can you point us to where
16	it says that this is an assumption that is a machine
17	surface that's not corrosional (sic)?
18	DR. HOPENFELD: Yes. I would have to go
19	back there. It's in the discussion. There's nothing
20	talked about the actual surface. You have to talk
21	about the actual surface.
22	JUDGE WARDWELL: Mr. Stevens or Mr.
23	Fitzpatrick from Entergy, do you have any indications
24	that these numbers refer to machine surfaces as
25	opposed to operational surfaces that may not be
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MR. STEVENS: No, sir. The testimony we
heard yesterday was the purpose of these factors was
to translate the ASME air data to components in
reactors and one of the items included in that is
surface finish. So that indicates that the surface
finishes that were considered are consistent with
components in nuclear reactors.
JUDGE WARDWELL: So to say it another way
if, in fact, it was a machine surface, the
recommendation may have been under here of a factor of

1.0 possibly.

MR. STEVENS: Possibly.

JUDGE WARDWELL: So the 4.0 accounts for those types of operational surfaces that you would expect.

MR. STEVENS: Yes, sir.

JUDGE KARLIN: Let me ask. On this chart on page 76 of NUREG 6909 -- Let me ask this of Mr. Stevens. These two columns, the present report and Section 3, are those CUFs or are they Fen numbers? MR. STEVENS: Neither. JUDGE KARLIN: Okay. Neither. MR. STEVENS: Do you recall we talked about --

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1086 JUDGE KARLIN: They are the air -- Are 1 2 they the air curve on smooth pieces of metal? 3 MR. STEVENS: They are adjustments to the air curve to come up with a design curve. 4 5 JUDGE KARLIN: Right. Okay. So they don't have -- They're not Fens. They are the air 6 7 curve, smooth metal, adjusted to reflect some 8 conservatism. 9 MR. STEVENS: Yes. JUDGE KARLIN: Okay. So where is the Fen? 10 Is there Fen? Where is the Fen -- These are not Fen 11 factors. 12 13 MR. STEVENS: No. JUDGE KARLIN: These 14 are not 15 environmentally adjusted in any way, shape or form. 16 They don't say, well, you know -- Is a rough surface 17 a different environment than a smooth surface or is there just not a Fen at all? 18 19 MR. STEVENS: These describe adjustments made to the curve prior to application of Fen factors. 20 21 JUDGE KARLIN: Right. 22 JUDGE REED: Mr. Stevens, to help my 23 colleague, if you adjust the curve down by a factor of 4.0 it implies that the Fen also is -- Well, I quess 24 25 the Fen goes up by a factor of 4.0, doesn't it? Isn't **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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JUDGE WARDWELL: Only the same. They are two different things. The factor of 4.0 is in recognition that you don't have a machine surface even in air so that you're reducing that to a recognition that you're not having a machine surface.

DR. HOPENFELD: No.

JUDGE WARDWELL: Is that a fair . . assessment, Mr. Stevens?

MR. STEVENS: Yes, that is.

11 JUDGE WARDWELL: Why is it not, Dr.
12 Hopenfeld?

DR. HOPENFELD: Because -- Let's stick to 13 14 the point in time. Because go back to where the original ASME Code comes from. 15 It comes from 16 laboratory tests. Then we have -- I said it already. 17 Then they got altogether. So we know we don't have a 18 perfect surface in a laboratory. We're using smooth 19 surfaces and -- reproducibility. Let's make allowances. Okay. Then we made allowances and they 20 21 say, "We made an allowance before." Okay.

JUDGE WARDWELL: Because it's not a machine surface.

DR. HOPENFELD: No. Because it is a machine. Because those tests we're doing -- with a

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machine surface. 1 2 JUDGE WARDWELL: Right. 3 DR. HOPENFELD: In real life, you're going to have a machine surface. 4 5 JUDGE WARDWELL: That's why you have 4.0. That's why they put 4.0. б DR. HOPENFELD: 7 JUDGE WARDWELL: Thank you. DR. HOPENFELD: But now comes the concept 8 9 that they have here and comes along and he says, "We want to get rid of all the curve. Okay. We want to 10 11 get it out there and " --12 JUDGE WARDWELL: Who is they? Who says 13 this? DR. HOPENFELD: The people who came -- The 14Argonne people with the hefty end concept. We want a 15 curve that uses the -- In air, I want to take it out 16 and put in, substitute, with a value, a light value, 17 18 okay, a stress value versus fatigue cycles in air --19 in water. The simple way of doing it is dividing the 20 value and multiplying it by the same factor. Do you see what I'm saying? That's -- Fen 21 22 is a factor of any air divided by 10 or -- in -- what 23 do you call it, in the reactor and Fen in air and divided it by the reactor and multiply by the ASMU 24 25 which is the AMA argued that you got in the reactor. **NEAL R. GROSS**

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MR. STEVENS: May I clarify? JUDGE WARDWELL: Mr. Stevens.

MR. STEVENS: This factor, surface finish, on NUREG 6909 page 76, the factor of 4.0 for the Criterion Document and 2.5 to 3.5 in the present NUREG, the specimens that were tested mirror polished specimens. What's in a vessel are machine components, forged components. That factor is intended to account for that difference.

JUDGE REED: And can you say what the ultimate effect is on a Fen value that would be calculated for machine if you had the exact same transient on the exact same specimen except one is mirror polished and one has a surface roughness? How do these factors translate to the ultimate answer that we're looking for, the Fens?

MR. STEVENS: The surface finish is included in these factors that develop the curve. Therefore, you don't double-dip and do it again when you compute an Fen.

JUDGE KARLIN: It's not in the Fen.

MR. STEVENS: That's correct.

JUDGE KARLIN: Okay.

JUDGE WARDWELL: The surface finishes are already accounted for in the --

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MR. STEVENS: It's already accounted for. 1 2 So there's no need to put it in the Fen. 3 JUDGE WARDWELL: Translation apply this 4 factor of 4.0. DR. HOPENFELD: I think that's a good --5 JUDGE REED: I guess I need a better 6 7 answer than that. I'm sorry. If I do a calculation of a CUFen for a mirror polished specimen and I do the 8 9 same calculation for -- What I'm trying to understand is what these factors mean in terms of the ultimate 10 11 limits that we're placing on these. So you have to 12help me understand whether a factor of 4.0 or a factor 13 of 20 here, how does that translate into an effect on 14 the calculated CUFen numbers? MR. STEVENS: The calculations we did were 15 16 components in a reactor. So we used a curve that had been adjusted for surface finish. 17 18 JUDGE REED: And if you had not used a 19 curve that was adjusted for surface finish, what would 20 -- how much smaller would the CUFens have been? 21 Can you say? 22 MR. STEVENS: From Section 3, 23 approximately a factor of 4.0. 24 JUDGE REED: That was my question. So 25 it's directly proportional to these numbers. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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.1	MR. STEVENS: Yes.
2	JUDGE REED: Okay. Thank you.
3	(Off the record discussions.)
4	DR. HOPENFELD: Are we allowed to explain
5	this a little, just a little bit about that?
6	JUDGE KARLIN: I think we are going to
7	take a break for a moment. It's 2:30 p.m. We will
8	reconvene in ten minutes. We'll take a break and
9	adjourn for ten minutes. Off the record.
10	(Whereupon, at 2:29 p.m., the above-
11	entitled matter recessed and reconvened at 2:41 p.m.)
12	JUDGE KARLIN: We're back on the record.
13	Ms. Tyler, did we lose Dr. Hopenfeld?
14	MS. TYLER: I just asked one of the ladies
15	in the back.
16	JUDGE KARLIN: Great. I'll wait until he
17	comes in before I remind everyone you're still under
18	oath. But I appreciate that you all have been sitting
19	there for most of two days in the warm and heat and
20	we're sitting here with glasses of water and enjoying
·21	ourselves and I don't think you have any sustenance
22	over there. So a secret weapon. Okay. That's fair
23	enough because it's been pretty warm.
24	I think our questions at this point are
25	not for Dr. Hopenfeld.
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1092 JUDGE WARDWELL: I just want to make sure 1 that he hears them though. 2 3 JUDGE KARLIN: Yes. (Off the record discussions.) 4 5 JUDGE KARLIN: Ms. Tyler, could you go and get Dr. Hopenfeld? 6 7 MS. TYLER: Yes. Apparently he has 8 injured himself downstairs and I think we need to go 9 down and see what happened. JUDGE KARLIN: Oh my gosh. 10 MS. TYLER: Yes. Hopefully 11 12 JUDGE KARLIN: Okay. 13 MS. TYLER: Hopefully, it's not serious. 14 I'll be right back. JUDGE KARLIN: Please do. Yes. Maybe we 15 should take a short break. .16 17 JUDGE WARDWELL: Might as well. 18 JUDGE KARLIN: Why don't we take a five 19 minute break and see if we can find out what Dr. 20 Hopenfeld -- So we'll be adjourned for five minutes. 21 Off the record. 22 (Whereupon, at 2:43 p.m., the above-23 entitled matter recessed and reconvened at 2:50 p.m.) 24 JUDGE KARLIN: We'll go back on the record 25 now. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701 (202) 234-4433 www.nealrgross.com

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1	The Atomic Safety and Licensing Board is
2	now back in session. I would remind the witnesses
3	that you are still under oath.
4	Dr. Hopenfeld, are you all right? I
5	understand you had an accident?
6	DR. HOPENFELD: I'm sorry for
7	interrupting.
8	JUDGE KARLIN: No, that's all right.
9	DR. HOPENFELD: Actually, I wanted you to
10	feel sorry for me.
11	JUDGE KARLIN: All right. Well, we'll
12	work on that. You've been very patient, and there's
13	been a lot of warm days and afternoons.
14	So I think we have some more questions.
15	JUDGE WARDWELL: I think we have pretty
16	much finished up with surface finish, drain rate,
17	oxygen and existing surface cracks or surface
18	cladding, which seem to be the most important.
19	I surveyed my colleagues, and we are
20	pretty clear on your position, Dr. Hopenfeld, on the
21	other issues.
22	DR. HOPENFELD: May I just make one
23	comment?
24	JUDGE WARDWELL: In what regard?
25	DR. HOPENFELD: I left you with the
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1	impression that I felt that I had done something
2	wrong. I didn't mean to do that. What I wanted to
· 3	say is they just haven't gotten that far.
4	JUDGE WARDWELL: Thank you.
5	For Entergy, these with the notice that
6 ·	in fact this table was presented as part of the
7	rebuttal, I wanted to query you in regards to whether
8	or not you had any comments on the other ones that Dr.
9.	Hopenfeld has brought up in his rebuttal with regards
. 10	to how you may have addressed these in your analyses.
11	JUDGE KARLIN: Let's clarify what the
12	table is.
13	JUDGE WARDWELL: Yes, it's table one, page
14	four of NEC JH 63.
15	And so the remaining other ones that Dr.
16	Hopenfeld agrees are less important than the three
17	most important ones are, deal with data scatter, size,
18	flow rate, heat to heat variation, loading history,
19	cyclic strain hardening, temperature below 150 which
20	we really have covered, trace impurities in the water,
21	and sulfite morphology.
22	If you have no additional comments, that's
23	fine. Also, that is fine, see if you wanted to
24	address how or refresh our memories of how these
25	are addressed in your cumulative use factors,
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environmentally factored into that analysis. 1 MR STEVENS: I guess the only thing I 2 3. would say is that this table indicates that none of these factors were addressed in Entergy's analysis. 4 I don't agree with that. 5 All but two of them were either directly 6 Ż or inherently included in the analysis. 8 JUDGE WARDWELL: And which two weren't either directly or indirectly included? 9 10 MR. STEVENS: On page six, we have already talked about item #13, existing cracks, and I had 11 identified that was not relevant. 12 item #11, it talks about trace 13 In impurities, and NUREG 6909 in fact points out that 14those kinds of things were not considered because it's 15 not -- it's very improbable that any kind of an 16 .17 impurity would be present during a transient event. 18 So therefore they did not feel it appropriate to 19 evaluate. JUDGE WARDWELL: Were all the others 20 considered under 6909? 21

MR. STEVENS: Yes.

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JUDGE KARLIN: Were they considered -- you mentioned considered under 6909. As I understand it, you didn't apply 6909. But they were considered by

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1096 Entergy, or were they considered by 6909? 1 2 MR. STEVENS: I would say both. 3 JUDGE KARLIN: Okay. MR. STEVENS: With that comparison I 4 5 testified on yesterday using a 6909 bounding the previous results. 6 7 JUDGE KARLIN: Okay. They are covered. 8 MR. STEVENS: 9 JUDGE WARDWELL: Thank you. JUDGE REED: Dr. Hopenfeld, you claimed 10 that Entergy used incorrect heat transfer questions in 11 their analysis; is that correct? 12 13 DR. HOPENFELD: Yes, absolutely. 14 JUDGE REED: You agree? Do you believe that the heat transfer coefficient should have been 15 16 larger or smaller than it actually is? DR. HOPENFELD: I don't know, in some 17 places it should be larger, in some places it should 18 19 be lower. I wasn't concerned that much with the absolute volume but more with the distribution. 20 And I would like to give you the background for that if I 21 22 may. 23 JUDGE REED: Yes, please. 24 DR. HOPENFELD: When I was into getting 25 into the area of calculating the CUF--**NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

JUDGE REED: We've left the FDN, and we're now back on CUF.

DR. HOPENFELD: We're on CUF now, you're not on the FDN. There were two items here that I'll have to go through. And I left off about the Green function that we've talked a lot about this morning, and I'd like to give you my perspective, that is different from you-hear from the grievants.

JUDGE WARDWELL: A little louder, please.

DR. HOPENFELD: My perspective is different than Mr. Stevens with respect to the refunction, and also, and then I'll talk about the heat transfers, which apply both to the Green function, Green's function, and the final element of the other analysis that they have done.

First, with respect to the Green function, what one has to understand that what the basic equation is that heat transfer, not linear heat transfer equation. When you go and make approximations by using the Green's function, what you are doing, you are linearizing that equation.

JUDGE REED: I'm a little puzzled. The Green's function has to do with how the stress is calculated.

DR. HOPENFELD: Correct. I said we are in

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1	the area of the CUF, not the CFEN. And the CUF does
2	a phase in calculating the using the Green function
3	and the finite element. Except it is not
4	JUDGE REED: We're going to relate this to
- 5	heat transfer?
6	DR. HOPENFELD: Yes.
· 7.	JUDGE REED: You used the term, heat
. 8	transfer equations.
9	DR. HOPENFELD: Right.
10	JUDGE REED: I think it's the heat
11	transfer coefficients, the expression.
12	DR. HOPENFELD: No, no, I'll get there.
13	But I will give you I am trying to elaborate what
14	you were told this morning about the Green function.
15	And I think it will be different, starting with the
16	heat transfer. I mean I could go immediately to the
17	heat transfer coefficients if you wish. But I thought
18	I would give you the whole background.
19	JUDGE REED: Please help me understand
20	what your contention is.
21	DR. HOPENFELD: Well, there are two items.
22	One has to do with the Green function, which was
23	discussed, and the heat transfer coefficient is
24	equally important there.
25	JUDGE REED: Does the Green function
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1	influence the heat equations, or are the heat
. 2	equations evaluated with the heat functions?
3	DR. HOPENFELD: Well, we are about to
4	suggest and that's why I was going because to
5	answer your question I would like to talk about two
б	things, and if I start with the Green's function, I
7	think that will come out.
8	JUDGE REED: We'll listen to your comments
9	about the Green's function.
10	DR. HOPENFELD: I'm sorry?
11	JUDGE KARLIN: Proceed with Green's
12	function.
13	DR. HOPENFELD: And you will see where it
14	goes. It does go to the heat transfer. I'll give you
15	the exact words when we get there. So what you are
16	going, because it is a nonlinear equation.
17	JUDGE KARLIN: Now what's a nonlinear
18	equation?
19	DR. HOPENFELD: Well, the terms under the
20	second differential equation depends on location and
21	time.
22	JUDGE KARLIN: But what equation?
23	DR. HOPENFELD: The basic energy equation
24	that describes the temperature distribution in a
25	component from which they take the stresses.
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JUDGE KARLIN: Is this the heat conduction 1 2 equation? 3 DR. HOPENFELD: This is the heat conduction equation. 4 5 JUDGE KARLIN: Now I understand. I call it the heat б DR. HOPENFELD: 7 transfer equation. This is the basic heat transfer 8 equation. 9 JUDGE REED: This is diffusion theory? DR. HOPENFELD: Correct. The terms is, 10 11 the heat capacity, the conductivity, the so forth. 12 And the reason I'm bringing it up is because they made 13 several assumptions which are not justified, and it just went through there. And I want to make sure that 14 15 you understand what is behind them. 16 They have linearized that equation. In 17 other words, I assume that the properties could be 18 used as an average volume. 19 Another place --JUDGE REED: Pardon me, that equation is 20 basically linear. It is only the properties. 21 22 DR. HOPENFELD: That is correct. 23 JUDGE REED: The thermal conductivity --24 DR. HOPENFELD: Yes, conductivity, heat 25 capacity, and density. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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JUDGE REED: Are functions of the temperature of the metal, hence nonlinear. DR. HOPENFELD: That's the

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correct, patterning of the temperature.

JUDGE REED: Okay, then I understand. DR. HOPENFELD: But that's part of it. So what you are doing in the concept, we're in the concept here so you will see where I am going with this, what you are doing is basically, the beginning of the Green's function is taking the surface integral, it's a double integral; you convert them into a lining, right, you look beneath the surface, just like you know if you are in the farm, instead of looking at the cows, you look at what's going on with the fence.

What is important here for doing this, when you apply this when you have Green's function, one of the inputs is the heat flux coefficient. First off that's how you calculate the temperature.

So the heat transfer coefficient has to be That is one of the basic constant, you see. assumptions there that they had made.

My contention is that the heat transfer coefficient is not constant. And the reason for that it's not constant during the transient which you have

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1	a force convection flow, and it is not constant during
2	the transients where you have a free convection flow,
3	and you have condensation.
4	JUDGE REED: Let me see if I understand
5	precisely what you say is not constant. I thought I
6	heard you say heat transfer coefficient?
7	DR. HOPENFELD: Correct.
. 8	JUDGE REED: Now this is the coefficient
9	expressing the heat transfer from the fluid to the
10	surface of the metal; is that correct?
11	DR. HOPENFELD: Correct. It's written as
12	K the heat flux H into the heat transfer
13	coefficient times the bulk fluid, that's the wall
14	temperature, or vice versa, that's being closed by
15	either way. And that heat transfer coefficient, as I
16	said, it's not constant, it's not constant along the
17	symmetry along the nozzle, either in the X
18	direction or circumferential.
19	You see the basic assumption of this
20	asymmetric model that they have that all these
21	properties are constant. Now why is that important?
⁻ 22	If you go
23	JUDGE WARDWELL: And all your discussion
24	relates only to the three nozzles, is that correct?
25	It doesn't
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DR. HOPENFELD: I am focusing on these three just for discussion. But anything else, because they are using different computer code in some type of pipe, what they call pipe, or proprietary code. I'm not too familiar what's in there. But I basically know when they have to.

But if you would please look at NEC JH-15.

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JUDGE KARLIN: JH-15?

DR. HOPENFELD: Yes.

JUDGE KARLIN: Page?

JUDGE WARDWELL: That's another calculation summary from Structural Integrity Associates?

DR. HOPENFELD: No, there is a curve there, let's see if I don't have the page number.

(Pause)

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DR. HOPENFELD: There is a curve in the document. I will talk about it if it doesn't come.

MS. TYLER: Dr. Hopenfeld, is that the stress/time.

21 DR. HOPENFELD: It provides the flat 22 stress versus time with two different heat transfer 23 coefficients.

> MS. TYLER: That's on page one dash seven. JUDGE KARLIN: This is page one dash seven

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of the exhibit? JH-15?

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MS. TYLER: Yes.

DR. HOPENFELD: I thought I had the page marked, and then I didn't. So it's -- okay. But you see the point here is that this was provided by Entergy, and what it does is, it shows you the result, the thermal stresses, are very sensitive to the heat transfer coefficient.

This is average heat transfer coefficient; it doesn't recognize the local heat transfer coefficient, because they made assumptions that it doesn't vary.

In the meeting that we had on January 8^{th} , we had --

JUDGE KARLIN: Meeting? What meeting? DR. HOPENFELD: The meeting we had that -the public meeting between NRC, public and Entergy, they had discussed the results of their calculations with regard to the CUF for the prenozzle, because they wanted to continue with that Green function, to use the Green's function.

And in doing so, one of the items that wasn't very clear was they indicated that any discrepancies were very important to the heat transfer coefficient. The results were very very sensitive to

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the heat transfer coefficient.

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JUDGE REED: Now I have to question you about this particular figure, because this figure is making the point that the stress depends on the heat transfer it says for a different set of heat transfer coefficients representing different flow rate conditions.

MR. STEVENS: Correct. Correct.

JUDGE REED: Since this calculation was done by Structural Integrity, let me turn very quickly to Mr. Stevens, and ask him to explain to me what these two curves really represent?

MR. STEVENS: This is a, first off it's a typical representation for the purposes of describing the methodology in the report, so -- but it's showing the stress response to two different flow rates, same transient. It doesn't specify what flow rates. It's just showing as a typical example.

JUDGE REED: What was changed between the two curves? Was it just the heat transfer coefficient itself, or was it the entire assumption of what the heat transfer equation is struck, as Hopenfeld would call it, it looks like.

24 MR. STEVENS: This curve would have only 25 varied the heat transfer coefficient.

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1106 JUDGE REED: Because different flow rates 1 have different Reynolds numbers. So you have a 2 3 Reynolds number dependence built into your heat transfer expression. 4 So what I'm trying to understand is, the 5 coefficient in front is also dependent on the flow 6 7 rate? Or is it just the Reynolds number to the point 8 eight power? 9 MR. STEVENS: Just the Reynolds number. JUDGE REED: Okay, so you really are not -10 11 - you are just changing -- this is just basically two curves at different flow rates. 12 13 MR. STEVENS: That's correct. JUDGE REED: I don't get the point then. 14JUDGE WARDWELL: Before we get to that, 15 can I just fix one other thing? 16 17 .In your confirmatory analysis this doesn't 18 apply at all; is that correct? 19 MR. STEVENS: That's correct. And it won't for the 20 JUDGE WARDWELL: 21 future, two other nozzles that will be evaluated using 22 the same confirmatory analysis. This only applies to 23 the refined analysis for those two? 24 MR. STEVENS: That's correct. 25 JUDGE WARDWELL: Thank you. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealroross.com

1107 JUDGE REED: However, you would expect a. .1 similar curve, a similar dependence on heat transfer 2 even with the confirmatory calculations, would you 3 not? 4 5 MR. STEVENS: Yes, sir. 6 JUDGE REED: So the only thing that 7 doesn't apply here is that you use this Green's function methodology, but a different, an improved 8 9 methodology would produce similar curves, different 10 but similar. JUDGE WARDWELL: 11 Well, it wouldn't 12 linearize it as much, would it, as Green's function 13 does? 14 MR. STEVENS: The effect of heat transfer on stress results depicted in this figure would be 15 16 important to the confirmatory analysis. The Green's 17 function shown in this figure would not. 18 JUDGE REED: So Dr. Hopenfeld, you were in 19 the process of discussing. 20 DR. HOPENFELD: I want to make sure I'm 21 not running ahead of myself. I'm going really step by 2.2 step. 23 JUDGE REED: Well, you[.] called our 24 attention to this particular curve, and now I 25 understand it, so we can move along. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	DR. HOPENFELD: Yes.
2	JUDGE KARLIN: We don't want to go too
3	step-by-step. Let's move it along if we can.
4	DR. HOPENFELD: The next step is the
5	important one.
6.	JUDGE KARLIN: Great.
7	DR [.] HOPENFELD: And what it is, it says,
8	that because the two different velocities, you see, if
9	I had doubled that's the first thing if I double
10	the velocity, okay, I double the stress, I affect the
11	changes in the stress, and that's the message of this
12	graph, okay.
13	In turn the velocity affects the heat
14	transfer almost linearly if you say the stresses are
15	directly affected; it's very sensible.
16	MR. STEVENS: May I clarify from the
17	standpoint of a fatigue analysis, would you care about
18	peak stress? There is no difference between these two
19	curves. The peak stress of the two curves near the
20	coordinate is the same. So whereas the stress out at
21	steady state is different, what is important to the
. 22	fatigue analysis is the peak stress, and in this
23	particular case those two curves are not
24	distinguishable.
25	So depending on the heat transfer level,
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1	it may or may not have an impact on the stresses of
2	interest for fatigue analysis.
3	DR. HOPENFELD: Can I say
4,	JUDGE KARLIN: Please respond.
5	DR. HOPENFELD: Because that is not where
6	I'm going. I will just tell you that you don't want
.7	to come from nowhere and tell you there's a
8	relationship between different velocity and different
9	stress modes. That's all I'm trying to say here, in
10	setting out the basis. You see the affected velocity
11	on the stress level.
12	Now they made the assumption that the
13	velocity is similar throughout the flow, and I'll
14	define similar in a minute; and they also made the
15	assumption that there is now circumferential
16	difference in the velocity, and because of that there
17	is no difference in the heat transfer coefficient, and
18	the temperature is uniform throughout the whole thing.
19	How does that affect, how that assumption
2,0	affects the where he picks up decides where the
21	maximum stresses are is something that I cannot say.
22	But I can show you from this that the effect is
23	significant on the local stresses.
24	Now so the next thing is, we look as to
25	why what is the justification for them to neglect
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1	the velocity distribution throughout the nozzle, both
2	circumferentially and axially.
3	JUDGE REED: Now, can we pause there for
4	a moment, and let me repeat back to you what I think
5	you said, and see if I understood correctly.
6	If I'm understanding, your point is that
7	if we go take a point in the nozzle and go
8	circumferentially around the nozzle, that the flow
.9.	field may be larger at the top of the nozzle than it
10	is around the bottom. Hence the heat transfer
11	coefficients would be different as we go around the
12	nozzle.
13	And your contention is
14	DR. HOPENFELD: And axially.
15	JUDGE REED: And by axially, you mean as
16	you move along the length of the pipe.
17	DR. HOPENFELD: Yes.
18	JUDGE REED: So whereas the bulk flow
19	through the nozzle is constant. So if they used this
20	bulk flow to determine a single velocity, then they
21	would not your conjecture or your assertion is that
22	Mr. Stevens used a constant heat transfer across the
23	entire surface, the inner surface of this nozzle.
24	DR. HOPENFELD: Right.
25	JUDGE REED: And that if he had varied the
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1	heat transfer coefficient, it would have caused
2	significantly higher stresses
3	DR. HOPENFELD: Correct.
4	JUDGE REED: to be calculated in the
.5	nozzle?
6	That seems to me on the face of it to be
7	a plausible argument. Could I ask you to respond, Mr.
8	Stevens?
9	MR. STEVENS: Yes, would you like me to
10	respond with respect to the refined analyses or the
11	confirmatory analyses?
12	JUDGE REED: Well, I think both.
13	MR. STEVENS: Well, the refined analyses
14	used well, let me back up.
15	Heat transfer, I agree, is a function of
16	velocity and temperature. So we need to account for
17	those in our calculations.
18	One way I can do that, because it is
19	commonly recognized by analyses of this type that the
20	higher the heat transfer coefficient you apply, the
21	more conservative your stress results are, because you
22	increase the heat transfer and introduce larger
23	temperature differentials in the component which would
24	lead to higher thermal stresses.
25	So if I am going to do a linear
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integration technique like the Green's function, it is important that I pick a bounding heat transfer coefficient if I'm only going to use one single value.

When I do the Green's function, I do have to use one set of heat transfer coefficients.

JUDGE REED: One set meaning uniform on the entire surface, inner surface of this nozzle?

MR. STEVENS: One set as in we would transfer different values of heat transfer coefficient along the component where appropriate. But in each region there would only be one value of heat transfer coefficient.

JUDGE REED: What would a region be? MR. STEVENS: A region would be an area where it is constant, say diameter. So therefore the velocity in that region would be the same.

JUDGE REED: I see.

MR. STEVENS: I change diameter, that's another region, I need to use another diameter because the velocity changes.

JUDGE WARDWELL: And you designed your finite element mesh to be able to do that in the regions of your interest, to change that heat? MR. STEVENS: Well, an input to our finite -- not exactly. Yes, our model is built with those

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1113 transitions in it. But an input to that model is heat 1 2 transfer coefficients. So when we calculate those 3 heat transfer coefficients, we have to take account of those different diameters in the model. 4 5 JUDGE WARDWELL: But your mesh is still also designed so that you can put them into the model 6 7 8 That's correct. MR. STEVENS: 9 JUDGE WARDWELL: -- and not only calculating from those regions, but it gives you an 10 11 opportunity as an application point for those coefficients. 12 13 MR. STEVENS: That's correct. 14 So I would calculate for each one of those 15 regions a value of heat transfer coefficient. And I 16 would pick it to bound flow rates, and temperatures 17 that the component will seek. So for these 20 transients that we talked 18 19 about yesterday, where the flow rate might range from 20 very low to very high, I would pick the highest flow 21 rate to compute my heat transfer coefficients. 22 JUDGE WARDWELL: And is that what you did 23 during the refined analysis? 24MR. STEVENS: Yes. 25 JUDGE WARDWELL: Thank you. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1114 1 JUDGE REED: So again you believe you are 2 picking conservatively large heat transfer coefficients that would yield maximum stresses? 3 MR. STEVENS: Yes. 4 Or conservatively large 5 JUDGE REED: 6 stresses. 7 MR. STEVENS: We calculated heat transfer 8 coefficients to cover these effects I just mentioned, 9 velocity and temperature, to bound those effects. JUDGE REED: Now in these models, your 10 model, your finite element model of this nozzle is 11 two-dimensional or three-dimensional? 12 13 MR. STEVENS: It's an axi-symmetric model 14 which you have seen in cross section and it's two 15 dimensional. 16 JUDGE REED: So that's two dimensional. 17 MR. STEVENS: But it is treated as a solid 18 revolution. The computer program can actually give us stresses at different azimuths circumferentially. 19 20 JUDGE REED: How would it do that if in 21 fact you have no mesh grid in that azimuthal 22 direction? 23 MR. STEVENS: It's a technique of the 24 finite element program that if all conditions are the 25 same, you tell it that, it will compute the same **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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answer around circumferentially. But it also gives the ability, a good example is moment loading on these nozzles. It does allow you to supply non-symmetric loading to that component, and then it will properly compute the stresses around the circumference of that component for that non-symmetric loading.

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So the conditions have to be right in order to use that model for those. They have the ability to analyze certain non-symmetric loads, like applied mechanical loads, but not things like temperature transients. So the temperature transients are assumed to be uniform around the circumference.

If you wanted to take into acccunt those kind of effects, where appropriate, you would have to build a three-dimensional model that also included the circumferential portion of the structure.

JUDGE REED: Would it be excessively difficult to build that model?

MR. STEVENS: It does take a significantly longer amount of time to perform these analyses using such a model.

JUDGE WARDWELL: Certainly more than 30 percent more time that the extra direction might indicate?

MR. STEVENS: That's correct.

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JUDGE WARDWELL: What about your confirmatory analysis? Are we ready to move on? JUDGE REED: I'm not sure we're done with heat transfer. JUDGE WARDWELL: No, I mean what he did, he said this is what he did for the confined. Now what you do for the confirmatory. MR. STEVENS: On the confirmatory.

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evaluation, since we modeled the transients in the 9 10 finite element model, apply them as the temperature 11 variation, now we have the ability to change the heat 12 transfer coefficient through that transient, since we 13 are modeling it, as opposed to the Green's function, where we want to make sure we bound it because we are 1415 going to use that result to integrate the stress response of this transient, and that process requires 16 17 us to have a constant value for that integration 18 process.

So we kind of have one shot at heat transfer in a Green's function input. And the confirmatory evaluation, much more sophisticated, we can specify it throughout the transient.

23 So we can vary heat transfer as a function 24 of temperature and flow rate during that transient as 25 it would occur during the confirmatory analysis.

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JUDGE REED: Wouldn't you expect significantly larger shear stresses at the nozzle corner if in fact there was considerable variation in the heat transfer coefficient azimuthally around that opening? And isn't that not accounted for in your model?

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MR. STEVENS: We -- our axi-symmetric model does not account for circumferential variations in temperature. There is no indication -- I mean that would be an inappropriate assumption under the transients and the high flow rates we are using.

JUDGE REED: Well, it was Dr. Hopenfeld's conjecture that in fact the heat transfer coefficients would vary significantly as we go azimuthally around the nozzle. That would lead to a significant fluctuation in the temperature field azimuthally around the nozzle. That would lead to larger shear stresses, would it not?

MR. STEVENS: Under the conditions we are evaluating, I don't known of any circumstances where that would come into play.

JUDGE REED: So you don't --

MR. STEVENS: I don't agree with that assessment.

JUDGE REED: You don't agree with the

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1	assumption that the heat transfer coefficient varies
2	around the is that
3	MR STEVENS: That is correct, for the
. 4	condition, these transients that we are evaluating,
5	yes, I agree.
6	JUDGE KARLIN: Are you saying it didn't
7	happen, or it's not scientifically correct?
8	MR. STEVENS: Not scientifically correct.
9	JUDGE REED: I'm sorry, now what does that
10	mean, not scientifically correct?
11	JUDGE KARLIN: I withdraw the question.
12	JUDGE REED: Because I believe it's
13	scientifically correct to say you have got a
14	significantly distorted temperature field as you went
15	azimuthally around the nozzle, that you would develop
16	fairly large shear stresses.
17	JUDGE KARLIN: Right, now let's ask that
18	question, is that scientifically true? Do you agree
19	with what he just said?
20	MR. STEVENS: I agree with that.
21	JUDGE KARLIN: Okay. I thought you said
22	the opposite a moment ago.
23	MR. STEVENS: Well, what I was saying is,
24	for the conditions we are evaluating
25	JUDGE KARLIN: You're saying it just
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1	didn't happen here.
2	MR. STEVENS: That's correct.
3	JUDGE KARLIN: So scientifically the
4	proposition Dr. Reed just said, yes, you agree with
5	the proposition that Dr. Hopenfeld stated you agree
6	with, but you are just saying it didn't happen here?
7.	MR. STEVENS: Yes, I agree.
8	JUDGE WARDWELL: And why doesn't it happen
9	here? You mean by happening here is for the modeling
10	associated with Vermont Yankee?
11	MR. STEVENS: Yes.
12	JUDGE WARDWELL: And why I guess I
13	don't understand what you mean by, didn't happen here.
14	You didn't incorporate it, or it physically doesn't
15	happen at Vermont Yankee for whatever reasons?
16	MR. STEVENS: Given the conditions we are
17	evaluating, that does not happen. We have very high
18	flow rates causing these significant transients on
19	these nozzles, fully developed flow that would not
20	allow for those kinds of temperature variations.
21	JUDGE WARDWELL: So now it seems like we
22	are getting down to whether or not you have fully
, 23,	developed flow.
24	DR. HOPENFELD: I would like to say that
25	Mr. Stevens is scientifically wrong. And if you
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1	please go to NEC JH-14, 10.
2	JUDGE REED: Fourteen, page 10?
3	DR. HOPENFELD: Right, this is feedwater
. 4	piping, it's a sketch, it's a cartoon of the feedwater
5	piping in at VY that we were given.
6	JUDGE REED: Where is the vessel in this?
7	Where is the nozzle?
8	DR. HOPENFELD: I believe it's on the top
9	there. By the two hangers there. Hard to see. But
10	my point here is, Mr. Stevens makes the assumption
11	that it doesn't happen, then he said it doesn't
12	happen.
13	He said the flow is fully developed
14	because it's 48 inches.
15	JUDGE REED: Because what?
16	DR. HOPENFELD: Because it's 48 inches
17	away from the entries.
18	JUDGE KARLIN: You're saying there is a
19	linear flow of 48 inches and therefore he says it's
20	fully developed, and you are saying 48 inches is
21	enough for it to be fully developed.
22	DR. HOPENFELD: That's the next dialogue.
23	JUDGE KARLIN: Oh, yes.
24	DR. HOPENFELD: But let me first say what
25	is a fully developed flow. Fully developed flow is a
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flow where the velocity is similar everywhere along the pipe. If you take a cut section somewhere, anywhere, the velocity distribution for turbulent flow is going to be like power, one-seventh power, and it is well established.

If you go somewhere else, it's all the same. It's similar. When you come for undeveloped flows, for an undeveloped flow, and I am talking about force convection now -- there are two items here I want to talk -- one is force convection, another is pre-convection, because some of those transients are both.

Ι am going to go now to the force convection first. If he says that all you need is 48 inches, and this 48 inches, you look at this figure, that's exactly what it is. If you look at the data, before you look at the data, you usually in engineering terms, you need 48 inches for the feedwater. The feedwater diameter is about 10 inches, you are talking about four diameters, so five diameters.

Usually in engineering --

JUDGE REED: Well, can I stop you? We are looking at this exhibit, NEC JH-14, page 10, and there is a Figure 1, and where does it say 48 inches?

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1122 DR. HOPENFELD: That is the --1 2 JUDGE REED: You said it's right here. 3 DR. HOPENFELD: Yes, it's right here. If you look on the top you see a scale there. But you 4 5 can't read the scale. If I try to strain my eyes, and 6 I really don't want to cause you to do that. But you 7 can see it's around four to five. But he claims it's four. 8 9 JUDGE KARLIN: What's 45? 10 DR. HOPENFELD: Four to five inches. 11 JUDGE KARLIN: What is? 12 DR. HOPENFELD: I mean four to five feet; 13 it's about 48 inches. JUDGE KARLIN: What is? 14 15 DR. HOPENFELD: The length of the pipe 16 from the elbow to where it enters the nozzle. 17 JUDGE REED: We don't see -- we don't even know where the nozzle is. 18 19 Well, I think there's a DR. HOPENFELD: 20 nozzle in the end there, you see the very end. But if 21 you can't see very well, I can't either. Mr. Stevens 22 testimony is that the length is 48 inches, from the 23 straight line is 48 inches. 24 JUDGE WARDWELL: So why did you have to 25 refer us to this figure? All we have to say is, his **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W.

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1	testimony is that it's 48 inches.
2	DR. HOPENFELD: Right. Because you can
3	see it with your eyes
4	JUDGE WARDWELL: No, you can't, that's
5	what I'm saying. And you can't say it either, you
6	can't point to where it is.
7	DR. HOPENFELD: Okay, but there is a point
.8	I want to show the figures too, because it's not only
.9	that straight actor. There's a whole I have a
10	reason to get there.
11	JUDGE WARDWELL: You are arguing about the
. 12	48 inches in regards to developing flow? You think it
13	should be longer?
14	DR. HOPENFELD: Oh, yes. Let me just say
15_	why. First of all I provided you data here showing
16	JUDGE KARLIN: Well, why don't we let's
17	all take a time out here. Do we have any questions?
18	Where are we in terms of questions?
19	JUDGE REED: Well, the subject was heat
20	transfer coefficients. And I think I am essentially
21	done.
22	JUDGE KARLIN: You don't have anymore?
23	You are done? Rich?
24	JUDGE WARDWELL: Yes, I do. I'd like to
25	go back to Mr. Stevens, and ask him to defend the 48
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1	inches for uniform flow, fully developed flow, because
2.	I think that hinges on how you do your justification
3.	for the selection of your heat coefficients.
4	MR. STEVENS: Okay, I'm going to actually
5	point to one of Dr. Hopenfeld's exhibits, NEC JH-29.
6	JUDGE KARLIN: Okay, we're there.
7	MR. STEVENS: That's a two-page extract of
8	a textbook, Heat and Mass Transfer by Eckhard. I'm
9.	looking at the second page which is page 212 of the
10	textbook, Figure 8-9. What this figure is, it's not
11	really applicable to the conditions and geometry we
12	have, but it's useful for me trying to answer your
13	question.
14	This says, this is flow near entrance of
15	a tube. And the chart is showing what is called the
16	Nusselt number on the ordinates, NU, and that is
17	proportional to the heat transfer coefficient.
18	As a function of X over D, which is the
19	distance downstream of the tube entrance, as
20	nondimensionalized to the diameter of the tube, so if
21	you will what this graph gives us is a variation of
22	heat transfer downstream from that discontinuity.
23	Now we don't have a sharp entrance to a
24	tube; what we have is an elbow, and therefore the
25	discontinuities associated with this, this would be
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overstating it. But nevertheless, let's take a look at it.

The other thing you will see on this picture is several lines that is a function of Reynold's number. And given that we are looking at a constant diameter tube, these lines would indicate increasing velocity in that tube as you move vertically up the chart. Higher Reynold's number, higher velocity.

What you see here is -- and actually as you look to the far extreme right of the curve, of these curves, that would be indicative of fully developed flow, what the heat transfer coefficient does for fully developed flow.

What you see with increasing velocities is that these lines flatten out. The effect of that entrance becomes more and more insignificant.

Now the part of this graph that is not really applicable to some of our nozzles is the Reynold's number. This goes up to -- the largest Reynold's number is 101,600; it's one E to the five. Our Reynold's number in the upper E to the five to the mid-E to the sixth range, well off the chart here.

But I think if you look at the tendency of

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this chart is, you can see that the effects of the . entrance are diminished. And now when you add to the fact that we don't have an entrance; what we have is an elbow. These effects of using fully developed flow are appropriate. And in fact that's what has been done in our industry in piping for more than 40 years, as Dr. Hopenfeld testified yesterday, the way we do these analyses has been very robust, and hasn't changed in 40 years, with respect to this element. In fact these textbooks we are looking at, the methodology has been well developed for many years longer than I've actually been around. It has not changed; it's still consistent.

And all the commercial piping codes still use this methodology. I'm not aware of any instances of any components in our industry where it's been shown that the relationships we are using are inappropriate or nonconservative.

JUDGE REED: Dr. Hopenfeld, what would you use in regards to the number of diameters --

DR. HOPENFELD: Could I answer the --JUDGE REED: -- flow.

DR. HOPENFELD: Can I make a comment about

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JUDGE REED: I would like you to answer my

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1	question.
2	DR. HOPENFELD: What would I use?
3	JUDGE REED: What do you what do you
4	recommend being used as a number of diameters to
- 5	develop fully developed flow?
. 6	DR. HOPENFELD: Oh, okay, I would say that
7	for this that for their application it would be, at
8	the minimum, at the very very minimum, 12. I would
9	say that you probably would go up to 40.
10	JUDGE REED: Forty?
.11	DR. HOPENFELD: Forty. Let me tell you
12	why, where the 12 comes.
13	JUDGE REED: I'm not interested yes, I
14	want to know the basis of that.
15	DR. HOPENFELD: You try to put a flow
16	meter in a line. You just want to measure your flow.
17	You are going to talk to the vendor, and he will tell
18	you you need at least 100 feet in order to get
19	accurate readings on your flow meter so the flow would
20	be similar; it would be fully developed.
21	And he will tell you, well, I don't really
22	believe they don't need that kind of accuracy.
23	What you need is a flow meter, because especially if
24	you are running and gauging fuel.
25	So the guy will tell you, well, you could
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put a flow straightener ahead of that component so the flow is not going to be -- you have all these tornadoes around, it's going to be fully developed.

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But you still have to have even with a flow straightener some section ahead which is straight, and then you ask, you know, what -- how straight should it be? And so what it depends what's up there, if you have an elbow or you have a valve, or whatever you have, an elbow is one of them. An elbow by my memory, the minimum number is -- like one of the twelve and a half diameters with a straightener. Ιf you don't have a straightener, the customarv engineering number is hedging for years. It's not today. This is a new invention here, what we got. It's been for -- since I can remember going to school.

And this I gave you, this is just an example and it -- the -- because this is easy to understand what's needed. But it -- the flow is going to be different whether you are downstream from the valve or you are downstream from the elbow.

JUDGE WARDWELL: Thank you, I think youanswered my question, thank you.

Dr. Reed?

JUDGE REED: Dr. Hopenfeld, in your testimony, JH-03 on page 20, you give a table in which

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1	you recalculate your own CUFen numbers.
2	DR. HOPENFELD: Yes.
3	JUDGE REED: Page 20, there is a table,
4	Table 3, recalculated cumulative usage factors for
5	sample locations.
6	Do you have that table?
7	DR. HOPENFELD: Yes, it's on page 20.
8	JUDGE REED: So you you would propose
9	that for Vermont Yankee that these are more
10	appropriated CUFens than the ones they calculate, is
11	that correct?
12	DR. HOPENFELD: Correct
13	JUDGE REED: Now the largest CUFen that
14	you calculate is 13.77 on a particular outlet and all
15	
16	DR. HOPENFELD: Yes.
17	JUDGE REED: Is that correct?
18	DR. HOPENFELD: Yes.
19	JUDGE REED: So if I use the definition of
20	a CUFen, and apply it to that particular component,
21	then I would maintain that one would expect failure of
22	that component, since this was calculated for 60
23	years; correct?
24	DR. HOPENFELD: That's correct.
25	JUDGE REED: You assumed 60 years for the
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1 DR. HOPENFELD: 2 That's correct. I used their numbers. 3 4 JUDGE REED: Then would you not expect failure of that component in 4.63 years? 5 DR. HOPENFELD: I don't know, I do not б 7 know how to relate these numbers --JUDGE REED: By the very definition of C-8 U-F-e-n. 9 Well, yes, for the --DR. HOPENFELD: 10 11 regarding the definition of term, which I really wanted to elaborate on that, because it depends how 12 13 people define, how they got the number of cycles under what conditions, whether it was engineering crack, or 14 15 whether it was complete failure. I would say this is all statistical. The higher the number --16 17 JUDGE REED: Of course it's statistical, 18 but there is a definition fo what this factor is 19 supposed to mean. DR. HOPENFELD: Right, it means potential 20 21 failure, but it doesn't mean --22 JUDGE REED: It means that you are way 23 past failure. You expect failure in much shorter than 24 60 years. 25 Well, DR. HOPENFELD: you have to **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com
understand the way they defined their FEM and the way their FEM has been used here, it's an engineering crack.

JUDGE REED: No, I'm talking about a definition. There is a very simple definition of both a CUF and an FEN. So it's the number of cycles to failure, divided by - I'm sorry, the expected number of cycles, divided by the number to failure.

DR. HOPENFELD: Correct, but the number to failure doesn't mean that it really has to fail.

JUDGE REED: No, no, that's the definition. It has to fail.

13 DR. HOPENFELD: By definition, it has to 14 fail.

JUDGE REED: That is the definition of this factor. You are talking about conservatisms built into how we calculate it. I'm talking about the definition.

19DR. HOPENFELD:But sir --20JUDGE REED:I can put it to you, sir,21that if you calculate a number, 15.77, for a 60-year22analysis, that you are predicting failure in four23years, or a little over four years.24How can that be possible?

iow can chac be possible.

DR. HOPENFELD: I don't predict it. I

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don't believe that that's what it is.

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JUDGE REED: That's your number.

DR. HOPENFELD: Yes, my number is 13.7, but I don't agree with your supposition that this relates to -- that there is a correlation between this number and when it fails.

JUDGE REED: Given that the plant has not failed, that none of these nozzles has failed, how can you justify proposing that the CUFen numbers could possibly be as large as what you propose?

DR. HOPENFELD: How can I justify? All this says, all these numbers say, and I think that's what the ASME code, to the best of my understanding, and what the guidance are, to say if you have -- and I believe that Mr. Stevens talked about that too -- it doesn't mean everything falls apart once that number is about one. All it says, when you reach about one you have got to do something. I cannot buy your supposition --

JUDGE REED: Even if I accept your point, that it doesn't fall apart, just major cracking occurs, we have not seen major cracking in any of these components in 30-something years of operation. And yet your CUFens predict that they fail in periods of time that would be substantially shorter than that.

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COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701 Hence I have to infer that your calculations are extremely excessively conservative. DR. HOPENFELD: They are conservative, but I'd like to explain why.

JUDGE REED: Well, I'm concerned that these CUFens that were 100 or 200, but that doesn't mean that they are appropriate for use in licensing. DR. HOPENFELD: Well, for the reason that this tells you, this is the guideline, it tells you. because of this I have got to do something. They calculate it in such a way that less than one they say you don't have to do anything.

All this says, you've gct to take an action.

JUDGE WARDWELL: Let me ask it in this way if I might. It seems to me that the CUFens that you calculate are highly dependent on the FEN that you selected.

DR. HOPENFELD: Correct.

JUDGE WARDWELL: What is your technical justification for a selection of 17 and 12 for stainless and carbon steel, specific technical basis. DR. HOPENFELD: Specific technical base, the specific technical base that in the abstract of your 6909, the people have -- that came up with these

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1	equations to calculate the FEN have done research and
2	have looked and I've counted about 41 different
3	papers different research and concluded that you
4	could have bounding numbers, conservative numbers,
5	which are would vary. One major difference between
6	6909 and 6583 is that this gives you a guideline.
7	But I'd like to say one more thing
8	JUDGE WARDWELL: Are you saying Argonne
9	recommends these things?
10	DR. HOPENFELD: Yes, I'll give you the
11	reference. Let me just read this thing to you please.
12	That's the most important thing in the whole
13	presentation.
14	This is in the abstract of the of NUREG
15	6909. That's what this thing does.
16	JUDGE KARLIN: You are saying they
17	recommend this for all plants and
18	DR. HOPENFELD: There
19	JUDGE KARLIN: in lieu of that there
20	are no other values.
21	DR. HOPENFELD: The implication as far as
22	I'm concerned, there is an uncertainty in this
23	technology, and we gave into bottom numbers.
24	JUDGE KARLIN: But that's not an
25	application of that in a practical sense then; is that
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1	correct?
2	DR. HOPENFELD: I think it is. Because it
Ĵ	doesn't say I don't buy into the proposition that
4	in fact it's 12 even if it was 20. The fact that this
5	falls apart.
6	JUDGE KARLIN: Well, point us to where
7	that is anyhow.
8	DR. HOPENFELD: All I'm saying, it doesn't
9	take You can run up, I have done it
10	JUDGE KARLIN: Point it out, could you,
11	where 17 and 12 is used here?
12	DR. HOPENFELD: I'm sorry?
13	JUDGE KARLIN: In 6909 you say, 17 and 12
14	
15	DR. HOPENFELD: Yes, I'm just trying to
16	get
17	JUDGE KARLIN: Could you point that out so
18	we have it on the record?
19	DR. HOPENFELD: Yes, I am just trying to
20	find where the exact word is.
21	JUDGE KARLIN: Well, why don't we give you
22	time, and you can come back to us later with where
23	that is.
24	DR. HOPENFELD: Oh, I know where that is.
25	JUDGE KARLIN: That's all the questions I
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1	have.
2	DR. HOPENFELD: It's in the abstract.
3	It's on the top of that page.
4	JUDGE KARLIN: That's okay. Just take
5	your time and find it. We'll get back you can just
6	give it to us later, give it to your counsel.
7.	DR. HOPENFELD: Can I make just one
8	comment if I could say, I would like to
9	JUDGE KARLIN: Well, let's just stop here.
10	Let's look at NUREG 6909, I have the abstract in front
11	of me, Dr. Hopenfeld. I think we should all refer to
12	that. Because it does appear to me that there are a
13	number 12 and a number 17 show up on that page. I'm
14	not sure what they all mean, but hopefully somebody
15	will explain that to me.
16	And in the abstract, on page triple I, is
17	this what you are referring to, quote: Under certain
18	environmental loading conditions fatigue lives and
19	water relative to those in air can be a factor of 12
20	lower for austenitic stainless steels, three lowers
21	for nickle-chromium-iron alloys, and 17 lowers for
22	carbon and lower alloy steels.
23	Is that where you are getting the 12 and
24	17?
25	DR. HOPENFELD: That is exactly what I was
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1	referring to, saving time looking it up here.
2	JUDGE KARLIN: I'm not sure what that
3	means, but I found the numbers for you. You tell us -
4	- do my colleagues have any questions? Does that mean
5	anything?
6	So that's where your numbers came from on
7	this chart?
8	DR. HOPENFELD: Yes, yes. For the FEN.
9	JUDGE KARLIN: The FEN.
10	DR. HOPENFELD: The original came from the
11	application.
12	JUDGE KARLIN: All right.
13 ·	JUDGE REED: Mr. Fair, what gives you
14	confidence in the analysis performed by Entergy?
15	MR. FAIR: Well, I have to say I was not
16	the reviewer on these analyses. I think based on the
17	safety evaluation report, though, we did have a review
18	of these calculations that determined that the
19	parameters input were adequate, and the analysis
20	methodologies were adequate.
21	That's the basis for my conclusion that
22	they have an acceptable calculation.
23	JUDGE REED: So you believe that let's
24	talk in terms of their refined analysis you believe
25	their refined analyses are conservative. I think
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there is a statement in the testimony by the staff that the staff believes the refined analysis were conservative.

MR. FAIR: The confirmatory analysis of the feedwater nozzle came up with a lower ultimate CUF than the defined analysis, so that it did demonstrate that the original refined analysis for the feedwater nozzle was conservative.

JUDGE REED: So it's still the position of the staff that all of the refined analyses for all nine locations are conservative?

12 MR. FAIR: No, that is not the position of 13 the staff. The fact that the feedwater nozzle 14confirmatory analysis came out to demonstrate that the 15 refined analysis was conservative in that particular 16 nozzle, we couldn't draw a conclusion that the same 17 level of conservatism would exist in the other two 18 nozzles, which is why we requested that they do 19 further confirmatory analysis.

20JUDGE REED:Were you completely21comfortable with all the changes that were made to do22the confirmatory analysis?

MR. FAIR: Again, I was not the one who went in an audited and reviewed that analysis. But I believe based on what I've read in the essay, the

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review of that analysis, that it -- that that analysis was adequate.

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3	JUDGE REED: Even though that analysis
4	assumed that used a different FEN technology, a
5	different assumption, instead of using a single
6	environmental factor applied at the tail end of the
7	calculation, they used different FENs for each
8	transient I believe, and the net effect was that the
9	correction factor, the FEN applied, was substantially
10	lower in the confirmatory analysis of the feedwater
11	analysis than it was for the refined analysis.
12	You are still comfortable with the way
13	that was done?
14	MR. FAIR: Yes, I am comfortable with
15	using the FEN that applies to the transients being
16	analyzed for each fatigue usage calculation.
17	JUDGE REED: So why then did the staff ask
18	after the fact, ask that Entergy go back and apply the
19	original FEN to the new CUF that was calculated in the
20	confirmatory
21	MR. FAIR: Well, the reason that the staff
22	did that was to try and determine whether we could use
23	the feedwater analysis as a confirmation for all three
24	nozzles, so we wanted to get as close to a one-to-one
25	comparison of the two analysis methodologies as

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And when that analysis came up higher than the original analysis, then we decided we couldn't assume that they were going to get the same level of additional conservatism by breaking the transients up and looking at an FEN for each transient, without further confirmatory analysis.

JUDGE REED: And that's what led you to require that Entergy do additional calculations of two more nozzles?

MR. FAIR: That's correct.

13JUDGE WARDWELL:That calculation will14include individual events for each transient?

MR. FAIR: Well, we didn't specify how they are going to do it. They could -- the CUFens are fairly low on those two nozzles. They may make a conservative assumption --

JUDGE WARDWELL: Just to save time? MR. FAIR: -- just to save time. JUDGE REED: Okay. JUDGE WARDWELL: Quick question while we

are on JH 03, we had that out for Dr. Hopenfeld on page 16 of that. I'll quote you, so I think you will remember it anyhow.

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It said: In my opinion -- this is you saying this -- the number of transients proposed by Entergy should be a minimum multiplied by 1.2 to account for the probability of an increase in unanticipated failures due to the 20 percent uprate, power uprate.

How did you arrive at the 1.2 number? DR. HOPENFELD: Okay, as we briefly talked the other day, with the -- from the information given to us, from the information given to us, the first time, I thought I understood how they calculated the numbers. They took the number of transients today after 40 years, multiplied that number by 1.5, and that was the number of transients.

Then there was a change evidently. 15 And 16 then when I went to read -- when I read and I quoted to you what Entergy stated, it was difficult for me to 17 understand how they arrived at that number. They had 18 19 -- they talked about it, but they haven't really indicated how they got it, and what kind of changes 20 were involved with in the past. Because I don't know 21 what they were counting. They didn't really give us 22 23 data from day one. I don't know whether some of these 24 changes were more severe or less severe.

JUDGE WARDWELL: How did you arrive at

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DR. HOPENFELD: I arrived at 1.2 through judgment because they increased the power by a factor of 20, and I wanted to account for the fact that under EPU conditions, even recent experience shows that the proprietary a few years ago, as the EPU and the power is increased, I want them to take into account that factor.

JUDGE WARDWELL: You selected it using engineering judgment?

11DR. HOPENFELD: Oh, completely engineering12judgment. I needed a hangar to hang my hat on.

JUDGE REED: Well, just a quick follow up to that, what is the experimental observation, what, two years of operation now at increased power, have you seen an increased number of transients in that period? I'm assuming you are tracking these transients, so you should now?

19 MR. FAIR: The only transient we had since 20 power uprate and the normal shutdown for the 2007 fuel 21 outage was in August running at 25 percent power. We 22 went down in the spring to the refueling outage, or 23 the plant. We went down in the spring for the 24 refueling outages. There were no transients during 25 the power extension phase. Not even the test

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1	transient. We actually did a test transient. It did
2	not the feedwater pump trip test phase. But that
3	was part of the EPU power extension plan.
4	JUDGE REED: Was the change in power level
5	held as transient?
6	MR. FAIR: Yes.
7	JUDGE REED: Didn't you recently change
8	power level?
9	MR FAIR: Power level went up. The power
10	level at EPU, they had this big test to show that if
11	they lost one of their Carter tank pumps, the feed
12	pumps will research all that before you got your
13	reduced power.
14	JUDGE KARLIN: So you had a transient in
15	August of 2007. This was unplanned reduction in power
16	as a result of the problem with the cooling structure?
17	Okay, so there was a transient there.
18	Did you have a transient two weeks a
19	week ago when you had another problem with the cooling
20	switch?
21	MR. FAIR: Yes, when they were at 25
22	percent power, they tripped.
23	JUDGE KARLIN: Okay, let me ask. What I'm
24	trying to get to is, I guess, from the first, from the
25	point of startup to the uprate there was a certain
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1	number of transients that occurred over a certain
2	period of time, from the point of uprate to today
3	there are a certain number of transients that occurred
4	over a certain period of time.
5	Has the rate increased, decreased, or
6	remained the same?
. 7	MR. FAIR: We've got three data points.
8	I'd say I wouldn't characterize it as an increase.
9	It may have decreased. But it's a small
10	JUDGĖ KARLIN: You are saying it's a small
11.	data point, small timeframe. I understand the small
12	timeframe. But if you extrapolated that out for, you
13	know, the 36 years or whatever minus the time since
14	the uprate would you have the same number, more or
15	less?
16	MR. FAIR: Same, probably.
17	JUDGE KARLIN: You haven't done that?
18	MR. FAIR: I don't have those numbers, no.
19	JUDGE KARLIN: So you don't know whether
20	it's increasing after the uprate, or decreasing or the
21	same?
22	MR. FAIR: No.
23	JUDGE KARLIN: Okay. Did you have
24	something on that, Mr. Stevens?
25	MR. STEVENS: No, sir.
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1	JUDGE WARDWELL: Mr. Fair, in your
2	experience, reviewing well, let me ask you, how
3	many license renewal applications have you reviewed?
4	MR. FAIR: It's more than a dozen. I
-5	don't have a count.
6	JUDGE WARDWELL: That's fine.
7	Cumulative use factors are calculated as
8	a predictive mode in the license applications; is that
9	correct?
10	MR. FAIR: That's correct, yes.
11	JUDGE WARDWELL: Is it fair to say that
12	these are continually calculated and recalculated
13	during actual operations once we get into once the
14	plants get into the renewal period as a tracking tool?
15	MR. FAIR: Well, there are two ways they
16	do it. One is to monitor the actual fatigue usage and
17	track that.
18	Another method is to count the number of
19	cycles that were used in the calculation, and assure
20	yourself that you don't exceed that number of cycles,
21	and therefore that verifies the CUF
22	JUDGE WARDWELL: So it's essentially doing
23	the same thing in regards to that?
24	MR. FAIR: Correct.
25	JUDGE WARDWELL: It's used in some fashion
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1	as a tracking tool; is that correct?
2	MR. FAIR: Correct.
3	JUDGE WARDWELL: And those are really two
4	different types of applications of the CUFs, isn't it?
5	One is a predictive mode, and one is a tracking,
6	monitoring, and however else you want to call it, type
7	of mode during operations?
8	MR. FAIR: That's correct.
9	JUDGE WARDWELL: Thank you.
10	JUDGE KARLIN: I have, Mr. Fair, probably
11	these questions are for you, relating to what I'll
12	call commitment #27. If you could refer to the FSER,
13	which I guess is staff Exhibit No. 1, and we will go
14	to page 4-34 again.
15	I'm interested in what y'all refer to
16	there as commitment #27, and there are four pages in
17	the FSER, 4-34 to 4-37 inclusive I think, that spent
18	almost the bulk of the time talking about the
19	evolution of this commitment, #27.
20	Now I understand you didn't do the review.
21	Mr. Chang, Dr. Chang, did the specific review here.
22	But perhaps you can help me.
23	MR. FAIR: I'll try.
24	JUDGE KARLIN: Okay. Now on page 4-34 in
25	the I guess the second full paragraph on that page,
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1147 you start talking about, the staff reviewed the 1 2 applicant's commitment #27 which was provided in a letter dated July 26th, 2006. 3 So that was way back there in 2006 they 4 came in with a commitment #27, I quess, that's what it 5 reflects. Then later in that paragraph it talks about 6 7 January 4th, 2007, the applicant provided a revised commitment #27, all right. 8 9 You see that? MR. FAIR: Yes. 10 JUDGE KARLIN: Agree that's there? 11 12 Then over on page 4-35 in the one, two, 13 three, four, five, the fifth paragraph down, we have yet another revised commitment #27 of July 3rd, 2007; 14 15 right? You see that? 16 MR. FAIR: Yes. 17 JUDGE KARLIN: You agree with that? 18 And then the next page talks about a letter dated July 30th, 2007, from the applicant. You 19 follow that? And there is a long quote that goes into 20 21 4-37, page 37, right? .22 MR. FAIR: Right. 23 JUDGE KARLIN: You have to speak so he can 24 record it, yes? 25 MR. FAIR: Yes. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	JUDGE KARLIN: Okay, because what I'm
2	trying to get at is, you know, let's see if I can find
3	that other exhibit, this conversation that took place
4	on August 20 th , around 2007, right in the middle of
5	all this it seems like. And I don't see a word about
6	that in here.
7	JUDGE WARDWELL: It's a 10/25/07 memo that
8	summarizes that if that helps you locate that.
9	JUDGE KARLIN: Yes, a 10/25 memo. I'm
10	trying to find the
11	JUDGE WARDWELL: While he's looking for
12	that, is there any indication of why a submittal
13	summarizing a phone call took from August 25 th to
14	10/25 to be written?
15	MR. FAIR: Well, usually, the staff
16	documents their correspondences with licensees. I
17	don't know the specifics of the memo.
18	JUDGE KARLIN: Okay, well, let's to the
19	memo. It's NEC JH 62, but if you could look at that
20	exhibit.
21	NEC JH 62, are you with me?
22	MR. FAIR: I'm with you.
23	JUDGE KARLIN: Okay, great. And it's an
24	October 25, 2007 memo from the NRC, subject, summary
25	of telephone conference held on August 20 th , 2007, all
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1	right?
2	MR. FAIR: Yes, I'm following.
3	JUDGE KARLIN: Okay, and it says,
4	enclosure two contains a summary of the issues
5	discussed with the applicant, and this concerns
. 6	commitment #27, right?
7	MR. FAIR: Yes.
8	JUDGE KARLIN: So we go to enclosure two,
9	and it's in that memo it says, the enclosure two. that
10	the NRC staff's position is that in order to meet the
11	requirements of 10 CFR 54.21©)(1) an applicant for a
12	license renewal must demonstrate in the LRA, the
13	license renewal application, that the evaluation of
14	the time limited aging analysis has been completed.
15	The NRC does not accept the commitment to complete the
16	evaluation of the PLAA prior to entering the period of
17	extended operation.
18	Now were you involved in that
19	conversation?
20	MR. FAIR: No, I was not.
21	JUDGE KARLIN: No, you weren't in the
22	meeting, but are you familiar with this memo or this
23	concept?
24	MR. FAIR: I believe I saw it when I was
25	looking through the exhibits is the only time I've
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1	seen it.
2	JUDGE KARLIN: Well, one question is, why
3	isn't that reflected in the FSER? You have a four-
4	page discussion of commitment #27, and this seems like
5	a significant event?
6	MR. FAIR: Again, I can't answer the
7	question, because I didn't develop that section of the
8	SER.
9	JUDGE KARLIN: Okay. And it's true to
10	note, if you would look at that, that the regulation
11	being cited is 10 CFR 54.21(c)(1),right?
12	MR. FAIR: That's correct.
13	JUDGE KARLIN: It doesn't say
14	(c)(1)(3),does it?
15	MR. FAIR: No, it doesn't.
16	JUDGE KARLIN: Or one or two or three.
17	MS. BATY: Your Honor, if you look at
18	those documents, it lists the individuals who were
19	present for this phone call. And there were three
20	individuals, NRC staff representatives, and one of
21	those individuals is in the room right now, and that
22	is the project manager, Jonathan Rowley. The other
23	individual the other staff individual has passed
24	away, and then the other one was Dr. Chang.
25	JUDGE KARLIN: All right.

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MS. BATY: If it would be helpful to the board, Mr. Rowley is in the room and will be testifying later on, and he wrote this document, to explain it. But otherwise I don't think Mr. Fair knows any of the other details.

JUDGE KARLIN: I posited that Mr. Fair was not part of that conversation. I did want to make that clear, and I asked him that question. So I think that is clear on the record; the thing speaks for itself.

Enclosure one has a list of participants, and Mr. Fair's name isn't on it, and he said he did not participate in this, and Dr. Chang did. And that's one of the problems with Dr. Chang not being here.

And I don't think we are in a position to add new witnesses on behalf of the staff at this point on contention number two.

But I'm just troubled by the fact that that is never mentioned in the FSER. And it just seems like a significant event.

But let's go to the FSER, and the last of the appendix, what, A -- I think it's appendix A to the FSER, if you could refer to that, because now we are going to get to the actual commitment #27 as it

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1	survived the evolution that the FSER mostly reflects
2	with the absence of the August 2007 problem.
3	And what is that, Appendix A, FSEN,
4	Vermont Yankee NPS license renewal commitments. Mr.
5	Fair, what are these commitments?
6	MR. FAIR: Well, they are commitments by
7	the applicant to the NRC staff to complete certain
8	actions.
ġ	JUDGE KARLIN: Okay. Are they legally
10	binding?
11	MR. FAIR: I believe the commitments in
12	the FSER are not legally binding, but the I believe
13	there is a that they have to be made conditions of
14	the license.
15	JUDGE KARLIN: Okay, all right. How are
16	they made conditions of the license? What happens
17	these are not legally binding in the FSER. But are
18	all of these converted into some license condition?
19	MR. FAIR: I can't speak to that.
20	JUDGE KARLIN: Okay. Or sometimes they
21	are and sometimes they're not?
22	MR. FAIR: I believe they are. I believe
23	they normally are taken as license conditions when
24	they have commitments.
25	JUDGE KARLIN: Okay, do you want to ask
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1 something? 2 JUDGE WARDWELL: Yes, just a quick 3 guestion. 4 To the best of your knowledge are all the -5 promises made by the applicant in response to RAIs converted into these commitments as presented here as 6 7 best you know? 8 MR. FAIR: As best I know. 9 JUDGE KARLIN: So everything they say in 10 the whole licensing process for two years or three years, I don't think you really want to say that 11 everything they promise is put into writing as a 12 13 commitment? MR. FAIR: Well, every commitment -- okay. 14 15JUDGE KARLIN: Every commitment -- it's a more formal thing. There may be other informal things 16 17 that are not incorporated as commitments, and thus . 18 perhaps not incorporated as license conditions? 19 MR. FAIR: That's possible. I can't say. 20 JUDGE KARLIN: Yes, we are speculating. 21 But we can go -- if we could go to Appendix A of the 22 FSER on page A8, and here we have the wonderful 23 commitment #27, all right. Two years prior, at least two years prior to entering the period of extended 24 25 operation for the location specified in -- and there's

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1154 locations -- NUREG 6260 for BWRs of the VY vintage, VY 1 2 will refine our current fatigue analyses to include 3 the effects of reactor water environment, and verify that the cumulative use factors are less than -- that 4 5 one, I think it's a typo, less than one. 6 Does that say -- is that the condition we 7 are talking about where they are going to do two additional CUFen analyses on the core spraying of 8 9 reactor recirculation? 10 MR. FAIR: I believe that is. 11 JUDGE KARLIN: Okay, I mean that's what I 12 thought. But why didn't they just say that? 13 MS. BATY: Your Honor, the license conditions expresses that out in part one of the SER. 1415 JUDGE KARLIN: Okay. 16 MS. BATY: One point seven of the SER. 17 JUDGE KARLIN: Okay, 1.7. We'll go to that in a minute perhaps. But let me go to the next 18 19 one. 20 This includes applying the appropriate FEN 21 factors to valid CUFs. Who decides what's 22 appropriate? 23 MR. FAIR: In implementing the commitment, 24 it would be the applicant. 25 JUDGE KARLIN: So the applicant decides NEAL R. GROSS COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1 what he thinks is appropriate? 2 MR. FAIR: Yes. 3 JUDGE KARLIN: Down on subparagraph two of this, more -- I'm reading -- more limiting VY-specific 4 locations with a valid CUF may be added in addition to 5 -- who decides whether they are added? 6 7 MR. FAIR: Again, this would be the 8 applicant. 9 JUDGE KARLIN: Okay, and number three, represented CUF values from other plants adjusted to 10 or enveloping the VY plant-specific external loads may 11 be used. Who makes the decision on that, the NRC or 12 13 the applicant? MR. FAIR: Again, it's the applicant. 14 JUDGE KARLIN: Why doesn't the NRC make 15 these things? I mean isn't it a judgment call? 16 17MR. FAIR: Yes, it is. 18 JUDGE KARLIN: What if the applicant makes 19 a choice that's wrong? Anyway to catch them? 20 MR. FAIR: Well, yes, they could be all expired but have a period of extended operation to 21 22 verify the commitments are implemented. 23 JUDGE KARLIN: So the licensee will make 24 a choice on all these "mays" in here, because there 25 are quite a few more of them. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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MR. FAIR: Yes.

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2	JUDGE KARLIN: Item #4 says, an analysis
3	using NRC-approved version of ASME code, or an NRC-
4	approved alternative may be performed in the next
5	paragraph. During the period of assembly operations,
6	VY may also use one of the following options.
7	So there are a lot of options, a lot of
8	discretion in there, right?
9	MR. FAIR: Yes.
10	JUDGE KARLIN: And those discretionary
11	choices are the applicant's discretionary choices?
12	MR. FAIR: As this commitment states.
13	JUDGE KARLIN: If the applicant chooses
14	something the staff doesn't agree with, can the staff .
15	say something and get them to change it?
16.	MR. FAIR: If they audit the
17	implementations of these commitments and have concerns
18	with it, yes they can add some kind of an issue.
19	JUDGE KARLIN: All right, now what if Dr.
20	Hopenfeld didn't agree with one of these choices that
21	was made, would he have an opportunity to come weigh
22	in? Would NEC have an opportunity to file an
23	contention and have a is there a notice of
24	opportunity for a request a hearing every time one of
25	these things happens?

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1	MR. FAIR: I don't believe so.
2	JUDGE KARLIN: Okay, so it's just the
3	it's pretty much the applicant's choice to do Yankee's
4	judgments, and unless the staff objects that is going
. 5	to be it. No public scrutiny allowed on whether that
6	cuts the mustard or not.
7	MR. FAIR: Yes, I agree that's true.
8	JUDGE KARLIN: Thank you.
9	Okay, I think we are getting there with
10	regard to convention #2. We have asked pretty much
11	the questions we thought were of concern to us.
12	We are going to go back into the room and
13	take a recess now, 15 minutes, and go over our notes
14	and see if there is something we think we might have
15	missed or want to ask any further clarification on.
16	During that timeframe hopefully you all
17	will think about whether you think there is something
18	that has come up in this process that we should probe
19	or ask or something we missed.
20	And this is the time when you will give us
21	suggestions. So we will take a well, why don't we
22	reconvene at 4:30. That will be a 20-minute break.
23	So we are now adjourned for 20 minutes.
24	(Whereupon, at 4:12 p.m. the proceeding in
25	the above-entitled matter went off the record to
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JUDGE KARLIN: All right. As we
discussed, the Board went back and reviewed its
questions to try to think through if there was
something we thought we hadn't covered or we still
wanted to get some information on or needed
elicitation in the record. And so we've done that.
We have also received thank you from
a number of the parties some proposed questions. I'm
not going to read the questions that we have received,
but I would acknowledge that we received questions
from the State of New Hampshire, several questions in
written form, and we received some questions from
Entergy. And we received a set of questions in

writing from New England Coalition, I believe in coordination with the State of Vermont. So thank you.

We have taken a look at those and tried to study whether we think the matter is -- needs clarification on the record. I also understand -does the Staff have something you want to give us orally?

MS. BATY: Your Honor, we have changed our mind. We don't have anything further. JUDGE KARLIN: Okay. All right, fine.

That's great. I appreciate that.

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And having done that, we have several questions we are going to ask. And if your question does not get asked, it's because we believe -- we don't have any -- we feel we are clear enough on the record and we're clear enough for our understanding that we don't need to ask those questions. The record and the evidence is sufficient for us to understand the issue.

So with that, we have several questions that are going to be asked, and I believe Dr. Wardwell will start.

So let me say this -- the witnesses all remember we are -- you are still under oath. So thank you.

JUDGE WARDWELL: I think the first will be addressed to Mr. Fitzpatrick in regards to discussions we had in relationship to the transients that have occurred so far under the -- our uprate existing there. And the first question is: what is your definition of the transients for the purpose of the cycle count? Is it only the zero to full power, or full power to zero, or all transients included in anything considered to be a major transient? MR. FITZPATRICK: Major transients --

startup/shutdown is a major transient. A trip from

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power level would be a major transient. A power reduction and a gradual heat -- for example, when they -- the cooling tower was offline last year, they reduced power percent, they reduced power 50 gradually. There's a tech spec they have to follow to reduce power and increase power. JUDGE KARLIN: You previously testified

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that you have approximately 90 transients over the history of a facility, right?

10 MR. FITZPATRICK: The question was since we did power uprate.

12 JUDGE KARLIN: Well, let's just go from 13 the beginning. What is your -- when you say you had 90 transients since the beginning -- 96 -- is that 14just full power transients, or all transients of 15 16 whatever magnitude?

17 MR. FITZPATRICK: That's startup/shutdown 18 transients. That was that one particular category.

19 JUDGE KARLIN: So that only includes 20 startup and shutdown transients?

MR. FITZPATRICK: Yes.

JUDGE KARLIN: Are there other transients

you've had since -- the last 36 years?

MR. FITZPATRICK: Yes.

JUDGE KARLIN: And that's not included in

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MR. FITZPATRICK: That was one number from one transient that gave us that example.

JUDGE KARLIN: Well, I misunderstood. JUDGE WARDWELL: So what are the total number from -- do you know?

JUDGE KARLIN: Yes. What's the total number of transients?

JUDGE WARDWELL: From '72 to 2008.

MR. FITZPATRICK: The total number of every transient? I'd have to go back and recalculate it -- or look it up and calculate it. It's calculations out there that were put in discovery that evaluate the plant, how many transients you've had at certain times. They are documented in that. The last time we did an assessment was in -- in response to an RAI -- peak usage, CUF -- at the end of 2005. And that was one of the license renewal amendments.

JUDGE WARDWELL: Do you have any estimation of how many of those would be in the life of a plant? And how it compares to --

22 MR. FITZPATRICK: Well, major -- turbine 23 trips, I think it was -- say HPSI injections in the 24 feedwater. Turbine trip is one of those shutdown --25 in 2005 we had that when we -- failure, the plant went

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from zero power, breakdown, and tripped offline. That was included in the CUF that's -- we've tracked.

3	JUDGE KARLIN: Well, but we're not asking
4	about 2005. I'm trying to understand I was under
5	the impression that you we asked you, for CUFens,
6	how many and a transient is an event which causes
7	stress, I thought, which is a part of the calculation
8	of the metal fatigue, stress, and that sort of thing,
9	and so how many transients have you had since the
10	plant started operation. And you said something in
11	the range of 90 to 96. Now I understand that that's
12	only a special kind of transient, and you have a lot
13	of other kinds that you didn't tell me about.
14	MR. FITZPATRICK: I said, for example,
15	startup transients, shutdown transients, and
16	JUDGE KARLIN: What about '78 or '83? I
17	don't care about a year. I just want the total number
18	of transients.
19	MR. FITZPATRICK: That's the total number
20	of startup/shutdown transients.
21	JUDGE KARLIN: Well, I want all
22	transients. Since the beginning of time to today, how
23	many have you had, of any magnitude, of any kind, of
24	any color or description?
25	MR. FITZPATRICK: I don't have that answer
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offhand. 1 JUDGE KARLIN: Okay. 2 3 JUDGE WARDWELL: Can you get that to us? MR. FITZPATRICK: Yes, sir. 4 JUDGE KARLIN: All right. Then, we'll --5 JUDGE WARDWELL: Within this week? 6 7 MR. FITZPATRICK: I'd have to consult with 8 the people who --JUDGE KARLIN: Mr. Lewis, do you think you 9 10 all could arrange to have that for us? MR. LEWIS: I'll do my best. 11 JUDGE KARLIN: Thank you. I think that 12 13 number actually came out in the uprate proceeding, so you might go back and check. It might need to be 14 15 updated. JUDGE REED: Would Mr. Stevens have those 16 17 numbers, since he did -- you had to have those figures 18 for those transients in order to do your analyses, is 19 that correct? 20 MR. STEVENS: Well, no, we had the input 21 provided by Entergy. Recall, those were design 22 numbers that were shown to be conservative compared to 23 the actual counts. The only indication I have of what 24 you're asking for was in the license renewal 25 application. **NEAL R. GROSS**

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1164 I believe it was Table 4.3.2 maybe that 1 2 had a tabulation for several different transients and 3 the number that had been accumulated as of a certain date in the projection forward. I don't recall 4 5 specifically what those numbers are, but they were in 6 the application. 7 JUDGE REED: So in the CUFen transient count, did you include all transients or only some 8 subset of transients? 9 10 MR. STEVENS: We included all transients 11 that had any impact on fatigue. 12 JUDGE KARLIN: So that's a subset of 13 transients. 14MR. STEVENS: A subset of design 15 transients, that's correct. 16 JUDGE KARLIN: And how many were they? 17 MR. STEVENS: I can only speak 18 approximately. 19 JUDGE KARLIN: Okay. 20 MR. STEVENS: Depending on the component, 21 so for a feedwater nozzle approximately 20. 22 JUDGE WARDWELL: Different types of 23 transients. STEVENS: Different types 24 MR. of 25 transients. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701 (202) 234-4433 www.nealrgross.com

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	- 1	JUDGE REED: Types, not numbers.
	2	MR. STEVENS: No, not numbers.
	3	JUDGE REED: Not quantities. How many
	4	total numbers?
	5	MR. STEVENS: Each one of those transients
	6	would have had a different quantity associated with
	. 7	them.
-	8	MR. FITZPATRICK: May I speak?
	9	JUDGE KARLIN: Yes, Mr. Fitzpatrick
	10	MR. FITZPATRICK: The calculations for the
	11	feedwater nozzle show the transients that were
	12	actually evaluated. And each one of those is a
	13	certain number. There are
	14	JUDGE KARLIN: Was that in one of the
	15	exhibits?
	16	MR. FITZPATRICK: Yes.
	17	JUDGE KARLIN: Okay, great. Which exhibit
	18	would that be?
	19	JUDGE WARDWELL: That number is based on
	20	what?
	21	MR. FITZPATRICK: That's the design
	22 [:]	number, plus any additions we did for 60 years using
	23	the EF analysis.
•	24	JUDGE WARDWELL: But it's a selective
	25	design number, not the actual number that has
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1 occurred. 2 MR. FITZPATRICK: Right. The actual numbers are lower than that, and there is a 3 calculation that actually tracks it. The results ---4 5 JUDGE -WARDWELL: Well, what would be 6 useful for us is to see the actual numbers, just to 7 confirm -- · 8 MR. FITZPATRICK: Yes. 9 JUDGE WARDWELL: -- what you intended to 10 do for your analysis. MR. FITZPATRICK: Yes. Yes. 11 12 JUDGE REED: I think a comparison between the actual numbers that occurred and the numbers 13 14assumed in the analysis would make us more 15 comfortable. 16 MR. FITZPATRICK: Entergy has that. 17 JUDGE KARLIN: But we haven't seen it yet. We haven't been provided it. 18 19 MS. HOFMANN: We don't have that as an 20 exhibit? 21 JUDGE KARLIN: No. They are still looking 22 for the exhibit. 23 MR. FITZPATRICK: We have -- this shows 24 the numbers that we used. 25 JUDGE KARLIN: Do you have it, Mr. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com
1167 1 Stevens? 2 MR. STEVENS: Yes, I can answer half the 3 question, which is, what did we analyze? JUDGE KARLIN: All right. 4 MR. STEVENS: Exhibit E-2-11. E-2-11 is 5 Structural Integrity Associates' calculation, VY 16Qб 7 302, dated July 18, 2007. 8 JUDGE KARLIN: Yes, okay. 9 MR. STEVENS: There's a couple of places 10 we could refer to in here. The best one, in terms of 11 number -- different types of transients and the 12 quantity, one place we could look is starting on 13 page 18, Table 5. JUDGE KARLIN: Table 5, yes. It's a nice, 14 15 long table. 16 MR. STEVENS: Two pages. 17 JUDGE KARLIN: Two pages, okay. Long 18 enough. MR. STEVENS: In column number 1, it's 19 transient number. These would be the different types 20 21 of transients, 25 transients. 22 JUDGE KARLIN: Twenty-five different types 23 of transients. 24 MR. STEVENS: Different type. In the far 25 right column, 13 is the number of cycles of each of **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

1168 1 those transients. Each transient is defined by 2 multiple points in time. That's why you'll see multiple lines within each transient number. 3 2 4 So just as an example, on page 19 --5 - JUDGE KARLIN: No, but wait a second. Let's just stay with this -- or I guess we're still on 6 7 the chart. Go ahead, 19 is --8 MR. STEVENS: This would be the second 9 page of that table. 10 JUDGE KARLIN: Yes, okay. .11 MR. STEVENS: Event number 20, far right, 12 300 cycles were assumed for 60 years. JUDGE KARLIN: We're still -- but that 13 14doesn't tell us the actuals. 15 MR. STEVENS: That's correct. JUDGE KARLIN: And when you say transients 16 17 are assumed, are these -- these are 25 different types 18 of transients. Okay. Within each type, is there any 19 -- is it only a -- is it any amount of amplitude of a 20 transient, or is it only a major? Is there any other 21 qualifier which excludes or includes -- you know what 22 I mean? 23 MR. STEVENS: Within each transient, the 24 temperature and pressure would vary. 25 JUDGE KARLIN: Yes. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. WASHINGTON, D.C. 20005-3701

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MR. STEVENS: And those --1 JUDGE KARLIN: I mean, is there something 2 3 that says, "Well, they are too small, we're not going to count those, " within each category or --4 MR. STEVENS: Not within those listed 5 here, I don't believe. We had --6 7 JUDGE KARLIN: Oh. But -- okay. But this does not give us actual transients. 8 9 MR. STEVENS: No. 10 JUDGE KARLIN: And --11 MR. FITZPATRICK: Entergy has those 12 numbers. 13JUDGE KARLIN: Great. And I think we would probably request that be submitted by Entergy, 14 15 if you could, Mr. Lewis. Thank you. 16 JUDGE REED: I'm a little curious about 17 one thing. One particular transient occurred 10,000 times? 18 19 JUDGE KARLIN: It didn't occur, actually. 20 JUDGE REED: I'm sorry. Well, they 21 assumed it occurred. It must have occurred a large 22 number of times in -- what's that, a small power 23 fluctuation? 24 MR. That's a daily STEVENS: power 25 reduction. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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JUDGE REED: Okay.

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JUDGE WARDWELL: Mr. Fitzpatrick, have you had any actual thermal transients throughout the life of the plant that are outside the design basis as provided by the designer?

MR. FITZPATRICK: Not that I know of. JUDGE WARDWELL: You testified, did you not, that there is -- well, maybe there's some confusion on how many transients have occurred since the uprate. And I think you stated that there has only been one full transient: there are other less than. Have you included the July '08 power reduction down to 25 percent for the cooling towers as a transient, the August 7th cooling tower collapse, and a 50 percent power-down, an August '07 turbine stop valve incident resulting in a 100 percent power-down, and the 2004 condenser leak resulting in a 50 percent power-down?

MR. FITZPATRICK: 2004 was prior to power uprate.

 21
 JUDGE KARLIN: Right, prior to the power

 22
 uprate.

JUDGE WARDWELL: Would the other three be included in the transients that have occurred since power uprate, in your testimony?

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1 MR. FITZPATRICK: Power reductions and the 2 trip at 25 percent in August. 3 JUDGE REED: Sorry. You've got to speak louder. 4 5 MR. FITZPATRICK: The power reductions and 6 the trip from 25 percent power in August 2008. The. 7 power reductions have a small -- a power reduction has a small effect on cumulative usage. It's mostly seen 8 9 in the feedwater. That's why there's -- it's a large number of transients where feedwater is evaluated, and 10 11 this is small usage -- very small usage factor -factor from those deductions. 12 13 PARTICIPANT: Could you speak up? JUDGE KARLIN: Yes. 14 15 MR. FITZPATRICK: I think I am. 16 JUDGE KARLIN: Yes. Try to speak up some more if you could. It has been a long day. 17 18 Appreciate it, Mr. Fitzpatrick. 19 JUDGE WARDWELL: Let me rephrase. Hasn't 20 the total number of less than full transients that have occurred in the uprate include the July 8th 21 power-down of -- July of '08, power reduction down 25 22 23 percent because of the cooling tower leaks? Would 24 that be considered a transient? 25 MR. FITZPATRICK: It would be considered

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. 1	a transient. I did leave Entergy in March, so I		
2	haven't followed every case since then.		
- 3	JUDGE WARDWELL: How about the August '07		
.4	cooling tower collapse, resulting in a 50 percent		
5	power-down?		
6`	MR. FITZPATRICK: That would be a		
7	transient, yes.		
. 8	JUDGE WARDWELL: How about the August '07		
- 9	turbine stop valve incident resulting in a 100 percent		
10	power-down?		
11	MR. FITZPATRICK: Pardon me?		
12	JUDGE WARDWELL: The August '07 turbine		
13	stop valve incident resulting in a 100 percent power-		
14	down.		
15	MR. FITZPATRICK: Stop valve incident		
16	occurred at 25 percent		
17	JUDGE WARDWELL: Okay. And it occurred		
18	August '07.		
19	MR. FITZPATRICK: Yes.		
20	JUDGE WARDWELL: Was that an incident? Is		
21	that a transient?		
22	MR. FITZPATRICK: That was a transient,		
23	yes.		
24	JUDGE WARDWELL: Thank you.		
25	JUDGE REED: We're really confused, still,		
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1173 1 about this issue of trace elements and impurities. 2 And, first, I want to clarify that we are talking about trace elements in the fluid itself, not in the 3 In your earlier testimony Is that correct? 4 mud. about trace elements --5 MR. STEVENS: 6 Yes. 7 JUDGE REED: -- we were speaking about impurities within the cooling. 8 9 MR. STEVENS: Correct. 10 JUDGE REED: Okay. And so I believe your 11 testimony was that they were not considered because you felt it was unlikely that they would be present 12 13 during a transient. 14 MR. STEVENS: Correct. JUDGE REED: Now, it has been brought to 15 16 our attention that there was an incident in which 1.7there was a leakage of service water through the condenser. Was it -- is it possible that impurities 18 were injected into the system as a result of that 19 20 incident? MR. STEVENS: I can't speak to that. 21 22 MR. FITZPATRICK: What date is the 23 incident? 24 JUDGE REED: I'm assuming it was probably 25 this incident in 2004, but I'm not certain. **NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS 1323 RHODE ISLAND AVE., N.W. (202) 234-4433 WASHINGTON, D.C. 20005-3701 www.nealrgross.com

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1	MR. FITZPATRICK: Some sort of	
2	JUDGE REED: Pardon me?	
. 3	MR. FITZPATRICK: Some sort of impact to	
4	the condenser that under normal operations.	
5	JUDGE REED: All right. So that answers	
6	our question. Thank you.	
7	JUDGE KARLIN: Now, this is a question for	
8	Mr. Stevens. We had talked I had asked you some	
9	questions, I think probably vesterday, about 6909 and	
10	the calculations that you did over a weekend I guess,	
11	applying 6909 to the nine I.guess locations, and you	
12	took four hours to do it, remember that?	
13	MR. STEVENS: I do, sir.	
14	JUDGE KARLIN: Good. That was fast, that	
[.] 15	was good. I'm trying to make sure I understand what	
16	you did and what was meant by that. When you did that	
17	analysis, did you you substituted the 6909 curves,	
18	by just substituting the 6909 curves? What would have	
19	been the result if you had done everything according	
20	to 6909?	
21	What did when you did the four-hour	
22	analysis applying 6909 let me back up what did	
23	you do? You used 6909 in full, the air curves, the	
24	95/95, you know, confidence levels, the Fens, and	
25	everything else, or just some component of it?	
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	1175	
1	MR. STEVENS: Everything.	
2	JUDGE KARLIN: So you did the soup to nuts	
. 3	as if the from scratch it was calculated under	
4	6909.	
. 5	MR. STEVENS: Yes, sir.	
6	JUDGE KARLIN: Okay. And so you applied	
7	all of 6909 to the CUFen analysis for Vermont Yankee,	
8	and came up with the numbers that were less than one,	
9	in all respects.	
10	MR. STEVENS: Yes, sir.	
11	. JUDGE KARLIN: Okay.	
.12	JUDGE REED: But let's see, those numbers	
13	and maybe I'm recalling the testimony wrong, but I	
14	thought your point was that they were not only less	
15	than one, but less than the refined analyses. Was	
16	that	
17	MR. STEVENS: That was my testimony, yes.	
18	JUDGE KARLIN: Yes, yes, that's right.	
19	Well, do we have anything else at this	
20.	point? I think we are done with the witness panel	
21	today. Thank you very much for all of your time and	
22	effort. You have obviously spent a lot of time on	
23	this, and have been patient in trying to answer our	
24	questions.	
25	We are about to adjourn until tomorrow.	
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1176 obviously start with contention number We'11 3 .1 2 tomorrow morning. I think it's safe to say contention number 4 will not -- they don't need to show up until 3 after lunch at least. 4 5 . (Laughter.) 6 But we may go a little faster with 7 contention 3 and 4 than what we had with 2. 8 We have also thought about the Chang 9 testimony problem. And it's our ruling that we are 10 going to leave the Chang testimony in for what it's 11 worth. And we think that we've had some reference to Dr. Chang's testimony here today. I think that was 12 all right. 13 14And I think we found it to some extent 15 helpful, and so we are going to leave that in as 16 testimony that we might, for what it's worth, use in 17 this proceeding. And so that's our ruling on the Chang testimony -- and the exhibits that went along 18 with it. 19 20 With that, we are adjourned for today, and 21 I look forward to seeing everyone here tomorrow 22 morning at 8:30. MS. BATY: Your Honor, I want to ask a 23 24 was wondering, are witnesses question. Ι on 25 contention 2 panel, are they excused or --**NEAL R. GROSS** COURT REPORTERS AND TRANSCRIBERS

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1	· · ·	JUDGE KARLIN: They are excused.
2		MS. BATY: Okay. They don't need to
3	remain in V	ermont.
4		JUDGE KARLIN: They are excused. Good
- 5	question.	
6		MS. BATY: Thank you.
7		JUDGE KARLIN: Thank you. We are
8	adjourned.	See you all tomorrow at 8:30, please.
9	Thank you.	
10		(Whereupon, at 5:14 p.m., the proceedings
11		in the foregoing matter were adjourned,
12		to reconvene at 8:30 a.m., the following
13		day.)
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CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission

in the matter of:

Entergy Nuclear Vermont Yankee, LLC & Entergy Nuclear Operations, Inc.

Name of Proceeding: Hearing

Docket Number: 50-271-LR,

Location:

Newfane, Vermont

ASLBP No. 06-849-03-LR

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Toby Walter Official Reporter Neal R. Gross & Co., Inc.

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