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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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METALLURGY AND REACTOR FUELS SUBCOMMITTEE

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MORNING SESSION

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THURSDAY

DECEMBER 15, 2016

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:31 a.m., Peter C. Riccardella, Chairman, presiding.

COMMITTEE MEMBERS:

PETER C. RICCARDELLA, Chairman

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR., Member

WALTER L. KIRCHNER, Member

DANA A. POWERS, Member

GORDON R. SKILLMAN, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

WILLIAM SHACK

DESIGNATED FEDERAL OFFICIAL:

DEREK WIDMAYER

ALSO PRESENT:

ERICA GRAHAM, Public Participant*

ROBERT HSU, NRR

TIM LUPOLD, NRO

GARY STEVENS, Structural Integrity Associates*

BRIAN THOMAS, RES

ROB TREGONING, RES

ALEXANDER TSIRIGOTIS, NRO

ANDREA D. VEIL, Executive Director, ACRS

*Present via telephone

C-O-N-T-E-N-T-S

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

2 8:31 a.m.

3 CHAIRMAN RICCARDELLA: Let's get started.
4 The meeting will come to order. This is a meeting of
5 the Metallurgy and Reactor Fuels Subcommittee. I'm
6 Pete Riccardella, member of the subcommittee and I'll
7 be chairing this meeting. ACRS members in attendance
8 are Charles Brown, Jose March-Leuba, Dennis Bley, Matt
9 Sunseri, Dana Powers, Gordon Skillman and our
10 consultant, William Shack.
11 Christopher, no Derek Wedmayer will be the
12 designated federal official for this meeting. The
13 purpose of this meeting is to receive a briefing on Reg
14 Guide 1.207 Guidelines for Evaluating the Effects of
15 Light-Water Reactor Environments in Fatigue Analyses
16 of Metal Components. The Reg Guide was issued for
17 public comment as Draft Reg Guide DG-1309. We'll hear
18 presentation from representatives of the Office of
19 Nuclear Regulatory Research, the subcommittee will
20 gather information, analyze relevant issues and facts
21 and form a composed position in action as appropriate
22 for deliberation by the full committee. The rules for
23 participation in today's meeting were announced as part
24 of the notice of the meeting, previously post in the
25 Federal Register on December 13th, 2016. We've

1 received no written comments or requests for time to
2 make oral statements for members of the public.
3 A transcript of the meeting is being kept
4 and will be made available as stated in the Federal
5 Register Notice; therefore we request that
6 participants in this meeting use the microphones
7 located throughout the meeting room when addressing the
8 subcommittee. Participants should first identify
9 themselves and speak with sufficient clarity and volume
10 so that they can be really heard. Please silence all
11 phones.
12 We have one bridgeline established for
13 interested members of the public to listen in. The
14 bridge number of password were published in the agenda
15 posted on the NRC public website. To minimize
16 disturbance the public line will be kept in a listen-in
17 mode only, the public will have the opportunity to make
18 statement or provide comments as designated time toward
19 the end of the meeting. Our last meeting with the staff
20 was on December 14th, 2014 in which Gary Stevens
21 discussed the background information, reason for
22 revising the Reg Guide and revisions to the FEN
23 equations. We understand that you have addressed
24 public comments and are ready to issue the Reg Guide.
25 The full committee is scheduled to hear this matter on

1 February 9th, 2017.

2 We will now proceed with the meeting and

3 I call upon Brian Thomas of research to make

4 introductory remarks.

5 MR. THOMAS: Good morning. I'm Brian

6 Thomas, the Director of the Division of Engineering in

7 the Office of Research. We thank you for having us

8 here; we really appreciate the opportunity of the ACRS

9 for us to brief you on Reg Guide 1.207.

10 Just a few thoughts about the Reg Guide and

11 the activities involved in it prior to turning it over

12 to your briefer who is Rob Tregoning. Research

13 activities with regard to environmental fatigue on

14 light-water reactors started back in the 90's. Since

15 then a lot of issues have evolved with respect to this

16 Reg Guide. Reg Guide 1.207 first got issued originally

17 back in 2007 and it was based on research that was

18 documented in NUREG CR-6909; that's the effects of

19 light-water reactor coolant environment on the fatigue

20 life of reactor materials, which was also issued in

21 2007. So the textbook basis was also first issued in

22 2007.

23 The Reg Guide, as you know, provides the

24 basis for some of the current guidance documents that

25 has to do with subsequent license renewal. That is the

GALL and the SRP for SLR, subsequent license renewal. So it's the preponderance of the bases for the guidance that's in those documents. The SLR NUREGs, as you know, that provides the basis for GALL and the SRP is NUREGs 2191 and 2192. These NUREGs are currently being finalized, the GALL and the SRP are currently being finalized and targeted for issuance by mid-2017. So the guidance in the Reg Guide is a good proponent of the guidance that's included in those documents.

In 2014 Reg Guide 1.207 was issued for public comments; as you know, we received substantial public comments and those comments contributed to some significant changes in the Reg Guide. So, based on that it's hopeful that the ACRS will consider this guidance and the associated technical basis. Rob will speak to the background, some more of the background as well as what was involved in those comments, the nature and scope of the comments, how the staff resolved those comments.

So with that said, let me turn it over to Rob Tregoning for the briefing.

MR. TREGONING: Okay, thanks. I'm sorry. I'm clearly not qualified to be up here.

(Laughter.)

MEMBER POWERS: He's a metallurgist,

1 don't expect too much.

2 MR. TREGONING: If there's going to be

3 some sort of task, I'm clearly --

4 (Laughter.)

5 So, yes, I wanted to thank Brian for the

6 introduction and Pete as well for a nice summary of the

7 background of this topic. As he mentioned, it's been

8 a couple of years since, almost two years exactly since

9 we were in front of ACRS talking about this topic. So,

10 I'm going to be covering this proposed Revision 1 to

11 this regulatory guide on addressing environmental

12 effects in fatigue analyses of metal components. I

13 have to acknowledge Gary Stevens and Omesh Chopra;

14 they're the ones clearly that did what I believe is the

15 very good technical work that forms the basis of this

16 regulatory guide. Unfortunately, neither of them

17 could be here in person, but I think Gary at least is

18 on the line and Omesh at least told me he was going to

19 call in, but for those of you who don't know Omesh know

20 he's living now out in San Francisco area, so it's quite

21 early. I don't know if he's going to be up for the

22 beginning part of the meeting, but I expect him to call

23 in at some point.

24 So, a little bit of background; I think

25 Pete covered most of this, but I just want to make sure

1 we're all on the same page in terms of what we're here
2 to do and what we're hoping to achieve as a result of
3 this meeting, and then hopefully the February full
4 committee meeting. So, we're here to talk about
5 revising guidance for environmentally assisted
6 fatigue, also called EAF, which we use quite
7 frequently. There is one regulatory guide that went
8 out as a draft for public comment; as Pete mentioned,
9 it's DG-1309. Then there's a supporting technical
10 basis document which is Draft NUREG 6909 Revision 1.
11 We briefed this subcommittee almost exactly two years
12 ago before we went out for public comment, the
13 subcommittee agreed at the time yes, you should send
14 this out for public comment.
15 So we sent both of the documents, both the
16 NUREG and the Reg Guide out for public comment, not at
17 the same time, slightly different times. We sent the
18 NUREG out first in mid-2014 and then we sent the Reg
19 Guide, really it went out just after this meeting, so
20 it went out in December of 2014. So they were out for
21 public comment during 2014, 2015 we received public
22 comments roughly a month or two after depending on the
23 document. Then since 2015 through this year we've been
24 working on developing responses to the comments, and
25 over that same time period we've been modifying the

1 documents and we're hoping in the upcoming year, we're
2 hoping in February to go in front of the full ACRS
3 Committee and hopefully get a letter of support from
4 that committee, go forth with the guidance.
5 As Brian mentioned, the whole idea is that
6 this guidance is really related, or the thing that's
7 driving this revision of the guidance is for subsequent
8 license renewal, so if you look at the GALL document
9 and then the SRP document for subsequent license
10 renewal, the drafts that went out for public comment
11 both referenced Revision 1 of 6909, so the plans are
12 that the guidance will say we want you to use this
13 revision for those applications. So, that's why we're
14 here; we want to make sure that we have the guidance
15 in place before the SLR guidance gets finalized and goes
16 out as well. So the licensees when they come in at the
17 end of 2018 or 2019, they've got plenty of time to factor
18 in this guidance in their applications.
19 MR. SHACK: It is a little funny, though,
20 that you seem to accept the old versions for everything
21 except subsequent license renewal. I mean, you do it
22 for license renewal, you do it for new reactors as I
23 read the Reg Guide, but SLR's are the --
24 MR. TREGONING: We're going to talk about
25 that. That's a good question, we got a public comment

on that. We can talk about it now or we can wait till later, because we talked a lot of internal discussion about that as well, what's the best way to do that. Again, you guys know as well as I do, this is just guides, it's not regulations. It's one acceptable way for meeting the regulations. Especially in this area I can say historically the staff has been very flexible, and as long as the licensees have demonstrated an appropriate technical basis, the staff has generally tried to accept that. So, the philosophy that we're trying to have here is that we want to put out what we think is the best guidance, the best most up-to-date guidance. It doesn't mean it closes the door to other analyses, it doesn't mean it closes the door to modifying old analyses, right, but if all we're saying if we use -- again, as with any Reg Guide if you use that, you get a little bit of a past because the staff has already seen that okay, we buy into this Reg Guide. If you want to use a slightly different method, then the staff would need to review and approve it.

MEMBER SKILLMAN: For several licensees that are serious about SLR, has there been discussion with them about the differences between the current regulatory guidance and what will be the Revision 1 to 207?

1 MR. TREGONING: We have had -- with
2 respect to the GALL and the subsequent license renewal
3 guidance documents in general, there have been a number
4 of public meetings that have outlined the changes that
5 are being proposed or have been proposed by the staff
6 on those guidance documents. In fact, in 2016, and I
7 don't want to speak for the license renewal guys because
8 there's nobody here, but they had public meetings
9 roughly every month on this topic. So, the industry's
10 been well-informed and I think based on the comments
11 that we got back from the industry, the comments that
12 we got back, not just from industry but stakeholders,
13 on both of these documents I thought were particularly
14 well-informed. I think part of that was the fact that
15 we communicated not just through public meetings but
16 through other forms like ASME meetings, we spoke at
17 conferences, symposiums. We let people know what work
18 we're doing and a variety of different methods well
19 before we've gotten to this point.
20 So when we released these for public
21 comments, we had a lot of people that were sort of armed
22 and ready for unloading on us with everything that they
23 thought about this topic. I'll say up front that as
24 far as technical topics go, and maybe I'm a bit
25 parochial here, but this topic elicits a lot of passion

1 from people and people feel very strongly about their
2 beliefs. So that's one of the reasons it's taken us
3 quite frankly a good bit of time to go through so many
4 of the public comments, because we wanted to make sure,
5 A, that we understood the public comments and that we
6 understood the basis for the comments. We tried to
7 thoughtfully consider every single comment that we got
8 and respond in what we felt was the most appropriate
9 manner.
10 Now, you may agree or disagree that we did
11 that, but that was at least the intent that we tried
12 to --
13 MEMBER SKILLMAN: The reason that I ask
14 that question is kind of building on Bill's question
15 to you; we met last night with DLR on the GALL SLR which
16 is just about complete. It's going through OGC right
17 now, but there are two licensees that are well down the
18 road of getting their ducks in a row for their
19 application for subsequent life renewal, life beyond
20 60.
21 MR. TREGONING: Sure.
22 MEMBER SKILLMAN: So the question that's
23 in my mind is are these licensees going to find that
24 their toil is going to be invalidated because of this
25 revision? That's the real center of my question.

1 MR. TREGONING: My opinion is no.
2 MEMBER SKILLMAN: No, okay.
3 CHAIRMAN RICCARDELLA: As I understand
4 it, I think the changes tend to be in the less
5 conservative, making the FEN less conservative.
6 MEMBER SKILLMAN: But not all.
7 CHAIRMAN RICCARDELLA: Not always, but
8 for the most part, they tend to make it less
9 conservative. So if you've done it by the old
10 requirements --
11 MEMBER SKILLMAN: You ought to be on the
12 mark, you ought to be in good shape?
13 CHAIRMAN RICCARDELLA: Yes.
14 MEMBER SKILLMAN: Thank you, Pete.
15 MR. TREGONING: That's generally the
16 case, but we can't make that blanket statement. So you
17 really need to do the analysis for your specific plant
18 configuration and inputs and everything to be able to
19 make that assessment blanketly. So that's why we're
20 very careful about that.
21 MEMBER SKILLMAN: Thank you. That's
22 good, thanks.
23 CHAIRMAN RICCARDELLA: Another aspect of
24 this that I think we need to recognize is we think about
25 this as analyzing for the fatigue lives of the

1 component. But what we're really talking about here
2 is crack initiation in a very small specimen, and in
3 a real component which is much thicker than those small
4 specimens, you have almost equivalent life from when
5 you initiate the crack until the crack grows to a
6 significant size, so there's another element of
7 conservatism in this as well.
8 MR. TREGONING: That's one of the things
9 we tried to clarify what we thought failure in a
10 specimen meant to a component in the NUREG, not so much
11 the Reg Guide but in the NUREG, so we have a whole
12 section that talks about what we mean by a CUF exceeding
13 one. It doesn't mean your component's failed as Dr.
14 Riccardella said, it means that in my opinion that if
15 you have a CUF that exceeds one, that you have a like,
16 a possibility of having a crack. It doesn't even mean
17 that you have a crack, but you have a possibility of
18 having a crack.
19 CHAIRMAN RICCARDELLA: Based on 95.
20 MR. TREGONING: Well, again, if you do an
21 ASME analysis and then, again, which has conservatism
22 in it, I feel comfortable making the other statement.
23 If you did an ASME analysis with FEN and you were below
24 one, I would say with pretty good certainty that it's
25 not likely that you have a crack in that component.

1 That statement I can make with much more certainly than
2 the converse statement, the corollary statement.
3 Anyway, Dr. Shack often says that I speak
4 too long and have too many slides, so I think I need
5 to keep going, if that's okay.
6 So, here's the agenda and it's basically
7 split the meeting --
8 MEMBER POWERS: Dr. Shack can offer that
9 comment in his written documents here for the rest of
10 us to enjoy what you have to say, Rob.
11 (Laughter.)
12 MR. TREGONING: You obviously didn't read
13 the acknowledgments in the NUREG. I think we stated
14 it quite plainly in those acknowledgments.
15 MEMBER POWERS: That was a topic I was
16 going to bring up with you on some needed changes in
17 the document.
18 (Laughter.)
19 MR. TREGONING: I'm sure you'll have other
20 comments. So, the meeting's basically broken into
21 three parts; the first part is a background and I'll
22 apologize for those that were here at the 2014 meeting.
23 This is really a recapitulation and a condensation of
24 most of the work that Gary presented at a full
25 subcommittee meeting in 2014. I feel it's important

1 to go back over some of it just for people that might
2 not have been here, but also to try to set the stage
3 for the rest of the talk and make sure you guys have
4 full understanding for the guidance and the basis for
5 the guidance and why we're making changes.
6 MEMBER BLEY: Rob?
7 MR. TREGONING: Yes?
8 MEMBER BLEY: Is it safe to say that if
9 there'd been any changes since that meeting, they're
10 in response to comments you've received?
11 MR. TREGONING: Yes.
12 MEMBER BLEY: And you're going to go
13 through those?
14 MR. TREGONING: Response to comments as
15 well as staff review that might have resulted from a
16 comment. We made some changes that the comment had us
17 go back and look at the NUREG and we said, "Yeah, that's
18 an issue, and oh, by the way, while we're looking at
19 it here's something else that we think might be related
20 that we should go back and either clarify and modify
21 in some sense." Yes, everything was initiated by the
22 public comments.
23 Then the second part of the meeting I'll
24 go over the technical basis document which is NUREG
25 CR-6909, we'll give an overview of public comments.

1 We're not going to go through every public comment, but
2 I'll try to pick some of the most interesting ones and
3 good representative ones. Then I'm going to walk you
4 through an overview of the changes to the document that
5 resulted from the public comment. Then we're
6 basically going to follow the same format when talking
7 about the Regulatory Guide; I'll give you an overview,
8 some sample comments and then changes to the documents.
9 Then I'll finish with where we're at with respect to
10 finalizing this guidance and then the next steps.
11 So, the background. So somebody, I think,
12 somebody mentioned CUF, or as I call it C-U-F. The way
13 you do CUF design using Miner's Rule is you have, I show
14 here that's your design curve that's plotted there and
15 these U's are basically called usage factors, so you
16 look at all the different fatigue transients that your
17 plant goes under and you can characterize those as
18 different cycle regimes or usage factors. You sum up
19 all your regimes and if you're less than one, you're
20 okay. If you're greater than one, you exceed the
21 design curve and you have to do something else. It
22 doesn't mean your component's failed, it means you have
23 to do something else at that point.
24 So, the way we base this is so this is a
25 plot of site, and I apologize for the, you can't read

1 the ordinate and abscissa, but this is a plot of
2 alternating stress on the Y axis and the number of
3 cycles to failure on the X axis. So N is the number
4 of cycles of failure that's a function of alternating
5 stress, which is often called SA and these curves are
6 material dependent as you see in the new ray. These
7 curves right now are currently is ASME Code Section 3
8 and they have codes for different materials. The way
9 those ASME codes were developed, they were based on best
10 fits of test data taken on small laboratory specimens,
11 and then ASME applied what they call design factors to
12 account for things such as data scatter, size effects
13 surface finish, and the term they use is atmosphere.
14 They don't use water, they use the fact that different
15 laboratory environments where these tests are
16 conducted might be slightly different levels of
17 humidity, different even temperatures, things like
18 that, and all those things can add to variability.
19 When you look at fatigue data, the thing
20 that you're always struck by is the amount of
21 variability you get in the data that you see. Some of
22 it's irreducible and some of it is clearly due to
23 factors that are potentially controllable. All of
24 this keeping of usage factor stuff is just considered,
25 as I mentioned, a laboratory air. So what's

environmentally-assisted fatigue? Okay, so we have the ASME Section 3 fatigue curve there from, again, developed from small specimen, polished specimens in air. The sub-bullets tell us how they got those curves, they did some adjustment of the curves, the best fit mean curves for mean stress effects using the modified Goodman relationship, and then they apply these design factors of two on strain amplitude and 20 on cycle, so you basically have two different margins and then you can construct the design curve as being whichever is the limiting of those margins.

That's how ASME developed their air fatigue curves. But if you do test those same specimens that you tested in air and you just test them in water, either reactor coolant water or water that's high temperature, what you'll find is that, and that's the data that you see up here, is that you get tests in water that fall below the design curve. So, if you looked at the air data plotted on there, the air data would all basically be bounded by the design curves. The water data you would say, at least the data that are plotted there, those air design curves are maybe close to a best fit or maybe not even, maybe like a 60 to 70 percent fit.

So there's clearly an effect of water on

1 the fatigue life of laboratory specimens and I think
2 that's been clearly well-documented at this point.
3 CHAIRMAN RICCARDELLA: Rob?
4 MR. TREGONING: Yeah?
5 CHAIRMAN RICCARDELLA: Refresh my memory,
6 the factor of 2 and 20, as I recall the factor of 2 tends
7 to apply in the high cycle range and the 20 in the low
8 cycle range, is that true?
9 MR. TREGONING: That's right. So if you
10 took this mean curve and dropping it by 2 and
11 constructed a curve like that and then shifted by 20,
12 what you would find at the curve site, the curve that
13 you have left the high cycle regime is really governed
14 by the factor of 2 on stress or strain, while the low
15 cycle fatigue is governed more by the factor on life,
16 so that's entirely correct. The break point is maybe
17 around, I don't know, 10 to the 4 to 10 to the 5th,
18 something like that.
19 CHAIRMAN RICCARDELLA: Thank you.
20 MR. TREGONING: So, what the
21 environmental correction factor is, the
22 environmental correction factor tries to adjust these
23 curves for the fact that you have degradation of
24 specimen life in water environments, so it's a very
25 simple concept with a simple definition. So FEN, it's

1 just a shorthand way of calling our environmental
2 fatigue correction factor, is just defined as the
3 number of cycles of failure in an air environment,
4 defined as the number of cycles in a water environment.
5 So if you apply this, it's very simple to apply, you
6 take your same CUF equation where you have the little
7 usage factors for each of the regimes that you're
8 analyzing, and each of those regimes would also have
9 an associated FEN factor. So you multiply the usage
10 factors by the FEN's, sum them up, and at least
11 conceptually if your CU-FEN is less than one, then that
12 gives you a high degree of likelihood that you don't
13 have a fatigue crack in your component.
14 MEMBER SKILLMAN: Rob, is the data readily
15 available, the N air divided by N water?
16 MR. TREGONING: All the data, if you look
17 at the NUREG it's all heavily referenced and there's
18 a lot -- yes, so, in fact, all the references in the
19 NUREG are publically available. The challenge, I will
20 say, is with fatigue data. It looks like a scatter plot
21 and a lot of times you can have ten data points that
22 are very close, so it's not the type of data set that
23 you would want to try to dispertise from a plot. So
24 you really need to have the raw data available. In many
25 cases we try to develop and make sure we had actual data

1 for every data set we had. We weren't always
2 successful, sometimes we had to go back with historical
3 data and it's from digitized sources, but by-and-large,
4 and Gary and Omesh can comment better than me on this,
5 the bulk of the data that we have now is the actual data
6 that we have from the first article source or the
7 original source documentation.
8 That's one of the thing in this revision
9 that Gary and Omesh spent a lot of time doing that we
10 didn't have any earlier revision going back and
11 actually trying to get that source data.
12 So the FEN itself, this is an expression
13 from Rev. 0 for stainless steel materials, so it's a
14 function typically of temperature, dissolved oxygen
15 and then also strain rate, and then if I had the
16 expression for carbon and low alloy steel, sulphur
17 content is another variable, it's explicitly modeled
18 in these FEN expressions.
19 CHAIRMAN RICCARDELLA: I've got a
20 question; I was playing around with this equation a
21 little bit last night. If you go to the range where
22 you wouldn't expect much of an environmental effect
23 which is low temperature and fast strain rates, then
24 that second term of that equation goes to zero and it
25 defaults to 2.

1 MR. TREGONING: Yes.

2 CHAIRMAN RICCARDELLA: That's the prior
3 rev, I assume that's been fixed in the new revision that
4 we don't say it's 2 if you have no environmental effect,
5 right?

6 MR. TREGONING: I think we should be up
7 here, to be honest with you. When Rev. 0 came out we
8 got a lot of comments, that was one of the most common
9 comments that look, your FEN expressions are hosed up,
10 because even if I don't meet your thresholds, I still
11 have a FEN of approximately 2 that I have to apply.
12 That can't be right. Then we realize yes, that's the
13 danger of doing correlative development of factors.
14 Again, the FEN is clearly a correlative approach, it
15 looks at data and tries to make sure that the data is
16 predicted by this correlative approach, so it's not
17 based on mechanistic arguments. If it were based
18 mechanistically or phenomenologically, you wouldn't
19 run into these challenges.

20 Yes, that was a comment that we got from
21 several stakeholders and it was one of the things that
22 we wanted to fix in this revision so that we didn't have
23 these sort of anomalous behaviors that you wouldn't
24 expect due to the inadequacies of your correlative fit.

25 Okay, so that's a quick background on just

1 the technical aspects. Now I want to talk a little bit
2 about related regulations and current NRC guidance on
3 the AF -- Oh, I'm sorry.
4 MEMBER POWERS: Let me ask you just one
5 question.
6 MR. TREGONING: Sure.
7 MEMBER POWERS: You're driven into a
8 parochial approach. Is there any activity not
9 necessarily in the agency to understand fundamentally
10 what is going on with respect to environmental effects
11 and fatigue?
12 MR. TREGONING: You know, the good Dr.
13 Shacks here can comment probably more eloquently than
14 I can about this, but I would say this topic --
15 MEMBER POWERS: He doesn't do eloquent
16 well.
17 MR. TREGONING: This topic as well is
18 crack initiation in general, there's been 50 years of
19 work looking at mechanisms and phenomena. I think the
20 problem that this particular scientific topic has, and
21 this is my opinion, is that there are so many factors
22 that are potentially important that could leak to crack
23 formation, that it's very difficult to have a model
24 that's both I'll say necessary and sufficient, that's
25 comprehensive and yet doesn't --

1 MEMBER POWERS: There are lots of things
2 in this world that are difficult, that have been
3 overcome. My impression is the challenge we face, so
4 within the crack, the electrostatic fields are
5 exceptionally big, and that as a consequence the
6 chemistry and physics that we know, chemistry
7 especially, thermodynamics especially, just falls all
8 apart in those potential fields. You're operating in
9 a regime where surface forces on adjacent sides of the
10 cracks, the so-called van der Walls forces are just
11 enormous and make anything you do for free field
12 thermodynamics just totally unapplicable. That's my
13 impression. The challenges that you can't reproduce
14 those fields in a macroscopic assembly is big enough
15 to instrument.
16 MR. TREGONING: Yes, I'm not going to get
17 into a debate with you on thermal-hydraulics of cracked
18 tip chemistry or environments. I would agree with you
19 that when you're dealing with cracks, especially
20 fatigue cracks that are very tight, understanding the
21 exact environment of the cracked tip can be a challenge
22 and understanding how that environment is really from
23 a mechanistic point of view affecting the formation of
24 an accumulation of bandage starting off at the
25 atomistic level and progressing through dislocation

1 and ultimately leading to what we can see as a crack.
2 Again --
3 MEMBER POWERS: Just one of those things
4 that the CASL organization salivates over.
5 MR. TREGONING: I'm sorry, could you
6 repeat that?
7 MEMBER POWERS: Is this one of those
8 things that the CASL community salivates over or are
9 they ignoring it or?
10 MR. TREGONING: Again, it's not that
11 they're ignoring it. Again, I've seen many
12 mathematical models to predict crack initiation and
13 fatigue. I'll just say we've had much better success
14 developing models to predict crack growth, because
15 those models are governed more by mechanics, things
16 that we model well. Again, it's the atomistic and the
17 metallurgical factors that lead to the formation of
18 that significant engineering crack. Those are things
19 that are just, they're just a challenge to model. You
20 said yes, there are lots of things that are complex,
21 but there's many inert related factors that lead to the
22 formation of an engineering crack, and I would just say
23 that I don't think that we have the tools to monitor,
24 to model the physics to significant or sufficient
25 enough extent to really develop a phenomenological or

first principles model to address something such as this.

MEMBER POWERS: It's just that many times they may not have the problem solved, but they give you a functional form that's better for things like correction factors on, and you end up with where often-termed semi-empirical kinds of correlations rather than something totally ad hoc.

MR. TREGONING: I would agree with you. In this case I would say that that's not been the case. If I use an analogy with reactor pressure as an embrittlement, that's one where we've used mechanistic understandings to help drive the correlative models that we've had. So, that's an analogy that fits your scenario very well. For this particular phenomena, though, it's not been guided as quantitatively by theoretical or analytical understanding. So I hope that's --

MR. THOMAS: Can I get clarification on your comment, Dr. Powers? Brian Thomas. So you mentioned CASL, were you referring to the modeling efforts?

MEMBER POWERS: Yes.

MR. THOMAS: So I was at a COE meeting last week on Light-Water Reactor Sustainability Program,

1 which they did a presentation on the whole CASL efforts.
2 It seems like they are really embracing or embarking
3 upon a lot of efforts focused on crack growth, crack
4 initiation, crack growth rate and so forth. So,
5 information that was communicated to me there, we were
6 not previously aware of. Let's say that. With
7 respect to your comment about the community, I think
8 they're ignoring it, they're really striving to really
9 address it more in depth.
10 MEMBER POWERS: Well, that's good. I
11 mean, nice to have other people looking at the problem
12 every year. It's just that sometimes these
13 semi-empirical things even though you can't
14 quantitatively predict anything a priori, they could
15 do a functional form that's just a little more
16 forgiving. You can't, you can, hopefully more in the
17 future.
18 MR. TREGONING: Yes, I think that would be
19 a place we would like to get to in the future.
20 MEMBER POWERS: I mean, maybe just what
21 you said, that you go to the meetings, you make sure
22 they're aware of what your problem is and if they catch
23 fire over it, great, and if they don't, we are really
24 in questioning. I mean, I'm definitely not advocating
25 that NRC immerse itself in this. This is kind of

1 stuff that you might implore NSF or Department of Energy
2 to pursue, they have the resources and it's not
3 something that's going to resolve itself in a useful
4 timescale for you.
5 MR. THOMAS: Right, and that's what I'm
6 thinking, to what extent can we leverage the resources,
7 at least as communicated there apparently would be
8 applying to this effort. We want to be cognizant of
9 what they're doing, who's doing what, when, and how does
10 it contribute to our program going forward.
11 MR. SHACK: Even in the Light-Water
12 Sustainability Program, they focus on stress corrosion
13 cracking, which again, simplifies the problem
14 somewhat. They still have the environmental effect,
15 but they don't have the repeated cycling. Fatigue is
16 really a complicated problem.
17 CHAIRMAN RICCARDELLA: Well, especially,
18 as I mentioned earlier, this crack initiation phase of
19 it and then the crack propagation phase and what we're
20 talking about here is just the nucleation of very small
21 cracks where you're dealing with things that are
22 smaller than a grain size in the material. So you get
23 outside of the realm of continuum mechanics, really.
24 You can't apply continuum mechanics to that.
25 MEMBER POWERS: I haven't used continuum

1 mechanics in a long time.

2 (Laughter.)

3 MR. TREGONING: Okay, any other questions

4 or can I move on?

5 So I just wanted to cover related

6 regulations, why we even need any guidance on EAF and

7 talk a little bit about the history behind EAF guidance

8 just so we have a framework for the revisions. There

9 are basically two general design criteria within Part

10 50 that apply to these fatigue calculations, and it's

11 DDC 1 and 30 and they're fairly general, broad DDC's

12 about good design practices and fabrication practices

13 for safety significant system structures and

14 components. Then also 30 which is related

15 specifically to components in the reactor pressure

16 boundary. Then elsewhere, 50.55(a) of course EAF

17 endorses the ASME code for design of these safety

18 related systems and components. It's really the ASME

19 Code Section 3 fatigue curves that are endorsed by

20 50.55(a). As I mentioned, the fatigue design curves,

21 currently ASME do not address the impact of the water

22 environment within the curve.

23 So the regulatory guidance on EAF exists

24 to provide an acceptable method for addressing the

25 impact of the environment on the fatigue calculation.

1 MEMBER POWERS: Is there a reason that the
2 ASME code has eschewed the water environment?
3 MR. TREGONING: That's a great question
4 and there's probably 15 to 20 years of history wound
5 up in it. To be honest, the simply way I answer is
6 people haven't agreed what to do yet. A variety of
7 approaches that have been proposed there just hasn't
8 been the wherewithal to move forward. That's the other
9 reason; we prefer not to be out in front of the code
10 on this, but the code's not going to act, we have to
11 do something, and that's sort of why we're in this
12 place. We've been trying to spur the code in this area
13 for 15, 20 years I think, and we continue to do that.
14 CHAIRMAN RICCARDELLA: I think it's more
15 like 50 years of when these original fatigue curves were
16 put into the code in 1960's, and at that time I think
17 the committee thought well, we can't predict what type
18 of environments people are going to use these for, so
19 we're going to pretty much leave the select the
20 addressing of environmental effects up to the user.
21 MR. SHACK: There's language in the code
22 that says that, you're supposed to address it but it
23 doesn't give you any guidance for how to do it.
24 MEMBER POWERS: Well, I mean, all you do
25 is tell me the code's useless and you're ineffective.

1 I mean --

2 (Laughter.)

3 MR. TREGONING: Look, there's a lot of

4 continued -- I'll say over the last two or three years

5 I've seen some positive motion, so I think the code is

6 going to get there. I think they finally now got

7 organized and gotten the right philosophy and there's

8 a number of code cases that address some of these

9 issues. I think this NUREG and this guidance might

10 actually be used to spur a lot of this, so I think it's

11 a timely NUREG from that perspective.

12 CHAIRMAN RICCARDELLA: There's a code, a

13 task group in place, isn't there, to address these at

14 this time?

15 MR. SHACK: There has been one for a long

16 time.

17 (Laughter.)

18 MR. TREGONING: There's a couple of

19 different task groups in ASME that address fatigue

20 related issues.

21 CHAIRMAN RICCARDELLA: I mean, it's been

22 addressed in depth in the Section 11 the crack growth

23 aspect of it.

24 MR. SHACK: Crack growth always move

25 faster than initiation.

1 MR. TREGONING: Okay, so --

2 MEMBER BROWN: I'm not a metallurgist, so

3 you made a comment earlier in the presentation that you

4 were relatively flexible on the CUF and the other in

5 terms of the fatigue analysis. Then I'm harkening back

6 to a couple of the license extension requests that we

7 had before us, and they do all the calculations and I

8 think they've always had a CUF of less than one. You

9 said but yet in your mind a CUF of greater than one is

10 not necessarily -- I'm putting words in your mouth,

11 unsatisfactory to granting an extension. I'm

12 paraphrasing, I'm going forward. Have we ever

13 accepted an extension request that ended up with

14 analyses that showed a CUF of greater than 1?

15 MR. TREGONING: I don't know that I -- I'm

16 going to --

17 MEMBER BROWN: I forgot one other point.

18 There was always the evaluation by the applicant that

19 they would take some action, something would be done

20 in order to move them or keep them out of an area where

21 they would exceed the 1, but yet your discussion earlier

22 sounded a bit mushy on it, so that's why -- given the

23 lack of clear either regulation or guidance, I'm just

24 -- and you guys don't want to get ahead of it. I'm just

25 trying to get a feel when I have to deal with this in

1 the future, how questioning should I be even though I'm
2 not a metallurgist per se?
3 MR. TREGONING: And Tim Lupold's here, he
4 might want to chime in. I'm not aware that we ever
5 accepted an application that came in and said my CUF
6 is greater than 1 and that's it. If someone's come into
7 us, and usually they wouldn't even come into an
8 application with that, they would come into us before
9 their application and say, "I'm doing these CUF
10 calculations and I'm getting greater than 1." Then we
11 would usually at that point work through with them,
12 "Well, here's what you need to do to address that. You
13 might need to inspect, you might need to put that
14 component in your fatigue monitoring program." So
15 there's other actions that the plan or the licensee
16 would take at that point if they had a CUF that was
17 greater than 1.
18 So that's been what's commonly happened.
19 I strongly doubt and I'm certainly not aware of a case
20 where a licensee has come in and said, "Here's my CUF
21 calculation. It's greater than 1, but I've got all
22 this other margin. Here's why I have all this other
23 margin, so I'm okay." We've accepted that without them
24 doing something else that's related to defense and
25 depth. These other things are sort of defense and

depth things. CUF is an analytical approach in calculation. If they exceed that, that just says, well you've exceeded sort of a screening criteria to show that your analysis by itself may not be sufficient to provide us reasonable assurance that you don't have a damage component. You need to do something different, be it inspection or monitoring to see what the real plant transients are to provide us assurance that that component is still able to maintain and perform its intended safety function at that point.

MEMBER BROWN: But if you do an inspection or something else of that nature, that still doesn't reduce, it only just says we're looking to see if we actually do have a crack initiation. It doesn't make the CUF less than 1?

MR. TREGONING: That's exactly true.

MEMBER BROWN: I understand that properly?

MR. TREGONING: Yes, so that's true. The calc is just an analysis result.

MEMBER BROWN: I understand that.

CHAIRMAN RICCARDELLA: If you went that approach and did the inspection, then you would do a fatigue crack growth analysis and demonstrate.

MEMBER CORRADINI: You have to find a

1 crack under those -- if you don't find a crack, what
2 do you do? You can't inspect --
3 CHAIRMAN RICCARDELLA: No, then you
4 assume a crack equal to the detection limits of your
5 NDE and then you do the crack growth analysis on that.
6 MEMBER CORRADINI: So you make an
7 assumption then based on the ability to detect the
8 crack?
9 CHAIRMAN RICCARDELLA: Correct.
10 MR. TREGONING: So what typically would
11 happen is, like Dr. Riccardella said, you would assume
12 a crack of a certain length, you do a fatigue crack
13 growth and you would set your inspection period based
14 on that. You do an analysis that says well, even if
15 I have a crack, this component's not going to fail for
16 another ten years. Then you would say well, based on
17 that I need to do an inspection at least every whatever,
18 seven or eight. That's when you would negotiate with
19 the NRC on what the actual period would be. Maybe it'd
20 be ten years, maybe it'd be five years depending on what
21 the results show. Maybe it'd be one year, I don't know.
22 CHAIRMAN RICCARDELLA: Also, if you have
23 a CUF issue say on a component, it's not a general issue
24 that applies to the whole component, it applies to a
25 very specific focused area and you can do the inspection

of that area and do your crack growth of that area, only those areas where you exceed 1. There's a code appendix on that, I forget what it's called, Damage Tolerant Design or something like that. There's a section level appendix that gives guidance to that.

MR. TREGONING: Are you thinking of L or -- Gary's on, he would know better.

CHAIRMAN RICCARDELLA: Yes, he can't speak, unfortunately.

MR. TREGONING: Or Robert, which -- Robert, I think --

CHAIRMAN RICCARDELLA: Yes.

MEMBER BLEY: So Ron can turn it on.

MEMBER SKILLMAN: Yes, or go to the mic and then maybe we can turn it on.

PARTICIPANT: I know you asked a question to Rob, but may I respond?

MR. HSU: Okay, this is Robert Hsu. Okay, that's Section 11 Appendix S, specifically for CUF greater than 1, you can use the evaluation to determine the inspection period. They use the inspection, okay, to address that.

CHAIRMAN RICCARDELLA: I understand that maybe Gary Stevens might want to make a remark. Can we turn on the --?

1 MEMBER BLEY: As a reminder to all the
2 members, we now have a process where if you just tell
3 Theron, we'd like to hear from the person on the line,
4 the line should open and he should be able to talk.
5 Is he there?
6 MR. STEVENS: Hi, this is Gary. Can you
7 hear me?
8 CHAIRMAN RICCARDELLA: We hear you loud
9 and clear, Gary.
10 MR. STEVENS: Okay, thanks for letting me
11 speak. Yes, to answer the question, I think you can
12 go look at license renewal applications and see many
13 instances where CUFN is greater than 1, were sent into
14 the commission. But as Rob said, you'll never find a
15 case where the commission approved that without a
16 promise to do something else. There are several ways
17 that this can be addressed; you just heard about
18 Appendix L, there's repair replacement and most of
19 those articulated in a promise to the commission by the
20 licensee of what they'll do to address that issue. So,
21 there's plenty of ways to address it and in fact
22 licensees have done that.
23 MR. TREGONING: Thanks, Gary.
24 CHAIRMAN RICCARDELLA: Thanks, Gary.
25 Let me just say, Gary, we're going to put the line back

on mute, but if you feel you need to chime in, just send me an email and we'll turn it back on again.

MEMBER BLEY: Just again, for the members, all he has to do is say he wants to speak and through Ron's monitoring, he'll put him on.

CHAIRMAN RICCARDELLA: Okay.

MR. TREGONING: So, anybody on the phone they just need to say that they would like to speak.

MEMBER BLEY: Not anybody. If we have people on the line, we expect to have speak. It's not an open --

PARTICIPANT: Invitation.

MEMBER BLEY: Everybody out there.

MR. TREGONING: I understand.

MR. STEVENS: Two other questions that came up I wanted to comment on, if I could, or you want me to wait until the end?

CHAIRMAN RICCARDELLA: No, absolutely. Go ahead.

MR. STEVENS: Okay, so there was a question about five minutes to 9:00 that had to do with availability of the data, and I just wanted to clarify on top of what Rob said, 100 percent of the data used in this work, and that was summarized in a lot of detail on the 2014 presentation, all of this is available to

1 the NRC, they have it all. Just about 25 percent of
2 that data is publicly available that came from tests
3 at Argonne and in the literature. However, about 75
4 percent of it came from the Japanese and that's
5 proprietary and only the Japanese Nuclear Regulatory
6 Authority and NRC have access to that. So where as it's
7 summarized in the report, it's not available yet to
8 researchers, only the NRC.
9 Then there was a question about 9:10 a.m.
10 on if anybody's doing research to explain this cracking
11 other than water is worse than air. Chapter 2 of the
12 NUREG 6909 there is a section on mechanism of cracking
13 that gets at that. Right now there's kind of two
14 theories as to what drives cracking, the slip
15 oxidation, dissolution mechanism and the hydrogen
16 induced cracking mechanism; there is some amount of
17 research going on to look into that further. I've seen
18 come out of Argonne recently, but that discussion I
19 refer you to, to help answer that question for you, as
20 Rob said it's difficult research to do, but that gets
21 at your question in more detail, and it starts on at
22 least Page 31 of the draft that went out for public
23 comment.
24 MR. TREGONING: Yes, just to append what
25 Gary said; there's been a lot of research on

1 understanding mechanisms of fatigue, but Dr. Powers was
2 specifically asking about quantitative modeling of
3 fatigue, and that's an area that's had much less I'll
4 say success and just leave it at that.
5 MEMBER BROWN: Well, thank you for -- I'm
6 just trying to make sure I have a better understanding
7 for --
8 MR. TREGONING: Good question, thank you.
9 Okay, so a little bit of background and history of
10 regulatory guidance; initially as Brian Thomas said,
11 we've been doing work in this area since the 90's, at
12 least explicitly, and with two NUREGs in the late 90's
13 that came out, one on carbon and low alloy steels and
14 one on stainless steels. Those NUREGs were the basis
15 for what went into at the time the 2001 edition of the
16 GALL report, and specifically in Chapter X.N1 on metal
17 fatigue. So, that was the first NRC efforts into
18 research in this area. Then in 27, as Brian Thomas
19 mentioned, we consolidated and updated all the EAF
20 technical guidance we had in the original version of
21 NUREG 6909 and that was issued in February of 2007.
22 So, this next slide just talks about what's
23 required now, so this is what's required now for either
24 operating or new reactors. This gets a little bit
25 about what Dr. Shack was talking about today. So,

1 operating reactors and their original licensing period
2 there's no guidance or requirements for considering
3 EAF at all. In many cases for the existing plants it
4 was not considered at all in the original design of this
5 plant. In the license renewal period, again, this
6 spans quite a range so I'm just focusing on recent
7 applicants since those that would be I guess since 2010,
8 but they would be using NUREG 1801 Rev. 2, basically
9 Rev. 2 of the GALL report. Rev. 2 of the GALL Report
10 says for carbon you can either use one of the older 6583
11 NUREG approach or 6909, the original version or NRC
12 approved alternative, and that's where the flexibility
13 comes in for anybody that wants to come in and provide
14 a technical basis for a particular approach, they can
15 do so.
16 Stainless is similar, it calls out NUREG
17 5704, 6909 or a NRC approved alternative. And then
18 nickel-chrome-iron, the first time we really addressed
19 that was 6909, so for license renewal they can use 6909
20 or a NRC approved alternative.
21 Now, I bolded what we put in for subsequent
22 license renewal, this is what went out for the draft
23 for comment that went out, and it said that you may use
24 6909 Rev. 4 or a NRC approved alternative. So, similar
25 language that went into GALL Rev. 2, it just updated

1 the technical basis from 6909 to 6909 Rev. 1, and the
2 notion here is we'd like people to use the newest and
3 best guidance, so we're not explicitly referencing
4 these older guidance, but if people have used the older
5 guidance and they believe it's still applicable and
6 acceptable, that's something that would fall within
7 this already NRC approved alternative. So that's in
8 there to give licensees and applicants flexibility.
9 So, as far as new reactors goes, the
10 original version of the Reg Guide for those of you that
11 are paying attention, explicitly in the title said four
12 new reactors. So when we issued that Reg Guide in March
13 of 2007 we limited it for a variety of reasons at that
14 time just for new reactors. The technical basis for
15 the original Reg Guide was that original NUREG 6909 and
16 both Reg Guide 1207 and the proposed revision of Rev.
17 2, of 7, use the FEN method summarized in Appendix A
18 of the NUREG. So, if you read the Reg Guide there's
19 not a lot in the Reg Guide, it basically just says go
20 use Appendix A summarized in NUREG 6909, so with Rev.
21 0 it was use Appendix A and NUREG 6909 Rev. 0. For draft
22 Rev. 1 use Appendix A and 6909 Rev. 1.
23 So why do we go about doing this? I've
24 touched on some of this. Why do we even bother to
25 revise this Reg Guide at this point? I think we've

1 touched on some of these. One, we want to consolidate
2 all the EAF guidance in one place, have one regulatory
3 guide that applies for EAF. As Dr. Riccardella
4 mentioned, we've gotten stakeholder feedback including
5 such things as when the FEN factor didn't appear to be
6 quite right. Again, we also have got a lot more data,
7 which I'll touch on that we had back in 2007, so we
8 wanted to use all of the data that we had available to
9 update the guidance.
10 Again, Reg Guide 1207, what is significant
11 revisions? These are significant revisions for the
12 draft went out to public comment, so everything I'll
13 talk about are changes with respect to that draft.
14 What did we do two years ago? Well, first of all, we
15 took four new reactors out of the title and just made
16 it applicable to all WR's, right. The component
17 doesn't care if it's in a new reactor or an existing
18 reactor environment, if it's a water, if it's LWR water
19 and existing plant or new plant, the effects are
20 basically the same. We clarified the guidance, the
21 stated applies to all metal components exposed to LWR
22 environments, and then here's where it gets tricky,
23 they have a CUF calculation required by their plant's
24 licensing basis.
25 So, you're not going back and telling

1 people to do fatigue analyses, you're just saying if
2 you've got a CUF calculation that's required, that's
3 part of your licensing basis, you need to at least
4 consider environmental effects as part of that
5 calculation. Then the Reg Guide the background
6 section was revised a little bit. Then the main thing,
7 which I've highlighted, is FEN equations in that draft
8 Reg Guide were revised based on the new data as well
9 as stakeholder feedback.
10 What did we do? Again, Gary showed this
11 in 2014. I just wanted to highlight it here. This is
12 just a quick chart --
13 MEMBER SKILLMAN: Please go back on the
14 slide, if you can.
15 MR. TREGONING: Sure.
16 MEMBER SKILLMAN: Your Item 2, don't all
17 plants have in some form, for instance, all the plants
18 that I've been associated with for years are all ASME
19 Section 3 Class 1 for the reactor coolant system
20 pressure boundary. And so by that very definition they
21 have a U which I think is the CUF, and so at least as
22 I see it to be complaint under 50.55(a) and in
23 compliance with the code, you have a U, you have a CUF.
24 That goes back to Oconee and for the Babcock plant, it
25 goes back to Ganey and Perry for the old Westinghouse

1 plants, back to what would have been Maine Yankee for
2 the combustion plants. So while you seem to identify
3 an "if" statement on 2, isn't 2 thoroughly applicable
4 to all plants?
5 MR. TREGONING: Again, the key phrase
6 there is all metal components. So yes, every plant has
7 some metal components that have CUF's, right, and
8 different plants have a different number of components
9 that they have that they do CUF calculations on.
10 MEMBER SKILLMAN: So I would agree with
11 that. Now I see that distinction.
12 MR. TREGONING: So what we're not saying
13 is if you don't have a CUF, we're not requiring you to
14 go back and do a CUF on another component and then
15 consider environmental effects on that component, but
16 where you already have a CUF make sure you're addressing
17 environmental effects as part of that analysis.
18 MEMBER SKILLMAN: Okay.
19 CHAIRMAN RICCARDELLA: As I recall, the
20 piping, if it was done to NB3600 doesn't really have
21 a CUF, it had an approximate approach, not a CUF.
22 MR. TREGONING: That's true.
23 MEMBER SKILLMAN: Thank you.
24 MR. TREGONING: Okay, so we're back on the
25 main screen. A couple of charts here that just shows,

1 and I just want to, Gary made this point, but we
2 significantly expanded the database between Rev. 0
3 which is in the second column and Rev. 1 showing the
4 number of heats and data points for the main alloys that
5 we talked about, both carbon and low alloy steels as
6 well as austenitic and the nickel-chrome-iron alloys.
7 So we increased at least in many cases almost doubled
8 the amount of data that we considered, and the majority
9 of this, as Gary mentioned, came from the Japanese data
10 set. Gary in particular did really a yeoman's job of
11 getting that data from the Japanese. It's very
12 difficult to share data and the Japanese were just
13 incredibly grateful that they provided their data to
14 us. We of course provided the data that we had to them,
15 but we wouldn't have been able to do this revision
16 without the additional data that they supplied us, so
17 I can't understate their contribution as to this effort
18 at all; it was significant.
19 The Japanese have done a lot of work over
20 the years in this area. In some cases much more than
21 has been done in the U.S., so we're just very grateful
22 to the Japanese mode of contribution in this regard.
23 Same thing with water, you see in some cases, in fact
24 water it was the number of additional data points have
25 doubled or even more, so we just felt like, especially

1 as Mr. Powers mentioned, for a correlative approach
2 more data is really needed and welcome because you
3 always want to make sure that your correlative approach
4 addresses the data sets that you have adequately.
5 So what are the changes to the curve? I'm
6 going to talk about changes between Rev. 0 of NUREG
7 CR6909 and Rev. 1. So the best fit mean data air curves
8 are exactly the same, no changes at all between Rev.
9 1 and Rev. 0 of the NUREG. The one thing we did in Rev.
10 1 is we did a Monte Carlo analysis, which again, Gary
11 went into pretty good detail in 2014. Not going to go
12 into a lot of detail now, but to account for these things
13 that they identified in the ASME code, things like
14 surface finish, variability, size effects and loading
15 history. Based on data we took distribution of ranges
16 and assigned them all normal distributions with the
17 balance representing the 5th and 95th percentile, just
18 crank through a Monte Carlo, and develop at least
19 adjustment factors on life. Again, these aren't
20 adjustment factors on strain, but just adjustment
21 factors on life. I've just documented the factors that
22 we got there, for carbon steel we got a factor of about
23 10, low alloy steel a factor of about 9 and stainless
24 steel a factor of about 9.6.
25 This is one area that we specifically

1 requested public feedback on when we went out for public
2 comment, we wanted to see what the public thought about
3 the analysis that we've done. If you read the NUREG,
4 though, it talks about these very, more precise
5 factors, but at the end of the day it says well, we're
6 still going to use adjustment factors of 12 on cycles
7 or life and 2 on strain or stress. We did that for two
8 reasons; one, it's not that much different than the
9 Monte Carlo analysis and at least initially we wanted
10 to retain consistency with Rev. 0 and the ASME code.
11 Again, this is one case where we didn't want to get out
12 ahead of the ASME code.
13 CHAIRMAN RICCARDELLA: So did the ASME
14 code from 20 to 12 at some point?
15 MR. TREGONING: For stainless it did that.
16 CHAIRMAN RICCARDELLA: Oh, okay.
17 MR. TREGONING: For carbon it's still 20.
18 CHAIRMAN RICCARDELLA: Gotcha.
19 MR. TREGONING: I'm hoping that that's a
20 change that they'll adopt relatively soon. That one
21 to me is a low-hanging fruit, so I would think they would
22 be addressing that.
23 So, at the end of the day the design curves
24 in NUREG Rev. 0 and Rev. 1 are exactly the same, there's
25 no difference whatsoever. Then the other thing that

1 we do in Rev. 1 and it's similar to both ASME as well
2 as Rev. 0 is it says for nickel-chrome-iron you can use
3 the stainless steel design curves. Even though we
4 recognize that the nickel-chrome-iron has a little bit
5 better feed life than stainless steel, so this is a
6 conservative position, but we adopted it because we had
7 less data for the nickel-chrome-iron alloys, and so we
8 didn't feel comfortable necessarily recommending
9 design curves specifically for those alloys, but we
10 felt very comfortable saying that the stainless steel
11 curves is certainly conservative to use.
12 So there weren't any changes to the design
13 curves or the air curves at all between Rev. 0 and Rev.
14 1, so the biggest changes are with FEN. So in Rev. 0,
15 if you read Rev. 0 we had different FEN expressions for
16 carbon and low alloy steels, now we have one expression
17 just for ferritic steels basically. As Pete
18 mentioned, you could have no environmental effects and
19 get FEN factors greater than 1 in Rev. 0, so we fixed
20 that now. If you don't exceed the thresholds required
21 to get environmental effects, your FEN automatically
22 is 1.
23 We had different constants in expressions
24 for stainless and nickel-chrome-iron alloys if you look
25 at the FEN expressions, now we have the same functional

form for the stainless and the nickel-chrome-iron alloys, so make it easier to use. The only thing that's different are the transform variables are somewhat different. As we talked about already, the expressions are generally less conservative for all materials, can't say categorically that's the case. I just show some plots here for carbon and low alloy steels for different levels of dissolved oxygen, and the curves are a little bit hard to make out, but the solid curves there are the Rev. 1 expressions and then the dash curves there are the Rev. 0 expressions. The other thing we added on there, the Japanese expressions. JNES or now JNRA, they have their own set of expressions that are a little bit different than ours, but I think since we've combined data sets, we're much better in alignment with the Japanese in terms of the curves that they require as well.

CHAIRMAN RICCARDELLA: So the potential non-conservatism of Rev. 0 is just these regions where the solid curve is greater than the dash curve, right?

MR. TREGONING: Again, there's enough competing variables here that it's hard to show in one plot all the possibilities that you can get. For the variables that I've plotted you'll see that there's some regions of the curve that cross over. Again, the

1 scale of this plot is a little disingenuous, especially
2 the one on the right, because it shows FEN factors going
3 up to 60. To be honest, any real fatigue transient that
4 we've ever seen, I don't think we've ever seen a FEN
5 factor greater than like 6 or 7 or so. So there's sort
6 of exponential behavior that you could potentially get
7 that would lead you to very large FEN factors, that's
8 just not going to show up in any sort of actual
9 evaluation that you do.
10 CHAIRMAN RICCARDELLA: Very low strain
11 rates, is that what you're saying you need to have?
12 MR. TREGONING: Well, high temperatures,
13 low strain rates, those are the sorts of things that
14 can give you the high FEN.
15 MEMBER SKILLMAN: Lots of sulphur.
16 MR. TREGONING: Lots of sulphur. Again,
17 in this case high dissolved oxygen for the carbon
18 steels. Yes, those are the things that could lead you
19 to a high FEN.
20 So what else did we do in Rev. 1 that we
21 didn't have in Rev. 0, which again, in these next two
22 areas I think have been big improvements. For one
23 thing we have a whole section to try to validate the
24 method, so we took other data sets both on specimens
25 or component tests that we didn't use to develop our

correlations and then said, all right, let's analyze these other tasks, these independent tasks using the methods and see how well they do. Again, we did this using both EAS code methods and the FEN approach, we just compared the prediction to what was measured in all these cases. When we were looking at the specimen tests, so those particular tests we actually did quite well, and in general, again, you get a lot of variability, but the predicted measures agreed reasonably well, within about a factor of 2, and with respect to fatigue life if you're in a factor of 2 you've nailed it I think. So that's about as good as you would expect. Now that's for the specimen tests, the component tests are much more challenging to predict. Again, you have to remember that the FEN method is built on specimen laboratory data, so you look at more real components with loading gradients, temperature gradients, potentially. Those are much more complicated.

What we've been able to show, at least those far, is that the tests that we've been able to analyze is that generally this approach is conservative, either agrees with or conservative. So we would clearly admit that there's a conservative bias with using this approach, or there appears to be in most

1 cases for actual component analysis. That's a whole
2 chapter now on Rev. 1 Section 6.
3 The other thing, and again, we can thank
4 Gary for this as well as some other people, we actually
5 included a sample problem in the appendix to
6 demonstrate how you would apply the methodology and
7 also provide a benchmark if someone wanted to develop
8 their own set of calculations they could at least test
9 to make sure the calculations are done correctly by
10 solving the sample problem.
11 CHAIRMAN RICCARDELLA: Gary was going to
12 comment on the differences between Rev. 0 and Rev. 1
13 as to where -- Go ahead, Gary, if you're on.
14 MR. STEVENS: Okay, can you hear me?
15 CHAIRMAN RICCARDELLA: Yes.
16 MR. TREGONING: So back to this.
17 MR. STEVENS: I was just going to comment
18 on Slide 17. To your comment, Pete, where the new FEN
19 expressions tend to be higher is that higher
20 temperatures, higher oxygen rates and low strain rates,
21 as you pointed out. What you generally see is those
22 are conditions that never factor into a fatigue
23 analysis. Plants really don't experience high oxygen
24 levels much anymore, and more particular when you have
25 a slow strain rate, you don't generate any fatigue

1 because the stress range is small, so even if your FEN
2 was very, very high you would be multiplying it by zero.
3 MR. TREGONING: And we got some public
4 comments that sort of touched on this phenomena that
5 we articulated that exact response that generally what
6 we've seen in applications, if you get a FEN your strain
7 range is very small so that the actual effect is not
8 that significant.
9 MEMBER BLEY: Without interruption I'm
10 going to toss two things in; I've never seen a report
11 like this NUREG that actually integrates the discussion
12 of the comments you received into the NUREG itself and
13 explains how things change. I like it, it helped me,
14 and your Appendix E that shows the equations in the
15 first and the second and how the first morphed into the
16 second was really helpful.
17 MR. TREGONING: Thank you. Okay, so this
18 sample problem, this was actually based on a sample
19 problem that was done as part of a code activity and
20 it was interesting to get some of the questions. We
21 put the sample problem out through the code to people
22 that do fatigue analyses all the time, we were amazed
23 at the variety of outputs that we got. So, not
24 surprisingly when we put the sample problem out for
25 public comment, we got people that worked the problem

1 and they found areas that we needed to improve. So,
2 this sample problem, I think it's been helpful for us
3 and we're hoping it's helpful for the user as well.
4 I'll talk a little bit more about that when we get into
5 actual changes to the Rev. 1 document.
6 That's it for the first third of the
7 presentation, but that's probably the most meaty third
8 where we go through the background of the existing
9 guidance, why we made changes, and this leads us up to
10 the next two parts where we talk about the public
11 comments that we got for both the NUREG and the Reg Guide
12 and then the responses to those comments and changes
13 to the documents.
14 CHAIRMAN RICCARDELLA: Okay, so by the
15 schedule, we're about ten minutes behind. I think
16 we're doing pretty well considering --
17 MR. TREGONING: That's the meaty part, I
18 think we're fine.
19 CHAIRMAN RICCARDELLA: Let's move on.
20 MR. TREGONING: Okay, so keep plowing
21 ahead. Let me, I'm going to talk now about the NUREG,
22 Revision 1 of the NUREG and provide an overview of the
23 public comments. So for this section of the talk, as
24 I mentioned, I'm going to provide an overview of these
25 comments and a sampling of comments and responses.

1 Like I said, I tried to pick some of the more both
2 representative and interesting/controversial
3 responses to talk to you guys about today, and then go
4 through a summary and overview of changes that we made
5 to Rev. 1, again, based on either public comments and
6 then further review of this document by both the staff
7 and the report authors.
8 As I mentioned, we went out, we sent this
9 out for public comment in April of 2014 and we
10 specifically asked for feedback on the following three
11 areas; the first one was the extension of the best fit
12 mean air curve for ferritic steel discussed in Section
13 3110. So this is the high-cycle fatigue regime beyond
14 like 10 to the 6 cycles. The second thing we asked for
15 feedback on are the adjustment factors that we
16 summarized in 5.5, that's what I talked about before
17 that we developed using Monte Carlo analysis. The
18 third thing, and I admit in hindsight that this was
19 probably a little bit disingenuous enough of us to ask
20 this, but we asked for an accuracy check of the
21 technical content of the NUREG, particularly with
22 respect to all the numerical content of the report.
23 So, we were pretty broad and expansive of asking our
24 reviewers to really do a QA check of the document and
25 to be honest, I don't cover these but we got some pretty

1 glib comments that said, "You gave me two months.
2 There's no way I can check all the technical content
3 of the report in two months." I would say we fully
4 agree with the public comment or that yes, I think that
5 you wouldn't be able to do all the technical content
6 check in two months.
7 Yes, in hindsight that could have been
8 worded maybe a little bit more clearly, but again, I
9 think we got a lot of really good comments anyway.
10 Public comment period ended in June of 2014. So we got
11 formal public comments received from ten commenters and
12 what this table does is list the comment's affiliation,
13 who the commenters were and then where you can find
14 those comments and items. We actually got three
15 additional commenters that provided feedback after the
16 public comment period, so while they're not listed
17 here, we've just put their comments into the whole
18 matrix and considered them as well. These other
19 commenters weren't as voluminous, so and I'll show you
20 with the statistics here, but we considered all the
21 comments that we got. Now when you read the response
22 document, and I apologize for this, the NUREG itself
23 is a bit of an unwieldy beast, and the response document
24 is also a bit of an unwieldy best. I think it's about
25 an 80-page document and that's just a reflection of the

1 number of public comments that we got, number one.
2 Number two, I think we tried to be as thorough as
3 possible in our response to those public comments.
4 So it's a mouthful and it's very dry
5 reading and I recognize that. So when you look at the
6 responses to public comment, we enumerated and track
7 each, and not only each comment, because if you looked
8 at the comments, many of these comments were expansive
9 and multi-part, so we took every individual comment and
10 broke it down into sub-comments which we thought
11 reflected individual issues. So we really articulated
12 in the NUREG we, so we tracked them with a unique number
13 from the table, so 1 is always the Higuchi comments,
14 plus this abbreviation that you see in the right column.
15 So I admit the number and the abbreviation are
16 redundant, we didn't need to do that, but hey, we're
17 the NRC, we over-design things all the time, I guess.
18 Then a sequential comment number and even a sub-comment
19 number to try to break down each individual issue with
20 respect to a given comment.
21 So in terms of the unique comments or
22 issues from those ten commenters, we identified about
23 254 comments or sub-comments; 235 came from the
24 commenters themselves, that additional set of three
25 commenters gave almost five more, so it was a small,

1 additional set. Then the other things that as we went
2 through, we said hey, here's a change we need to make
3 as well that was spurred by the comment. There were
4 another 14 things that we sort of found that fell into
5 that bin.
6 So, I think I've talked about this, but
7 with respect to the NUREG, we were really happy with
8 the comments that we got, we though they were
9 well-thought out, very good technical in nature,
10 thoughtful and expansive, so they were very helpful.
11 If I bend and I have a more explicit bend later on,
12 but if I just try to look globally, we got a lot of
13 comments related to the scope, when does FEN method
14 apply, when doesn't it. We got several comments on the
15 adjustment factor analysis and application. Again,
16 that was an area that we asked for comments on and we
17 did get a lot of comments. We got a lot of comments
18 that just said, "What are you trying to say here? Could
19 you clarify this? We don't understand what point
20 you're trying to make there." Those were very helpful
21 and we tried to go back whenever we got a clarification
22 statement and tried to be much more clear about what
23 we were trying to state. We got a lot of comments
24 related, "Hey, this stuff's great for specimens, but
25 it doesn't apply at all to actual plant components and

1 here's why." So, there's where the philosophical
2 comments came out.
3 Then we got a lot of kvetching, for lack
4 of a better term, of overall conservatism of current
5 ASME requirements. Especially then they said, "Look,
6 ASME's conservative enough and you're making us apply
7 this FEN factor and you're killing us now." So, we got
8 a lot of comments related to that. I think in general
9 we agree, so if you look through the response document
10 and search for words "disagree" or "not agree," you
11 won't find that in there often. We agreed with almost
12 all the comments. I think when I went back and looked,
13 and this is a bit of a type-o, there were about eight
14 that we didn't agree with in one way, shape or form.
15 Again, I just said when we didn't agree, they weren't
16 significant with respect to the FEN methods, so some
17 cases there was interpretations of ASME code
18 requirements that were within the comments that we
19 didn't necessarily agree with, but that's sort of
20 outside the scope of what we're doing here anyway.
21 We had some comments related to load
22 sequence effects that said that they weren't important.
23 Well, we think in certain cases that they are so; we
24 disagreed with those comments. There's been a big
25 debate about whether you need to include strain

1 thresholds or not in your FEN analysis, many people
2 think you don't need them. We included them here and
3 said if you don't include them, that's fine, it's
4 actually more conservative not to include them. So
5 we're giving them to you to relax some of the
6 conservatism. Then we had some comments we asked about
7 the high-cycle fatigue cut-off of the design curve, we
8 had some comments related to that that we didn't agree
9 to, and then the other area, some of the component
10 testing that was done was AREVA, interpreting that
11 testing is not an easy thing to do, and so we had
12 disagreements in comments about the best way to
13 interpret those test results, and we document how we
14 interpret them, but I'll just say there's not universal
15 acceptance at the way NRC chose to interpret those tests
16 and this NUREG is the way that other people would choose
17 to interpret those tests.
18 So then, here's some more data --
19 CHAIRMAN RICCARDELLA: Were any of those
20 comments from AREVA who actually ran the tests?
21 MR. TREGONING: Oh, yeah. No, we got a
22 lot of that. In fact, one of the things, and this put
23 us in a weird point because one of the tables that we
24 have in the NUREG, AREVA came back and said, "There's
25 some errors in the table." We said, "What do you mean?

1 We took your source documents." They said, "No, we had
2 errors in our source doc." That puts us in a weird
3 point because we're like, "Well, then you need to go
4 back and give us a referenceable thing to fix." They
5 were relatively minor things. I mean, nothing major,
6 but just that some of the actual numbers had changed.
7 That was one case where they actually gave us in their
8 responses, they said here's what that new Table 21
9 should look like. We didn't take all of their changes
10 because we said, "Well, you fix the source documents.
11 Give us something to reference and then we'll publish
12 an ERATA for the NUREG. Yes, we got a lot of comments
13 from AREVA on their own text.
14 Okay, so what you see on this slide I just
15 further discretized the comments. Again, I've
16 highlighted the ones, the ones I've highlighted are
17 related to the questions that I asked. We asked three
18 questions on adjustment factors, high-cycle fatigue
19 design curve and then miscellaneous was, hey, check
20 everything that we did in this report. So if I look
21 at this, again, we got a lot of questions on adjustment
22 factors, a lot of questions about the database, what
23 data are you using, is this material property really
24 the right one. We went back and did QA of the data
25 records to make sure all of that was right.

1 I mentioned the example problem, we got a
2 lot of good feedback on the example problem, people
3 actually going down and starting to work the problem,
4 and finding issues with it. If you look at Appendix
5 C we made some fairly substantial modifications to
6 Appendix C to help correct some of the deficiencies we
7 found from other people running the problem, as well
8 as to make it easier for other users. There was
9 information, we didn't have enough material
10 information for someone to really run the case that they
11 need to run.
12 Then I mentioned relevance to components,
13 we got a large number of comments with respect to that.
14 Then we got a sub-set of comments that were editorial,
15 strictly editorial in nature, and I think by-and-large
16 we tried to address those editorial comments, all of
17 them, if not largely all of them.
18 So now I'm going to give you some sample
19 public comments and responses themselves. Here's one;
20 this is comment FAIDY, so for those of you that know,
21 this came from Claude Faidy who was reviewer a comment
22 or two, and this was Comment 3A. Again, it's a very
23 good comment; he said, "All the reduction factors," and
24 he's talking about adjustment factors, "They're
25 considered to be independent of each other. It's not

1 accepted in all international approaches in particular
2 that a constant FEN independently of number of cycles
3 is not justified clearly." So here's actually a
4 sub-comment which really has two points that he's
5 making; one, that these reduction factors for light
6 material variability, size, surface finish, his point
7 is will you consider them in your analysis to be
8 independent. In reality that's necessarily the case,
9 that there could be relationships between those
10 parameters that if the surface finish is this, it might
11 have an effect on the size adjustment factor. We
12 agreed; we said the report does consider the reduction
13 factors are independent. We actually went back and
14 clarified the NUREG from that perspective, and then we
15 just said, "Look, we recognize that there may be
16 correlations between these things," but to really do
17 that in any sort of analysis requires really rigorous
18 and a pretty good data set to do that in any sort of
19 quantitative way.
20 So we just said, "Look, we recognize your
21 point. This is the assumption that we made and we just
22 don't have sufficient data to really evaluate if this
23 correlations, how strong they might be in some of these
24 areas."
25 CHAIRMAN RICCARDELLA: But do your

1 adjustment factors bound the worst that might be seen?
2 MR. TREGONING: Again, during a measure
3 they will comment -- how we basically develop those is
4 we looked at experimental data and tried to isolate it
5 as much as possible and said, okay, for surface
6 roughness we've seen effects of water that vary between
7 factors of 1 and 3, for instance. So what we did based
8 on that range is we said that's the 5th and 95th of our
9 distribution, right, so those are my 5th and 95th, and
10 then I'm going to fit it all normal through those
11 points, run the Monte Carlo. What the Monte Carlo
12 didn't do, if it took a point from that distribution,
13 it didn't rank/correlate it with another distribution
14 in the data set, so we did a fully independent Monte
15 Carlo on all those adjustment factors.
16 Is that clear?
17 CHAIRMAN RICCARDELLA: Yes, but if you
18 correlated them, would it make them less conservative
19 or more?
20 MR. TREGONING: It depends on how they're
21 correlated. If you correlated the first percentile,
22 it could make them very conservative. We didn't do
23 that, we did not do that. In fact, some people accused
24 us of doing that. We said, if you just multiplied the
25 ranges together and the bounds, you would get margins

1 that were bigger than 9 or 10, you would get margins
2 of like 20 or greater. We did not correlate them.
3 MR. SHACK: The ASME code does, the
4 multiplication straightforward?
5 MR. TREGONING: Basically. For the
6 carbon curves they do, yes. We did not multiply them,
7 but we did not consider -- we considered that they
8 didn't affect each other. The other point that Claude
9 makes in this is that FEN or the amount of adjustment
10 you give could be a function of strain. We assume here
11 that it's a constant regardless of the strain range that
12 you have, because if you notice the strain rate is
13 explicitly modeled, but it doesn't matter what the
14 strain is if it's low cycle or high cycle, we assume
15 that it's the same FEN.
16 MR. SHACK: For the threshold?
17 CHAIRMAN RICCARDELLA: If you have
18 cut-offs, say if you're below that?
19 MR. TREGONING: Of course. If your above
20 the thresholds that FEN is not an explicit function of
21 strain. Again, we said that that's assumption and you
22 could develop a method that would be a function of
23 strain, it's just a much more complicated approach at
24 that point. So we just clarified that within the NUREG
25 that yes, this is an assumption that we made.

1 Here's a sample of comments that we got
2 from adjustment factors and I think we touched on some
3 of this, this was an AMEC comment. I've paraphrased
4 it somewhat and tried to get to the meat of it, but it
5 basically talks about discussion about adjustment
6 factors for first of a factor of 10 on life being
7 supported, but the NUREG recommends a factor of 12 for
8 use pending further validation. The comment is, "It's
9 unclear what validation data is required because the
10 existing database is already large." Then another
11 comment was, "There was no clear justification for a
12 factor of 2 on stress provided in the NUREG." So here
13 was a summary of how we responded to that, that
14 basically the analysis supports a factor of 10 without
15 the need for additional data. I think we have enough
16 laboratory data to say a factor of 10 is a sufficient
17 margin. However, the report's maintained a factor of
18 12 to be consistent with the factor used in the ASME
19 design curve. So right now, again, we're retaining
20 that for consistency. But again, the fatigue world the
21 difference between 10 and 12 is not great.
22 CHAIRMAN RICCARDELLA: Like you said, if
23 you hit it with a factor of 2, you're doing great, and
24 here you're talking a factor of 1.2
25 MR. TREGONING: We're honest, we didn't

evaluate the factor of 2 on strain at all. So we clarified in NUREG we didn't do any analysis to look at this and we just retained that for consistency with the code. We haven't looked at trying to reduce that margin at all. So these were good points and we just tried to make sure that the NUREG clearly stated that in several places.

Here's a good one related to the ASME method and requirements in general and I think this is a good representative comment. We got several that are similar to this. The comment was basically first there just hasn't been a reconciliation between specimen fatigue test data and the complete, and I'll stress the word "complete," ASME code fatigue methodology, so how you do the analysis, all the assumptions that you have to make. Then it goes on to state the ASME methodology already contains a lot of multiplication of effects that have not been considered by both the developers of the in air design fatigue curves and the FEN factors. So the notion here is that ASME code in and of itself is so conservative and you haven't factored that into your approach here. We agree with that, we haven't, and not explicitly. So we developed, and I'll get into this a little bit later, one of the biggest things we developed in Rev. 1 with this whole new Section 1.5

where we try, and it's a long section, it's about ten pages, but we tried to go through the bases and assumptions for everything that we're going to lay out in the NUREG and we tried to be very clear.

One of the things we talked about here is we talked about some of the ASME code conservatism, and again, the purpose of this report was not to indict or evaluate the ASME code fatigue requirements. The purpose for this report was to make sure that we're addressing environmental effects. Again, we've tried to state that in many places the data shows, at least that we've accumulated in the NUREG, that we believe the FEN approach in concert with the ASME design curve will give you either accurate or conservative predictions of environmental effects. So accurate or conservative. Eliminate conservatism in the ASME code is outside of the scope of this particular report; however, we're trying to encourage people go forth and make changes to the code. If you want to revise the code procedure, let's do it through the proper channels.

I think we're hopeful that we'll be able to make some progress in this area, but we weren't going to solve the code problems within this particular report.

1 CHAIRMAN RICCARDELLA: Doesn't your
2 evaluation of your methodology against the component
3 tests do some form of reconciliation? Were those
4 constant amplitude tests or did they have varying
5 spectrum?
6 MR. TREGONING: It depends on the test. I
7 mean, again, even the component tests are
8 representations of reality. In an actual true
9 application of plants, way more complicated than any
10 of the component tests we've done.
11 CHAIRMAN RICCARDELLA: Just finding the
12 actual magnitude of the cycling is --
13 MR. TREGONING: So I think the notion that
14 look, you're required to use design stresses, design
15 cycles, you're required to pair them in a certain way
16 in the ASME analysis, there's lots of things about the
17 analysis. Gary's on, he can speak way better to this
18 than I can. If you look at them in total you'd say
19 there's a lot of conservatism here. But what we've
20 struggled with is try to identify okay, which
21 particular thing do we want to pick at without upsetting
22 the apple cart, because sometimes if you remove one
23 conservatism you need to make sure it still holds
24 together at the end of the day. I think that's part
25 of the challenge as well.

1 Okay, as I move on, so we also asked for
2 comments about the high cycle fatigue regime and one
3 of the comments we got back from MHI just said, "Look,
4 the extension that you guys are doing it's too
5 conservative." That was the comment, too
6 conservative. In our response we do agree that the
7 extension is too conservative. The extension that we
8 have in Rev. 1 is also identical to the extension that's
9 been proposed in the ASME code, so it's fully
10 consistent. Again, that's based on data that has a
11 prominent mean stress effect, and the mean stress
12 effect can really affect significantly what your high-
13 cycle fatigue cut-off is. Again, basing it on data is
14 meant to be both conservative and allow application of
15 components, which have high mean stress component. We
16 tried to be very clear that if you have data or
17 components without a significant mean stress effect,
18 then yes, the proposed curve could be significantly
19 conservative. So, I think while we don't argue with
20 the approach, you can always interpret if something is
21 too conservative or conservative enough.
22 Then, okay, I mentioned that there were few
23 comments that we disagreed on. I wanted to pull out,
24 this is probably the most interesting one that we
25 disagreed on in some sense, so I wanted to make sure

1 we covered this. This one came from AREVA and they
2 postulated in their comment that, "Look, the only
3 concerns we should have that should consider
4 environmental effects are those transients that have
5 low strain rates." So what they were proposing or
6 postulating is that look, for those low strain rates
7 you shouldn't even have to consider environmental
8 effects, and they go on to make that point here. The
9 other transients that you have, for example, insurgence
10 and outsurgence, need to be evaluated for fatigue, but
11 the current methodology without any FEN penalty is very
12 appropriate for those transients. That was the gist
13 of the comment.
14 Our response was, "Look, most transients
15 that you look at have a wide range of strain rates, and
16 it's not really important how environmental effects are
17 going to be until you look at the entire transient as
18 an entire beast." You can't just cherry pick one
19 portion of your transient and say I'm going to look at
20 the environmental effects here but not consider them
21 through the whole transient. Only through this way can
22 you say if the FEN for that transients is really
23 significant or not. That was really the point here
24 that we think this approach we don't want to cherry pick
25 and say you need to consider environmental effects

1 here, you don't need to consider them here. The whole
2 idea for the cut-offs and thresholds is that if you are
3 below all of those thresholds, by default then
4 environmental effects are one and there's no penalty
5 whatsoever.
6 CHAIRMAN RICCARDELLA: But if you
7 evaluated an insurge/outsurge change in the strain
8 rates for high, wouldn't you end up with a FEN that's
9 pretty close to 1?
10 MR. TREGONING: Exactly. Okay, so what
11 changes did we make to Rev. 1 compared to what went out
12 for public comment? That's what I'm going to cover
13 next. Again, I think we tried to address virtually all
14 the public comments and what we were trying to do by
15 addressing the comments in general, we wanted to
16 explain as clearly as possible the bases and
17 assumptions that support not only the NUREG but the Reg
18 Guide. We're using the NUREG as well to summarize the
19 current state of knowledge in this area. We wanted to
20 make sure we did that, and look, with any technical work
21 it's not the final question, it's sort of wherever you
22 are in that point in time. We want this NUREG to
23 provide a starting point or foundation for continued
24 work in this area. I think if there's a need for such
25 work, especially by licensees, we're hoping that we

1 would encourage them to pursue that.

2 As a result of these desires that I list

3 up front, the downside is the NUREGs turn into quite

4 a beast. Rev. 0 was 120 pages, Rev. 1 draft that went

5 out for public comment was 320, the final, it's not

6 final yet, but where we're at is almost 500 pages and

7 it's about a 90 meg file so it's becoming a little

8 unwieldy. As far as the main body goes we haven't added

9 a lot, there's maybe ten more pages, but what's really

10 adding the girth is we added this new Appendix D and

11 new Appendix E. Dr. Bley talked a little bit about new

12 Appendix E, I'm going to talk about those appendices

13 and why we added them here in a minute. The main body's

14 grown not as much as the appendices.

15 Here's what at least the table of contents

16 looks like after the public comments, and the only

17 things I've highlighted here, we actually changed the

18 title of Section 5 and we tried to be clear that we're

19 calling these adjustment factors and not, we don't want

20 to call them design factors or design margins or things

21 like that. These are factors to adjust for things that

22 weren't considered in the best fit mean air curves,

23 things like size effects, material variability,

24 surface roughness and loading sequences, so it's all

25 the same things that the ASME code calls reduction

1 factors. We're just calling it here to be clear,
2 adjustment factors.
3 So, it's a relatively minor change, but
4 we're just trying to be clear and distinguish what we
5 did in that chapter from what's done in the code. Then
6 the other main thing as I mentioned is we added an
7 Appendix D which is a compendium of figures. One of
8 the comments that we got back, first of all, the figures
9 that you got in the main body they're too small and
10 they're hard to read, so one of the things we did is
11 we went back and we're using high res files in the NUREG
12 now for all of the little individual files, so they're
13 better scalable. If you put them on your PC and you
14 try to scale the figure out, you don't run into
15 resolution issues. Now, that's caused a big increase
16 in the size of the document, but so be it. The other
17 thing we did is we took every figure in there and blew
18 it up and put it on either its own page or no more than
19 two figures per page and that's all Appendix D is, it's
20 every figure that's in the NUREG from 1 to N, bigger
21 so that if somebody really wants to look at it and really
22 wants to pick out fatigue data, they can at least have
23 that opportunity.
24 Then the other thing we did, if you look
25 at the draft that went out for public comment, because

1 we started with Rev. 0 and then built on it, there was
2 a lot of well, here's the Rev. 0 equation and here's
3 the Rev. 1 equation. A lot of commenters said, maybe
4 not a lot, but some said that's confusing. " We don't
5 know what equations we should use. What are you
6 telling us, which ones should we use?" So we made the
7 decision of look, Rev. 1 is only going to include the
8 latest equations and we struck all the old equations,
9 but we wanted people to understand here are the changes
10 to the equations. So we added Appendix E, all Appendix
11 E does it lists every equation that we had in Rev. 0,
12 that's one section of it, and then the next section
13 lists every equation that we had in Rev. 1, that's the
14 second section. Then the third section is a mapping
15 that says this equation number in Rev. 0 between this
16 equation or equation number in Rev. 1. So if somebody
17 really wants to map, they're able to do it in an easier
18 way. And I can just know from my own perspective, I
19 found that appendix to be pretty helpful. So those are
20 some of the major structural changes.
21 I just want to summarize, I do it in two
22 ways. I'm summarizing here the major comments and then
23 I'll walk you through by section by section and just
24 let you know what some of the changes were. But at
25 least this first slide summarizes the major changes

that we made to the NUREG due to comments. I mentioned this earlier, we added this new section up front, the Section 1 on bases/assumptions associated with the FEN method, and again, this was in response for a lot of the public comments that we just thought were good comments, but a lot of them were outside of the scope or intent of the reg itself, so we wanted to try to lay that bases much more clearly and explicitly.

The other thing that we did, and this was an artifact from Rev. 0, we had a Section 41-14 on the modified rate approach, and that's an approach you use regardless of what material you're looking at, but we had it within a section where we were dealing with carbon and low alloy steel. Somebody pointed out well, that's stupid, that's not just applicable to carbon and low alloy steel, that's applicable to any material. We agreed with that, so we moved that whole thing to its own section. It's a new Section 4.4 and then we got a number of questions related to lack of clarity in that write-off, so we tried to significantly clarify the write-off associated with the modified rate of approach.

I mentioned this previously, Gary did a lot of work to rework and revise the example problem in Appendix C. I mentioned this one, we eliminated all

1 the Rev. 0 equations from the main body and I talked
2 about Appendix E and I talked about these other things
3 with respect to the figures in Appendix D. The other
4 thing that we did which was I think an important change,
5 it was a change that we did with some care, is we
6 recognized we were sort of sloppy in our terminology
7 and we used a lot of different terms/adjectives for
8 environment. Sometimes we said reactor environment,
9 sometimes we said coolant environment, sometimes we
10 said water environment, so we went back and tried to
11 be more consistent and just talk about a water
12 environment, because again, a water environment that
13 trips the thresholds, we believe, leads to
14 environmental effects. We didn't make a categorical
15 change, but where we thought it was appropriate we made
16 those changes throughout the report.
17 So for instance, if somebody did a set of
18 tests and said we did testing in simulated reactor
19 coolant environment, we didn't go back and change that,
20 we left that source reference the same. But when we're
21 talking about applicability and guidance, we took out
22 the terms reactor coolant and said water environment,
23 and to try and make it more consistent with the Reg
24 Guide, and we got some comments with respect to the Reg
25 Guide, with respect to lack of clarity from that, that

1 we wanted to make sure that we were consistent in our
2 guidance and our interpretation.
3 The other thing we did, and we had done this
4 before but we're gluttons for punishment, we did it
5 again, we went through technical editing, so if I show
6 you guys a red line strike-out version of the document,
7 it'd probably look pretty messy, but a lot of these
8 changes aren't significant, so that's why we didn't
9 give you a red line strike-out version of the document
10 per se.
11 So, those were the major changes, now I'm
12 going to walk you through section by section and just
13 touch quickly on some of what was done on each section.
14 In the executive summary there wasn't anything
15 significant, but what we did is we added some new
16 language as well as clarified existing language related
17 to the applicability of the FEN method, margins and
18 adjustment factors. So, again, if you did a red line
19 strike-out you'd see a couple new sentences added in
20 the executive summary. As I mentioned in the
21 introduction, the big thing was this new Section 1.5
22 and we felt like this new Section 1.5 really addressed
23 a lot of the public comments we got, or at least that
24 was the intent of adding that section, and we
25 specifically addressed 26 topics in the sections, or

1 we called them items, and we got a paragraph or so
2 discussion on each topic within Section 1.5. Other
3 than that which was significant, there's no other
4 really significant changes in Section 1.
5 Gary mentioned before Section 2, which
6 this talks about some of Dana's question about our
7 understanding of the mechanisms of fatigue, what leads
8 to the formation of these cracks. No significant
9 changes to that section, but we did clarify what we
10 meant between, and Pete touched on this, what are sort
11 of micro-structural cracks, things that are on the
12 order of the grain size or the metallurgical features
13 of the material and things which are small which are
14 starting to become almost governed by mechanics, which
15 we're calling mechanically small, correct. So we
16 tried to be very clear about that terminology in Section
17 2. Section 3, this is where we look at all the
18 strain-like behavior in air, no significant changes,
19 but we did get a lot of questions about when we looked
20 at materials we looked at the common materials that we
21 use in U.S. applications. There's other applications
22 particularly in Germany where they use titanium and
23 niobium, stabilized stainless steels, that are
24 actually designed to have better fatigue performance.
25 So if you look at those materials and

compare them to the design curves, those have much better fatigue life. So we tried to be very clear that yes, we didn't look at or evaluate those particular grades of stainless steel in this particular analysis. Again, we made those statements in Section 3. Section 4 they were at --

MR. SHACK: On that topic, when those curves are originally drawn people use the high carbon steels by-and-large and the low carbon steels are sort of a toss-in. Now I suspect it's the other way around, that almost nobody is going to use a high carbon steel, it's all going to be L or LN or nuclear grade.

MR. TREGONING: For new applications.

MR. SHACK: Certainly for new applications. And they do have different behaviors, but you're following the code there. Again, the question is probably whether they should be broken out at this point.

MR. TREGONING: We agree. In fact, we gave a talk, we've given a couple of talks, one of the talks where we identified changes that we thought would be technically defensible. One of the things we did is for certain alloys for stainless and nickel, we said if enough data develops we think there's a basis for less conservative design curves here, certainly. We

1 also indicated with ferritic materials that there's a
2 good correlation between strength and fatigue life and
3 using that correlation and developing design curves for
4 specific classes of ferritic steel components, we think
5 that's also a modification that could be defended. We
6 don't do that per se, but we're trying to identify areas
7 that we think are right for making some modifications.
8 Those are a couple of them.
9 Okay, so back to this Section 4; this is
10 the section that we talk about with all the
11 environmental effects. I mentioned these changes
12 already, at least the significant ones that are in bold
13 I mentioned. We eliminated all the Rev. 0 equations
14 and we moved that modified rate approach. The other
15 thing that we did, this gets to Dr. Shack's point, is
16 718 was the one alloy that we know, it's used in some
17 U.S. applications and we had really good air date on
18 nickel 718. If you look at the air design data, nickel
19 718 is very much more resistant to fatigue or less
20 susceptible than the other nickel-chrome-iron alloys.
21 So we said, "Look, if you use a stainless steel design
22 curves for air, that's going to be very conservative
23 for 718." But we are clear to say that we don't have
24 data for 718 or enough data for 718 in water
25 environments to know if the FEN approach holds

1 together, so we do make it clear that at least this time
2 that we're not recommending use of the method with
3 nickel 718 until, again, sufficient data is developed
4 so we can either see if the FEN approach applies or if
5 different factors are actually appropriate for that
6 particular alloy.
7 Another thing we did, we had different
8 nomenclature for the transformed variables between
9 carbon and low alloy steels. We just unified the
10 nomenclature we were using so it's not different
11 depending on the material that you're looking at. It's
12 a minor thing but it can be pesky and annoying, so we
13 just did that.
14 MR. SHACK: That's confusing, though.
15 Your epsilon.star is a log of a strain rate, so it's
16 a negative number, but nobody thinks of epsilon.star
17 as a negative number. You look at the equations and
18 things are going the wrong way until you realize it's
19 really the log of a small number that you're looking
20 at.
21 MR. TREGONING: That's a valid point, I'm
22 not going to disagree with you. In fact, we went five
23 times around because if you looked at the NUREG we had
24 times because whether you have the negative sign or not
25 in front of the transformed variables, and we had

1 sometimes when it was negative and sometimes when it
2 was positive.
3 MR. SHACK: Just to find epsilon.star as
4 the strain rate with your factors, then written log of
5 that thing in that expression, it would have been much
6 clearer the way the signs went.
7 MR. TREGONING: I promised I wouldn't do
8 this, but I'm going to have to, and I'm just going to
9 blame Omesh for that.
10 (Laughter.)
11 I don't know if he's on and wants to defend
12 himself, but I'm not going to disagree.
13 CHAIRMAN RICCARDELLA: Yes, but then in
14 the FEN, it's exponential over negative.
15 MR. SHACK: It's exponential of log
16 epsilon.star and you would know that log epsilon.star
17 is negative, so negative times a negative is a positive
18 and in fact FEN is increasing. You keep thinking that
19 epsilon.star is a positive number and it isn't because
20 you've taken the log.
21 MR. TREGONING: Look, believe me, I
22 struggle, I have to check myself all the time, so I'm
23 not, like I said, I'm not going to disagree with you
24 on that comment. That's a valid point. If you feel
25 that strongly, maybe you can put that in your letter

1 and it might compel us to gauge, I don't know. Again,
2 some of this is historical based as well, that was how
3 it was defined historically.
4 MR. SHACK: I was the co-author of the
5 first report, so I can't hide.
6 MR. TREGONING: Okay, the other thing we
7 did we tweaked thresholds based on comments and some
8 people said "Well, we think the threshold should be this
9 and we think the data really shows that it should be
10 this." In all cases we went back and looked at the data
11 and sometimes we agreed with them and sometimes we
12 didn't, but in cases where we agreed with them, we
13 adjusted the thresholds accordingly, so that's
14 indicated in there.
15 Section 5, I've talked about this.
16 There's no real significant changes to that section,
17 but we did try to clarify why we ended up recommending
18 margins of 12 and 2 even though the analysis would argue
19 that you could maybe reduce at least a factor of 12 by
20 some additional percentage. Section 6, based on
21 comments, again, we actually went back and re-analyzed
22 a couple of the tests that we used in those sections.
23 The re-analysis we changed some of the quantitative
24 numbers, but overall in terms of significance, there
25 weren't really any significant changes associated with

1 the re-analysis. Just wanted to make sure everything
2 was accurate. Again, we tried to indicate at least in
3 some ways when FEN tends to be in conservative. I think
4 we would all agree with this, if you have gradient
5 effects in your tests and what gradient effects are in
6 either loading or temperature and sometimes it's
7 temperature that induces the gradient and loading, that
8 FEN tends to be conservative. I think we would all
9 agree on that.
10 MR. SHACK: But the whole ASME code is
11 conservative in those cases.
12 MR. TREGONING: Right. Yes, definitely.
13 No other significant changes to Section 6.
14 In summary, basically all the summary we
15 made changes that are consistent with any changes that
16 we made in the rest of the report, including the
17 executive summary. Then we also added a couple of
18 paragraphs on the evaluation of the procedure, and then
19 the applicability of the method and future work,
20 because again, we want to make sure that the door is
21 open doing future work and we want to try to at least
22 encourage that.
23 Other than that, no other significant
24 changes to the summary. As far as the appendices go,
25 Appendix A was really just a mimic of everything else,

1 so if we needed to make consistent changes based on the
2 equations, we made some changes. Again, that's
3 changing of thresholds and things like that. We
4 clarified what temperature you should use when picking
5 your Young's modulus. It's a relatively minor point,
6 but it's somewhat important, nonetheless. Some people
7 said what do you do if you have a maximum temperature
8 limit that's greater than your bound of 325, so we added
9 some clarification on what you would potentially do on
10 that. It's pretty vague, it's just says, "Look, 325
11 we think covers most applications." If you really
12 need to have an application that goes beyond 325, you
13 just need to justify what you're doing in that regard.
14 So we tried to be very clear because once
15 you get up closer to 400, the temperature effects on
16 FEN start to change dramatically, so we want to stay
17 outside of that regime. That's why we're pretty
18 careful about limiting things to 325. Again, if you're
19 really substantially higher than that, again, you have
20 different phenomena that are starting to come into
21 play.
22 Appendix B, this is where we summarized all
23 the material information that makes up the data sets
24 that we analyzed in the report, no real significant
25 changes to that information. I've mentioned, I've

1 already talked about the sample problem. Again, I
2 thank Gary as well as the public reviewers for scrubbing
3 this hopefully better. I'm sure we have three or four
4 more people that would do it, who will find more
5 problems with it, and we would encourage that. We're
6 hoping that as more people use this, if we need to modify
7 it further, will do so. The biggest thing, we added a
8 new Table C1 that had material properties that you would
9 use in the sample problem. So that was a glaring
10 admission, we needed to provide better guidance that
11 people could hopefully get the same result.
12 Then we added Appendices D and E which I've
13 already discussed. That's it for the NUREG. The next
14 piece is the same sort of talk but just talking about
15 the Reg Guide, and I don't know if you want to take
16 a break or?
17 CHAIRMAN RICCARDELLA: The schedule shows
18 a break within five minutes of that time, so let's take
19 about a 15 minute break and come back at 20 of.
20 MR. TREGONING: Just for planning
21 purposes, we're two-thirds of the report as far as
22 topic, but as far as content goes we're probably 80 to
23 85 percent of the way through, so there's not a whole
24 lot left.
25 CHAIRMAN RICCARDELLA: Yes, so we should

1 be done early is what you're saying.
2 Thank you.
3 MR. TREGONING: Did you say a quarter of?
4 CHAIRMAN RICCARDELLA: 20 of.
5 MR. TREGONING: 20 of, okay.
6 So we talked about the basis of the -- the
7 technical approach in the first part, and then we
8 covered the NUREG, its public comments and changes, in
9 the second part. Now we are going to cover the comments
10 to the Reg Guide itself. And again, as I mentioned,
11 the Reg Guide itself is pretty spartan. It just
12 basically says go forth and apply Appendix A of
13 NUREG/CR-6909 Rev 1.
14 So same thing here. I am going to provide
15 you an overview and sampling of the public comments and
16 responses, and then summarized changes that we have
17 made now to Rev 1 of Reg Guide 1.207. And again, these
18 are -- these changes are in direct response to public
19 comments and also further review by the staff.
20 So as I mentioned, we sent this out.
21 Actually, it was sent -- sent out at the end of November
22 2014. The public comment period ended in early 2015,
23 and for the Reg Guide itself, we got public comments
24 from seven different commenters, and you will see a very

similar table and similar way that we have categorized and abbreviated the comments.

And I will mention that four organizations, Rolls Royce, Westinghouse, AREVA, and EPRI, they commented on both the NUREG and the draft guide. And if you looked at their comments on the draft guide, they were -- a lot of them were similar comments and very technical in nature, where the other three commenters were more not necessarily technical in nature comments, but more applicability, procedural, things like that.

So some of the comments that you see in the Reg Guide are also -- they have been mimicked from comments that we got in the NUREG, and as you read the public responses, we have tried to reflect that whenever we can.

We have the same way of enumerating them where we track them both by abbreviation letter number and then sequential comment number. Here we did not have to break them into sub-comments, however, so we got -- from those seven commenters, we got 49 actual unique comments that we addressed in the responses to public comment.

So I have characterized, just like I did

1 with the NUREG, the following -- the areas associated
2 with the comments. Actually, the -- almost half of the
3 comments were editorial or clarification in nature, so
4 they -- they did not have a -- again, any technical or
5 any applicability issues that they were trying to
6 address. They had just found some editorial things
7 that they wanted to suggest changes, or areas where the
8 guidance was not clear in their perspective.
9 Another big percentage was, like I said,
10 related to the technical basis, so these were the
11 comments that were similar to comments that we got on
12 the NUREG itself, and that was about 22 percent of all
13 the public comments on the Reg Guide.
14 This third topic, which we have touched on,
15 we got a good number of comments about applicability
16 of earlier either reports or guidance for those
17 applications. Do they remain applicable? And then we
18 got a -- a subset that related to Reg Guide scope, use,
19 and applicability. And there were three comments that
20 I could not really fit neatly into any of these other
21 comments, so I just said they covered new topics.
22 Now I mentioned with the NUREG, we agreed
23 with virtually all the comments we got. Here it was
24 not quite as unanimous. I think we fully agreed with

1 about two-thirds of the comments. The remaining
2 third, about half of those we at least partially agreed,
3 and the other half of those, so the other six of those
4 comments, we probably -- we just disagreed with.
5 And the areas of disagreement -- and we
6 sort of -- you know, I wouldn't call them significant
7 areas of disagreement, but the one area was
8 applicability of earlier technical reports and
9 guidance, and I will talk about that in a little bit.
10 So in fact, maybe I will summarize it now.
11 They wanted us in the Reg Guide to cover this issue,
12 you know, what's the applicability of earlier guidance,
13 earlier reports within the Reg Guide? And we have
14 debated internally whether we thought we should include
15 that in the Reg Guide or not. Right now at least the
16 position is that we're not going to include it in the
17 Reg Guide, but where it is going to be included will
18 be in other documents like the SLR guidance documents,
19 things like that.
20 So the idea is that the Reg Guide wants to
21 focus on here's the method that we think is the best
22 applicable method, and if you have questions about old
23 analyses or things like that, that should be addressed
24 sort of offline, and we didn't want to try to be

1 expansive within the Reg Guide itself because you can't
2 cover every situation that might use this Reg Guide
3 anyway. So -- so --
4 MR. SHACK: But the first paragraph of
5 your discussion section says it's an alternative to --
6 for new reactors and for license renewal, which I read
7 that as you can use the old stuff for those things.
8 MR. TREGONING: Yeah, I think that is --
9 I think that is a fair interpretation. And with reg
10 guide language, you know, the language is meant to be
11 very precise and specific, so yes, and it is interpreted
12 literally, as it should be, so yes, I think that's an
13 accurate interpretation.
14 And then the other areas where reg guides
15 go --
16 MR. SHACK: But you said you weren't going
17 to address it, but it really is addressed.
18 MR. TREGONING: Not explicitly.
19 (Laughter.)
20 MR. TREGONING: People want to know --
21 PARTICIPANT: You're going to be a lawyer,
22 not an engineer.
23 PARTICIPANT: Evidently, some commenters
24 --

1 MR. TREGONING: Oh no no --
2 PARTICIPANT: -- wanted more.
3 MR. TREGONING: -- no, those were the
4 comments. The comments said we want you to explicitly
5 address me using -- and I will show you --
6 PARTICIPANT: Okay.
7 MR. TREGONING: -- NUREG -- I want -- what
8 if I use Rev 0, 6909? What do I do? Those sorts of
9 comments, so they wanted specifically to us address the
10 use of these prior existing NUREGs.
11 So I will have a comment that gets into
12 that, so we'll talk about that a little bit. In fact,
13 we will talk about it sooner rather than later.
14 Sample public comments and responses: so
15 this was one, you know, and I am only putting ones here
16 that I think are interesting or that we slash disagreed
17 on, so -- and I tried to find at least one from all of
18 these four topic areas. And I will be honest with you:
19 I struggled to find anything that was really that good
20 for the editorial or clarification comments.
21 So this is one that, you know, just shows
22 that we disagreed with it, but here is why. And, you
23 know, if you look at the Reg Guide, it is broken into
24 different sections, and Part D of the Reg Guide is the

1 implementation section, and it states there that the
2 guidance may be used to demonstrate compliance with the
3 -- with underlying NRC regulations. And the comment
4 said it would be useful to define the underlying
5 regulations, and then it goes on to say that the
6 background of the Reg Guide mentions 54.21, which is
7 license renewal regulation, but that would only apply
8 to renewed license applicants.
9 And then it goes on to say 54.21 addresses
10 and cites internal aging management reviews and TLAA
11 evaluations rather than the basis for environmentally
12 adjusted CUF analysis, and then we just clarified in
13 the response that the phrase "with underlying NRC
14 regulations" pertains to the applicable regulations,
15 which are defined earlier in the document, Part A and
16 Part C, and the purpose of Part C is not to restate that
17 information.
18 So Part D if you read it is mainly a lot
19 of boilerplate stuff. There is really not anything new
20 there, but again, so all that's in Part D is applicant
21 and licensee use of the Reg Guide and then NRC's planned
22 use of the Reg Guide. And like I said, it is pretty
23 much generic, not necessarily specific to this
24 particular guidance as well.

1 So again, I didn't think this is a great
2 example, but I tried to give you one example, really
3 the only one within this category where we didn't agree
4 with the comment. Otherwise, the editorial or
5 clarification questions that we've got we have tried
6 to address in some way.
7 Again, so here's the next group. These
8 were comments related to the Rev 1 technical basis, and
9 I pulled out an AREVA comment. And I didn't cover a
10 similar comment in the NUREG, but I can tell you that
11 we got some more comments of this in the NUREG, and I
12 will just summarize it.
13 Many do not agree with the direct
14 multiplication of the in-air design usage factors,
15 which, to be honest, we didn't do that anyway, that are
16 based on membrane types of loadings of small specimens.
17 And then it goes on to state, you know, this
18 conservatism is in addition to (a), quick
19 in-surge/out-surge types of loadings not being
20 considered; (b), favorable hold time effects not being
21 considered; (c), load sequence penalties being
22 incorporated into the factor of 12 although not
23 justified for nuclear plant applications, and it goes
24 on.

1 And at the end, it states why hasn't a
2 square root sum of squares of these factors be
3 considered? So instead of a Monte Carlo analysis, why
4 wouldn't you use something that you would do like an
5 uncertainty analysis, by doing a square room sum of
6 squares?
7 So, you know, in this case, we took the
8 comment, and we didn't -- if you read the responses to
9 the Reg Guide, they don't really respond to the comment
10 per se. It just basically says hey, we got a similar
11 comment to this in our public comments on
12 NUREG/CR-6909, and we tried to identify specifically
13 those comments that we got that are associated with
14 those same issues, and particularly for this comment,
15 we had NUREGs -- NUREG comments related to hold time
16 effects, surge loadings, and the basis of the factor
17 of 12, so we have tried to point that Reg Guide commenter
18 to the similar comments within the NUREGs so we're just
19 not replicating responses in both sets of documents.
20 So if you read those responses to the Reg
21 Guide comments that fall within the second category
22 that apply to the technical basis, in every case, we
23 have referred them to this other public comment
24 response document.

1 Okay. So this gets it -- we said we'd talk
2 about this, so this is a comment that we got on
3 applicability of prior guidance. And -- and we got one
4 of these for every NUREG, so every NUREG that we have
5 ever had guidance, we said what about this NUREG, what
6 about that NUREG? So I am just pulling this one out.
7 This said the draft guide does not clarify
8 if the use of NUREG/CR-6909 Rev 0 formulas remain
9 acceptable, and it goes on to state several license
10 renewal applicants have used Rev 0 methods and formulas
11 for computing FEN values and would not wish to revise
12 them just in order to meet Rev 1 criteria. And this
13 comment actually came from NEI.
14 And so we have disagreed that we need to
15 have explicit guidance for prior methods within the Reg
16 Guide, and we have tried to clarify in the response that
17 prior methods previously approved by the staff remain
18 valid for the period of their intended use. We don't
19 go back and revisit any decisions that we have made in
20 licensing space based on this Reg Guide at all.
21 We mention that for SLR, that we are -- as
22 part of that guidance, that we are going to try to
23 clarify at least for SLR use of prior methods that we
24 use for license renewal and how those were going to be

1 addressed within SLR, but we're going to include that
2 within the SLR-specific guidance documents themselves
3 and not this Reg Guide.
4 But we did -- what we have tried to do is
5 -- is clarify the intended use of this Reg Guide, and
6 we -- we have tried to put some statements in Part C
7 to modify that intended use statement accordingly.
8 Now, whether we -- we have achieved that or not still
9 remains to be seen, but that was the intent of some of
10 that new language in Part C.
11 The next set of comments, this is one
12 related to scope, use, and applicability, and this is
13 actually a good comment that covers a couple of
14 different issues, so I think I -- this is a Westinghouse
15 comment, and it goes on to say, you know, page --
16 Paragraph 2 states that quote "These methods apply to
17 those components exposed to reactor coolant that are
18 required by regulation to have a fatigue CUF evaluation
19 or have an existing current licensing basis, that is
20 CLB, fatigue CUF evaluation."
21 And then it goes on to state these
22 components that quote "have an existing CLB fatigue CUF
23 evaluation that are not exposed to reactor coolant but
24 are in secondary systems exposed to secondary fluid,"

1 it says they are not required by regulation to have a
2 fatigue CUF. And then it goes on to ask, "The
3 applicability of FEN factors to such components should
4 be clearly stated."
5 So what we have tried to do is at least
6 clarify what we think are applicable environments and
7 applicable analyses, so there's two things here. One
8 is this notion of reactor coolant versus water, so we've
9 said, look, we believe -- staff believes that the
10 methods described in the Reg Guide are applicable to
11 both primary and secondary systems. Again, if you're
12 above the thresholds for environmental effect, if
13 you're in reactor coolant water or secondary water,
14 you're still potentially going to see environmental
15 effects.
16 However, we do agree that the Reg Guide
17 does not clearly define the terms "reactor coolant" and
18 "coolant," so we went back through in the Reg Guide and
19 stripped out everywhere that we said "reactor coolant"
20 or "coolant" and just said "water," to make that
21 abundantly clear that we just mean water.
22 So that is what we did to address the first
23 part of that response, right? Now the second part of
24 the response, and all I have done here is to comment,

1 that's the same comment that we got before, so you see
2 that on the slide just for your own convenience. But
3 the summary is what is different, so this is the second
4 part of the requirement about the applicability of the
5 Reg Guide specifically in an existing licensing
6 application.
7 So there's two things that we would say are
8 required to consider environmental effects. One, the
9 component is required by regulation to have a CUF
10 evaluation, so you touched on that already a little bit.
11 And in one, a component has a CUF evaluation that may
12 not be required by regulation, but it's in their current
13 licensing basis, so they have it anyway even though it
14 is not required specifically by the regulation.
15 So we have tried to say if either -- if
16 either one or two above are true, then that needs to
17 be evaluated for subsequent -- depending on the period
18 of applicability for license renewal using GALL Rev 2
19 or GALL SLR for the subsequent license renewal period,
20 if both of those things are false, you don't have an
21 existing CUF calculation. You don't have to address
22 environment effects. And we have tried to -- we have
23 added clarifying language to the Reg Guide to make this
24 point -- or in an attempt to make this point even

clearer.

PARTICIPANT: What --

MEMBER SKILLMAN: Rob, let me --

PARTICIPANT: Oh, go ahead.

MEMBER SKILLMAN: The first bullet under summary, staff believes the methods described in Reg Guide are applicable to both primary and secondary systems. Some of the secondary heat exchangers are as large as the steam generator, some of the plants. Until I read that sentence and listened to what you said, I had pretty much said to myself this is applicable to reactor coolant system pressure boundary, and the steam boundary limited probably to the first valve out.

I wasn't thinking feedwater pumps, main feedwater heaters, reheaters. How is that boundary established in the Reg Guide so that we -- we don't have people deep in the secondary systems digging out CUF even though CUF might be needed from an ASME perspective?

MR. TREGONING: Right, so that boundary is not delineated in the Reg Guide. The Reg Guide just says if you have a CUF, you need to at least consider if environmental effects are important. Now for many

1 of these secondary systems, you probably can do a pretty
2 simple analysis to show that yes, we're not going to
3 -- we're not expecting environmental effects because,
4 again, either the strain rates are too high or the
5 temperatures are too low or the -- or the water, you
6 know, or the dissolved oxygen content of the water,
7 whatever it might be, don't meet those thresholds.
8 So it does not -- it does not say you have
9 to do a hardcore FEN analysis, it just means that you
10 have to think that environmental effects could be
11 important there, and you at least have to consider them
12 or determine if they're going to have an effect or not.
13 But again, that is only if you have a CUF calculation.
14 CHAIRMAN RICCARDELLA: Yes. I think a
15 lot of the components you're referring to were probably
16 ASME Class 2 --
17 MR. TREGONING: Yes.
18 CHAIRMAN RICCARDELLA: -- Section 8,
19 which really didn't have a CUF.
20 MR. TREGONING: So I think I don't want to
21 preclude that there wouldn't be some secondary
22 component out there that you would have a CUF
23 calculation for. I think it's a very small, maybe null
24 subset.

1 MEMBER SKILLMAN: No, I think Dr.
2 Riccardella is right. I think it is a very, very small
3 group. I would just kind of --
4 MR. TREGONING: So that's why we didn't
5 make an effort --
6 MEMBER SKILLMAN: I was putting --
7 MR. TREGONING: -- to have --
8 MEMBER SKILLMAN: -- in Westinghouse's
9 place writing that comment, trying to understand why
10 I would have written that comment. What might I be
11 trying to not --
12 CHAIRMAN RICCARDELLA: Right. I think --
13 MEMBER SKILLMAN: -- apply this to?
14 CHAIRMAN RICCARDELLA: I think you took
15 care of that by replacing reactor coolant with water.
16 MR. TREGONING: I think that -- and that
17 was one of the reasons --
18 CHAIRMAN RICCARDELLA: But let me go in
19 the other direction: what about reactor internals?
20 MR. TREGONING: What about reactor
21 internals?
22 CHAIRMAN RICCARDELLA: I mean, if you've
23 got some internals that are -- that do have CUFs
24 calculated -- I think some of them might -- then you

1 would be required to apply this --

2 MR. TREGONING: We would --

3 CHAIRMAN RICCARDELLA: -- under SLR.

4 MR. TREGONING: -- we would want them to

5 consider environmental effects. Now whether they

6 would do that through the application of this Reg Guide

7 or not, that would be another issue. But yes, we would

8 want them to consider environmental effects, if they

9 have a CUF calculation on those internal components.

10 MR. STEVENS: This is Gary. I have a

11 comment.

12 CHAIRMAN RICCARDELLA: Yes, go ahead,

13 Gary.

14 MR. STEVENS: So yes, I was going to make

15 two comments, but Pete, you addressed the first one as

16 far as out in the secondary system, I think those are

17 Class 2 and therefore, you know, that the rules don't

18 apply because you don't have CUF. An example of a place

19 in Class 2 where you probably do have a CUF that is

20 driven by regulation would be feedwater nozzles and PWR

21 steam generators.

22 CHAIRMAN RICCARDELLA: Right, right.

23 MR. STEVENS: Now regards to internals, so

24 let's talk about that for a minute. Keep in mind that

1 the guidance does not say that you must calculate CUFen
2 if you have a CUF, so in the case of internals for
3 example, a licensee may choose to manage EAF through
4 inspection.
5 MR. TREGONING: That is always the case.
6 Anything else, Gary?
7 CHAIRMAN RICCARDELLA: Wait. I don't
8 think I understand. I mean, if you have a CUF of your
9 internals, and that is part of your current licensing
10 basis, does -- doesn't this require you to -- you to
11 address environmental fatigue? Or -- or wouldn't it
12 be included? I guess it is not required. You can do
13 another technically acceptable alternative. But --
14 MR. STEVENS: Yes, okay. I will let --
15 the staff can maybe comment, but my position would be
16 that you need to -- your aging management program needs
17 to address environmental effects.
18 CHAIRMAN RICCARDELLA: Yes.
19 MR. STEVENS: And how you choose to do
20 that, there could be several ways, one of which is a
21 CUFen calculation and showing that to be acceptable.
22 There are other ways, including inspection.
23 CHAIRMAN RICCARDELLA: Yes.
24 MR. TREGONING: But that's -- that's just

1 not internals, Garry. That would be the only thing I
2 would comment on. That is really any component, right?
3 Any -- any component, right?
4 MR. SHACK: But for --
5 MR. TREGONING: Any -- any component, you
6 have that option.
7 MR. SHACK: -- internals, you might
8 question the applicability of the NUREG since there is
9 very little on irradiated materials there, and whether
10 that would change --
11 CHAIRMAN RICCARDELLA: Well, the NUREG --
12 MR. SHACK: -- behavior.
13 CHAIRMAN RICCARDELLA: -- the NUREG does
14 have a section on irradiation --
15 MR. SHACK: Yes, but there is --
16 CHAIRMAN RICCARDELLA: I think it says
17 there is no effect.
18 MR. TREGONING: It says based on the data
19 we've seen, we haven't seen a significant effect.
20 CHAIRMAN RICCARDELLA: Yes.
21 MR. TREGONING: But you're right, there is
22 a paucity of data, to say the least, on irradiation
23 effects, and that is an area to be quite honest with
24 you we have been talking to DOE and others about trying

1 to address in some way, because again, it is just not
2 much knowledge out there. There's some data sets, and
3 you know -- and I think quite frankly, I think if there's
4 a detrimental effect, it would be within the low cycle
5 fatigue regime. I think within the high cycle fatigue,
6 it might actually be a beneficial effect because you
7 are --
8 MR. SHACK: Strengthening.
9 MR. TREGONING: -- you are strengthening
10 the material. So to me, if we were going to actually
11 do something in this area, I would want to focus on sort
12 of the more higher plasticity low cycle fatigue regime.
13 But that remains to be seen, whether we are
14 able to actually do some work. Like I said, we are
15 trying to partner with -- or we are trying to spur DOE
16 on for some activities here. Dr. Powers mentioned that
17 sometimes, they are better equipped to deal with these
18 more fundamental issues, and -- and might have better
19 resource availability to address some of these things
20 that also can be very pricey, so I think this is a great
21 PhD topic for instance, so -- .
22 CHAIRMAN RICCARDELLA: You know, let me
23 just address something. Gary, you said you could
24 address internals by inspection, but I assume it is not

1 just inspection, it is not just inspection, it is
2 inspections plus some sort of a flaw tolerance analysis
3 out into the future, right?
4 MR. STEVENS: Yeah, right. There would
5 have to be justification that whatever you are
6 inspecting occurs at the right frequency and you are
7 adequately managing the degradation mechanism.
8 CHAIRMAN RICCARDELLA: Understood.
9 Thank you.
10 MR. TREGONING: And thanks, Gary. Any
11 other discussion on that point?
12 (No audible response.)
13 MR. TREGONING: Okay. The last topic --
14 I mentioned there were three comments that could not
15 really group into any of the other comments, so I threw
16 that in miscellaneous, and I took again probably the
17 most interesting/controversial one that I want to
18 highlight here in Slide 52.
19 And the first comment was, you know,
20 introduction of Part C, it says Appendix A to that
21 report includes detailed descriptions and additional
22 guidance concerning the overall method and all the
23 required calculations. And the comment was kind of
24 wryly stated: look, Appendix A does not -- it is not

1 insufficient to develop practical engineering
2 procedures, and it goes on to say this is especially
3 true for analyses according to ASME sub-article
4 NB-3600, and just the further point that look,
5 insufficient guidance leads to the development of
6 individual methods with a greater risk of higher
7 operation and regulatory cost in the future.
8 So the gist of the comment was that we're
9 not overly prescriptive, and we don't say do Step A then
10 Step B then Step C following this rigorous set of
11 procedures. We provide an approach and a method, but
12 we recognize that there's a lot of different fatigue
13 analyses and assumptions that go into these analyses,
14 so this method is really designed to be general, and
15 it is designed to be used by someone that's an expert
16 in this area that understands the effect of other
17 assumptions within the analysis.
18 And for us to develop something
19 prescriptive that would try to account for all the
20 variability that's out there in fatigue analyses would
21 have just been an almost intractable problem. So
22 again, we have tried to develop a general method. So
23 we are not disagreeing with the comment. Yes, we
24 agree, it is not fully prescriptive, and that there is

1 some degree of application and assumptions that need
2 to still go into the application of -- of this method.
3 But again, the approach is tried -- we have
4 tried to design it to give the analyst, the person
5 that's using it, flexibility, right? And again, that
6 is another reason that we added this example problem,
7 was to try to at least show people the intent and the
8 general approach for using this method.
9 But we did agree that the quote that we had
10 that said that we have, you know, sufficiently detailed
11 descriptions was probably misleading, and that we went
12 and changed that and just said, look, we are providing
13 a general method, right, for you to account for
14 environmental effects.
15 So that was it as far as a snapshot of the
16 comments, and let me talk about changes to the Reg Guide
17 itself. And before I talk about changes, I at least
18 wanted to -- since I didn't do it anywhere else, I wanted
19 to at least cover what the Reg Guide looks at.
20 Part A is the introduction, and it covers
21 the purpose, applicable rules and regulation, and
22 related guidance. And again, I have sort of only
23 brought out here sort of the unique sections of the Reg
24 Guide and subsections that are unique to this

1 particular Reg Guide. There are other sections in
2 here, but they are pretty much boilerplate, so I am not
3 really covering those here.
4 And then there is a discussion part which
5 includes the reason why we're making this revision as
6 well as background. And then of course the true guts
7 of the Reg Guide is the regulatory positions section,
8 Section C, and there's three subsections, one on carbon
9 and low alloy steels and welds, one on wrought and cast
10 austenitic stainless steels and welds, and one on
11 nickel-chrome-iron alloys and welds.
12 And each of those subsections have
13 sub-subsections on each of the following areas: they
14 talk about -- they provide guidance for CUF in air
15 calculations, environmental factor or correction
16 factor, FEN, calculations, and then ultimately the
17 environmental CUF calculations. And then, as I
18 mentioned, there is an implementation section, and
19 followed by references, which is not a -- an
20 alphabetical section.
21 So I have talked about -- I think I have
22 covered most of these in general so far. There were
23 only a few of what I consider major changes to the Reg
24 Guide -- or, I am sorry, the -- yes, the Reg Guide, as

1 a result of public comment. One is that we --
2 everywhere it said "reactor coolant" or "coolant," we
3 have just changed it to "water," including the title.
4 And we actually did that -- as I mentioned earlier, we
5 made companion changes to the NUREG itself, so even the
6 NUREG title, we're, you know, planning to change the
7 NUREG title to "water" in the revision instead of
8 "reactor coolant."
9 We have tried to characterize the
10 applicability of the Reg Guide, and again, that would
11 be new applications, new licensing applications that
12 require CUF calculation or existing calculations that
13 are required by regulation as part of the current
14 licensing basis that -- that they want to, again, extend
15 -- extend in some way, so not -- the application itself
16 for the period of its intended use, there's no changes
17 that are required. It's only if they want to take that
18 existing application and extend it to another period,
19 like for subsequent license renewal.
20 MEMBER SKILLMAN: Rob, let me ask this --
21 MR. TREGONING: Yes.
22 MEMBER SKILLMAN: -- just to get me
23 calibrated. You're on Slide 55 --
24 MR. TREGONING: Yes.

1 MEMBER SKILLMAN: -- and the title is
2 "Summary of Revised NUREG: Summary of Major Changes."
3 If you go back to 54, it is "Summary of Reg Guide 1.207."
4 Are you on 1.207, or are you on the NUREG?
5 MR. TREGONING: I am on the Reg Guide. I
6 am --
7 MEMBER SKILLMAN: You're on the Reg Guide?
8 MR. TREGONING: -- sorry, when -- if I said
9 NUREG, I --
10 CHAIRMAN RICCARDELLA: No, the title, the
11 title --
12 MR. TREGONING: The title is wrong. I
13 apologize. I apologize.
14 MEMBER SKILLMAN: Good, okay --
15 MR. TREGONING: Yes.
16 MEMBER SKILLMAN: -- I was just trying to
17 make sure I --
18 MR. TREGONING: You caught something that
19 no one else caught, so I appreciate you -- even me, I
20 have looked at these slides a lot, so yes, I apologize
21 for that title.
22 MEMBER SKILLMAN: You're on the Reg Guide?
23 MR. TREGONING: I'm on the Reg Guide. I
24 apologize for the incorrect title, so that should read

1 "Summary of Revised" --

2 MEMBER SKILLMAN: You passed the test.

3 MR. TREGONING: And I hope I didn't say it

4 any -- anything else in this section is pertaining to

5 the Reg Guide.

6 MEMBER SKILLMAN: All right.

7 MR. TREGONING: I just want to see if I --

8 MEMBER SKILLMAN: Thank you.

9 MR. TREGONING: So I butchered it on that

10 slide. I probably butchered it the rest --

11 CHAIRMAN RICCARDELLA: The title --

12 MR. TREGONING: -- butchered it the rest

13 of the way through here, so these next three slides --

14 CHAIRMAN RICCARDELLA: Should be Reg

15 Guide.

16 MR. TREGONING: -- you know, should all be

17 Reg Guide, so thank you for -- thank you for catching

18 that.

19 Now the ACRS staff has found other -- other

20 problems with this, so --

21 PARTICIPANT: No, I --

22 MR. TREGONING: I am going to say it's

23 management's fault. They didn't review these things

24 adequately enough before they --

1 (Laughter.)

2 MR. TREGONING: No, it is clearly my

3 fault, so I apologize for that.

4 So we did try to be clear that at least as

5 of now, that the guidance isn't applicable for 718, so

6 we actually state that in the Reg Guide, again, due to

7 lack of data; and that we clarified that at least that

8 the nickel-chrome-iron alloys should use the stainless

9 steel design curves, either in NUREG 6909 Rev 1 or ASME

10 Code Section III. They are the same, so pick them from

11 whatever source you want, just clarify that point.

12 And so then just like I did for the NUREG,

13 for the Reg Guide, these are the changes by section.

14 Again, the introduction, the only significant thing,

15 we're changing "coolant" to "water." In the

16 discussion, we actually define what we mean by an LWR

17 water environment, so we add a sentence there. We

18 clarified the use of the method for the

19 nickel-chrome-iron alloys in the discussion section.

20 We provided some rationale for that adjustment factor

21 of 12 on life, and again applicability of 718.

22 Under the regulatory position section,

23 again, changed "coolant" to "water." This is where we

24 had the discussion on applicability of the Reg Guide

1 to either new or existing licensing applications, and
2 -- and clarified also, because we called out specific
3 curves in the NUREG reference, so we wanted to make sure
4 that we were using exactly the same language that's in
5 the NUREG. We didn't have exactly the same language
6 before, so we make sure we have that language.
7 And implementation, again, we just said
8 that with any regulatory guidance, you can either use
9 it in whole or in part. You don't have to use an entire
10 regulatory guide method. You can pick out parts of it
11 as are applicable and as you are able to justify.
12 So that is it with respect to the Reg Guide,
13 and then I've got a slide on at least the current status
14 and next steps. So before I go to that, are there any
15 other questions or comments? I know we went through
16 the Reg Guide pretty quickly, but again, most of the
17 meat was really on the NUREG, so there is not a lot
18 really with respect to the Reg Guide. If you did a red
19 line strike out of the Reg Guide, it's not that
20 different, the version now between the version that
21 went out as a draft for public comment.
22 (No audible response.)
23 MR. TREGONING: Okay. So no other
24 questions. I will move on to current status and next

1 steps.

2 And as far as status, and I apologize for

3 this, we are a little bit out of sync in that this

4 document is undergoing inter-agency concurrence now,

5 so I've had meetings with NRR and NRO and tried to at

6 least within the version that we have now reflect the

7 intent of the staff, but what --

8 MEMBER POWERS: Why do you call it

9 inter-agency and not intra-agency?

10 MR. TREGONING: Okay. I think

11 intra-agency would have been correct, so yes, I made

12 a grammatical error. So duly noted by --

13 MEMBER POWERS: Unless you're sending it

14 out to DOE --

15 MR. TREGONING: No --

16 MEMBER POWERS: -- or --

17 MR. TREGONING: -- I am not sending it out

18 to DOE --

19 MEMBER POWERS: -- DOJ or DoD? You may be

20 interested in DoD, or NRR, anyway.

21 MR. TREGONING: We at least have two

22 errors in the slide. If those are the only two, I am

23 happy, so --

24 (Laughter.)

1 MR. TREGONING: -- so yes, it's
2 intra-agency concurrence, so sorry.
3 And I recognize we're a little bit out of
4 process. Ideally, we would have gone through all the
5 office concurrence before we came to you guys to present
6 this. Now the reason that we did not is it is just
7 really schedule-related.
8 Based on your schedule, it was now, or it
9 was mid-2017. There really was not other
10 opportunities. So if I had -- in a perfect world, I
11 would have waited a month or two, gotten all my ducks
12 in a row, and then come here and said yea, verily, here
13 is the guidance, it has been concurred by staff, and
14 we --
15 MEMBER POWERS: The only difficulty that
16 arises from this, and the reason we usually don't review
17 these things, if there is any major change as a result
18 of the concurrence process.
19 MR. TREGONING: And I -- look, I do not
20 want to -- I do not want to try to predict --
21 MEMBER POWERS: You can't.
22 MR. TREGONING: -- what the concurrence
23 process --
24 MEMBER POWERS: You can't --

1 MR. TREGONING: -- is going to uncover --
2 MEMBER POWERS: -- but --
3 MR. TREGONING: -- I think -- in fact, I
4 expect there will be some changes. I don't expect
5 there will be significant technical changes. What I
6 expect is there will be -- there could be changes
7 related to these scope and applicability statements,
8 right? I could clearly see that, because again, we are
9 trying to make sure that -- we are trying to consider
10 existing reactor applications as well as new reactor
11 applications, and we just have to make sure that we sort
12 of serve both of those constituencies within the agency
13 because they both might have occasion to use this
14 document.
15 Sometimes each party reads it with their
16 own perspective in mind, so we just -- the final
17 language needs to be consistent from that perspective.
18 MEMBER POWERS: And that is fine, but when
19 you come to the Full Committee, that has to be resolved.
20 MR. TREGONING: So again, and why now
21 versus waiting till mid-2017? Well, as I mentioned
22 before, we -- this needs to get out in advance of the
23 GALL guidance because the GALL guidance says now, hey,
24 use this Reg Guide. So that was always the staff's

1 plan, to get this guidance issued first.

2 So again, I apologize. I think, you know,

3 there will likely be -- because I have been through

4 enough of these concurrence processes -- there will

5 likely be some changes resulting from concurrence in

6 the Reg Guide.

7 And again, as part of that concurrence

8 package, the NUREG as well as the public comments and

9 all the responses to comments are being concurred upon

10 now. And like I said, I am sure we will -- the other

11 thing that is going to be needed potentially is some

12 of the responses to public comments, even as we have

13 gone through technical editing and things like that,

14 we have made some minor modifications that we'll need

15 to go back through the public comments and make some

16 tweaks. Just sometimes we have quoted changes in the

17 NUREG, and we made actually changes, actual quotes, so

18 we are going to have to make some minor conforming

19 changes to those public comment responses, but again,

20 nothing significant will be made -- there will not be

21 anything significant in my opinion made to the

22 responses to the public comments at this point.

23 With respect to NUREG/CR-6909, we have

24 completed the technical editing review. We are still

1 incorporating some of the final changes from that, and
2 again, as a result of that, we might need to make some
3 conforming changes.
4 So ultimately, we are going to request ACRS
5 recommendation to finalize Reg Guide 1.207, and we are
6 hoping that we get this finalized before the issuance
7 of the SLR guidance. I think right now, we are
8 tentatively on the schedule to go in front of the main
9 committee in February.
10 CHAIRMAN RICCARDELLA: Yes.
11 MR. TREGONING: Certainly by February,
12 the expectation is everything -- we should have
13 completed the concurrence process by that point, and
14 we should have the final guidance as well as everything
15 finalized by the time we need to go in front of the main
16 committee. So there will be some changes, and I am --
17 I am -- I apologize for that, but I am hopeful that there
18 will not be anything that will be significant. And I
19 don't expect there will be anything significant from
20 a technical nature. And so that was all I've got.
21 CHAIRMAN RICCARDELLA: So I think, you
22 know, we're intending -- or my recommendation is going
23 to be for the main committee to write a letter on this
24 in February. I think that that letter won't just be

one on the Reg Guide, but it will have to refer to the NUREG as well --

MR. TREGONING: Sure.

CHAIRMAN RICCARDELLA: -- since all the technical need is in the NUREG.

MR. TREGONING: Yes, yes, I think that is reasonable.

CHAIRMAN RICCARDELLA: Okay. Okay. So if you are done, Theron, if we could open the -- the outside line for comments? We have had comments from Gary. Is there anybody else on the outside line? If so, would you please speak up?

(Pause.)

CHAIRMAN RICCARDELLA: Okay. I --

MS. GRAHAM: Hello, this -- hello, can you hear me?

CHAIRMAN RICCARDELLA: Yes we can.

MS. GRAHAM: Hi, this is Erica Graham calling from Richmond, Virginia.

Well, I first want to mention that I -- I did ask Christopher Brown for the slides, and he said he would send them to me, but of course I did not receive them. He mentioned that there were some virus issues and whatnot. They were having problems I guess at the

1 NRC, so of course I am kind of disappointed that I could
2 not follow along the slides because I was never given
3 the presentation.
4 So that's the first thing. I guess the
5 second thing would be I heard -- and excuse me for not
6 being able to kind of follow on, take notes so well on
7 such a long meeting -- but it was mentioned that the
8 NRC has never granted an extension for I guess it was
9 a greater than a 1, I guess when we are talking about
10 cracking, and then it was kind of I guess not -- I am
11 not totally sure exactly what exactly you were saying
12 because I know with the -- I live in Virginia, Dominion
13 is one of the licensees that is applying for an extended
14 license to take the plant to 80 years, the Surry plant.
15 And so if no extension has ever been given
16 for a size 1, how do we -- how do we know -- how do we
17 know if they have a size 1 or not at Surry?
18 PARTICIPANT: So I think I --
19 MS. GRAHAM: What tests are they doing to
20 be able to -- to qualify for that license extension?
21 MEMBER BLEY: This is Dennis Bley on the
22 committee. As a FACA committee, we only speak through
23 our letters so that we don't engage with comments at
24 this time. We'll receive your comments and consider

1 them, and our full transcript and all the slides will
2 be published on the website within about a week or two,
3 probably two weeks until we get the transcript back,
4 so you can see all the details at that time.
5 MS. GRAHAM: Okay. Well, I guess it will
6 be interesting to see how that plays out because if no
7 license has ever been granted for more than a 1, surely
8 by this point we probably got cracks and whatnot in some
9 of the facilities. So I guess you can't really answer
10 that.
11 And then also, I am not really sure about
12 when you all say that if it's greater than a 1 on the
13 crack analysis, then I guess the licensee can't
14 negotiate with the NRC about inspecting every 10 years
15 or so. This doesn't sound like that is much of a true
16 kind of formal way of knowing what you will do, if you
17 have more than a grade of 1, so I am a little concerned
18 about that.
19 CHAIRMAN RICCARDELLA: The word
20 "negotiate" wasn't used. It was do additional
21 analysis in accordance with the ASME codes.
22 MS. GRAHAM: Well actually, someone did
23 use the word negotiate. That's why I wrote down the
24 note, so hopefully there will be some real meaningful

1 ways to know about that inspecting every ten years or
2 so, because I was on a call at one point where they were
3 telling Dominion that they could be able to write it
4 up so that somehow, that they could go beyond that ten
5 years, so I am not really sure how you all will write
6 that up.
7 But needless to say -- and I am not sure
8 about when you were talking about what's required now,
9 it said no guidance or requirements at all for operating
10 reactors. I am hoping that we are being very careful
11 as these aging plants -- as these facilities are aging
12 and we can probably expect more problems to occur, so
13 I am hoping the NRC really addresses those issues.
14 And I guess finally, you know, I am not
15 really sure how -- how this committee, the subcommittee
16 is addressing the issue, but I did see that the Wall
17 Street Journal the other day on December 13th came up
18 with a story about the cover-up of French nuclear
19 supplier sparks global review. Inspector says AREVA
20 unit files suggest manufacturing flaws in critical
21 parts were covered up for decades.
22 Dominion is mentioned for their millstone
23 plant having one of those components, and I am assuming
24 -- it seems like this industry relies heavily on AREVA,

1 in particular on guidance, and obviously because of
2 their parts and manufacturing. I think we need to be
3 extremely careful in going over the data and whatnot
4 from AREVA because there seems to be an issue, and I
5 am not sure what components are -- because it mentions
6 nine other U.S. facilities were mentioned, but it's
7 only Dominion's name was put out for millstone, so I
8 don't know if some of those components are also in the
9 -- evidently the two -- I know Dominion is one -- for
10 their subsequent license renewal for Surry. I am not
11 sure what components might be also from that same
12 manufacturer, so I have concerns there.
13 But like usual, for most of the guidance
14 and regulations and whatnot I have noticed over the
15 years for the NRC, it is always typically these generic
16 guidances. I am sure hoping that safeguards are put
17 in and making them more conservative because I am very
18 disturbed to hear any time it is mentioned that things,
19 especially from NEI or whoever, that they are too
20 conservative. Well I think the issues at Fukushima and
21 the ongoing huge disaster there, I don't believe there
22 is a tie-in to the words of "too conservative" when it
23 comes to nuclear energy, so I would hope that we go way
24 beyond conservative when it comes to nuclear energy and

1 how we are using it.

2 And I guess that is all I have. Thank you.

3 CHAIRMAN RICCARDELLA: Okay. Thank you

4 for your comments. I don't see anybody else in the

5 room, members of the public in the room, so at this point

6 we will go around the room for member comments.

7 Charlie, do you have any comments?

8 MEMBER BROWN: No additional comments.

9 CHAIRMAN RICCARDELLA: Walt?

10 MEMBER KIRCHNER: No additional, thank

11 you.

12 CHAIRMAN RICCARDELLA: Dennis?

13 MEMBER BLEY: Yes, a few. I am thinking

14 forward to our Full Committee meeting, and I know you

15 will have to negotiate with staff some. My own

16 thoughts are, you know, you will get an hour-and-a-half

17 to two hours. I would do most of the tech, but maybe

18 simplify it a little bit, and really summarize your

19 responses to the comments, pretty short, and especially

20 for us highlight any changes that occur between now and

21 then with the technical side or the applicability.

22 I don't know if we will cover it in our

23 letter, but this idea that conservatism elsewhere, like

24 in the ASME Code, is a reason not to consider the

environmental effects when we know there are environmental effects just doesn't work. One can consider those other conservatisms and deal with them, but we don't have any way to know the true extent of the conservatisms over there under all situations, so that does not work.

I would like to compliment the staff. I think you guys did the most thorough job of responding to comments that I have seen and incorporating them in a way everybody can see how it was dealt with. Thanks a lot.

CHAIRMAN RICCARDELLA: Matt?

MEMBER SUNSERI: I appreciate the review. It was a very thorough review of the changes to the Reg Guide, and being a new member, it really helped me come up to speed, so thank you very much.

CHAIRMAN RICCARDELLA: And Dick, do you?

MEMBER SKILLMAN: I agree with Matt and Dennis. Thank you. Very thorough job, very comprehensive presentation. Thank you.

CHAIRMAN RICCARDELLA: And finally, our consultant, Bill Shack?

MR. SHACK: No, I -- you know, I think the staff has done an excellent -- has done an excellent

1 job in responding to the public comments. I mean, this
2 is the sort of topic that is never finished. You know,
3 it is a very complex thing.
4 And I would echo Dennis's thing. It is
5 very difficult to deal with conservatisms. You know,
6 when you don't really understand the uncertainties,
7 removing one piece of conservatism sort of leaves you
8 with an unanswered question, and it's, I mean, you're
9 either going to do a full-blown uncertainty analysis
10 or you're going to do conservative analyses, and it is
11 very difficult to get something in between. And I
12 think the staff has tried to eliminate conservatisms
13 to I think the sort of feasible or technical extent,
14 and -- and you're really going to have to take a much
15 more unified approach to go much further.
16 CHAIRMAN RICCARDELLA: Okay. Thank you.
17 I too agree that it was an excellent presentation, and
18 the staff has done a meticulous job of organizing and
19 addressing the comments received, and I look forward
20 to an abbreviated presentation in February, Full
21 Committee, and as I said, we will plan to make our
22 recommendations in a letter at that time.
23 If there is nothing else --
24 MR. THOMAS: Just again, thank you for the

1 opportunity. Yes, thank you for the opportunity again
2 for the staff to come before you and make this
3 presentation. I too want to compliment Rob and the
4 rest of the staff. I thought it was a pretty
5 comprehensive job, a job well done.
6 Thanks for the comments, the concerns. I
7 am -- one takeaway for me is your comment, Dr. Bley,
8 that has to do with the -- the quality of the report,
9 the way we approached the integration of the resolution
10 of the comments into the report. I will take that back.
11 We have a group that focuses on quality reviews of our
12 products, so I will take that back to them to see.
13 Well, we will have to talk more about that and your
14 appreciation of that and how we can continue that sort
15 of method, but thank you very much.
16 CHAIRMAN RICCARDELLA: Okay. So with
17 that, the meeting is adjourned.
18 (Whereupon, the above-entitled matter
19 went off the record at 11:33 a.m.)
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Regulatory Guidance for Evaluating the Effects of Light Water Reactor Water Environments in Fatigue Analyses of Metal Components

(Proposed Revision 1 to Regulatory Guide 1.207)

Rob Tregoning
Nuclear Regulatory Commission

Gary Stevens
Structural Integrity Associates

Omesh Chopra
Argonne National Laboratory (retired)

Meeting of Advisory Committee on Reactor Safeguards
Metallurgy and Reactor Fuels Subcommittee
Thursday, December 15, 2016
NRC Headquarters
Rockville, MD

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Issue Summary

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- Revising guidance for environmentally assisted fatigue (EAF)
  - Regulatory Guide (RG)
    - Draft Regulatory Guide DG-1309, "Guidelines for Evaluating the Effects of Light Water Reactor Coolant Environments in Fatigue Analyses of Metal Components"
  - Supporting technical basis
    - Draft NUREG/CR-6909, Revision 1, "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials"
- Briefed ACRS - Metallurgy and Reactor Fuels (December 2014)
- Released both draft documents for public comment (2014 – 2015)
- Received public comments on both documents (2014 – 2015).
- Developed responses to comments (2015 – 2016)
- Modified documents as a result of public comments (2015 – 2016)
- Soliciting ACRS support for final regulatory guidance (2017)
- Planning to finalize regulatory guidance for EAF in support of subsequent license renewal (2017)

Meeting Agenda

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- Background
  - Environmentally Assisted Fatigue (EAF)
  - Related regulations and NRC guidance on EAF
  - Proposed revision of NRC guidance
- NUREG/CR-6909, Revision 1
  - Overview of public comments
  - Sample public comments and responses
  - Changes to document
- Revision 1 of Reg. Guide 1.207
  - Overview of public comments
  - Sample public comments and responses
  - Changes to document
- Current status and next steps

Background:
Environmentally Assisted Fatigue (EAF)

Cumulative Usage Factor (CUF)

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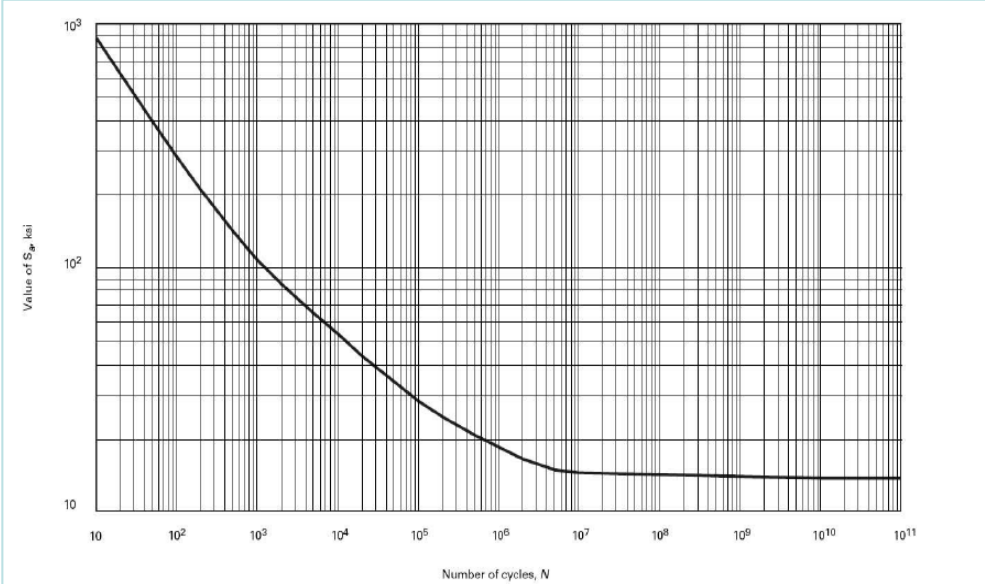
- For nuclear plant design, cumulative fatigue damage due to applied cyclic loading is estimated using cumulative usage factor (CUF)

$$\mathbf{CUF} = \sum_{\mathbf{i}}^{\mathbf{Z}} \frac{\mathbf{n}}{\mathbf{N}} = U_1 + U_2 + U_3 + \ldots + U_Z < 1.0$$

where: *n is the applied number of cycles for load i*
N is the allowable number of cycles for the stress associated with load i
Z is the number of applied loads

- N is a function of the alternating stress, S_a, applied to a component, and is material dependent
- S-N design curves ("fatigue curves") are provided in ASME Code, Section III, Mandatory Appendix I for different materials
- ASME fatigue curves are based on best fits of air test data with design factors applied to account for aspects such as data scatter, size effect, surface finish, atmosphere



GENERAL NOTES:
(a) $E = 28.3 \times 10^6$ psi
(b) Table I-9.2 contains tabulated values and a formula for an accurate interpolation of this curve.

FIG. I-9.2M DESIGN FATIGUE CURVES FOR AUSTENITIC STEELS, NICKEL–CHROMIUM–IRON ALLOY, NICKEL–IRON–CHROMIUM ALLOY, AND NICKEL–COPPER ALLOY FOR TEMPERATURES NOT EXCEEDING 425°C

Example Fatigue Curve

Environmentally Assisted Fatigue

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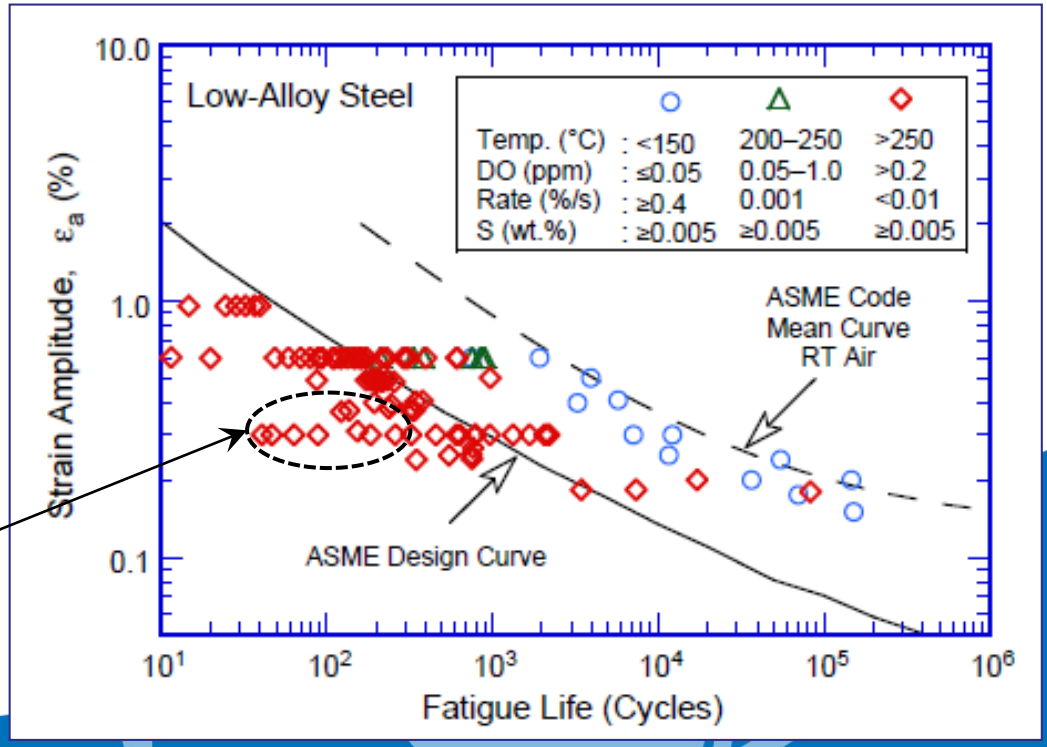
- ASME Code Section III fatigue curves developed from small-scale, polished specimens tested in **air**
  - Develop best-fit log-log curves for each material type
  - Adjust best-fit curves for worst-case mean-stress effects using modified Goodman relationship
  - Apply factors* of 2 on strain amplitude (e_a) or 20 on cycles (N), whichever is more conservative, to develop **air** design curves for each material

- Laboratory testing of specimens tested in water show that the air design curves may not adequately define fatigue life for materials exposed to water

*Some of the tests in **water** fall below the **air** design curve.*



Environmental Fatigue Correction Factor

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- Environmental fatigue correction factor (**F_{en}**) is defined as the ratio of fatigue life in air at room temperature to the fatigue life in water:

$$F_{en} = N_{air}/N_{water}$$

- F_{en} is multiplicative to the calculated CUF in air:

$$CUF_{en} = U_1 F_{en,1} + U_2 F_{en,2} \ldots\ldots U_Z F_{en,Z}$$

- From Revision 0 of NUREG/CR-6909 for stainless steel materials

$$F_{en} = \exp\,[0.734 - T'\ O'\ R']$$

where:

T' = transformed temperature:

T' = 0	for temperature, T ≤ 150°C
T' = (T – 150)/175	for 150 < T < 325°C
T' = 1	for T ≥ 325°C

O' = transformed oxygen:

O' = 0.281	for all fluid dissolved oxygen levels

R' = transformed strain rate:

R' = 0	for strain rate, R ≥ 0.4%/s
R' = ln(R/0.4)	for 0.001 ≤ R < 0.4%/s
R' = ln(0.001)	for R < 0.001%/s

Background:
Related Regulations and NRC Guidance on EAF

Related Regulatory Requirements

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Title 10 of the Code of Federal Regulations (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities, Appendix A, "General Design Criteria for Nuclear Power Plants"

- General Design Criterion 1

  Safety related SSCs must be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function performed
- General Design Criterion 30

  Components included in the reactor pressure boundary must be designed, fabricated, erected, and tested to the highest practical quality standards
- 10 CFR 50.55a (c), endorses ASME Code for design of safety-related systems and components (Class 1)
  - ASME Code, Section III fatigue design curves
  - Fatigue design curves do not address the impact of the water environment
- **Regulatory Guidance on EAF exists to provide an acceptable method for addressing the impact of water environment on fatigue calculations**

Regulatory Guidance on EAF

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- Initial NRC research efforts related to EAF
  - Chopra, O. K., and W. J. Shack, “Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low–Alloy Steels,” NUREG/CR–6583, 1998.
  - Chopra, O. K., “Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels,” NUREG/CR–5704, 1999.
- These NUREGs provided basis for guidance for license renewal applicants in the initial release of NUREG-1801, “Generic Aging Lessons Learned (GALL) Report” (2001)
  - Chapter X.M1, “Metal Fatigue of Reactor Coolant Pressure Boundary”
- Updated and consolidated EAF technical basis
  - Chopra, O. K., and W. J. Shack, “Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials – Final Report,” NUREG/CR–6909, Feb. 2007.

Regulatory Guidance on EAF, cont.

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- Operating reactors
  - Original licensing period: No guidance or requirements for considering EAF
  - License renewal period: Recent applicants use NUREG-1801, Rev. 2
    - Carbon steel: May use either NUREG/CR-6583, NUREG/CR-6909, <u>or</u> NRC-approved alternative
    - Stainless steel: May use either NUREG/CR-5704, NUREG/CR-6909, <u>or</u> NRC-approved alternative
    - Ni-Cr-Fe alloys: May use NUREG/CR-6909 <u>or</u> NRC-approved alternative
  - **Subsequent license renewal period: Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report (NUREG-2191) – draft for comment**
    - **All materials: May use NUREG/CR-6909, Revision1 <u>or</u> NRC-approved alternative**
- New reactors
  - RG 1.207, "Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components Due to the Effects of the Light Water Reactor Environment for New Reactors" March 2007.
  - Technical basis for RG 1.207 is NUREG/CR-6909
  - Both RG 1.207 and proposed Revision 1 of RG 1.207 use the F_{en} method summarized in Appendix A of the NUREG.

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Background:
Proposed Revision of NRC Guidance

Revision of Reg. Guide 1.207:
Draft for Public Comment

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- Rationale for revision
  1. Consolidate all EAF guidance
  2. Update the guidance based on stakeholder feedback
  3. Update the guidance based on all available research data
- RG 1.207 significant revisions
  1. The RG was made applicable to all LWRs
  2. The guidance was clarified to apply to all metal components exposed to LWR environments that have a CUF calculation required by a plant's current licensing basis (CLB)
  3. The background section was revised to incorporate the relevant content for operating reactors, license renewal, etc.
  4. The F_{en} equations were revised based on stakeholder feedback and the updated research as documented in NUREG/CR-6909, Rev. 1

Updated Air Fatigue Data

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Material	Data in NUREG/CR-6909, Rev. 0	Data in NUREG/CR-6909, Rev. 1	Increase*
Carbon Steels	153 points (8 heats) [Figure 7(a) of Rev. 0]	254 points (19 heats) [Figure 32(b) of Rev. 1]	66 %
Low-Alloy Steels	358 points (19 heats) [Figure 7(b) of Rev. 0]	430 points (22 heats) [Figure 32(d) of Rev. 1]	20 %
Austenitic Stainless Steels	357 points (38 heats) [Figure 35 of Rev. 0]	622 points (40 heats) [Figure 45(b) of Rev. 1]	74 %
Ni-Cr-Fe Alloys	Not quantified [Figures 56 & 57 of Rev. 0]	559 points (45 heats) [Figures 50 – 52 of Rev. 1]	N/A

* The majority of additional data from Report No. JNES-SS-1005.
* NRC gratefully acknowledges the release of the Japanese EAF research data. The NUREG revisions would not have been as comprehensive without this information.

Updated Water Fatigue Data

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Material	Data in NUREG/CR-6909, Rev. 0	Data in NUREG/CR-6909, Rev. 1	Increase*
Carbon Steels	318 points (12 heats) [Figure 27 of Rev. 0]	638 points (21 heats) [Figure 79 of Rev. 1]	100 %
Low-Alloy Steels	327 points (13 heats) [Figure 27 of Rev. 0]	536 points (20 heats) [Figure 79 of Rev. 1]	64 %
Austenitic Stainless Steels	276 points (14 heats) [Figure 52 of Rev. 0]	683 points (32 heats) [Figure 108 of Rev. 1]	147 %
Ni-Cr-Fe Alloys	Not quantified [Figures 58 & 59 of Rev. 0]	162 points (13 heats) [Figures 109 – 110 of Rev. 1]	N/A

* The majority of additional data from Report No. JNES-SS-1005.
* NRC gratefully acknowledges the release of the Japanese EAF research data. The NUREG revisions would not have been as comprehensive without this information.

Changes to Air Fatigue Curves

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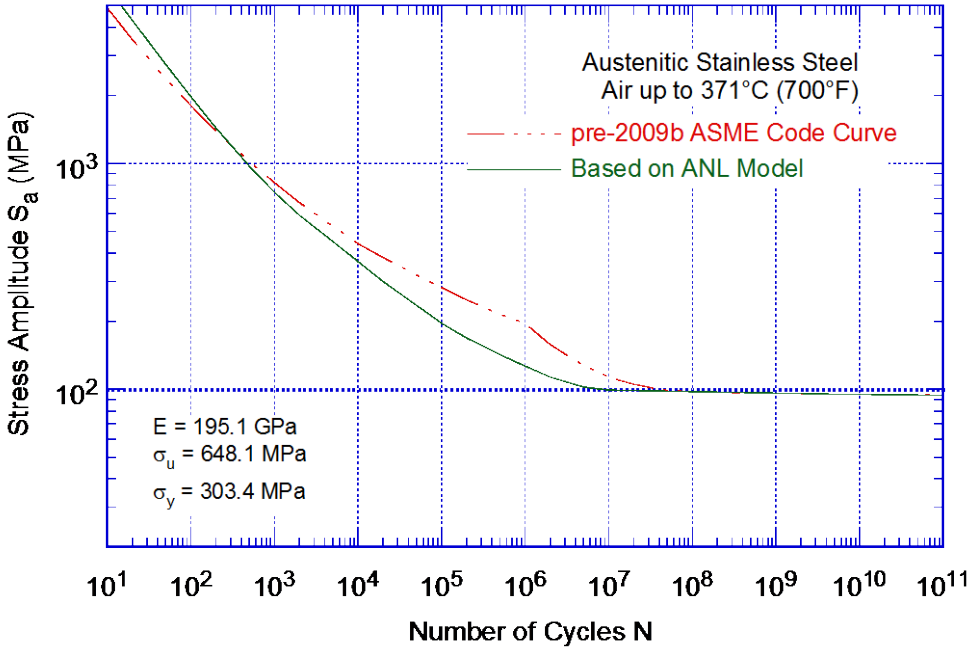
- Best-fit mean-data air curves are the same between NUREG/CR-6909, Rev. 0 and Rev. 1 for all materials
- Adjustment factors developed using Monte-Carlo analysis
  - Account for surface finish, material variability, size effects, and loading history
  - Chosen as the 95th percentile of the MC results
  - Carbon steel – 10; low-alloy steel – 9; stainless steel – 9.6
  - **Requested public feedback on adjustment factors in FRN**
- Adjustment factors of 12 on cycles retained for consistency with Rev. 0 and ASME
- Design curves are same in Rev. 0 and Rev. 1 for carbon, low-alloy, and stainless steels
- Recommend use of stainless steel design curve for Ni-Cr-Fe alloys (conservative)



Significant Changes to F_{en}

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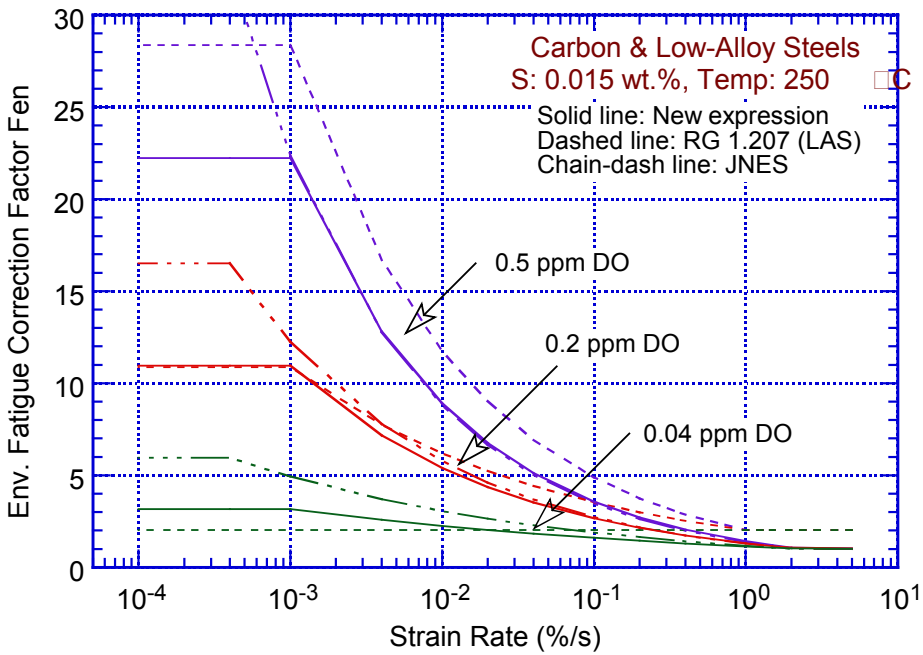
NUREG/CR-6909, Rev 0

- Different expressions for carbon and low-alloy steels
- F_{en} > 1.0 with no environmental effects
- Different constants in expressions for stainless steels and Ni-Cr-Fe alloys

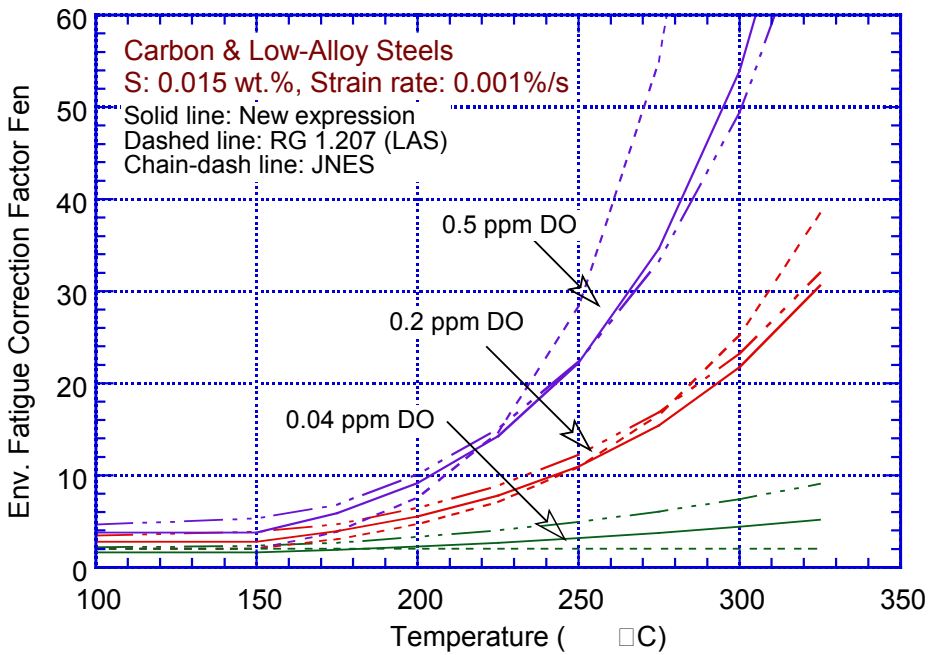
NUREG/CR-6909, Rev 1

- Same expression for carbon and low-alloy steels
- F_{en} = 1.0 with no environmental effects
- Same functional form for stainless steels and Ni-Cr-Fe alloys
- Expressions generally less conservative for all materials

F_{en} vs. Strain Rate, R



F_{en} vs. T



Other Significant Additions to NUREG/CR-6909, Rev. 1

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- Validation calculations
  - Performed on both specimen and component tests (6 total test series)
  - Estimated life using ASME Code methods with F_{en} and compared prediction to experimental fatigue life
  - The predicted and measured lives for specimen tests agreed within the data scatter (i.e., factor of 2)
  - The predicted lives for component tests either agreed with or conservatively predicted the experimental results
- Sample problem (Appendix C)
  - Demonstrate one example application of the F_{en} methodology
  - Promote consistency in the application of EAF methods
  - Received positive feedback from stakeholders

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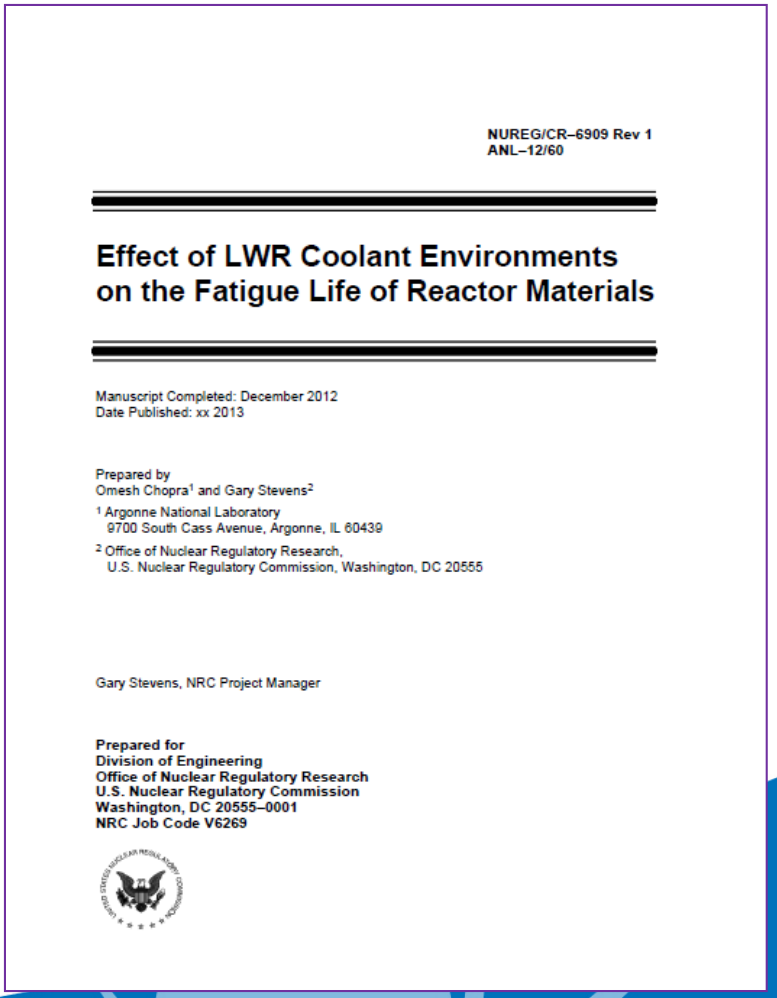
NUREG/CR-6909, Revision 1:
Overview of Public Comments

Section Objectives

- Provide an overview of public comments on draft NUREG/CR-6909, Revision 1
- Provide a sampling of public comments and responses
- Summarize changes to NUREG/CR-6909, Revision 1 resulting from both public comments and further review by the staff and report authors



NUREG/CR–6909 Rev 1
ANL–12/60

Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials

Manuscript Completed: December 2012
Date Published: xx 2013

Prepared by
Omesh Chopra[1] and Gary Stevens[2]

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Prepared for
Division of Engineering
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U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001
NRC Job Code V6269

Overview of Public Comments

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- Draft NUREG/CR-6909, Rev. 1 sent for comment under Federal Register Notice for docket ID NRC-2014-0023 dated April 17, 2014 (Vol. 79, No. 74) (FR Doc # 2014-08792)
  - Specifically asked for feedback on the following three areas:
    I. The extension of the best-fit mean air curve for ferritic steels discussed in Section 3.1.10.
    II. The air fatigue design curve adjustment factors summarized in Section 5.5.
    III. Accuracy check of the technical content of the NUREG, particularly with respect to all of the numerical content of the report.
  - Public comment period ended on 6/2/2014.

Overview of Public Comments

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- Formal public comments were received from 10 commenters.

Letter No.	ADAMS Accession No.	Commenter Affiliation	Commenter Name	Abbreviation
1	ML14157A322	Consultant, Japan	Makoto Higuchi	HIGUCHI
2	ML14157A323	Consultant – CF Int. Engineering, France	Claude Faidy	FAIDY
3	ML14157A324	AMEC, United Kingdom	David Tice	AMEC
4	ML14157A325	Westinghouse Electric Company, USA	James Gresham	WEST
5	ML14157A326	Mitsubishi Heavy Industries, Japan	Seiji Asada	MHI
6	ML14157A327	Rolls Royce PLC, United Kingdom	Keith Wright	RR
7	ML14157A328	Electricite de France, France	Thomas Metais	EDF
8	ML14157A330	Hitachi, Japan	Akihiko Hirano	HITACHI
9	ML14157A331	AREVA, Inc., USA	Devin Kelley	AREVA
10	ML14157A332	Kansai Electric Power Company, Republic of Korea	June-soo Park	KEPCO

- Three additional commenters provided feedback after the public comment period officially ended.

Overview of Public Comments

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- Comments enumerated (if they weren't already) and then partitioned into single issues (sub-comments) wherever possible
- Each issue was uniquely identified and tracked as [XXX]-[YYY]-[ZZZ][a]
  - [XXX] = Abbreviation from table
  - [YYY] = Letter No. from table
  - [ZZZ] = Sequential comment number
  - [a] = sub-comment
- Total sub-comments/Issues: 254
  - Formal commenters 235
  - Additional commenters 5
  - Authors and staff comments 14

Overview of Public Comments

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- Comments were generally technical in nature, thoughtful, and often expansive
- Most technical comments associated with the following areas
  - Scope of the F_{en} method
  - Adjustment factor analysis and application
  - Clarification of statements
  - Relevance to nuclear plant applications
  - Overall conservatism of ASME requirements in conjunction with F_{en}
- Staff and authors agree with over 95% (approximately 8) of the individual sub-comments
- Areas of disagreement are generally not significant with respect to F_{en} method.
  - Interpretations of ASME Code requirements
  - Application of load sequence effects
  - Basis for and application of strain threshold
  - Interpretation of AREVA test results
  - High-cycle cut-off of design curve

Overview of Public Comments

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- Technical comments can be broadly categorized

• **Adjustment factors**	**36**
• Applicability of F_{en} method	16
• ASME method and requirements	14
• Best-fit of mean curves in air	13
• Data base and material properties	22
• Definition of fatigue life/crack initiation	5
• Effects not considered in F_{en} method	12
• Example problem	26
• Fatigue crack growth/damage tolerant approach	6
• **High cycle fatigue**	**9**
• **Miscellaneous**	**7**
• Modified rate approach	12
• Relevance to components	27
• Thresholds and limits of applicability	11

- All other comments (38) were editorial

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NUREG/CR-6909, Revision 1:
Sample Public Comments and Responses

Sample Comments and Responses:
Adjustment Factors

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- Comment
  - *All the reduction factors are considered independent, it's not accepted in all international approaches in particular a constant F_{en} independently of number of cycles is not justified [stet] clearly* (FAIDY-2-3a)
- Summary of response
  - The report does consider the adjustment factors to be independent
    - There is insufficient data to develop correlation factors for a more rigorous analysis.
    - This point has been clarified in the NUREG..
  - The method presented does assume that F_{en} is not a function of applied strain.
    - The point has been clarified several places within the NUREG.

Sample Comments and Responses:
Adjustment Factors

U.S.NRC
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- Comment
  - *"…discussion about fatigue adjustment factors refers to a factor of 10 on life being supported… but a factor of 12 is recommended for use pending further validation…. It is unclear what validation data are required because the existing database is already large.*
  - *No clear justification of the factor of 2 on stress is provided.* (AMEC-3-12)
- Summary of response
  - Current analysis supports a factor of 10 without the need for additional data,
  - Report has maintained a factor of 12 on life to remain consistent with the factor used in the ASME design curve.
  - The factor of 2 on strain was similarly chosen simply for consistency with the factor in the ASME Code.
  - These points have been clarified in several places within the NUREG.

Sample Comments and Responses:
ASME Method and Requirements

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- Comment
  - *Hasn't been a "…reconciliation between the specimen fatigue test data… and the complete ASME-Code Fatigue Methodology …..."*
  - *"…ASME-Code Fatigue Methodology already contains a lot of multiplication of effects that have not been considered by the developers of both the in-air design fatigue curves and the F_{en} factors."* (AREVA-9-17f)
- Summary of response
  - New Section 1.5 identifies and discusses some ASME Code conservatisms.
  - The F_{en} approach, in concert with ASME design curve, will lead to either accurate or conservative predictions of environmental effects.
  - Eliminating conservatism in the ASME Code is outside the report scope.
  - A technical basis for revising ASME Code procedures could be developed by working through the appropriate Code committees

Sample Comments and Responses:
High Cycle Fatigue

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- Comment
  - *"…Extension of the Best-Fit Mean Curve from 10^6 to 10^{11} cycles …is too conservative."* (MHI-5-1a)
- Summary of response
  - Extension of the fatigue curve is conservative.
  - NUREG/CR-6909 Rev. 1, extension is identical to that proposed by the ASME Code committees.
  - Extension is based on data that has a prominent mean stress component.
  - Basing the curve on such data is meant to be both conservative and also allow application to engineering components, which often have high mean stress loading.
  - NUREG states that, for data without a significant mean stress effect, this proposed curve could be significantly conservative.

Sample Comments and Responses: Miscellaneous

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- Comment
  - *"…the only concerns we should have are for those transients with low strain rates (slow transients)."*
  - *The other transients (for example, in-surges and out-surges) need to be evaluated for fatigue, but the current ASME-Code Class 1 Component classic Fatigue Methodology (without any F_{en} penalty factors) is very appropriate for those transients…"* (AREVA-9-17k)
- Summary of response
  - Comment postulates that environmental effects should only be considered for slow transients.
  - Most transients have a wide range of strain rates and importance of environmental effects is not always obvious without evaluating their effects in totality.
  - Entire transient has to be evaluated to determine both the F_{en} and the accumulated strain associated with each strain rate range.
  - The average F_{en} for the transient can then be determined.

NUREG/CR-6909, Revision 1:
Changes to Document

NUREG/CR-6909, Revision 1:
Modifications After Public Comment

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- Authors and staff made significant modifications to the NUREG in an attempt to address virtually all of the public comments
  - Explain more clearly and completely all the technical bases and assumptions supporting the work.
  - Summarize the current state of knowledge
  - Provide a foundation for continued research
- NUREG has expanded significantly over time
  - Rev 0: 120 pages
  - Rev 1, draft: 320 pages
  - Rev 1, final: almost 500 pages
    - Revised Main Body – +10 pages
    - New Appendix D – 135 pages
    - New Appendix E – 12 pages

NUREG/CR-6909, Revision 1:
Major Sections - After Public Comments

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1. Introduction 1
2. Mechanism of Fatigue 21
3. Fatigue Strain vs. Life (ε–N) Behavior in Air 43
4. Fatigue ε–N Behavior in LWR Environments 81
5. **Adjustment Factors in ASME Code Fatigue Design Curves** 153
6. Validation of F_{en} Expressions 163
7. Summary 181

– References 187

– Appendices:

- A: Incorporating Environmental Effects into Fatigue Evaluations A-1
- B: Material Information B-1
- C: Sample Problem C-1
- **D: Compendium of Figures** D-1
- **E: Equations in NUREG/CR-6909 Rev 0 and Rev 1** E-1

NUREG/CR-6909, Revision 1:
Major Changes due to Comments

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- Added new Section 1.5 on bases and assumptions of F_{en} method
- Moved original Section 4.1.14 (Modified Rate Approach) to new Section 4.4 and clarified write-up.
- Reworked and revised example problem (Appendix C)
- Eliminated all Revision 0 equations from main body
- Added App. E: "Equations in NUREG/CR-6909 Rev. 0 and Rev. 1"
  - Equations and Equation Numbers from NUREG/CR-6909 Rev. 0.
  - Equations and Equation Numbers in NUREG/CR-6909 Rev. 1
  - Changes in the Equations or their Number in NUREG/CR-6909 Rev. 0 and Rev. 1
- Replaced all figures in main body with higher resolution images
- Added App. D: "Compendium of Figures"
  - Enlarged and high resolution images of all figures in main body
- Defined LWR water environment and changed "reactor coolant" to "water" throughout report, as appropriate
- Subjected NUREG to technical editing

NUREG/CR-6909, Revision 1:
Summary of Changes by Section

U.S.NRC
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- Executive Summary
  - No significant changes
  - Added new statements and clarified existing statements related to applicability of method, margins, and adjustment factors
- Section 1 - Introduction
  - **Added Section 1.5 – Bases and Assumptions**
    - Address the nature of many public comments.
    - 26 topics addressed
    - Generally, a paragraph discussion on each topic
  - No other significant changes
- Section 2 – Mechanism of Fatigue
  - No significant changes
  - Clarified discussion on effects of environment on microstructurally small cracks (< 200 μm) and mechanically small cracks (> 200 μm)

NUREG/CR-6909, Revision 1:
Summary of Changes by Section

U.S.NRC
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- Section 3 - Fatigue Strain vs. Life (ε–N) Behavior in Air
  - No significant changes
  - Clarified applicability of stainless steel grades
- Section 4 - Fatigue ε–N Behavior in LWR Environments
  - **Moved modified rate approach and clarified aspects of method**
  - **Eliminated Rev. 0 equations**
  - Clarified that In 718 cannot be used with method (insufficient data)
  - Unified the nomenclature for transformed variables
  - Decreased stainless steel temperature threshold from 150°C to 100°C
  - Decreased stainless steel strain rate threshold from 10%/s to 7%/s
- Section 5 – Adjustment Factors in ASME Fatigue Design Curves
  - No significant changes
  - Clarified that use of 12 for life factor is for consistency with ASME Code although 10 is justified by analysis
  - Clarified basis of the factor of 2 on stress/strain

Summary of Revised NUREG:
Summary of Changes by Section

U.S.NRC
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- Section 6 - Validation of F_{en} Expressions
  - Reanalyzed the tests in Sections 6.2 and 6.3 and made some relatively minor changes to associated text.
  - Indicated that F_{en} tends to be conservative, in part, due to gradient effects in these tests.
  - No other significant changes
- Section 7 – Summary
  - Made changes consistent with Executive Summary
  - Added a paragraph on the evaluation procedure
  - Added a paragraph on the applicability of the F_{en} method and future work
  - No other significant changes

Summary of Revised NUREG:
Summary of Changes by Section

U.S.NRC
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- Appendix A - Incorporating Environmental Effects into Fatigue Evaluations
  - Made changes consistent with those in main body for equations
  - Clarified the temperature to use for selecting Young's modulus, E
  - Clarified the use of the maximum temperature limit of 325°C
  - No other significant changes
- Appendix B – Material Information
  - No significant changes
- **Appendix C – Sample Problem**
  - Modified Problem Description (C2), Evaluation (C3), and Results (C4)
  - Added new Table C1 with material properties for use in sample problem
- **Appendix D – Compendium of Figures**
- **Appendix E – Equations in NUREG/CR-6909 Rev 0 and Rev 1**

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Revision 1 of Reg. Guide 1.207:
Overview of Public Comments

Section Objectives

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- Provide an overview of public comments on Revision 1 of RG 1.207 (DG-1309)
- Provide a sampling of public comments and responses
- Summarize changes to Revision 1 of RG 1.207 from both public comments and further review by staff

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

November 2014
Division 1

DRAFT REGULATORY GUIDE

Technical Lead
Gary L. Stevens

DRAFT REGULATORY GUIDE DG-1309
(Proposed Revision 1 of Regulatory Guide 1.207, dated March 2007)

GUIDELINES FOR EVALUATING THE EFFECTS OF LIGHT-WATER REACTOR COOLANT ENVIRONMENTS IN FATIGUE ANALYSES OF METAL COMPONENTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes methods and procedures that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in determining the acceptable fatigue lives of components evaluated by a cumulative usage factor (CUF) calculation in accordance with the fatigue design rules in Section III, "Rules for Construction of Nuclear Power Plant Components," of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (hereinafter "Code") (Ref. 1), to account for the effects of light-water reactor (LWR) coolant environments.

This guide supports reviews of applications for new nuclear reactor construction permits or operating licenses under *U.S. Code of Federal Regulations*, Title 10, "Energy" (10 CFR), Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 2); design certifications under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," (Ref. 3) and combined licenses under 10 CFR Part 52 that do not cite a standard design; and renewed operating licenses under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants" (Ref. 4).

Applicable Rules and Regulations

- General Design Criterion (GDC) 1, "Quality Standards and Records," in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 requires, in part, that structures, systems, and components that are important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function performed. In addition, GDC 30, "Quality of Reactor Coolant Pressure Boundary," requires, in part, that components that are part of the reactor-coolant pressure boundary be designed, fabricated, erected, and tested to the highest practical quality standards.

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position. Public comments are being solicited on this draft guide and its associated regulatory analysis. Comments should be accompanied by appropriate supporting data. Comments may be submitted through the Federal-rulemaking Web site, http://www.regulations.gov, by searching for Docket ID: NRC-2014-0244. Alternatively, comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments must be submitted by the date indicated in the *Federal Register* notice.

Electronic copies of this draft regulatory guide, previous versions of this guide, and other recently issued guides are available through the NRC's public Web site under the Regulatory Guides document collection of the NRC Library at http://www.nrc.gov/reading-rm/doc-collections/reg-guides/. The draft regulatory guide is also available through the NRC's Agency-wide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML14117A584. The regulatory analysis may be found in ADAMS under Accession No. ML14117A585.

Overview of Public Comments

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- Revision 1 of RG 1.207 (DG-1309) sent for comment under Federal Register Notice for docket ID NRC-2014-0244 dated November 24, 2014 (Vol. 79, No. 226) (FR Doc # 2014-27712)
- Public comment period ended on 1/23/2015.

Overview of Public Comments

U.S.NRC
United States Nuclear Regulatory Commission
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- Formal public comments were received from 7 commenters.

Letter No.	ADAMS Accession No.	Commenter Affiliation	Commenter Name	Abbreviation
1	ML15023A569	Rolls Royce PLC, United Kingdom	Keith Wright	RR
2	ML15023A570	Westinghouse Electric Company, USA	Camille Zozula	WEST
3	ML15023A571	Nuclear Energy Institute, USA	Jason Remer	NEI
4	ML15027A334	Union of Concerned Scientists, USA	David Lochbaum	UCS
5	ML15033A382	Southern Nuclear Operating Company, Inc., USA	Charles Pierce	SNOC
6	ML15033A383	AREVA, USA	Morris Byram	AREVA
7	ML15033A384	Electric Power Research Institute, USA	Nathan Palm	EPRI

- Four organizations (Rolls Royce, Westinghouse, AREVA, and EPRI) commented on both NUREG/CR-6909, Revision 1 and DG-1309.

Overview of Public Comments

U.S.NRC
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- As before, each comment was uniquely identified and tracked as [XXX]-[YYY]-[ZZZ]
  - [XXX] = Abbreviation from table
  - [YYY] = Letter No. from table
  - [ZZZ] = Sequential comment number
- Total Comments/Issues: 49

Overview of Public Comments

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- Almost all comments associated with the following areas
  - Editorial or clarification (≈ 45%)
  - NUREG/CR-6909, Rev. 1 technical basis (≈ 22%)
  - Applicability of earlier technical reports and guidance (≈ 14%)
  - RG scope, use, and applicability (≈ 12%)
- Remaining 3 comments covered unique topics
- Staff fully agree with about 2/3 of the comments
- Staff partially agree with about 1/2 of the remaining comments
- Most common areas of disagreement
  - Applicability of earlier technical reports and guidance
  - RG scope, use, and applicability

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Revision 1 of Reg. Guide 1.207:
Sample Public Comments and Responses

Sample Comments and Responses:
Editorial or Clarification

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- Implementation section states that guidance may be used to demonstrate compliance with underlying NRC regulations.
- Comment
  - *"…It would be useful to define the "underlying regulations."*
  - *"…background mentions 54.21, but that would only apply to renewed license applicants.*
  - *"…54.21 addresses license renewal aging management reviews and TLAA evaluations… rather than…the basis for environmentally adjusted CUF analysis." (NEI-3-26)*
- Summary of response
  - Phrase, "*…with underlying NRC regulations…*" pertains to the applicable regulations.
  - Applicable regulations are identified in Part A., *Introduction,* and Part C., *Regulatory Position*.
  - Purpose of Part D., *Implementation*, is to provide information on
    - Applicants and licensees use of the RG.
    - NRC's planned use of the RG.
  - Not intent of Part D. to repeat information provided earlier.

Sample Comments and Responses: NUREG/CR-6909, Revision 1 Technical Basis

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- Comment
  - *Many do not agree with…direct multiplication of the in-air design usage factors…that are based on membrane types of loadings of small specimens.*
  - *This conservatism…is in addition to a.) "quick in-surge/out-surge" types of loadings not being considered…, b.) favorable hold-time effects not being considered…, c.) load sequence penalty being incorporated into the factor of 12.0, although not justified for nuclear plant applications…"*
  - *"…Why has an SRSS combination of these factors not been considered? (AREVA-6-7)*
- Summary of response
  - Generally pointed the commenter to the responses to public comments associated with NUREG/CR-6909, Revision. 1.
  - Identified NUREG comments associated with the issues raised in the RG comment for response.
  - For this comment, identified NUREG comments in following areas
    - Surge loadings
    - Hold time effects
    - Basis for factor of 12

Sample Comments and Responses:
Applicability of Prior Guidance

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- Comment
  - *"…the DG does not clarify if the use of NUREG/CR-6909, Revision 0 formulas remains acceptable.*
  - *Several LR applicants have used NUREG/CR-6909, Revision 0 methods and formulas for computing F_{en} values and would not wish to revise them just in order to meet NUREG/CR-6909, Revision 1 criteria. (NEI-3-1)*
- Summary of response
  - Staff disagrees that guidance for prior methods is needed in RG
  - Prior methods previously approved by the staff remain valid for the period of their intended use.
  - Staff is developing SLR-specific guidance to clarify the use of prior methods for SLR.
  - Staff does agree that the intended use of this regulatory guide by staff should be clearly stated and Part C has been modified accordingly.

Sample Comments and Responses:
Scope, Use, and Applicability of RG

U.S.NRC
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- Comment
  - *Page 6, paragraph 2, states: "These methods apply to those components exposed to reactor coolant that are required by regulation to have a fatigue CUF evaluation or have an existing CLB fatigue CUF evaluation."*
  - *"…there are components that 'have an existing CLB fatigue CUF evaluation' that are not exposed to reactor coolant, but are in secondary systems…exposed to secondary fluid."*
  - *"…They are not required by regulation to have a fatigue CUF…."*
  - *"…the applicability of the F_{en} factors to such components should be clearly stated…." (WEST-2-3)*
- Summary of response
  - Applicable environments
    - Staff believes that the methods described in RG are applicable to both primary and secondary systems
    - Staff agrees that the draft RG does not clearly define the terms "reactor coolant" and "coolant"
    - Replaced "(reactor) coolant" with "water" and added definition for LWR water environment

Sample Comments and Responses:
Scope, Use, and Applicability of RG

U.S.NRC
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- Comment
  - *Page 6, paragraph 2, states: "These methods apply to those components exposed to reactor coolant that are required by regulation to have a fatigue CUF evaluation or have an existing CLB fatigue CUF evaluation."*
  - *"…there are components that 'have an existing CLB fatigue CUF evaluation' that are not exposed to reactor coolant, but are in secondary systems…exposed to secondary fluid."*
  - *"…They are not required by regulation to have a fatigue CUF…."*
  - *"…the applicability of the F_{en} factors to such components should be clearly stated…." (WEST-2-3)*
- Summary of response, cont.
  - RG applicability in existing licensing application
    1. Component is required by regulation to have a CUF calculation
    2. Component has an existing CUF calculation
  - If either 1 or 2 are true, evaluate using GALL, Rev. 2 (LR) or GALL-SLR (SLR)
  - If both 1 and 2 are false, not necessary to address environmental effects
  - Added clarifying language to the RG

Sample Comments and Responses:
Miscellaneous Comments

United States Nuclear Regulatory Commission
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- Comment
  - *Page 6 introduction of Part C: 'Appendix A to that report includes details descriptions and additional guidance concerning the overall method and all the required calculations':*
  - *"The staff's developed guidance in Appendix A is insufficient to develop practical engineering procedures…."*
  - *"…This is especially true for analyses according to ASME Sub-article NB-3600."*
  - *"Insufficient guidance leads to the development of individual methods with a greater risk of higher operational and regulatory cost in the future." (AREVA-6-2)*
- Summary of response
  - Guidance is general for adaptation within the range of methods used in existing fatigue CUF evaluations
  - Approach provides the analyst with flexibility
  - Guidance is not intended to provide prescriptive, step-by-step methods
  - Example problem was added to NUREG/CR-6909, Rev. 1 to provide additional guidance on using the F_{en} method.
  - Staff agree that the quoted phrase is misleading and have changed it accordingly.

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Revision 1 of Reg. Guide 1.207:
Changes to Document

Summary of RG 1.207:
Outline of Unique Sections

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A. Introduction
   - Purpose
   - Applicable Rules and Regulations
   - Related Guidance

B. Discussion
   - Reason for Revision
   - Background

C. Regulatory Position

   1. Carbon and Low-Alloy Steels and Welds
      1.1 CUF in Air
      1.2 Environmental Factor (F_{en})
      1.3 Environmental CUF

   2. Wrought and Cast Austenitic Stainless Steels and Welds

   3. Ni-Cr-Fe Alloys and Welds

D. Implementation

- References

Summary of Revised NUREG:
Summary of Major Changes

U.S.NRC
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- Defined LWR water environment and changed “reactor coolant” and “coolant” to “water” throughout RG, including title
- Clarified applicability of RG
  - New licensing applications that require a CUF calculation
  - Existing licensing applications that are either required by regulation to have a CUF or have an existing CUF as part of current licensing basis
- Clarified that guidance is not applicable for Inconel 718
- Clarified that Ni-Cr-Fe alloys should use the stainless steel design curves in air provided in NUREG/CR-6909, Rev. 1 (or associated ASME Code Section III curves)

Summary of Revised NUREG:
Summary of Changes by Section

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A. Introduction
   - Changed “coolant” to “water”
   - No other significant changes

B. Discussion
   - Defined LWR water environment
   - Changed “coolant” to “water”
   - Clarified use of F_{en} method for Ni-Cr-Fe alloys
   - Discussed additional margins that may be present in components
   - Provided rationale for adjustment factor of 12 on life
   - Clarified that guidance is not applicable for Inconel 718

Summary of Revised NUREG:
Summary of Changes by Section

U.S.NRC
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C. Regulatory Position
- Changed “coolant” to “water”
- Clarified applicability of RG to new licensing applications that require a CUF calculation
- Clarified applicability of RG to existing licensing applications that are either required by regulation to have a CUF or have an existing CUF as part of current licensing basis
- Clarified which design curves in NUREG/CR-6909, Rev. 1 are applicable for a given material.
- Identified that method is not applicable to Inconel 718

D. Implementation
- Clarified that guidance can be used in whole or part, as applicable
- No other significant changes

Current Status and Next Steps

Guidance Finalization:
Current Status and Next Steps

U.S.NRC
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- Revision 1 of RG 1.207
  - Undergoing interagency concurrence (December 2016)
  - Requested technical staff concurrence from NRR/NRO
  - Submitted NUREG/CR-6909, Revision 1, public comments, and responses to comments for information as part of package
  - Some additional changes may result from concurrence process.
  - Some conforming changes to responses to public comments will be needed.
- NUREG/CR-6909, Revision 1
  - Completed technical editing review
  - Incorporating technical editing changes
  - Some conforming changes to responses to public comments will be needed.
- Requesting ACRS recommendation to finalize RG 1.207
- RG 1.207 should be finalized before issuance of SLR guidance (i.e., NUREG-2191, NUREG-2192) in mid-2017.