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2 UNITED STATES OF AMERICA

3 NUCLEAR REGULATORY COMMISSION

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5 580TH MEETING

6 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

7 (ACRS)

8 OPEN SESSION

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10 FRIDAY, FEBRUARY 11, 2011

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12 ROCKVILLE, MARYLAND

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14 The Advisory Committee met at the Nuclear

15 Regulatory Commission, Two White Flint North, Room

16 T2B1, 11545 Rockville Pike, at 8:30 a.m., Said Abdel-

17 Khalik, Chairman, presiding.

18 COMMITTEE MEMBERS:

19 SAID ABDEL-KHALIK, Chairman

20 J. SAM ARMIJO, Vice Chairman

21 SANJOY BANERJEE, Member

22 DENNIS C. BLEY, Member

23 MICHAEL L. CORRADINI, Member

24 DANA A. POWERS, Member

25 HAROLD B. RAY, Member

1 JOY REMPE, Member
2
3 COMMITTEE MEMBERS
4 MICHAEL T. RYAN, Member
5 WILLIAM J. SHACK, Member
6 JOHN D. SIEBER, Member
7
8 NRC STAFF PRESENT:
9 AL CSONTOS, RES/DE/CIB
10 ROBERT DAVIS, NRO/DSRA/SRSB
11 BOB DENNIG, NRR/DSS/SCUB
12 JOHN HONCHARIK, NRO
13 STEVEN LAUR, NRR
14 RICHARD LOBEL, NRR
15 ERIC REICHETT, NRO/DE/CIB
16 WILLIAM RULAND, NRR
17 STEVE SMITH, NRR/DSS/SSIB
18 GARY STEVENS, RES/DE/CIB
19 DAVID TERAO, NRO/DE/CIB1
20 MICHAEL BENSON, Designated Federal Official
21
22
23
24
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Adjourn 100

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

2 (8:29 A.M.)

3 CHAIRMAN ABDEL-KHALIK: The meeting will
4 now come to order. This is the second day of the
5 580th meeting of the Advisory Committee on Reactor
6 Safeguards. During today's meeting, the committee
7 will consider the following.

8 One: draft final Reg Guide 1.34, Control
9 of Electroslag Weld Properties, Reg Guide 1.43,
10 Control of Stainless Steel Weld Cladding of Low-Alloy
11 Steel Components, Reg Guide 1.44, Control of the
12 Processing and Use of Stainless Steel, and Reg Guide
13 1.50, Control of the Preheat Temperature for Welding
14 of Low-Alloy Steel.

15 Two: Commission paper on the use of
16 containment accident ressure in analyzing emergency
17 core cooling system and containment heat removal
18 system pump performance in postulated accidents.

19 Three: Future ACRS activities, and report
20 of the Planning and Procedures Subcommittee. Four:
21 reconciliation of ACRS comments and recommendations.
22 And Five: preparation of ACRS reports.

23 This meeting is being conducted in
24 accordance with the provisions of the Federal Advisory
25 Committee Act. Mr. Michael Benson is the Designated

1 Federal Official for the initial portion of the
2 meeting.
3 We have received no written comments or
4 requests for time to make oral statements from members
5 of the public regarding today's sessions. There will
6 be a phone bridge line. To preclude interruption of
7 the meeting, the phone will be placed in a listen-only
8 mode during the presentations and committee
9 discussions.
10 A transcript of portions of the meeting is
11 being kept, and it is requested that the speakers use
12 one of the microphones, identify themselves, and speak
13 with sufficient clarity and volume so that they can be
14 readily heard.
15 We will now proceed to the next item on
16 the agenda, Draft Reg Guide 1.34, Reg Guide 1.43, Reg
17 Guide 1.44, and Reg Guide 1.50. Dr. Armijo will lead
18 us through that discussion.
19 MEMBER ARMIJO: Thank you, Mr. Chairman.
20 The subcommittee on Materials, Metallurgy, and Reactor
21 Fuels met on this subject with its staff in October of
22 this year. We reviewed these four draft regulatory
23 guides.
24 They address issues related to the quality
25 of welding of various ferritic and austenitic carbon

1 steels, and austenitic stainless steels, with a goal
2 of minimizing fabrication-induced defects caused by
3 welding, or fabrication-induced susceptibility to
4 future stress corrosion cracking, particularly inner
5 granular stress corrosion cracking of stainless steels
6 in reactor service.
7 There's quite a lot of discussion and
8 review, focused primarily on Reg Guide 1.44. In
9 making this presentation, I've asked the staff to make
10 sure where they have -- there's many ways that steels
11 can crack, and we seem to work with those that can
12 crack in almost every possible way.
13 So we have a lot of cracking terms, and
14 I've asked the staff to clarify when they use a term
15 for those members of the committee that may not be
16 familiar with that terminology. With that, I'd like
17 to turn it over to Gary, Gary Stevens, to lead the
18 staff's presentation.
19 MR. STEVENS: I'm Gary Stevens, from the
20 NRC Office of Research. Good morning, everyone.
21 These three young, strapping, good-looking individuals
22 to my right are going to help me answer all your
23 questions on these Reg Guides.
24 And I'll pretty much be following the
25 agenda. The presentation here, starting on slide 30

1 there's some backup slides, which are provided for
2 information should they be needed. It's not going to
3 be my intent to go through those unless the questions
4 lead us there. They're provided for your information,
5 to give you a little more detail backup on the
6 cracking mechanisms that these Reg Guides are trying
7 to address.
8 So with that, we'll launch in. This
9 pretty much reflects the agenda which you have in
10 front of you. We'll give an overview, we'll discuss
11 just briefly why these Reg Guides are being revised,
12 give you the timeline of revision that they've gone
13 through, and summarize the technical revisions that
14 have been made.
15 We'll give you an overview of the public
16 comments, as well as some other comments that were
17 received -- and in particular the ACRS Subcommittee
18 comments that Sam mentioned that we received at the
19 October briefing -- and our response to those
20 comments. And we'll give you the conclusions.
21 As the Chairman indicated, there's four
22 Reg Guides, which are listed here, all of which have
23 to do with welding of ferritic and austenitic
24 materials. These Reg Guides have been around for
25 quite some time. Last revised in the 1970s. And they

1 provide detailed and up-to-date guidance on welding
2 processes and materials for fabrication of reactor
3 components.
4 These Reg Guides provide guidance on a
5 position that the NRC finds acceptable to satisfy 10
6 CFR 50 Appendix A: General Design Criteria 1 and 30 as
7 they relate to standards for design, fabrication,
8 erection, and testing.
9 The Reg Guides provide an acceptable
10 method to satisfy 10 CFR 50 50.55a, and the criteria
11 that's given in these guides really is supplemental
12 fabrication controls beyond that that is included in
13 the ASME Code, in particular Sections III and IX, and
14 actually Section II as well.
15 The Reg Guides are referenced in the NRC
16 Standard Review Plan, NUREG-0800, Section 5.2.3, which
17 deals with reactor coolant pressure boundary
18 materials.
19 These Reg Guides describe one or more
20 methods that the staff has determined to be acceptable
21 but not required for new component fabrication. As
22 you're aware, reg guides do not impose requirements.
23 Applicants are free to use an alternative method,
24 provided that they can demonstrate the adequacy of
25 that to the staff, and that they satisfy applicable

1 regulations.

2 However, use of the Reg Guides obviously

3 conserves staff resources, because they do define a --

4 they give a predefined approach to meeting regulations

5 that's acceptable to the staff.

6 At the request of Dr. Armijo, I think, and

7 the ACRS Subcommittee, after the last briefing, this

8 slide is just trying to give you a top-level overview

9 of the cracking mechanisms that are addressed by the

10 four welding Reg Guides.

11 With respect to 1.34, that guide addresses

12 weld solidification cracking and weld toughness. And

13 basically, these type of cracks develop because of the

14 centerline bond that can occur as the welding process

15 occurs.

16 Reg Guide 1.43 addresses underclad

17 cracking, otherwise known as hot underclad cracking,

18 or reheat underclad cracking, due to the process of

19 cladding ferritic material with stainles steel

20 material.

21 Reg Guide 1.44 addresses IGSCC, inner-

22 grain, inner-stress corrosion cracking. And various

23 processes and all that that are used to control severe

24 sensitization that could lead to stress corrosion

25 cracking.

1 And then Reg Guide 1.50 deals with delayed
2 hydrogen cracking. Cold cracking or hydrogen cracking
3 may occur in weld underbead areas and heat-affected
4 zones if there is not proper treating temperatures and
5 whatnot maintained during the welding process and
6 controls.
7 So collectively, all these Reg Guides are
8 aimed at providing guidance to eliminate or minimize
9 the factors -- and there's many of them -- that could
10 lead to cracking.
11 I'll just go through a top-level overview
12 of each Reg Guide individually here, and with respect
13 to 1.34, Reg Guide 1.34 is Control of Electroslag Weld
14 Properties. And this Reg Guide contains implementing
15 guidance regarding the control of weld properties when
16 fabricating electroslag welds.
17 It provides guidance on acceptable
18 solidification patterns, impact test limits for class
19 one and two components, and the criteria for verifying
20 conformance during production welding. And these
21 criteria provide assurance that welds will not develop
22 microfissures during welding, or have high integrity,
23 sufficient degres of toughness and whatnot to furnish
24 adequate safety margins.
25 Regarding Reg Guide 1.43, this Reg Guide

1 is Control of Stainless Steel Weld Cladding on Low-
2 Alloy Steel Material. And it contains selection and
3 control criteria for welding processes to limit the
4 occurrence of underclad cracking in low-alloy steel
5 components.
6 Material known to have susceptibility to
7 underclad cracking should not be weld clad by high-
8 heat-input weld processes, and the Reg Guide provides
9 criteria for establishing that. And these controls
10 provide assurance, again, that practices that could
11 result in such cracking will be restricted.
12 Obviously, as mentioned, there's many
13 factors that contribute to this. And the Reg Guide
14 doesn't guarantee there won't be cracking. It just
15 tries to minimize, to the extent possible, the
16 possibility.
17 With respect to Reg Guide 1.44, this Reg
18 Guide has to do with the Control of the Processing and
19 Use of Stainless Steel. And it provides implementing
20 guidance about control of the application and
21 processing of stainless steel to avoid severe
22 sensitization that could lead to stress corrosion
23 cracking.
24 Staff positions related to unstabilized
25 austenitic stainless steel of the type 300 series used

1 for components in reactor coolant pressure boundary
2 are addressed, and acceptance criteria provided for
3 testing alloy compositions, heat treatment, et cetera,
4 to avoid sensitization.
5 MEMBER ARMIJO: Here you might want to
6 just clarify what you mean by "unstabilized" stainless
7 steels.
8 MR. STEVENS: Do you want to clarify?
9 MR. DAVIS: Unstabilized stainless steels
10 would be those that don't have stabilizing elements in
11 them, like titanium or niobium, for example, or
12 columbium -- well, not columbium. Like 321 or 347,
13 which have stabilizing elements that do not allow the
14 depletion of chromium during welding.
15 MR. STEVENS: So this Reg Guide identifies
16 acceptable methods for verification of non-
17 sensitization, and qualification of those methods
18 during the weld process. It also provides some
19 acceptance criteria regarding cleaning and protection
20 of material against contaminants that are capable of
21 causing stress corrosion cracking. Such things might
22 be acid pickling. Any necessary pickling should be
23 done in accordance with appropriate controls, and it
24 should not be performed on sensitized stainless
25 steels.

1 And then finally, the fourth Reg Guide
2 that we're discussing today, 1.50, has to do with the
3 Control of the Preheat Temperature for Welding of Low-
4 Alloy steel. This Reg Guide contains criteria related
5 to controls imposed on welding preheating temperatures
6 for low-alloy steel components.
7 And it provides reasonable assurance that
8 cracking of components made from low-alloy steel will
9 not occur during fabrication, minimizes the
10 possibility of subsequent cracking due to residual
11 stresses being retained in the weldment. So there's
12 basically criteria for preheat and interpass
13 temperatures that are specified in this Reg Guide, and
14 specifications are given for the welding procedure
15 qualifications to ensure those are met and included.
16 Okay. So why are these Reg Guides being
17 revised? Well, there's a need to update the Reg
18 Guides. These were last revised in the 1970s. Also,
19 there's the new reactor applications coming in that
20 are driving new component fabrication, that hasn't
21 been present since the 1970s. They are used for
22 repair/replacement activities for the current fleet as
23 well, and then the Standard Review Plan, NUREC 0-800,
24 does reference these Reg Guides.
25 There have been many technology changes

1 over the past 35 years that vendors have been
2 including in their repair/replacements that have
3 occurred, so that these Reg Guides are being revised
4 to incorporate those improvements and technology
5 changes.
6 And then finally, the NRC staff has a
7 commitment to the commissioners that was made in 2006
8 to revisit Reg Guides more frequently and update them
9 where appropriate, to go along with SRP updates. And
10 so this is also being done as a part of that process.
11 Revision timeline: the draft Reg Guides
12 were completed and issued out for public comment in
13 the Federal Register back in summer of 2009. They
14 were issued in the Register on July 6th. The initial
15 comment period was through the end of August, so
16 August 31st.
17 On August 6th of that year, NEI requested
18 a 30 day extension to give the industry adequate time
19 to review. NRC granted that extension, and the
20 comment period was extended out to October 1st, 2009.
21 So these Reg Guides had about a three month public
22 comment period.
23 A total of 68 comments were received from
24 the public, and you can see there they were received
25 from five sources. And in particular the third one,

1 EPRI -- EPRI compiled from three or four other
2 sources, namely utilities and themselves, totaling the
3 68 comments.
4 And as you can see, in fact, more than
5 half of the comments are the ones that were received
6 in December. The staff accepted comments well beyond
7 the public comment period, late-arriving. In fact, we
8 were open and accepting of comments up until the mid-
9 April 2010 timeframe, so a very extensive public
10 comment period.
11 In March of 2010, the Nuclear Fabrication
12 Consortium had requested a six month to two year
13 extension of the Reg Guides, and NRC management
14 decided to proceed with finalizing the Reg Guides
15 without that extension, because there were so many
16 comments, we had extended the comment period out
17 longer.
18 And in fact, NFC members had provided
19 comments as a part of that public comment period, so
20 we didn't see the need to extend that period further.
21 And at the end of May, we responded to public
22 comments -- May 2010. And in July, these Reg Guides
23 were sent to the other offices for concurrence review.
24 Office of General Counsel review occurred
25 in September. As you heard earlier, we had the ACRS

1 Subcommittee briefing in October. We're here today,
2 and pending satisfactory results of this meeting, we
3 would expect these would be published drafts next
4 month. So we're approaching -- these have been a work
5 in process for about two years now.
6 Okay, the next set of slides, I'm going
7 through just the technical revisions that were made on
8 each Reg Guide. So this summarizes at a top level the
9 significant technical changes that occurred to each
10 Reg Guide.
11 With respect to 1.34, which has to do with
12 electroslag welds, again, previously core support
13 structures were identified as needing to meet
14 requirements for class one components in the Reg
15 Guide.
16 And this was removed because in the time
17 since the Reg Guide was last revised, core support
18 components are now addressed in Section III,
19 Subsection NG of the code. That did not exist at the
20 time of the last revision of the Reg Guides. So that
21 requirement or that guidance -- there was no need for
22 it, because it was covered elsewhere in the code.
23 The Reg Guide previously specified impact
24 testing to be included for class two vessels, because
25 Section III did not mandate that. And this was

1 removed because that's now included in Section III, in
2 sub-paragraph NC-2311. So again, that's covered
3 elsewhere; no need to include it in the Reg Guide.
4 Regulatory Position 5 was expended for the
5 case where there is a specific reason to question the
6 welder's ability to make production welds that meet
7 approved procedure specified in Positions 3 and 4.
8 And I think this change really reflects -- is this the
9 one, Bob? Am I right? -- that reflects kind of what's
10 been going on for the last 30 years anyway?
11 MR. DAVIS: Consistent with Section IX
12 requirements.
13 MR. REICHETT: And basically that
14 position, if you look at that, it's just addressing if
15 there's a concern by either the management or an ANI
16 that the welder that's performed the welding does not
17 have adequate control over his welding process, or
18 does not, in their opinion, have the technical
19 expertise needed, they can call the weld unacceptable.
20 And that's really incorporated as well into the
21 requirements of Section IX.
22 MR. STEVENS: And the Reg Guide made
23 reference to outdated ASME Code articles, and those
24 were either removed, in the case of the first two
25 bullets, or updated accordingly to reflect the current

1 code.

2 With respect to Reg Guide 1.43, and this
3 is the stainless steel weld cladding on low-alloy
4 steel components, ASME Material Specifications for SA-
5 508 material have changed, and so these are updated in
6 the Reg Guide to reflect the current naming
7 conventions specified in Section II of the ASME Code.

8 Section B Discussion for underclad
9 cracking was expanded significantly to further
10 describe this mechanism based on all our collective
11 knowledge to date, in particular to clarify the
12 advantages of using fine-grain forging materials.

13 And guidance was added to performe NDE
14 following post-weld heat treatment, because underclad
15 cracking can grow during that process. In addtion, a
16 second test method for determining existence of
17 underclad cracking was added, and that additional test
18 is provided in the sub-bullet there.

19 An additional observational area was
20 included in Regulatory Position 2.e, which was in
21 there before regarding testing, as shown by the sub-
22 bullet, just an expansion of the previous position.

23 And then essential variables are now
24 defined in Section IX of the ASME Code, and that
25 wasn't previously the case. So that Section of the

1 Code was added as a reference in Regulatory Position
2 2.
3 Regarding 1.44, additions were made to
4 Section B to identify process controls that should be
5 modified based on operating experience. Regulatory
6 Position 6 was expanded to identify the controls, to
7 prevent sensitization during welding, include low heat
8 input and limiting the interpass temperature.
9 And again, this Reg Guide referenced
10 several references -- or provided reference to several
11 outdated standards that were updated, and these were
12 primarily, I think, American Welding Society
13 standards.
14 MEMBER ARMIJO: Gary, since this may come
15 up during -- if it doesn't come up later, I might as
16 well raise it now. In this Reg Guide, there is no
17 section that addresses the issue of cold work, or
18 post-weld grinding. Which as we know, is very, very
19 deleterious to stainless steel, just as far as
20 susceptibility to stress corrosion cracking in
21 service.
22 And particularly with -- and the other
23 issue it doesn't address is the issue of irradiation-
24 assisted stress corrosion cracking, which is basically
25 the same mechanism as IGSCC, only worse, because it

1 involves radiation hardening of the material. And I
2 was wondering why the staff did not address those two
3 issues in this Reg Guide.
4 MR. DAVIS: I can answer that. As far as
5 the internals, for radiation, this Reg Guide applies
6 to class one and two components, and the internals
7 would not be class one or two. And so that's not
8 addressed in here because this is meant for pressure
9 boundary components.
10 The cold work, and those issues, is
11 clearly addressed in the Standard Review Plans, and
12 all those questions -- those issues are thoroughly
13 addressed in all design certification reviews.
14 There's ample discussion in all of our safety
15 evaluations related to cold work, and control of cold
16 work, and those types of issues.
17 MEMBER ARMIJO: And why not in the Reg
18 Guide? Because that's what it's there for.
19 MR. DAVIS: I think that we already have -
20 - there's other guidance available on what is
21 acceptable. It's already in the Standard Review Plan,
22 the standard for the control of sensitization. The
23 Standard Review Plan references the Reg Guide.
24 For control of cold work, which is not
25 sensitization -- this Reg Guide deals with

1 sensitization, or control of the use of sensitized
2 stainless steel. And that's not what this Reg Guide -
3 - this Reg Guide is not meant to address cold work.
4 But that is addressed in our other documents, NUREG 0-
5 800.
6 MEMBER ARMIJO: Okay. Well, I think
7 that's an awfully narrow scope for a Reg Guide that's
8 addressing, really, IGSCC and the mechanisms that
9 cause IGSCC in nuclear plant service. And we
10 certainly have plenty of experience with both IGSCC
11 and IASCC in both BWRs and PWRs. Mostly in BWRs.
12 So it just seems to me that someone
13 looking for guidance in this area shouldn't have to
14 look in Standard Review Plans when there's a perfectly
15 acceptable Reg Guide where they could look and get all
16 of that information at one time, and where you could
17 put all your information, all your knowledge, and make
18 that available as guidance. But it's not in there
19 now, and you've told us why it's not in there.
20 And the other issue, and you'll get up to
21 it during the comments, because we made these comments
22 during the review, is the issues of the water
23 chemistry that we'll come up with, and the high-carbon
24 stainless steels. What you call standard carbon.
25 MR. STEVENS: Yes, we have slides and

1 further discussion those issues.

2 MEMBER ARMIJO: Okay.

3 MEMBER SHACK: While we're bringing this

4 up, you've just sort of rung a bell with this

5 unstabilized. And it hadn't really quite dawned on me

6 that we don't have any guidance on stabilized

7 stainless steels. The only place I can think of we're

8 using stabilized stainless steels in the new reactors

9 is the EPR control drive, right?

10 MR. DAVIS: The pressure housing using, I

11 believe, 347. And some of the internal components for

12 the control rod drive, the structural components, are

13 made of 321.

14 I believe there's some 321 there. So

15 those are the only two -- those have been used

16 overseas. I believe the Germans used quite a bit of

17 stabilized stainless steel. And I belive that the EPR

18 --

19 MEMBER SHACK: We do it in underwater

20 reactors, but not in ones that stay on dry land.

21 MR. DAVIS: Right. I believe that the

22 EPR, I think that their control rod drive is kind of

23 modeled after the German units.

24 MEMBER SHACK: Now, do we have

25 restrictions on the carbon levels in those stabilized

1 stainless steels, so we can avoid knife-edge cracking
2 kind of stuff?
3 MR. DAVIS: I'd have to go back. I
4 haven't looked at that information for quite some
5 time. I know that they do not do a stabilizing
6 treament, because obviously those types of treatments
7 are for 347 used at a very, very high temperature.
8 So they're just using the solution in the
9 old condition -- of course, then you receive the
10 benefit when they're welded, that the stabilizing
11 element is going to combine with the oxygen, so that
12 you don't form chromium carbides and rob your chromium
13 from your grain boundaries. And all of that, I think,
14 is clearly discussed in the safety evaluation for the
15 EPR for control rod drive.
16 MR. STEVENS: Last Reg Guide, 1.50,
17 Preheat Temperature for Welding of Low-Alloy Steel.
18 In this one, clarification was added to Section B
19 Discussion to describe that preheating at recommended
20 temperatures can reduce local hardening by reducing
21 the cooling rate during welding.
22 Additions were made to Section B again to
23 specify a maximum interpass temperature, in accordance
24 with Section IX, for the case where toughness is a
25 requirement of the Construction Code. Clarification

1 was added to the Section B Discussion to describe that
2 a maximum interpass temperature be selected for low-
3 alloy steel welds requiring impact testing.
4 ASME "P" material designations were added
5 to Section C to specifically identify which low-alloy
6 steels are applicable and covered by the reg guide.
7 MEMBER SHACK: A whole lot less
8 information.
9 MEMBER ARMIJO: Yes. The P numbers are
10 one level removed from what most of us understand. You
11 know, 304,304L, 316L. Other than those common 304,
12 316 L-grades, LN-grades, what additional steels are
13 included in those P numbers?
14 MR. DAVIS: This doesn't have anything to
15 do with stainless steels. This is just low-alloy
16 steel. Basically, P3 would be like a pressure vessel
17 steel, low-alloy steel for the reactor pressure
18 vessel, and maybe some of the other vessels.
19 P4 is one and quarter chrome, and P5 is
20 two and a quarter chrome. We added these -- typically
21 this Reg Guide, before, was strictly for the P3
22 materials. Now some of the newer designs are using P5
23 materials, two and a quarter chrome, for some of their
24 feedwater piping, like in the BWR. Which is class
25 one.

1 MEMBER ARMIJO: Okay.

2 MR. DAVIS: So that's why -- we got a
3 public comment to -- and when we say low-alloy steel,
4 it means a reactor pressure vessel. That's not always
5 true now, because we're looking for these materials
6 with chromium for FAC, for the feedwater line,
7 specifically in a BWR.

8 So that's why they requested -- I think we
9 had an industry comment requesting --

10 MEMBER ARMIJO: Okay. I may have gotten
11 confused, but I thought there was a comment in one of
12 the public comments related to P numbers related to
13 stainless steel. But you're saying that's not
14 correct?

15 MR. DAVIS: Well, this is for low-alloy
16 steel. This is Control of Preheat for Welding of Low-
17 Alloy Steel, which has absolutely nothing to do with -
18 -

19 MEMBER ARMIJO: No, I understand that.
20 But are there P numbers that describe --

21 MR. DAVIS: For stainless steels?

22 MEMBER ARMIJO: For stainless steels.

23 MR. DAVIS: Absolutely. And those are --

24 MEMBER ARMIJO: That's what my question
25 would be.

1 MR. DAVIS: P8s would be the stainless
2 steels. And that comes from Section IX, so if I
3 qualify a procedure to weld 304 stainless steel, then
4 I should be able to use that procedure to weld 316
5 stainless steel. They're in the same family, and
6 they're given the same P number.
7 And when you go from one P number to
8 another, that means that those materials are different
9 such that a new procedure should be qualified.
10 MEMBER ARMIJO: Okay.
11 MR. STEVENS: We made changes to
12 Regulatory Position 1, to specify that a welding
13 procedure specify a maximum interpass temperature and
14 a minimum preheat temperature. Additions were made to
15 Regulatory Position 2 to also allow for post-weld
16 hydrogen bakeout at a given temperature range for a
17 specified period of time.
18 And then additions were made to Regulatory
19 Position 4 to clarify that acceptable examination
20 procedures must meet Section III. Again, various
21 references to outdated ASME Code articles were updated
22 to reflect current code.
23 Public comments. As I mentioned before,
24 the initial public comment period was extended, and
25 these Reg Guides had approximately three months for

1 public review. 68 comments were received, and
2 actually almost two thirds of them came in December,
3 which was past the extended comment period.
4 And I've summarized the number of comments
5 received on each of the four Reg Guides there. You
6 see 1.43 and 1.50 received the majority of the
7 comments. All comments were addressed. The majority
8 of the comments led to several minor -- what we would
9 consider clarifications to the draft guides.
10 And all the comments were really
11 consistent with the intent of the revisions, which was
12 to improve and clarify the welding processes used to
13 preclude cracking. In other words, there weren't any
14 comments that wanted to steer us in another direction.
15 So we thought the comments were good, and
16 in the end led to a better product. All of the
17 comments, we provide those to the ACRS subcommittee
18 briefing in October, and we actually reviewed
19 specifically with the Committee the comments where the
20 NRC in some form or fashion disagreed with the
21 commentor.
22 And I think it's fair to say that those
23 disagreements were really minor, in the sense that the
24 comments were pretty benign, and it was obvious why we
25 were disagreeing. And the Committee took no

1 disagreement with us on those comments.

2 Other comments, there were editorial

3 improvements that came out of the technical editing

4 and the Office of General Counsel reviews, which

5 occurred after the public comment period and the other

6 offices' concurrence reviews. There were some

7 formatting changes to meet the NRC's latest formatting

8 protocol.

9 And then what we're going to be discussing

10 next are, there were two comments provided at the

11 October briefing to the ACRS subcommittee, both on Reg

12 Guide 1.44, associated with one of the Regulatory

13 Positions. And we're going to discuss those in detail

14 next.

15 Comment number one, and this is the text

16 of the comment. And it has to do -- Regulatory

17 Position 4 indicates that L-grade materials should be

18 used, but identifies exceptions where you don't have

19 to use the L-grade materials.

20 And the commentor was suggesting that we

21 shouldn't allow material to be used with a carbon

22 content greater than .03 percent. In other words,

23 remove the exceptions from the Reg Guide for allowing

24 that. And this is the text of the comment here. And

25 we'll have some discussion. We have a response and

1 some further discussion on this.

2 The second comment -- this will test your

3 eyes a little, but the second comment was related to

4 the same position, and this comment was associated

5 with the exceptions that allowed the use of non-L-

6 grade material in primarily the water chemistry

7 limits.

8 There's a .1 ppm or a 100 ppb dissolved

9 oxygen limit in there, and this comment was suggesting

10 that that limit was too high, and there was data that

11 indicated it should be lower.

12 Our response to the first comment, which

13 would be essentially to eliminate the exceptions --

14 MEMBER ARMIJO: Gary, there's really two

15 points in there, although the last one was kind of

16 mild. And that related to the effect of cold work, in

17 that comment.

18 MR. STEVENS: Yes, you're right. And our

19 response to the first comment -- you know, there's not

20 sufficient data to indicate that non-L-grade

21 austenitic stainless steel experiences significant

22 stress corrosion cracking in a PWR low oxygen

23 environment.

24 There have been sporadic instances of

25 cracking, and I've given a reference there where some

1 of those have been discussed. And general operating
2 reactors have not seen any issues. And therefore, L-
3 grade material is allowed for use in PWRs under
4 certain conditions, which are the --
5 MEMBER SHACK: Non-L-grade material,
6 right?
7 MR. STEVENS: Sorry. Non-L-grade
8 material. I stand corrected. Non-L-grade material is
9 allowed for use in PWRs under certain conditions, as
10 identified in Position 4. The exception with Position
11 4 really is intended to be applicable to PWRs. It was
12 intended to screen out boiling water reactors, where
13 the use of non-L-grade material has historically been
14 problematic.
15 Subsequent to the briefing in October, we
16 made some editorial additions to the Reg Guide to
17 further clarify this point. And obviously, as more
18 data becomes available, the staff will consider
19 eliminating the use of non-L-grade material for PWRs
20 in the future.
21 MEMBER ARMIJO: Gary, here's where I have
22 a problem. You know, sporadic instances of cracking.
23 That reminds me of the early days of BWR cracking, of
24 sensitized welded non-L-grade stainless steels.
25 That's how it starts. A little crack

here, it's disposition by saying "Well, that's not a very good heat of material," or "That's a rare instance," and on and on and on, until it became a very, very serious problem.

We're now seeing in the PWRs, and I refer to the EPRI Materials Degredation Matrix, that they have started research to look into these various sporadic instances of IGSCC on weld-sensitized -- maybe weld-sensitized and cold work -- normal grade, standard grade, stainless steels.

And they attribute it, obviously, to oxygen, cold work. But we still have got a long way to go. Most of the stainless steels in PWRs have performed better, but we are seeing cracking. And in fact, the people who are building and specifying the new materials for -- the materials for new reactors, are abandoning the use of the standard grade or high-carbon stainless steel for their important systems.

The DCD for the AP1000 design, PWR, specifies a use for type 316 low-carbon nitrogen-enriched stainless steel for the primary-loop hotleg, coldleg, surge line, heat removal supply system, depressurization system, RHR, and it goes on and on and on.

So the industry has sufficient concern,

1 even though these are rare, but they just don't want
2 to have an important system have a failure due to
3 IGSCC, and take that kind of a risk.
4 And I can't understand why the staff
5 wouldn't have the same concerns with the use of a
6 material that is really not adequate if it's going to
7 be in contact with a primary cooling system in a PWR,
8 or the coolant system of a BWR, when better materials
9 with proven resistance to IGSCC are available.
10 That's really the crux of my concern.
11 NRC's Reg Guide should set the standard for best
12 practices, and let someone who wants to do something
13 else come to you and make a case for the use of a less
14 resistant material. So I think that's really the
15 heart of my concern, that this Reg Guide should not be
16 behind the times and permissive of the use of less
17 resistant materials.
18 MR. HONCHARIK: I guess I can comment on
19 that. I guess -- I know you mentioned that AP1000
20 will be using low-carbon stainless steel. I was a bit
21 confused, because in the DCD, in chapter five, which
22 covers the reactor coolant pressure boundary, it has a
23 table in there where it specifies all the material
24 specifications. And in that table, it references 304,
25 304L, or 304LN for the components.

1 MEMBER ARMIJO: Well, maybe we've got
2 conflicting tables here, John. But here's this table
3 3B, is the AP1000 leak-before-break bounding analysis
4 section. It's systems parameters, but these are all
5 the really important pressure boundary selections.
6 This is very specific on what they're using, and --
7 MR. HONCHARIK: For the analysis. That's
8 the leak-before-break analysis.
9 MEMBER ARMIJO: Well, you don't make the
10 leak-before-break analysis on a material that you're
11 not going to use.
12 MR. HONCHARIK: That is correct. And that
13 is why, when we did look at this, and they wanted to
14 use something other than the LN, we specifically
15 stated in our SER that if they use anything other than
16 specified LN, that they would have to make sure that
17 they'd account for that in their leak-before-break
18 analysis.
19 MR. REICHETT: And that analysis would
20 still be bounding for that change of material.
21 MR. DAVIS: And in addition --
22 MEMBER ARMIJO: I don't know what you're
23 saying, then. You're saying they can use the better
24 material in their analysis, but they can build the
25 plant of something else, and somehow the better

1 material analysis bounds the susceptible material
2 performance? I doubt it.
3 MR. HONCHARIK: No, what we're saying is
4 what they proposed there for their leak-before-break
5 analysis included factors for leak-before-break for
6 the LN material. What we're saying is if you use
7 something other than the LN, you're going to have to
8 modify that methodology for leak-before-break to
9 include any factors for these other than LN-type
10 material. So they'd have to go back with their
11 methodology and revise some of their methodology for
12 leak-before-break.
13 MEMBER ARMIJO: So you're saying as far as
14 the AP1000, they are going to use stainless grade
15 stainless steels --
16 MR. HONCHARIK: They have the option. We
17 don't know.
18 MEMBER ARMIJO: For the primary --
19 MR. DAVIS: They have the option. We
20 don't know what they're going to do. They say here
21 that they could either use 304, 304L, or 304LN. And
22 not only that, but they feel that -- because they're
23 going to do it in accordance with the Reg Guide.
24 So if they have any dead legs or areas
25 where they have stagnant water, they're going to use

1 the L grade. If they have -- probably in the main
2 coolant loop, where they know they're going to have
3 low oxygen, they could use the standard grade 304.
4 So it all depends on how they're going to
5 use that material in a specific application. So say
6 for the coolant piping, they may use 304. For surge
7 line, they may use 304LN.
8 And we are not tying their hands on it,
9 but they are also following the Reg Guide, which kind
10 of leads us to say that okay, if you use these other
11 than L-grade material, you need to make sure you don't
12 sensitize it.
13 Because that EPRI Degradation Matrix kind
14 of specifically said that the field experience dealt
15 with association of sensitized and/or cold work
16 material. So it's the sensitized part that this Reg
17 Guide tries to address, that if you use this other
18 than L-grade material, you need to make sure you don't
19 sensitize.
20 MEMBER ARMIJO: And that's the other issue
21 that's come up, and I think Bill's raised the issue.
22 It's that the tests that we accept as demonstration
23 that the material hasn't been sensitized during
24 welding is this oxalic acid test, or something like
25 it. An acid test.

1 And there is no corrolation that success
2 in that test means success in the BWR or the PWR
3 service. Failure of that test means you've got a
4 serious problem, but it doesn't assure success. So
5 how do they really know that they haven't sensitized
6 this standard-grade carbon during welding? In fact,
7 they will. There's no way around it. It's how badly
8 it's sensitized, is the only issue.
9 So again, getting back to the point, we
10 know that there's things happening. We're a
11 regulatory body, and we should be much more sensitive
12 to upcoming problems, that are already happening.
13 And they could get worse, and in future
14 applications, guidance -- not a requirement, but
15 guidance -- should push people towards the better
16 material so that we don't have so many of these
17 problems, particularly in safety systems. So I'll
18 leave it at that. That's a speech.
19 MR. DAVIS: I'd like to point out one
20 thing. It's not just AP1000. USA PWR plans on using
21 standard grades. So it's two of the three PWRs, the
22 DCDs are planning on allowing the use of standard
23 grades.
24 MEMBER ARMIJO: Yes, and I think that's a
25 big mistake. But that's -- and for the NRC to endorse

1 that with all sorts of little conditions that might
2 allow it to work. The biggest -- you know, in the
3 course of a plant life, you can't guarantee the water
4 chemistry will be maintained precisely as you'd like
5 it. In fact, we know there's many, many transients
6 that occur that allow ingress of oxygen.
7 And so the choice of the material doesn't
8 change. The material doesn't change during service
9 unless it's in the radiation field, so that's your
10 best defense. That, plus good chemistry control and
11 good fabrication practice.
12 And it just seems to me that the guidance
13 should be for the best practice. And if people want
14 to use a lesser, a riskier practice, they have to come
15 to you with an exception, and make the case that
16 they're going to provide those controls.
17 MR. DAVIS: But I think also that the
18 Committee needs to understand that there are controls
19 during the welding process. And I don't want to have
20 it out there that because you have 304 material, that
21 doesn't mean that you can't weld it. You can weld it.
22 MEMBER ARMIJO: Of course you can weld it,
23 but you'll always sensitize it, Eric. There's just no
24 way around it.
25 MR. DAVIS: I'm going to disagree with

1 that. I'm sorry. Respectfully.

2 MEMBER ARMIJO: You don't even have to do

3 it respectfully, I'm just telling you --

4 MR. DAVIS: The way you control it is, you

5 need to control your heat input. And that's by

6 controlling your current, your voltage, your travel

7 speed. There's limiting the interpass temperature.

8 There's a bead technique. Instead of using a weave,

9 the welders are using a string of beads. You're

10 incorporating less heat into the material.

11 These are things that are what's called --

12 for those that aren't aware on the committee -- these

13 are called essential variables in Section IX. And

14 what I mean by an essential variable is that if any of

15 these variables are changed outside of the range

16 that's identified in the weld procedure, it requires a

17 complete requalification with the addition of the ASTM

18 8.262 test that you're talking about.

19 And that's the controls, you know? I

20 mean, the welding committee, the welding -- there's a

21 lot of people, if you were to be sitting on Section IX

22 and make a statement like that, they would be --

23 MEMBER ARMIJO: Disagree.

24 MR. DAVIS: Well, they would be --

25 MEMBER ARMIJO: There's no way you can

1 melt a stainless steel in the weld bead, and have a
2 heat-affected zone that doesn't go through the time
3 and temperature range in which carbides, chrom
4 carbides can precipitate.
5 Now, you may minimize it. You may
6 minimize a degree of sensitization. It will always be
7 there. Now, we use a low carbon steel, the C curves
8 are moved over an enormous amount of time. You have
9 plenty of margin. And in that case, you don't pass
10 through the precipitation region during welding and
11 cooling.
12 So fundamentally, you are protected by the
13 material and it's much more forgiving. And I grant
14 you, I still appreciate that people have done a better
15 job on the welding. Don't put any more heat in than
16 you need to make a good joint.
17 But what I'm talking about is the use of
18 these kind of good welding practices with the most
19 forgiving materials, which are readily available,
20 don't cost any more. And why the NRC just still says
21 "Well, we can make the old stuff work, provided we put
22 all these controls in." It just sends, to me, the
23 wrong message.
24 MR. STEVENS: This might be the
25 appropriate time to say, Sam, I think we have an olive

1 branch to offer here on this.

2 MEMBER ARMIJO: I'm not at war.

3 MR. STEVENS: Well, we've had significant

4 discussion on this since the Subcommittee meeting.

5 Internally, we met with you and Dr. Shack yesterday.

6 We've had significant discussions since then. And we

7 have some other changes.

8 It was too late to get into the

9 presentation, and what I thought I would do is we'll

10 go through the presentation and show the changes we've

11 made. And then I have a handout too, of additional

12 changes that we're proposing, that we think will go a

13 long way towards resolving both of your comments.

14 MEMBER SHACK: I'll hold my peace, then.

15 MEMBER SIEBER: Until you read it.

16 MEMBER SHACK: Until I read it, right.

17 MR. STEVENS: So this is giving us

18 background for how we got here today, but in the end

19 we're going to show a markup here, and then I'm going

20 to give you something else that's going to change

21 things a little. So with respect to this slide, I

22 think we've got all the issues on the table.

23 MR. TERAO: Gary, this is David Terao.

24 I'm chief of the Component Integrity Branch in NRO.

25 I'd like to make one more statement. I think we've

had some good dialogue between the NRC staff and ACRS on this issue.

And what Gary is going to show are changes that I think emphasize the need to use low-grade stainless steel. But the changes that we're going to propose is about as far as we can go now without dialoguing with the industry.

As you saw, we didn't get many public comments on this Reg Guide because we weren't making many substantive changes. So to go beyond what we're proposing now, we would have to go back and discuss this and get more public comments. And that's why we don't feel that we can go any further than what we're going to be proposing.

MR. STEVENS: Thank you, David. That's correct.

MEMBER ARMIJO: Yes, I understand. Thank you.

MR. STEVENS: Regarding the second comment, this is a little bit different, in that this comment is addressing if we keep the exceptions and allow the use of non-L-grade material in the Reg Guide, having to do with the .1 ppm dissolved oxygen screening level that's in the exception.

And this level was intended to be a

1 PWR/BWR screen, and that in concert with some of the
2 other guidelines and all that, as well as the
3 potential burden on the industry to change the limit,
4 because of its use in procedures and whatnot, we were
5 disagreeing with changing it.
6 Now, having said that, the change that I'm
7 about to show you, I think, would be consistent with
8 our conversations yesterday. Although we're leaving
9 that value in, we're adding other information in that
10 I think will address the comment.
11 So I'll show you that here in a second,
12 but recognize that where we're coming from here is
13 that -- I guess the other background to say on this
14 is, dissolved oxygen by itself is not the ultimate
15 measure of water chemistry that may preclude instances
16 of cracking. There's lots of other criteria that
17 comes into play. And it's not 100 percent clear on
18 what a level is. And we referenced some documents
19 here that would support the .1.
20 MEMBER SHACK: I'll make my snarky comment
21 that the first one says it's non-sensitized stainless
22 steel. That means we're not dealing with high-carbon
23 steels anymore. And the second one doesn't say it in
24 the title, but if you look at the paper they're
25 dealing with an LN steel. So the .1 is a pretty good

1 limit for L-grade materials.

2 MEMBER ARMIJO: Yes.

3 MEMBER SHACK: It doesn't really support

4 it as a limit for high-carbon materials.

5 MR. STEVENS: I think our proposed change

6 will read into your -- smooth over that issue.

7 MEMBER SHACK: I just kind of half agree

8 with Sam, and half agree with Eric. The test is

9 useful. You know, I don't think you can pass that

10 test with a high, high caarbon steel. You'll probably

11 have to be somewhere around .05, and do careful

12 welding.

13 You probably couldn't pass it with a .08

14 steel, which is within the limits. I don't care how

15 you welded it. So Sam's sort of right. There is a

16 nose there.

17 MR. REICHETT: Which half is more? Are

18 you agreeing with my half more?

19 (Laughter)

20 MEMBER SHACK: I agree with Sam in the

21 sense that since this is a recommendation, not a

22 requirement, the recommendation should be to use low-

23 carbon steels. I'm perfectly -- I agree that you have

24 to accept for PWRs what you've done in the DCDs.

25 I would like this to be stronger in the

1 Reg Guide, so when the utility guy is out there
2 discussing his contract with the vendor, he can say
3 "Okay, I could use either one of these, but I'd really
4 like to use the best material." And I think this Reg
5 Guide should be supporting him in that position, is
6 sort of where I'm coming from.
7 MR. CSONTOS: Dr. Shack, this is Al
8 Csontos. I'm Component Integrity Branch Chief in the
9 Office of Nuclear Regulatory Research. I think what
10 you just said is what you'll see in the comment,
11 revised comment -- or the revised discussion section.
12 So we can go in there in a little bit, but
13 I think exactly what you just said is what we're going
14 to be talking about.
15 MR. DAVIS: To address what Bill said, in
16 the Regulatory Position here, we say if you don't use
17 low-carbon, if you use standard grade -- I don't like
18 the term high grade, because none of this is high
19 carbon. None of this is high grade.
20 MEMBER SHACK: None of this is high grade.
21 MR. DAVIS: All these things in here, we
22 say if you don't use low carbon, you have to follow
23 these things. That's going to remain the same no
24 matter what. If you take this out, then the licensee
25 is going to have to put it in their application.

1 The truth is that these other units are
2 coming in with standard grades of stainless steel, and
3 we do not have a technical basis to tell them that
4 they cannot use it. Typically, with the Reg Guide --
5 for example, with Reg Guide 1.50. For years we've
6 been giving an exception to that to use post-weld
7 baking.
8 So we put post-weld baking in the Reg
9 Guide. We don't really have a technical basis to tell
10 them -- it's a commercial decision -- to tell them
11 that they cannot use low carbon.
12 So these extra requirements for testing
13 the welding procedures and these other things, and the
14 exception in here, the things you have to do if you do
15 not use low carbon, it really doesn't make any sense
16 for us to take that out and to say that they can't do
17 it, because we're going to turn right around and let
18 them do that.
19 MEMBER SHACK: I agree. I wish you could
20 say in here that they can't do it. The language on
21 page two starts to look more like what I like. I'll
22 have to see how the exception is handled in the back.
23 I agree that the Reg Guide should, somewhere in the
24 fine print, let them get away with it. But it should
25 make it clear up front that really, the good

1 engineering would be to use the low-carbon material.
2 MR. DAVIS: And to provide what they need
3 to do if they do use it.
4 MEMBER SHACK: Well, and I like additional
5 limitations that you have with Position 7, if they're
6 going to do it. And those other restrictions, I
7 think, are good restrictions to have. And even to
8 make sure you don't abuse your low-carbon material, I
9 think Position 7's a good thing to have.
10 MR. STEVENS: Okay. Before we get into
11 the markup, a couple other points. We did mention
12 Position 7, which is performance test, and that is in
13 place to accommodate the uncertainties that are
14 associated with the exceptions in the Reg Guide. And
15 we talked about other factors that can lead to stress
16 corrosion cracking independent of all these things,
17 such as cold work.
18 MEMBER ARMIJO: Gary, you know what
19 bothers me about that test is that fundamentally it's
20 looking for the phenomenon of chromium depletion in
21 grain boundaries, which we know is a key thing.
22 But there's never been a test that says
23 "Here, I've got these series of specimens that I heat-
24 treated in such a way that these failed that test,
25 that acid test and these passed."

1 Take the same materials to Bill's lab, or
2 anybody else that's running PWR water chemistry or BWR
3 water chemistry at the appropriate levels -- say your
4 100 ppb -- and determined whether that test is
5 confirmed as providing IGSCC resistance in these
6 laboratory tests, which do duplicate what's going on
7 in the reactor.
8 Mechanically, they force the cracking
9 because they put a lot more stress than you might
10 normally see in the field. But then they'd say "Okay,
11 at least I've correlated the laboratory chemistry test
12 to what actually will happen in the field." And if
13 you do that, I'm much more comfortable with the use of
14 that test and those restrictions.
15 Absent that, it's just a nice test, but I
16 don't know if it really predicts what's going to
17 happen in the reactor. And the reactor is much more
18 aggressive, and the 100 ppb level is totally
19 inadequate for BWRs and PWRs.
20 PWRs don't get into that except during
21 these transients, and that is the reason that at least
22 the people that are studying this problem in PWR
23 cracking, it's those oxygen periods where there's too
24 much oxygen -- for whatever reason, in leakage or
25 whatever -- that's causing the cracking there.

1 So if the water chemistry's the same, it
2 doesn't matter whether it's a PWR or a BWR. These
3 materials are susceptible to cracking. And so the
4 limits should be very tough, and should be basically
5 the EPRI guidelines on water chemistry control, which
6 are addressing IGSCC and IASCC.
7 So if you're going to allow the use of a
8 material that's inherently less resistant, you have to
9 put a lot of confidence in your test, acceptance test,
10 and you have to put a lot of restrictions on its use.
11 Otherwise you're going to have cracking, and I don't
12 think that's what any of us want.
13 MR. STEVENS: So at this time, let's go
14 through it. I handed you three pages, which are the
15 relevant pages of the Reg Guide with the additional
16 changes that we're proposing here in response to the
17 comments. And also shown on these pages -- and I'll
18 point them out to you -- are the editorial changes we
19 previously made after the subcommittee briefing in
20 October, to clarify these points.
21 And so the first one, which is on page two
22 of the Reg Guide, first paragraph under Discussion,
23 we're adding the sentence shown there. And this is
24 in the spirit of the comment Bob made, where the staff
25 doesn't feel that we have enough technical supporting

1 data to require that L-grade material be used, and
2 state, though, that the preference would be to use it.
3 And here we just added a sentence, "Low
4 carbon grade stainless steel (that is, 304L and 316L)
5 should be used where the material comes in contact
6 with the reactor coolant."
7 MEMBER SHACK: I'd only add the LN grades
8 too.
9 MEMBER ARMIJO: We're just giving them an
10 example.
11 MEMBER SHACK: Okay, for example. You're
12 right.
13 MEMBER BROWN: i.e. is "in other words."
14 MEMBER SHACK: It should be e.g. rather
15 than i.e.
16 MR. STEVENS: Got it, e.g. On page 3 of
17 the Reg Guide, which is the second page that we handed
18 out, here is -- and this is also in the background of
19 the Discussion section, B of the Reg Guide. And you
20 can see there in the third paragraph on the page, we
21 do bring up the .1 ppm dissolved oxygen limit.
22 And here we're inserting the words in
23 front of that as "The limiting value of .1 ppm." And
24 then you'll see -- and I think I have this here, too.
25 The following sentence, there's been some editorial

1 changes to focus this in on the L-grade material use
2 for BWRs.
3 And there was one word added and three
4 words stricken, as shown on the screen up here. And I
5 think your markup reflects that as well. And again,
6 this is in the Discussion section, so it's background
7 information. It's no Regulatory Position, so where
8 the rubber meets the road is on page five of the Reg
9 Guide here, Position four.
10 That's on the third page of your handout.
11 And this is the Position where the comments came, and
12 this is where the exceptions are provided. Under item
13 a, you can see first off that consistent with the
14 slide on the screen, we made an editorial addition
15 after the October briefing to hone this in to
16 pressurized water reactor coolant.
17 Again, this was intended to be a screen to get the
18 BWRs out of these exceptions, and we felt this further
19 clarified that.
20 And then the read-in here, in response to
21 the discussion we had late yesterday afternoon, would
22 be instead of having the dissolved oxygen less than .1
23 ppm, we're saying that it's controlled to "typically
24 less than 20 ppb," and probably what I'll do to be
25 consistent is I'll make that .020 parts per million,

1 "with a limiting value of .1 ppm," which is consistent
2 with EPRI's water chemistry guidelines.
3 So in addition to what you see in the
4 presentation, these three markups are what we're now
5 suggesting to try to come to a compromise based on
6 your comments that we've received since October. And
7 we feel, as David pointed out, we're going as far as
8 we can.
9 Call it an editorial clarification,
10 without the need, we feel, to go out and get public
11 comments again. Because we still feel that the
12 changes allow what folks have been doing and what
13 they're used to seeing to still be allowed. We're
14 still clarifying in response to the comments we've
15 received here. We're sensitive to those. And so
16 we're thinking this is the best compromise, and what
17 we can do without going out for public comment.
18 And again, back to the spirit of what Bob
19 mentioned, that we don't think there's sufficient
20 technical information that would allow us to go and
21 remove the exceptions and only limit it to L-grade
22 materials.
23 MEMBER ARMIJO: Okay. Well, I think we've
24 spent a lot of time on this thing. The committee will
25 have to think about this. And then we'll get back to

1 you. So I think we have covered the issues, and at
2 least we've raised a couple that we haven't really --
3 the cold work thing bothers me a lot, that this Reg
4 Guide isn't -- you know, because this is a materials
5 fabrication Reg Guide addressing IGSCC, and all the
6 things that can lead to IGSCC should be addressed in
7 this one Reg Guide. That's my position.
8 And I don't know where else to look for
9 IASCC guidance. You say it's in the Standard Review
10 Plan on cold work, but it's missing here. And it
11 would be good to have it in one place.
12 MEMBER BLEY: I always get confused when I
13 get to these Reg Guides and they don't have this. And
14 if they don't have cross-references to help you find
15 those things, that might be an alternative. But if
16 you come here to look, you just have to know the other
17 places.
18 MEMBER ARMIJO: And the other thing,
19 there's new people building these plants. You know,
20 the guys that built the plants long ago are no longer
21 here. And unfortunately, they built them wrong. Used
22 the wrong material.
23 But new people will look -- you know, I
24 would like to see this Reg Guide really be something
25 that the industry guys who have no experience can see

1 and be guided in the right direction. Not forced, I
2 agree with you. There's just so far the government
3 can go on telling you what to do. But when it comes
4 to safety-related components in contact with BWR or
5 PWR water, we ought to lead them towards the most
6 conservative, most like likely to work. That's a
7 philosophy.
8 MEMBER CORRADINI: So Sam, I've been
9 listening, and I'll just ask a question. So you think
10 it's a safety issue that a phenomenon would actually
11 be catastrophically different if they were to choose -
12 - because what I'm hearing now, it's more on the gray
13 edge of a commercial decision, as long as they have
14 proper practice.
15 MEMBER ARMIJO: No, it isn't. Well, if
16 you crack a primary coolant line, it'll leak. We've
17 never had them blow up, but it is a leak. Or if you
18 have a core internal that breaks, it can affect the
19 safety of the plant. These are safety-related
20 components. So I think there are safety issues, but
21 I'm not saying they'll lead to catastrophe if they do
22 crack.
23 MEMBER CORRADINI: I'm not an expert in
24 all this, but the way I hear the discussion going, my
25 interpretation of this is this is something that's a

1 commercial decision as long as they have good practice
2 within this. And what I'm hearing, unless I'm
3 misunderstanding, they're recommended to have the --
4 shall we say the newer materials. I don't want to use
5 the word better, but the newer materials.
6 And as long as they take less newer
7 materials and properly have the right chemistry
8 controls and construction practices, it's acceptable.
9 That's what I'm hearing.
10 MEMBER ARMIJO: They aren't newer
11 materials. Both the low grades and the standard
12 grades have been around for forever. The low carbon
13 grades are better with respect to this phenomenon.
14 There's no question about that. Laboratory, operating
15 experience, everything.
16 So it is truly better. Part of it is a
17 commercial decision on things that don't affect
18 safety. You know, if guys want to have their plants
19 cracking and fixing them, that's their problem. But
20 if it's safety-related components, that's our problem.
21 Or else we shouldn't even be writing a Reg Guide on
22 it.
23 MR. CSONTOS: Dr. Armijo, can I just say
24 one other thing? This is Al Csontos again. Just as a
25 point of reference, a lot of these Reg Guides --

1 especially this one is older than I am. And so we
2 really want to get this updated, okay?
3 We have a position in Office of Research
4 to update these every five years after this, or at
5 least look at revising them. So just for a point of
6 reference, please remember that this is over 35, 38
7 years old. So please, if we can modernize this one,
8 and then go to the next step and revise them again
9 within the next five years.
10 So we're at a place now, we've been
11 working on this for the last two-plus years at a
12 minimum. And we'd love to go and try to finalize
13 this, get it out there for the industry and for the
14 public, and then go on after that to update them
15 within the next five years.
16 MEMBER ARMIJO: It hasn't been updated
17 very much, I can tell you. If you look at the
18 redline/strikeout on this Reg Guide, it hardly made
19 any changes. And I agree that it should be updated,
20 but it should be updated completely.
21 MEMBER BLEY: Sam, I learned something on
22 the last Reg Guide I did. When they give us a
23 redline/strikeout, that's a redline/strikeout between
24 this draft and the previous draft, not a
25 redline/strikeout between this Reg Guide and the

1 previous Reg Guide.

2 MEMBER ARMIJO: I belive this is a --

3 MEMBER SHACK: In this case, the changes are not

4 very large --

5 MEMBER BLEY: I believe that.

6 MEMBER SHACK: The changes here are

7 important ones to me, at any rate.

8 MEMBER ARMIJO: I think they're moving in

9 the right direction.

10 MEMBER SHACK: I think they kind of agree

11 that they've probably gone as far as they can go in

12 terms of --

13 MEMBER ARMIJO: Without going out again.

14 MEMBER SHACK: And especially because

15 they're regulating safety, not commercial reliability.

16 But it does give you, I think, good engineering

17 practice, which is what the Reg Guide, I think, ought

18 to do. Even if they accept something lesser, perhaps,

19 in a DCD

20 MEMBER BROWN: But why aren't cracks in

21 pipes or materials subject to reactor coolant

22 chemistry and pressures -- why aren't they safety

23 issues?

24 MEMBER BLEY: When you start getting them,

25 they sure turn into safety issues.

1 MEMBER ARMIJO: Any time it happens
2 there's a big flap. Whenever it happens in something
3 new, there's a big flap. We all get pulled in. So it
4 is a safety issue, and it's not catastrophic.
5 Because, fortunately, all of these materials are very
6 forgiving as far as catastrophic rupture. That's why
7 we have leak-before-break. But we should discourage
8 anything that threatens the pressure boundary.
9 MEMBER SHACK: And again, we're talking
10 about PWRs, where the experience really has been
11 pretty good. I mean, if somebody was trying to come
12 in here to sell 304 for use in a BWR, we would not be
13 having this discussion.
14 MR. REICHETT: And I think the changes
15 that we have made overall, from the last subcommittee
16 meeting up until now, including this, we've tried to
17 identify those specifics. For BWRs, you need to use
18 the L-grade. We're not disagreeing that L-grade is
19 the better material to use. I mean, you've got three
20 welding guys up here that would say "Yes, we concur."
21 But I think the changes that we've made
22 here also identifies -- hey, we're identifying to the
23 industry, out in the commercial field, that low-carbon
24 stainless steel is the material that should be
25 utilized. But to impose it, we just don't have that

1 operating experience.

2 MEMBER ARMIJO: I appreciate that staff

3 has provided some more information for the committee

4 to look at. We only have 15 minutes left. I think

5 we've got all the issues on the table. We've had a

6 good discussion.

7 I think we have one more Reg Guide that I

8 don't think was very controversial, but you may want

9 to cover that, Gary, so that we can finish on time.

10 MR. STEVENS: I covered them all.

11 MEMBER ARMIJO: Oh, I'm into your backup

12 slides. I'm sorry. You did.

13 MEMBER SHACK: We're not getting into his

14 backup slides.

15 MEMBER ARMIJO: I was looking, and I said

16 "Oh my God, we didn't let the guy give his

17 presentation."

18 MEMBER SHACK: He was ready to back it up.

19 MR. STEVENS: So I guess what we're

20 proposing with what I handed out there, we're ready to

21 issue these four Reg Guides, 1.44 with those changes.

22 We have satisfactorily addressed all the public

23 comments we've received, and we're ready to go. And

24 that's all we had. Any other questions?

25 MEMBER ARMIJO: Any comments or questions

1 from members?

2 MEMBER BROWN: Just one. How much -- in

3 most plants where you have high-carbon steels --

4 MEMBER SHACK: Standard grade.

5 MEMBER BROWN: Standard grade, high-carbon

6 steels.

7 MEMBER CORRADINI: They're not high-

8 carbon.

9 MEMBER BROWN: Relatively high.

10 MEMBER SHACK: Relatively high.

11 MEMBER BROWN: How much experience is

12 there of actual leaks that have had to go be repaired.

13 Because I mean, it's radiation exposure for people to

14 go in there, blah blah blah, all that type of stuff.

15 MEMBER ARMIJO: Charlie, in the case of

16 the BWRs there were two separate shutdowns of all BWRs

17 in the United States by the NRC due to IGSCC cracking

18 caused by this weld sensitization phenomenon. And it

19 happened on standard grade welded stainless steel made

20 with the best industry practice, passed all these

21 tests, and things like that. And since then, there

22 have been numerous other cracking events. Not just

23 the piping, but other components.

24 MEMBER BROWN: In BWRs?

25 MEMBER ARMIJO: In BWRs. And there have

1 been instances of the same cracking type, the same
2 phenomena, in PWRs.
3 MEMBER BROWN: But I mean is it half a
4 dozen in the last 20 years, or is it 100?
5 MEMBER ARMIJO: I would say you could
6 count them maybe in the order of 10, 20. But you know
7 these things, the big problem with these phenomena,
8 it's nucleation is the name of the game. What causes
9 it to start, once it starts it'll propogate. So we
10 don't know.
11 MEMBER BROWN: Thank you.
12 MR. DAVIS: I'd like to point out that the
13 issues associated with stress corrosion cracking in
14 operating PWRs, a lot of those have been cold work,
15 which could happen -- even if it's low grade, you're
16 going to get it.
17 Or chloride contamination, which has
18 absolutely nothing to do -- there have been instances
19 of chloride contamination, stress corrosion cracking,
20 OD stress corrosion cracking, in plants underneath
21 pipe supports in solution-annealed standard grade,
22 which is no different --
23 MEMBER ARMIJO: But those are very rare,
24 and that's not the issue we're talking about. And so
25 the problem is what's happening with our fluid-related

1 chemistry problems. That's where the problem is. And
2 the PWR has favorable water chemistry, no doubt about
3 it.
4 The BWR guys have changed their water
5 chemistry to drive it towards PWR conditions by adding
6 hydrogen and noble metals. And so they're driving to
7 converge on PWR water chemistry even though they're
8 still using, proposing to use, low-grade steels.
9 That's what they've been doing for years.
10 So we're moving in the right direction. I
11 would like to see our guidance, NRC guidance, pushing
12 people in the right direction to the point where we
13 never have to have these conversations again, and the
14 next thing that cracks we don't have to pull a team
15 together to explain what happened here.
16 So I'm trying to be proactive in
17 preventing cracking, rather than responding to
18 cracking. And I will end my speech, and unless
19 there's other comments I'll turn it over to the
20 chairman. I don't htink there's any public comment.
21 CHAIRMAN ABDEL-KHALIK: Thank you. Our
22 schedule calls for us to take a break at this time,
23 and reconvene at 10:15. So we will reconvene at
24 10:15.
25 (Whereupon, the above-entitled meeting

1 went off the record at 9:50 a.m. and resumed at 10:14
2 a.m.)
3 CHAIRMAN ABDEL-KHALIK: At this time,
4 we're back in session. At this time, we will move to
5 the next item on the agenda, Commission Paper on the
6 Use of Containment Accident Pressure in Analyzing
7 Emergency Core Cooling Cystem and Containment Heat
8 Removal System Pump Performance in Postulated
9 Accidents. And Dr. Shack will lead us through that
10 discussion.
11 MEMBER SHACK: This is a topic that hardly
12 needs introduction, I think. The Commission paper is
13 responding to a Commission SRM that directed the staff
14 to discuss the areas in which it aligns with the ACRS
15 and disagrees with the ACRS with regard to the use of
16 CAP, including defense in depth implications, the use
17 of risk information, and whether to assess the
18 practicability of plant modifications to eliminate the
19 need for CAP credit.
20 As I read the Commission paper that was
21 prepared, I think the disagreement in our position and
22 that of the staff appears to have increased. The
23 staff continues to disagree with our position that
24 credit for containment accident pressure is a serious
25 compromise of the independence of prevention and

1 mitigation functions.

2 They continue to argue that there's no
3 basis that licensees provide plant-specific risk
4 information to support crediting CAP. Reg Guide 182
5 has always included a position that the CAP credit
6 should be granted only if the design cannot be
7 practicably altered to eliminate the need for credit.

8 The SECY now states that the staff does
9 its safety evaluations based on regulations,
10 regulatory guidance, and commission policy. The staff
11 does not judge whether the licensee could have met its
12 objective in some other way, i.e., they do not need to
13 make a judgment on the practicability of a design
14 change.

15 On a more positive note, I believe the
16 staff's guidance on the deterministic analysis of CAP
17 credit is significantly improved. There's a more
18 explicit accounting of uncertainties, more
19 consieration of modes of pump degradation, and the
20 paper now presents a technical case for the integrity
21 of the containment under accident conditions, which of
22 course is crucial to the defense-in-depth argument.

23 I think Bill Ruland will start with some
24 introductory remarks.

25 MR. RULAND: Thank you Dr. Shack and Mr.

1 Chairman for the invitation to summarize our
2 Commission paper on the use of containment accident
3 pressure credit when analyzing ECCS pump performance
4 during postulated accidents.
5 As I know, and Dr. Shack mentioned, the
6 committee is well aware, the staff and the ACRS have
7 discussed this subject for years, and it has a long
8 history, probably going back, I suspect, four years.
9 During our discussions -- and these are the recent
10 discussions -- the staff has learned much about the
11 ACRS concerns, and we have explored several ways to
12 address those concerns.
13 Through our discussions, we have, in our
14 view, made substantial improvements in our
15 understanding and criteria for ECCS pump NPSH
16 requirements, improved our knowledge and application
17 of the uncertainty around NPSH margin, and improved
18 our generic understanding of the risk associated with
19 CAP credit.
20 We would have not reached our current
21 position without our interaction with the Committee.
22 We have now reached the stage where the Commission has
23 required the staff to put our views in writing and
24 discuss where we agree and disagree with the ACRS.
25 And as you have seen, we have proposed a path forward.

1 Our path forward, as described in the
2 paper, did not come easily to us. We have taken and
3 continued to take the opinions of the ACRS seriously,
4 and we do not take our position lightly. We believe
5 we have rendered our best technical and regulatory
6 judgment in developing our proposal.
7 Fundamentally, the staff agrees that
8 taking credit for CAP can reduce defense-in-depth.
9 But the question the staff must answer is whether or
10 not CAP credit compromises adequate protection, which
11 we have concluded it does not, given the actions the
12 staff has taken or will take.
13 The issues that remain between us, we
14 believe, bear on the policy questions that revolve
15 around CAP credit, and rightly belong to the
16 Commission to decide if they need to intervene or not.
17 Ultimately, the staff will implement the policy that
18 the Commission directs.
19 The good news is that we are now on a path
20 where we will be able to provide the industry a level
21 of predictability that has been missing from this
22 issue. And now we will present our summary of CAP
23 credit, the CAP paper. And we hope to provide the
24 answers to your questions.
25 MR. LOBEL: Good morning. My name is

1 Richard Lobel. I am a senior reactor systems engineer
2 in containment and ventilation branch in NRR. I'd
3 like to briefly summarize SECY-11-0014.
4 As Mr. Ruland just said, the paper was
5 written in response to a Commission Staff Requirements
6 Memorandum. As part of the presentation, I'll discuss
7 a little of the background.
8 As Mr. Ruland also said, at this point I
9 think the Committee is familiar with the issue. We've
10 given more thought to the definition of containment
11 accident pressure -- and I'll discuss that. The
12 change affects the number of PWRs considered to use
13 containment accident pressure, but doesn't affect how
14 the calculations for a given plant are done.
15 The Commission SRM requested that the
16 staff discuss, quote, "Where the staff aligns with the
17 ACRS and disagrees with the ACRS regarding containment
18 accident pressure (CAP) credit," unquote. In
19 particular, the Commission requested the staff to
20 consider defense-in-depth, risk, and the need to
21 assess the pracicability of hardware changes to
22 eliminate the need for CAP credit.
23 The Commission paper addresses these
24 subjects and presents two options to the Commission.
25 Before discussing the paper, I'd like to discuss the

1 definition of CAP and how it is used, since this has
2 evolved a little in -- maybe not our understanding,
3 but our use of the term.
4 This figure I'll use to discuss both BWRs
5 and PWRs. The figure illustrates containment pressure
6 versus time during a postulated accident. The
7 horizontal line represents the pressure prior to the
8 accident, to the LOCA. Remember, Reg Guide 1.1 says
9 that this pressure should be used to calculate
10 available NPSH.
11 The red line is the total containment
12 accident pressure. It consists of the air partial
13 pressure and the vapor partial pressure. The 19 BWRs
14 using CAP greater than the containment pressure prior
15 to the accident use some fraction of the total
16 containment pressure in determining available NPSH.
17 Some operating PWRs also use some fraction
18 of the total containment pressure in determining
19 available NPSH. The yellow line shows the vapor
20 pressure at the temperature of the PWR sump water.
21 Some PWRs assume this vapor pressure in calculating
22 available NPSH.
23 While this is conservative for calculating
24 available NPSH, since it ignores the air partial
25 pressure, it does assume that the containment is

1 leaktight. During the first part of a PWR accident,
2 before switchover to the sump, the pumps are taking
3 suction from the RWST, and the containment pressure is
4 not important in determining available NPSH.
5 The Commission paper stated that the
6 number of PWRs for which containment accident pressure
7 was greater than the pressure prior to the accident is
8 60. This is the number of PWRs for which the vapor
9 pressure corresponding to the sump temperature is
10 greater than the pressure in containment prior to the
11 accident, meaning that containment must remain
12 leaktight.
13 Some of these PWRs also include the
14 partial pressure of air in calculating available NPSH.
15 Others use a small amount of air pressure in order to
16 demonstrate that flashing of the hot sump water will
17 not occur as the water flows through the sump screens.
18 Summarizing, we define CAP credit as the
19 assumed pressure in containment during the accident
20 used to determine the available NPSH. It can be some
21 fraction of the total accident pressure,
22 conservatively calculated, the vapor pressure
23 corresponding to the sump water temperature, or the
24 temperature in containment prior to the postulated
25 accident may be assumed to be the pressure during the

1 accident, which agrees with Reg Guide 1.1.

2 MEMBER CORRADINI: So the way you've just

3 described it, just so we're clear -- I was hoping

4 there would be a slide where you would have this in

5 there. You've gone down from a lot of credit, to less

6 credit, to no credit. That's the way you've described

7 it.

8 MR. LOBEL: Yes.

9 MEMBER CORRADINI: Okay. And you're

10 saying that current operating PWRs are -- shall we say

11 soup to nuts? Some use total, some use the partial

12 pressure, some use none.

13 MR. LOBEL: Right.

14 MEMBER CORRADINI: Okay

15 MR. LOBEL: The first specific topic

16 requested in the Commission SRM is defense-in-depth.

17 The basic issue involved with the use of containment

18 accident pressure in determining pump available NPSH

19 is defense-in-depth. The staff recognizes that the

20 loss of containment accident pressure can affect the

21 independence of the fission product barrier, which is

22 one -- but not the only -- definition of defense-in-

23 depth.

24 Still, our review of the regulations shows

25 that independence of barriers is not a requirement.

1 Design-basis accidents assume containment integrity,
2 and several regulations assume containment integrity.
3 MEMBER CORRADINI: I'm sorry, can I just
4 ask a question?
5 MR. LOBEL: Sure.
6 MEMBER CORRADINI: If I had a dry
7 containment, unless I had leakage that I was pushing
8 out the air, the steam partial pressure is the gray
9 line?
10 MR. LOBEL: The steam partial pressure
11 would be the yellow line.
12 MEMBER CORRADINI: I'm sorry, is it the
13 gray area?
14 MR. LOBEL: Yes.
15 MEMBER CORRADINI: All right.
16 MEMBER SHACK: But again, you assume
17 containment integrity. But the question is whether
18 you're assuming containment integrity as part of your
19 prevention function or your mitigation function.
20 Certainly, you always assume it to be true
21 for your mitigation function. That's the purpose of a
22 containment. But the question is whether you should
23 presume it for your prevention function, also.
24 MR. LOBEL: Right.
25 MEMBER SIEBER: Of the three barriers,

1 they're supposed to be independent. In the case where
2 you use the containment pressure for pump NPSH, they
3 aren't independent.
4 MR. LOBEL: The fission may not be
5 independent. There may be cases where credit is taken
6 for containment accident pressure where it may not
7 really be necessary, where the amount of time the pump
8 spends depending on containment accident pressure is
9 so little that it doesn't matter, or that kind of
10 thing. But the basic idea is like you said.
11 MEMBER SIEBER: The basic idea is for them
12 to be independent. That's the original concept.
13 MR. LAUR: Excuse me, that's the part that
14 is not in the regulations. The independence of the
15 barriers is part of the defense-in-depth philosophy,
16 but I as I understand it the original idea was
17 multiple fission product barriers, and engineered
18 features to protect and maintain the barriers.
19 MEMBER BLEY: But if they aren't
20 independent, you don't have multiple barriers. I
21 mean, that was implicit in that definition.
22 MEMBER POWERS: Multiple independent
23 barriers of increasing conservatism. It takes a more
24 severe accident to threaten the barriers as you move
25 outward from the core.

1 MEMBER SIEBER: Well, I think in
2 mitigation of that, compromise took place when they
3 first started to use the subatmospheric containments.
4 And almost all of those rely to some extent on
5 containment pressure for pump cavitation.
6 MR. LOBEL: That decision to allow that
7 was made in the late '60s.
8 MEMBER SIEBER: So now we've marched down
9 that road for a while, and the idea is to figure out
10 what constraints that philosophy should have.
11 MR. LOBEL: And that was identified as one
12 of the things that the Commission asked us to address,
13 and that the Commission hopefully will give us
14 direction on: how important is defense-in-depth in the
15 implementation of license amendments that involve CAP.
16 MEMBER SIEBER: Well, the issue is a
17 philosophical issue, as opposed to a technical one,
18 really.
19 MR. LOBEL: And that's the point I was
20 trying to make.
21 MEMBER CORRADINI: Can I go -- I'm sorry
22 that I keep on going back to it, but can we jsut go
23 back to that slide. I'll probably say this wrong, so
24 you can correct me. But if the containment wasn't
25 heating up, it would be the blue line. The fact that

1 the containment's heating up and I'm keeping air in
2 there, it's the white part between yellow and red.
3 And in fact, I have steam partial pressure of some
4 sort, is the gray.
5 If I have a containment that's leaking
6 like a sieve, it will hold at blue, and I will simply
7 have the vapor pressure become the pressure, and I
8 have to use, essentially, the total containment
9 pressure as my starting point. I have no partial
10 pressure anymore.
11 MR. LOBEL: Well, you'd have one
12 atmosphere.
13 MEMBER CORRADINI: But it's all going to
14 be steam, so I have to use that. And I'd be at 212
15 Fahrenheit, and I have to start that, and get all the
16 positive pressure and all the negative losses to the
17 friction before I might cavitate inside the pump,
18 right?
19 MR. LOBEL: Yes.
20 MEMBER CORRADINI: So they're always
21 interlinked, just because the containment is behaving
22 in some manner.
23 MR. LOBEL: Right.
24 MEMBER CORRADINI: Okay.
25 MR. LOBEL: The May 19th, 2010 ACRS letter

1 discussed the use of risk analysis in connection with
2 the use of containment accident pressure. It stated
3 that the Committee thought that the staff PRA studies
4 were helpful in assessing the importance of pre-
5 initiator and post-initiator leakage probability, and
6 leakage test interval. However, the Committee stated
7 that seismic events, fires, and operator actions are
8 potentially risk-significant.
9 These were not included in the staff study
10 that was done. The staff study was a BWR/3 with a
11 Mark I containment, and that was presented to the
12 Committee, I think, at our last meeting on this, on
13 May 6th, 2010.
14 Finally, the Committee stated that only a
15 plant-specific risk analysis can adequately assess
16 risk.
17 MEMBER BANERJEE: When you say
18 impractical, that's one of the sort of sticking
19 points.
20 MR. LOBEL: I'm going to get to that. The
21 Commission paper explains that the staff follows the
22 current guidance, formulated to follow the
23 Commission's direction as to what it requests of
24 licensees with respect to risk in non-risk-informed
25 license actions.

1 License amendment requests, including the
2 use of CAP, are typically not risk-informed. If
3 approved by the staff, they comply with existing
4 regulations. The staff review of risk in terms of
5 whether special circumstances exist is always part of
6 the review. The staff has not identified special
7 circumstances with the use of CAP up to this point.
8 The Commission paper does not ask the
9 Commission to revise its direction on the review of
10 non-risk-informed license amendment requests. Option
11 two would have the staff perform a backfit regulatory
12 analysis to assess whether options to avoid the use of
13 CAP result in a substantial increase in safety. A
14 plant-specific PRA would probably be considered as
15 part of option two.
16 The staff did present the results of a
17 risk study of a BWR/3 with a Mark I containment that
18 showed the risk to be small. The study was through a
19 large recirculation line break. The risk was
20 nominated by pre-initiator failures.
21 The study demonstrated the importance of
22 the frequency of the surveilance for pre-existing
23 leakage. And as pointed out, seismic events, fire,
24 and operator actions were not modeled.
25 Pracicability to eliminate CAP. As was

1 pointed out before, Reg Guide 1.82, revision 3 has a
2 position that states that for certain operating
3 reactors for which the design cannot be pracicably
4 altered, containment accident pressure may be used.
5 The staff has not questioned whether licensees could
6 practicably alter their designs.
7 This is partly because it has been the
8 staff's judgment that such modifications would not be
9 practicable. More importantly, and the position
10 stated in the Commission paper, it's the staff
11 position that the staff evaluates a licensee's
12 proposal and makes a judgment as to whether the
13 proposal is acceptable based on safety, compliance
14 with regulations, guidance, and Commission policy.
15 The staff has done this with respect to the use of
16 containment accident pressure.
17 The ACRS has questioned to BWR licensees
18 requesting extended power uprates about the
19 practicability of modifying their plants so the use of
20 containment accident pressure will not be necessary.
21 And in both cases, the ACRS agreed with the licensees
22 that such modifications were impracticable.
23 MEMBER SHACK: Now, does this mean that
24 you're going to revise the guidance in 1.82 to
25 eliminate that statement on the practicability?

1 MR. LOBEL: We'll wait for Commission
2 direction. But yes, that would be the intent.
3 MEMBER SHACK: That would be the intent?
4 MR. LOBEL: Yes.
5 MEMBER CORRADINI: And maybe this is not
6 the right place to stop you, but so you make -- just
7 the way you read the statement, my impression is right
8 now the staff's position is you make no judgment, you
9 simply accept what the licensee says. They say "We
10 can't make a change," you say "Fine, show us the
11 safety case given you can't make a change." You do
12 not review whether or not a change can be made to
13 reduce the amount of CAP credit.
14 MR. LOBEL: We haven't asked the question.
15 So we haven't gotten an answer back from the
16 licensee. ACRS, during the extended power uprates,
17 has asked that question of licensees, but in our RAIs
18 we have not asked that question.
19 MEMBER CORRADINI: And that's what I'm
20 trying to get at. You have not asked that question
21 because you don't feel it's your judgment, that that's
22 not part of what you need to ask?
23 MR. LOBEL: That's part of it.
24 MEMBER CORRADINI: In other words, where
25 we started with all this that I remember -- and again

1 I'm not following this. Bill is the expert. In our
2 logic, it was always first ask "Can you do some sort
3 of practical fix that reduces the time or the amount?"
4 And if you can't do a practical fix,
5 whatever practical is defined as -- I don't know if we
6 volunteered to define it -- then you move on and say
7 "Okay, if not practical, then what are you doing to
8 assure us that safety is -- the adequacy of the safety
9 you have.
10 So you're not even asking that first
11 question, and you never have?
12 MR. LOBEL: Never have.
13 MEMBER BANERJEE: And now you're going to
14 eliminate that?
15 MR. LOBEL: If we don't get any guidance
16 to the contrary from the Commission, we would
17 eliminate that.
18 MR. RULAND: It's the staff's view that we
19 are not -- that to do that kind of review is beyond
20 what the staff has done historically, for not just CAP
21 credit, but the whole series of the way we conduct our
22 licensing.
23 It is the licensee's job, even when they
24 are trying to address staff's question, we provide the
25 licensees, frankly, the liberty to decide how they are

1 going to meet our regulations. And then we just make
2 a judgment about whether or not what they propose is
3 acceptable.
4 MEMBER CORRADINI: But if a licensee -- I
5 heard that, but in so many other examples, you guys
6 are fairly aggressive at deciding if way one is
7 appropriate or not. So I'm trying to understand the
8 logic as to why not even ask the question if an
9 engineering fix is not possible or practicable?
10 That's what I'm still not understanding. I'm missing
11 something. Maybe all the other Committee can
12 understand this, and I'm the only one.
13 MR. RULAND: Can you give me an example
14 where the staff has prescribed a particular fix?
15 MEMBER CORRADINI: No, I'm just kind of
16 going with what Richard said, which is they come in
17 with a case and they said "We want to do X." And I
18 would expect the staff have asked "Have you thought of
19 Y," which is make the pump lower, or find a way to
20 arrange your components so that you have more NPSH.
21 And if you haven't asked the question, my question --
22 my curiosity is why.
23 MEMBER RAY: The implication, Mike, is
24 that there is no circumstance in which the Commission
25 would accept less than a required measure because the

1 required measure is impractical. That never happens.
2 Now, the history he's talking about
3 doesn't include when I was involved in making the
4 history, years ago, because you sure as heck did get
5 into that kind of a discussion. But now we don't make
6 that judgment. That's what I hear him saying.
7 MEMBER CORRADINI: So there's an evolution
8 of whether this was asked or not?
9 MEMBER RAY: Yes. In other words, there's
10 no -- it's best to do it this way, and you can do it
11 some other way only if it's not practical. That's the
12 implication of what's being said. I think it's an
13 evolution, as you say.
14 MEMBER BROWN: And that's even though the
15 Reg Guide says the practicality should be evaluated.
16 MEMBER RAY: Well, they're going to change
17 the Reg Guide.
18 MEMBER BROWN: I know, but they said they
19 have never used that as a judgment object, even though
20 the Reg Guide says you should use it.
21 MEMBER RAY: I would disagree with it, but
22 that's --
23 MEMBER BROWN: That's what they said.1
24 MR. RULAND: Rich, you did these reviews,
25 right? Have you ever asked this question?

1 MR. LOBEL: We never asked the question.

2 MEMBER CORRADINI: I think Harold is

3 thinking historically, back -- not one, two, three

4 years ago, but 10, 20 years ago.

5 MEMBER RAY: Yes. I'm not talking about

6 CAP, either, particularly. I'm just saying the basic

7 position you're taking is that the Commission doesn't

8 have a preferred way of doing something. Anything, it

9 doesn't matter what it is. Fire protection. It

10 doesn't matter.

11 And that's absurd. Of course they do.

12 They say "You do it this way, but if you can't then

13 there's some other acceptable measure." And maybe

14 fire protection, which we were talking about

15 yesterday, is as good an example as any.

16 You can't tell me that the Commission

17 doesn't have a preferred way to do things when it

18 comes to fire protection. Separation barriers, and so

19 on. Use fire watches when you can't, it's not

20 practical. And now we're acting as if this is

21 uniquely different than fire protection, to use that

22 example. And I just think that's sophistry to an

23 extreme.

24 MR. LAUR: Excuse me. There is a

25 difference here. We have promulgated regulations --

1 and let's just talk about Appendix R, not the 805 --
2 that proscribe -- prescribe the things you're talking
3 about, the separation and the barriers and everything.
4 And what we're saying here is that as a
5 result of interactions with the ACRS, we have come to
6 regulation, and we cannot find a regulation that says
7 these barriers shall be independent, that they shall
8 not have some level of independence, or what that
9 would be.
10 MEMBER CORRADINI: Is this another way of
11 saying that it's hard to define "practical," so you're
12 not going to ask the question? Or "impractical"?
13 MR. LAUR: No, I think it's a way of
14 saying that if --
15 MEMBER CORRADINI: That's what I sense is
16 happening.
17 MEMBER RAY: Well, but stick on the
18 example here. I believe that the answer to my analogy
19 -- it's really, really strained. But I hear you, and
20 I'll think about it.
21 MR. RULAND: There have been times when
22 the staff debates with licensees on specific technical
23 matters where it appears within the guise of a
24 specific approach a licensee has taken that we
25 question them.

1 And sometimes we're not as rigorous in the
2 way we make our questions, but ultimately it is the
3 licensee's job to make the final proposal about what
4 is acceptable or not. As everybody here knows, our
5 Regulatory Guides are guidance, and typically have
6 boilerplate language that say "This is one way that
7 the staff feels it's appropriate to accept -- is an
8 acceptable way, and there are other ways."
9 Licensees, of course, know that it's a lot
10 easier, usually, to do that way that the staff has
11 already found acceptable. They know that. And the
12 staff, of course, knows that. And we typically ask
13 lots of additional questions when a licensee proposes
14 some other alternative way.
15 But that does not prohibit a licensee from
16 doing this. And likewise, with this particular way,
17 what has happened in the past when we finally asked
18 the question, based on the ACRS's question, we
19 accepted what the licensee did.
20 And we don't feel it's practical for the
21 staff to ask this question, because ultimately, how
22 are we going to judge this? Are we going to do cost-
23 benefit analyses? Do we know the licensee's plant?
24 We're not the experts about the licensee's plant. So
25 that's why we're going to do this. That's why we're

1 recommending that we eliminate practicality.

2 MEMBER BANNERJEE: But Bill, there is a

3 change in the flavor of this, once you do it. You

4 know, it used to be that CAP was an exceptional thing,

5 and if you proved it was not practical, or whatever,

6 we did it. Allowed it. Now it's becoming that you've

7 taken that away, and it changes the whole flavor.

8 CAP can be a routine thing. Everyone can

9 have CAP now. They don't have to do anything. Now,

10 even in the 60 or 30 plants that have it, the reason

11 they have it, to some extent, is because that margin

12 was there.

13 And when issues like GSI-191 and all came

14 along, unexpected things, then they could appeal to

15 that. And we had to cut into that margin, but at

16 least there was a reason for that margin. And we were

17 lucky we had that margin. Today we are going to say

18 that any EPU can just do it, and we don't have that

19 margin any more. It's a different point of view.

20 MR. RULAND: I appreciate your comment,

21 Dr. Bannerjee. It turns out, as we have discussed

22 these EPUs with some of the licensees, we heard from

23 them -- particularly given our new deterministic

24 criteria that we have, with margin -- licensees are

25 thinking about "Gee, do I want to go down that path?"

1 They know that we have raised the bar on
2 seeking containment accident pressure. I don't think
3 there's any question about that. And licensees are
4 going to have to make a judgment about whether or not
5 they want to go down that road, or whether or not they
6 want to eliminate that, eliminate taking credit for
7 containment accident pressure.
8 And this is usually the way it works.
9 Licensees say "Oh, my gosh. I don't want to go down
10 there. I'm going to eliminate taking credit for it."
11 And we've already heard that from some licensees, so
12 I don't think it is as stark as you are suggesting.
13 MEMBER BANNERJEE: I agree that some
14 licensees are coming in, definitely, without appealing
15 to --
16 MEMBER ARMIJO: Maybe this is really kind
17 of a safety culture issue. Because I always felt that
18 the preferred way of handling a problem -- the
19 regulators preferred that a problem should be fixed.
20 A plant should be repaired. A component should be
21 changed if it doesn't do the job adequately.
22 And so asking this question up front, to
23 me, was the first thing that you had to do. And just
24 eliminating this and saying "Whatever you propose,
25 we'll evaluate it," I think is a degradation of our

1 safety culture, the same thing as independence of
2 barriers.
3 You know, I'm not a fan of using "safety
4 culture" as something you put into some prescriptive
5 thing, but it does exist. And this is a change.
6 MEMBER BROWN: Not only that, we've now
7 gone to the point of saying "We don't have a
8 regulation that requires independence of our barriers,
9 our multiple barriers from the reactor to the field to
10 the cooling system to the containment. They can be
11 dependent, which doesn't seem to make a whole lot of
12 sense as a basic approach to doing business.
13 MEMBER BLEY: It seems to me --
14 MEMBER BROWN: I have a hard time with
15 that.
16 MEMBER BLEY: -- that if I understand what
17 you guys started with, you've scoured and you don't
18 find the word independent in the regulation. But
19 where it's stated that you must have the multiple
20 barriers, it was the presumption of independence from
21 the beginning. I mean, that's why you have three. So
22 I think we're -- the focus of the argument has somehow
23 changed, here. I think there's a misinterpretation of
24 what the intention --
25 MEMBER CORRADINI: We should let him get

on. But I guess the only thing though, Dennis, is because the barriers interact, they can never be totally independent. That's why I asked the question about leakage.

If I had a leakage, now all of a sudden the pool temperature or the sump temperature changes because nature says it will, right? So it's not that the barriers are independent, it's just that they are interdependent by their very physical behavior.

We're trying to make them as independent as we possible can given the laws of nature. What I'm more bothered by is the fact that you're taking out even the question, the qualitative asking of "Gee, what did you practically think of to do instead of seeking more credit?"

Just asking the question. "Even if I don't understand what's practical or impractical, what did you think of? Did you think of this? Did you think of that? Why didnt' you do that?" That questioning of the applicant, I think, is a fair thing to do coming into the game.

MEMBER BLEY: I don't disagree with you, except that I probably do on the independence issue. I think just because they interact doesn't mean their failures are dependent.

1 MEMBER STETKAR: You don't care about the
2 leakage had you not failed the first two barriers.
3 You know, you're coupling the third barrier as a
4 dependent function, leakage of the third barrier. But
5 you wouldn't need those had you not already failed the
6 first two barriers. You wouldn't care about the
7 leakage.
8 MEMBER CORRADINI: So just to fight back,
9 if I were to say that I'm going to change how I
10 actively use a containment spray because I want to
11 keep the pressure high, I'm on your side. But if I
12 say that I have a vapor pressure and that vapor
13 pressure's there because I've got a leak-tight
14 containment, then I might be able to --
15 MEMBER STETKAR: Why do you need pressure
16 at all if I hadn't had a LOCA? You know, you're
17 operating your plant with water --
18 MEMBER CORRADINI: Right, but the sump
19 water's going to heat up to the saturation pressure --
20 MEMBER STETKAR: After LOCA. After you've
21 failed at least the second barrier, if not the first.
22 CHAIRMAN ABDEL-KHALIK: Let's allow him to
23 continue.
24 MR. LOBEL: So the Commission paper has
25 two options. The first option -- under the first

1 option, the staff would resume work on the extended
2 power uprates that have been on hold. Applications
3 requiring CAP would be evaluated consistent with the
4 current risk guidance and the recently developed
5 deterministic guidance.
6 For new reactor reviews, deviations from
7 the guidance would be reviewed on a case-by-case
8 basis, since these are new designs. And following
9 direction from the Commission, the staff guidance
10 documents would be revised to be consistent with the
11 current staff practice and Commission direction.
12 CHAIRMAN ABDEL-KHALIK: Very big picture,
13 would you agree that this recently developed
14 deterministic guidance aims to answer the question --
15 not how much containment accident pressure is needed,
16 but whether or not, if one were to give the entire
17 containment pressure as credit, that the pumps would
18 not cavitate?
19 Let me just clarify my words. If credit
20 is given for all the increase in containment pressure
21 resulting from the accident, that the pumps would not
22 cavitate.
23 MR. LOBEL: That would be part of it. The
24 all would be part of it. But the all would be at the
25 95/95 level for the available NPSH. And then you'd

1 have to consider the uncertainties in the required
2 NPSH, and there should be some margin between the
3 required-with-uncertainties and the available 95/95.
4 CHAIRMAN ABDEL-KHALIK: I understand the
5 issue of uncertainties, but that's why I said very big
6 picture. The question that you're trying to answer
7 with this deterministic guidance is "If one were to
8 use all the available containment pressure, allowing
9 for uncertainties, would the pumps cavitate or not?"
10 MR. LOBEL: They --
11 CHAIRMAN ABDEL-KHALIK: That's the
12 question that you're trying -- rather than "How much
13 of the accident pressure does one need to prevent the
14 pumps from cavitating?"
15 MR. LOBEL: Well, you'd have to look at
16 the margin between the required and the available.
17 The available being what you're talking about, the
18 containment pressure. So if you calculated and took
19 credit for all the containment pressure and you still
20 had margin to the required, then that would be
21 acceptable.
22 CHAIRMAN ABDEL-KHALIK: So the point of
23 unacceptability is zero margin, which means that
24 you're asking the question, not how much credit do
25 they need, but do we have enough accident pressure to

1 prevent the pumps from cavitating?

2 MR. LOBEL: Yes.

3 CHAIRMAN ABDEL-KHALIK: Thank you. I just

4 wanted that to go on the record.

5 MR. LOBEL: The second option -- let me

6 say first, we wrote many versions of this Commission

7 paper. And the one we started out with had many

8 options and many sub-options. And they started to get

9 into really technical questions rather than policy

10 questions for the Commission.

11 And so we retrenched. We went back and

12 thought about things some more, and decided that A, it

13 wasn't fair to ask the Commission technical questions

14 at the level that we've just been talking about. And

15 also that things were just getting too complicated

16 with this first approach.

17 Then we thought that perhaps the things

18 that we were presenting as options were really things

19 that were in the policy area, and not just technical

20 questions. And that's why we decided to make the

21 second option a regulatory analysis option, to include

22 all the things that might be done.

23 Modifications to the plant to preclude

24 having to use accident pressure, doing plant-specific

25 PRAs, all these things would be in the realm of

1 regulatory analysis. And the result of that
2 regulatory analysis would show whether there was a
3 substantial increase in safety, which according to the
4 regulations is what the staff needs to show.
5 And so that was the background for
6 recommending the regulatory analysis. Under that
7 option, the staff would resume work also on the
8 extended power uprate applications. In parallel, we
9 would do this regulatory analysis, and the staff would
10 update the regulatory guidance to reflect the results
11 of the backfit analysis and Commission direction.
12 And finally, in conclusion, we believe
13 that the ongoing staff-ACRS dialogue has resulted in a
14 better understanding of the issue, our better
15 understanding of the issue, improved guidance on ECCS
16 and pump performance, and an improved understanding of
17 the risk-significance. The CAP SECY presents policy
18 issues to the Commission, and we're awaiting
19 Commission direction.
20 MEMBER BROWN: Right now there are also
21 systems to keep containment pressure down?
22 MR. LOBEL: Yes.
23 MEMBER BROWN: Obviously, those work
24 against the utilization of whatever pressure would
25 come up, right? Is this the approach -- the way I'd

1 read this, if a licensee came in and said "No, we're
2 going to turn these off to make sure we have enough
3 pressure," that would be okay also? Is that correct?
4 That would be deliberately turning off one of the
5 ECCS functions that's there to minimize the stress on
6 the containment.
7 MR. DENNIG: This is Bob Dennig, Branch
8 Chief of Containment. Those sprays affect dose. They
9 affect the quality of the water in the sump. The
10 timing of those sprays, the on and off of those
11 sprays, is a focus of the safety analysis.
12 So there's no generic answer to your
13 question, although certainly that's one way to address
14 the pressure issue. There are other issues that also
15 need to be taken into consideration.
16 MEMBER SIEBER: You have to also consider
17 if you enhance containment pressure you might have a
18 part 100 problem. Because all containments leak a
19 little bit, and the higher the pressure, the closer
20 you get to part 100 limits.
21 MR. LOBEL: Well, from an analysis point
22 of view, that's considered in the analysis.
23 MEMBER SIEBER: Right. It's a factor.
24 MR. LOBEL: The containment is assumed to
25 leak at its maximum tech spec leakage rate for the

1 dose analysis. The case that you're talking about
2 came up with the Browns Ferry review, where we asked
3 the licensee the question "It appears that you're
4 leaving your fan coolers on. How do you know you're
5 going to have enough pressure?"
6 And the licensee's response for a while
7 was that they would turn off the fan coolers. They
8 since did a revision of their analysis that showed
9 that they didn't have to turn off the fan coolers,
10 that it was acceptable to leave the fan coolers on and
11 they'd still have some margin, some NPSH margin.
12 MEMBER CORRADINI: So you're done, is that
13 correct?
14 MR. LOBEL: I'm done.
15 MEMBER CORRADINI: So if Plant X came in,
16 a PWR, and wanted a power uprate, and needed to take
17 more CAP credit, what would you allow, given Said's --
18 I think Said's interpretation, at least that's the way
19 I was interpreting it -- are you allowing them to
20 consider the yellow line as additional above P-
21 infinity.
22 MR. LOBEL: Red line in some PWRs now
23 already use -- not the total, but some PWRs do use the
24 red line already.
25 MEMBER CORRADINI: Totally?

1 MR. LOBEL: No, they don't use the total
2 amount. But they are above the yellow line.
3 MEMBER SHACK: So the answer to Said's
4 question was yes, if you needed it the red line was
5 the red line.
6 MEMBER CORRADINI: With uncertainty.
7 MEMBER SHACK: With uncertanties and
8 margin, yes.
9 MEMBER CORRADINI: And the uncertainties
10 are such that the staff would ask questions to see how
11 low the red line might go.
12 MR. LOBEL: Right.
13 MR. DENNIG: Yes. We have been focusing
14 on BWRs, but we will also do the same thing for PWRs
15 MEMBER CORRADINI: I guess I
16 misinterpreted it. As you were discussing it, I was
17 thinking "Yellow line, yellow line, yellow line."
18 Sorry.
19 MR. LOBEL: From a very early version of
20 the Standard Review Plan -- I think the original --
21 the Standard Review Plan said "You can make the
22 assumption, the conservative assumption, that the
23 pressure in the containment atmosphere is equal to the
24 vapor pressure.
25 And that was supposed to be a conservative

1 assumption, because you were ignoring the air pressure
2 in containment. Some licensees have taken credit not
3 just for the vapor pressure, but for the air pressure
4 at one atmosphere, which gives them 33 extra feet of
5 head.
6 MEMBER CORRADINI: Which is somewhere
7 between red and yellow?
8 MR. LOBEL: But the thought that it was
9 requiring the containment to be intact wasn't really
10 addressed when that assumption was put in the Standard
11 Review Plan, and that was the thing that we've gone
12 back and thought about, and that was what led us to
13 change the definition of CAP slightly.
14 Or you may say not slightly, but to change
15 the definition of CAP. It hasn't changed any
16 assumptions that licensees have been making in their
17 analysis. It's just what we've been calling CAP.
18 CHAIRMAN ABDEL-KHALIK: As you're probably
19 aware, the Commission has directed that resolution of
20 GSI-191 should be risk-informed. And given the close
21 coupling between GSI-191 and this containment accident
22 pressure, do you believe that this deterministic
23 guidance that you plan to use in option one is
24 consistent with that direction?
25 MR. LOBEL: No, I don't think it addresses

1 risk. It does address barrier integrity to some
2 extent, some of the deterministic guidance. But it's
3 not meant to justify CAP in any general way. It's
4 just meant to address the ACRS question that when we
5 came to the ACRS and we said "Look at all the
6 conservatisms we have in the analysis," you would say
7 "Yes, there may be conservatisms, but you're not
8 telling us how much."
9 And so we went back to try to answer that
10 question. And that's all that the deterministic
11 guidance tries to do. It's not trying to justify the
12 whole concept of giving CAP.
13 CHAIRMAN ABDEL-KHALIK: So despite that
14 obviously close coupling between GSI-191 and the
15 containment accident pressure, your proposed option
16 one is really inconsistent with this general guidance
17 that has been provided by the Commission.
18 MR. LOBEL: I don't think there's that
19 much of an inconsistency, because we have a
20 disagreement, I guess, on plant-specific or generic
21 risk analysis.
22 But we have done a risk analysis for a BWR
23 of the kind that have been asking for containment
24 accident pressure, and we intend to ask Research -- we
25 have a user need letter in concurrence to ask Research

1 to do a PWR risk analysis. So we are going to look at
2 the risk of using CAP in a PWR.
3 MR. RULAND: Steve Smith, who is part of
4 our GSI-191 team, could you talk to how we take credit
5 for containment accident pressure in that regard?
6 MR. SMITH: Yes. Some plants do take
7 credit for a small amount of the actual air pressure
8 with respect to GSI-191, just to ensure that there is
9 no flashing across the debris bed, because if the
10 submergence of the screen is not much, and you assume
11 that the water is at the saturation temperature,
12 that's the assumption that we make. It would flash.
13 So some plants need a little bit of air
14 pressure to suppress the flashing. We did look at
15 their NPSH calculations, and when we did that, no
16 plant needed to add any additional air pressure on top
17 of the vapor pressure, except for -- there's eight
18 plants that were already licensed, and Rich has talked
19 about those, to include some air pressure in their
20 NPSH calculations. So what they're crediting for GSI-
21 191 is a very small amount.
22 MR. RULAND: On the order of?
23 MR. SMITH: Most plants, it's less than
24 two feet. You know, less than one psi.
25 MR. RULAND: Thank you, Steve.

1 MR. LOBEL: Some of the PWRs also that are
2 taking credit for the red line curve are plants that
3 were licensed, got their CPs before Reg Guide 1.1 was
4 issued. So they're the older PWRs in general, and the
5 subatmospherics.
6 MEMBER SIEBER: Yes, but the
7 subatmospheric, if the containment fails, the pressure
8 goes up.
9 MEMBER POWERS: This never goes away.
10 CHAIRMAN ABDEL-KHALIK: In your paper, you
11 point to some inconsistencies in regulatory guidance,
12 in current regulatory guidance. I'm particularly
13 interested in the inconsistency between SRP Section
14 6.2.2 and SRP Section 19.2.
15 You say that you intend to harmonize all
16 these regulatory guidances. Which of these two will
17 prevail?
18 MR. LAUR: That depends on what the
19 Commission directs as the result of this SECY paper.
20 MEMBER SHACK: But the intent would be to
21 harmonize to 19.2?
22 MR. LAUR: Without any additional
23 guidance, yes. That's Commission direction, and we
24 could go that way.
25 MEMBER SHACK: Are there any additional

1 questions? I think we understand the positions.
2 Thank you very much.
3 MR. LOBEL: Thank you.
4 MEMBER SHACK: I turn it back to you, Mr.
5 Chairman. We're a bit ahead of schedule.
6 CHAIRMAN ABDEL-KHALIK: Thank you. Yes,
7 we are quite a bit ahead of schedule, so we will take
8 one hour for lunch, and we will reconvene at 12:10.
9 (Whereupon, the above-entitled meeting was
10 concluded at 10:07 A.M.)
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Updated Welding Regulatory Guides: 1.34, 1.43, 1.44, and 1.50

Gary L. Stevens, P.E.
Senior Materials Engineer
RES/DE/CIB

ACRS Full Committee Briefing
February 11, 2011

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Agenda

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Overview of the Regulatory Guides (RGs)
- Why are These RGs Being Revised?
- RG Revision Timeline
- Technical Revision Summary
- Public Comments
- Other Comments
- ACRS Subcommittee Comments
- Response to ACRS Subcommittee Comments
- Conclusions

Overview of the RGs

General Information

U.S.NRC
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Protecting People and the Environment

- RG 1.34: Control of Electroslag Weld Properties
- RG 1.43: Control of Stainless Steel (SS) Weld Cladding of Low-Alloy Steel (LAS) Components
- RG 1.44: Control of the Processing and Use of SS
- RG 1.50: Control of Preheat Temperature for Welding of LAS
- RGs provide detailed and up-to-date guidance on welding processes and materials for fabrication of reactor components
- RGs provide guidance on an NRC acceptable method to satisfy 10CFR50 Appendix A GDC-1 and -30 as they relate to quality standards for design, fabrication, erection, and testing

Overview of the RGs

General Information

U.S.NRC
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- RGs provide guidance on an NRC acceptable method to satisfy:
  - 10CFR50 Section 50.55a: as it relates to quality standards applicable to the reactor coolant pressure boundary
- Criteria specified in these RGs provide supplemental fabrication controls beyond that specified in ASME Code
  - Section III, “Rules for Construction of Nuclear Facility Components”
  - Section IX, “Welding and Brazing Qualifications”
- RGs are referenced in the NRC Standard Review Plan (NUREG-0800), Section 5.2.3, “Reactor Coolant Pressure Boundary Materials”

Overview of the RGs

General Information

U.S.NRC
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- RGs describe one or more method(s) that the NRC has determined to be acceptable (but not required) for new component fabrication
- RGs do not impose requirements
- Applicants are free to use an alternative method, provided that they demonstrate to the NRC that the selected method satisfies applicable regulations
- Use of RGs by applicants conserves staff resources and simplifies licensing because the guides describe methods that the staff has already determined to be an acceptable approach to meeting the regulations

Cracking Mechanisms Addressed by the 4 Welding RGs

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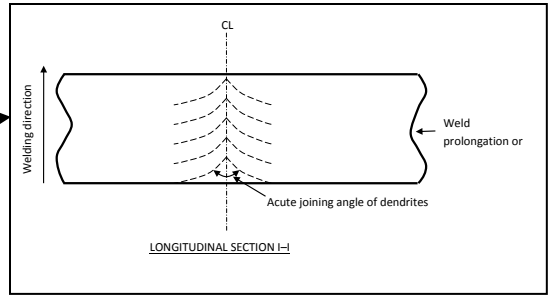
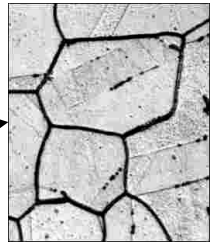
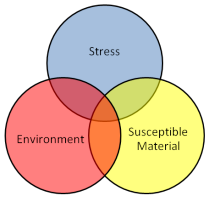
- All 4 of these RGs address forms of cracking that can occur due to welding:
  - RG 1.34 addresses weld solidification cracking and weld toughness
    - Cracks may develop because of the weaker centerline bond between dendrites



  - RG 1.43 addresses underclad cracking
    - Underclad cracking (or "hot" underclad cracking) and reheat underclad cracking
  - RG 1.44 addresses IGSCC
    - This RG addresses the control of the application and processing of stainless steel to avoid severe sensitization that can lead to SCC

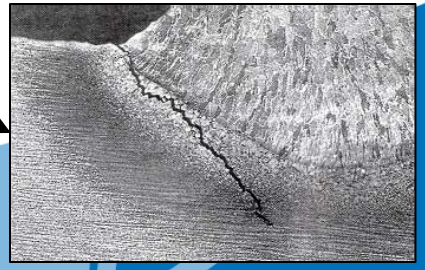


Sensitized stainless steel



SCC

  - RG 1.50 deals with delayed hydrogen cracking
    - Cold cracking or hydrogen cracking may occur in the weld underbead areas and heat affected zones if proper preheat temperatures are not maintained concurrent with controls on other welding variables



- RGs provide guidance that eliminate (or minimize) the factors that cause these types of cracking

Overview of the RGs

RG 1.34: Control of Electroslag Weld Properties

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- Contains implementing guidance regarding the control of weld properties when fabricating electroslag welds for nuclear components made of ferritic or austenitic materials
- Contains acceptable solidification patterns and impact test limits (for qualification of welds in Class 1 and Class 2 components) and the criteria for verifying conformance during production welding
- Provides assurance that welds will not develop microfissures during welding, will have high integrity, and will have a sufficient degree of toughness to furnish adequate safety margins during operating, testing, maintenance, and postulated accident conditions

Overview of the RGs

RG 1.43: Control of SS Weld Cladding of LAS

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- Contains selection and control criteria for welding processes to limit the occurrence of underclad cracking in LAS safety-related components clad with SS
- Material known to have susceptibility to underclad cracking should not be weld clad by high-heat-input welding processes and should be qualified for use to demonstrate that underclad cracking is not induced
- These controls provide assurance that practices that could result in underclad cracking will be restricted (but absence of cracking is not guaranteed)

Overview of the RGs

RG 1.44: Control of Processing & Use of SS

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- Implementing guidance about control of the application and processing of SS to avoid severe sensitization that could lead to stress-corrosion cracking
- Staff positions related to unstabilized austenitic SS of the AISI Type 3XX series used for components of the reactor coolant pressure boundary
- Acceptance criteria for testing, alloy compositions, and heat treatment to avoid sensitization in austenitic SS
- Identifies acceptable methods for verification of non-sensitization of austenitic SS materials and qualification of welding processes employed in production

Overview of the RGs

RG 1.44: Control of Processing & Use of SS

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- Acceptance criteria on the cleaning and protection of the material against contaminants capable of causing stress corrosion cracking
  - Acid pickling is to be avoided on fabricated SSs
  - Necessary pickling is to be done only with appropriate controls
  - Pickling should not be performed on sensitized SSs

Overview of the RGs

RG 1.50 Control of Preheat Temp for Welding of LAS

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- Contains criteria related to controls imposed on welding preheat temperatures for LAS components during initial fabrication to prevent cold cracking
- Provides reasonable assurance that cracking of components made from LAS will not occur during fabrication and minimizes the possibility of subsequent cracking due to residual stresses being retained in the weldment
  - Minimum preheat and maximum interpass temperatures should be specified, and the welding procedure should be qualified at the minimum preheat temperature
  - Preheat temperature should be maintained until a post-weld heat treatment has been performed for production welds
  - Production welding should be monitored to verify that the limits on preheat and interpass temperatures are maintained

Why are These RGs Being Revised?

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- Need to update these RGs
  - Last revision: early 1970s
  - New reactor applications
  - Used for repair/replacement activities for the current operating fleet
  - NRC Standard Review Plan (NUREG-0800) references use of Regulatory Guides in Section 5.2.3, "Reactor Coolant Pressure Boundary Materials"
- Technology changes
  - Improvements to welding methods & materials over past 35 years
- NRC Staff Commitment to Commissioners in 2006 (ML060760667)
  - Update RGs where appropriate to go along with the SRP update associated with new reactor applications
  - Commitment to update RGs on a regular basis

RG Revision Timeline

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Revised draft RGs completed	Jun-30-2009
Draft RGs issued for public comment in Federal Register	Jul-06-2009
Initial comment period response date	Aug-31-2009
NEI requested a 30-day extension to comment period	Aug-06-2009
NRC granted extension to comment period to 10/1/2009	Aug-11-2009
Total of 68 comments received:	
Westinghouse comments received	Aug-13-2009
Dominion comments received	Aug-26-2009
EPRI comments received	Sep-29-2009
J. F. Hunt, P.E. comments received	Dec-21-2009
B&W comments received	Dec-22-2009
NFC requested 6-month to 2-year extension	Mar-15-2010
NRC management decided to finalize RGs without NFC comments	Mar-15-2010
Public comments addressed and RGs finalized	May-31-2010
RGs issued to NRR/NRO for concurrence review	Jul-14-2010
OGC review	Sep-01-2010
ACRS Subcommittee review	Oct-21-2010
ACRS Full Committee Review	Feb-10-2011
Final publication	Mar-01-2011

Technical Revision Summary

RG 1.34: Control of Electroslag Weld Properties

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- Previously, welds for core support structures were identified as needing to meet the requirements for Class 1 components – this was removed because ASME Code, Section III now includes Subsection NG, "Core Support Structures," which addresses these structures
- The RG previously specified impact testing be included for Class 2 vessels because ASME Code, Section III did not mandate the need for this testing – this was removed because such testing is now a requirement in Section III (NC-2311)
- Regulatory Position 5 was expanded for the case where there is a specific reason to question the welder's ability to make production welds that meet the approved procedure of Regulatory Positions 3 and 4 – in this situation, the production weld is unacceptable
- References to outdated ASME Code articles were removed or updated

Technical Revision Summary

RG 1.43: Control of SS Weld Cladding of LAS

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- The ASME material specifications for SA-508 material have changed – these were updated to reflect current ASME Code, Section II naming conventions
- The Section B Discussion for underclad cracking was expanded significantly to further describe this cracking mechanism based on modern-day knowledge, and to clarify the advantages of using fine-grain forging material
- Guidance was added to perform nondestructive examination following postweld heat treatment because underclad cracking can grow during postweld stress relief heat treatment

Technical Revision Summary

RG 1.43: Control of SS Weld Cladding of LAS

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- A second test method for determining the existence of underclad cracking was added:
  - Make a minimum of three cross section specimens in the through thickness direction either transverse or parallel to the weld and examine the weld, heat affected zone (HAZ) and base metal for cracks
- An additional observation area was included in Regulatory Position 2.e
  - "…or over the area of review of the polished surface…"
- Essential variables are now defined in Section IX of the ASME Code, so reference to Section IX, "Welding and Brazing Qualifications," was added to Regulatory Position 3

Technical Revision Summary

RG 1.44: Control of Processing & Use of SS

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- Additions were made to the Section B Discussion to identify that process controls should be modified based on operating experience
  - "…exercised in accordance with good manufacturing/welding practices and knowledge gained from operating experience…"
- Regulatory Position 6 was expanded to identify that controls to prevent sensitization of the material during welding include maintaining low heat input and limiting the interpass temperature
- Various references to outdated standards were updated

Technical Revision Summary

RG 1.50 Control of Preheat Temp for Welding of LAS

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- Clarification was added to the Section B Discussion to describe that preheating at the recommended temperatures can reduce local hardening by reducing the cooling rate during welding
- Additions were made to the Section B Discussion to specify that a maximum interpass temperature be specified in accordance with the requirements of ASME Code, Section IX, “Welding and Brazing Qualifications,” for the case where toughness is a requirement of the Construction Code
- Clarification was added to the Section B Discussion to describe that a maximum interpass temperature be selected for LAS welds requiring impact testing
- ASME “P” material designations were added to Section C to specifically identify which LASs were applicable

Technical Revision Summary

RG 1.50 Control of Preheat Temp for Welding of LAS

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- Changes were made to Regulatory Position 1 to specify that a Welding Procedure Specification specify a maximum interpass temperature and a minimum preheat temperature that are equal to those temperatures used during procedure qualification
- Additions were made to Regulatory Position 2 to also allow for a post weld hydrogen bakeout at a given temperature range and for a specified period of time based on the materials being welded, the geometry, and the welding process used
- Additions were made to Regulatory Position 4 to clarify that the acceptable examination procedure must meet the acceptance criteria specified in ASME Code, Section III
- Various references to outdated ASME Code articles were updated

Public Comments

Timeline and Comments Received

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- Public comment period:
  - Initially July 9, 2009 to August 31, 2009
  - NEI requested, and NRC granted, an extension to October 1, 2009
- Summary of public comments received:
  - 68 comments total
  - ~2/3 of comments received in December 2009
    - RG 1.34: 1 letter containing 4 comments
    - RG 1.43: 5 letters containing 36 comments
    - RG 1.44: 3 letters containing 8 comments
    - RG 1.50: 4 letters containing 20 comments

Public Comments

NRC Responses

U.S.NRC
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- All comments addressed
- Majority of comments led to several minor clarifications to draft RGs
- Comments consistent with intent of revisions: improve and clarify welding processes to preclude cracking
- The comments and the NRC responses where the NRC disagreed with the commenter were reviewed with the ACRS Subcommittee at the briefing on October 21, 2010

Other Comments

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- Incorporate editorial improvements from technical editing and OGC review
- Format revised to match the latest NRC guide formatting protocol and content
- ACRS provided two comments on RG 1.44 at Subcommittee Briefing on October 21, 2010
  - Comments associated with exceptions provided in Regulatory Position 4

ACRS Subcommittee Comments

RG 1.44

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Comment #1 (regarding Regulatory Position 4):

- We should not allow the use of material with a carbon content greater than 0.03%, i.e., no exceptions. Since this is a Reg. Guide, the licensee can always submit an exception with sufficient justification.
  - If situations come up such as having to leave non-L grade (carbon content greater than 0.03%) stainless steel in place in order to effect a repair, then the applicant can approach the NRC and provide a justification.
  - I don't think this wording would prohibit IHSI, or structural weld overlays. If it does, you may want to clarify that this is not the intent of the guide.
  - In any event, the staff has the experience and authority to make these calls.

ACRS Subcommittee Comments

RG 1.44

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Comment #2 (regarding Regulatory Position 4):

I did have a comment on RG 1.44 which relates to your concern about SCC in PWRs. In reg position 4 (a) the RG says it is OK to use high carbon SS (and hence sensitized SS if you weld it) in 100 ppb O2 water. I think just about everybody who has tested sensitized SS would agree that cracking in 100 ppb O2 is possible. The enclosed results from GE show that the potential corresponding to this O2 level is probably -100 to 0 mV SHE and that at these potentials CGRs are not negligible. There is a reason we expect BWRs on HWC to be at -230 mV or less.

As a practical matter, BWRs without HWC are 200 ppb or higher and PWRs are 10 ppb or less in the main coolant loops. The main coolants in LWRs just aren't in the 100 ppb range. But as you point out local chemistries in PWRs could be different. However, the RG is being expressed in general terms and there is a large amount of experimental that would suggest 10-20 ppb as a more reasonable threshold for O2 to avoid IG cracking in sensitized SS (and hence use 0.08C SS). Peter A would point out that with some cold work it could even be lower.

Response to ACRS Subcommittee Comments

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- Response to Comment #1
  - There is not sufficient data to indicate that non-L-grade austenitic stainless steel experiences significant IGSCC in PWR environments
    - Only "sporadic instances"* of cracking have been identified
    - Operating reactors have not had any issues
  - Therefore, non-L-grade material is allowed for use in PWRs under certain conditions, as identified in RG under Position 4
  - The exception associated with Regulatory Position 4 is intended to be applicable only to PWRs, i.e., it is intended to screen-out BWRs
    - Editorial additions made to the RG to clarify this point (refer to upcoming slide)
  - The NRC Staff will consider eliminating the use of non-L-grade material for PWRs in the future if data becomes available to support a change to this position

* EPRI Report No. 1020987, "Primary System Corrosion Research Program: EPRI Materials Degradation Matrix, Revision 2," August 2010.

Response to ACRS Subcommittee Comments

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- Response to Comment #2
  - There is a wide range of dissolved oxygen levels* associated with the onset of IGSCC
    - Recent papers suggest 0.1 ppm is an adequate screening level**
  - There are several other variables present that may lead to IGSCC
    - For example, the presence of cold work, which can lead to cracking in many materials
  - Position 7 (i.e., perform a test) is in place to accommodate the uncertainties associated with the exceptions in the RG

* Peter L. Andresen, Martin M. Morra, "IGSCC of Non-Sensitized Stainless Steels in High Temperature Water," Journal of Nuclear Materials, Vol. 38, pp. 97-111, 2008.

** Catherine Guerre, Olivier Raquet, Emmanuel Herms, Marc Le Calvar, Guy Turluer, "SCC Growth Behavior of Austenitic Stainless Steels in PWR Primary Water Conditions," Proceedings of the 12th International Conference on Environmental Degradation of Materials in Nuclear Power System – Water Reactors – Edited by T.R. Allen, P.J. King, and L. Nelson TMS (The Minerals, Metals & Materials Society), 2005.

Response to ACRS Subcommittee Comments

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- Response to Comment #2 (cont'd)
  - A change to the limits specified in Position 4 would cause a significant burden on the industry, as these limits are promulgated in welding procedures, specifications, new reactor applications, repairs, etc. throughout the industry
    - Therefore, this limit should only be changed if technically justified, and if the suggested change has been vetted and reviewed by the nuclear industry.
  - The dissolved oxygen exception associated with Regulatory Position 4 is intended to screen-out BWRs
    - Editorial additions made to the RG to clarify this point (refer to upcoming slide)
  - The NRC Staff will consider revising this limit in the future if data becomes available to support a change to this position

Response to ACRS Subcommittee Comments

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Editorial clarifications made to RG 1.44 in response to ACRS Subcommittee comments:

- Section B, Discussion, 8th paragraph:

  Controls should be maintained on the chemistry of the reactor coolant and auxiliary systems fluids to which the material is exposed. Chloride and fluoride ion concentrations should be specified to be less than 0.15 parts per million at all times. Dissolved oxygen concentrations should be maintained below 0.10 parts per million during periods when the material is at elevated temperatures. ~~When~~ If the oxygen content ~~regularly~~ exceeds this level, such as ~~occurs~~ in boiling water reactor coolants during normal operation, sensitization of material that is welded without subsequent solution heat treatment should be further controlled by limiting the carbon level in the material to 0.03 percent. Carbon level …

- Section C, Regulatory Position, Item 4.a:

  a. material exposed to pressurized water reactor coolant that has a controlled concentration of less than 0.10 parts per million dissolved oxygen at all temperatures above 90 degrees C (200 degrees F) during normal operation; or

Conclusions

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- Welding RGs 1.34, 1.43, 1.44, and 1.50 have been revised
  - Last revised in early 1970s
  - Revision needed for new reactor applications
- These RGs provide necessary guidance for new component manufacturing to help alleviate cracking caused by welding processes
- Public comments received and addressed
  - Several manufacturers provided comments
  - Several minor clarifications were made to the draft RGs based on public comments
- All four RGs ready for final publication

Backup Slides

Cracking Due to Welding

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- All four of the welding RGs address forms of cracking that can occur due to welding:
  - RG 1.34 deals with weld solidification cracking and weld toughness
  - RG 1.43 deals with underclad cracking
  - RG 1.44 deals with intergranular stress corrosion cracking (SCC)
  - RG 1.50 deals with delayed hydrogen cracking
- RGs provide guidance that eliminate (or minimize) the factors that cause these types of cracking

Electroslag Welding

(RG 1.34)

- This RG provides supplementary guidance to the requirements contained in ASME Code, Section IX, “Welding Qualifications” that are desirable to provide assurance of adequate weld metal properties when the electroslag welding process is used for joining

Electroslag Welding
(RG 1.34)

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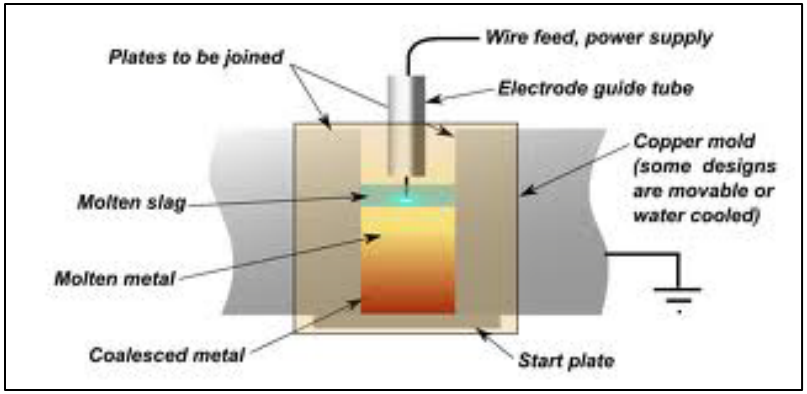
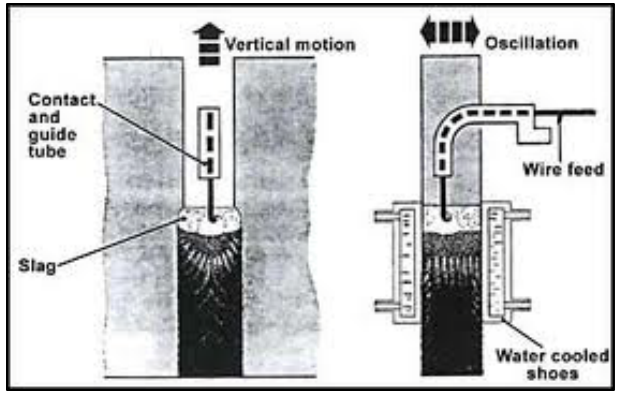
- Definition:
  - Electroslag welding: A welding process in which consumable electrodes are fed into a joint containing flux; the current melts the flux, and the flux in turn melts the faces of the joint and the electrodes, allowing the weld metal to form a continuously cast deposit between the joint faces.





Electroslag Welding
(RG 1.34)

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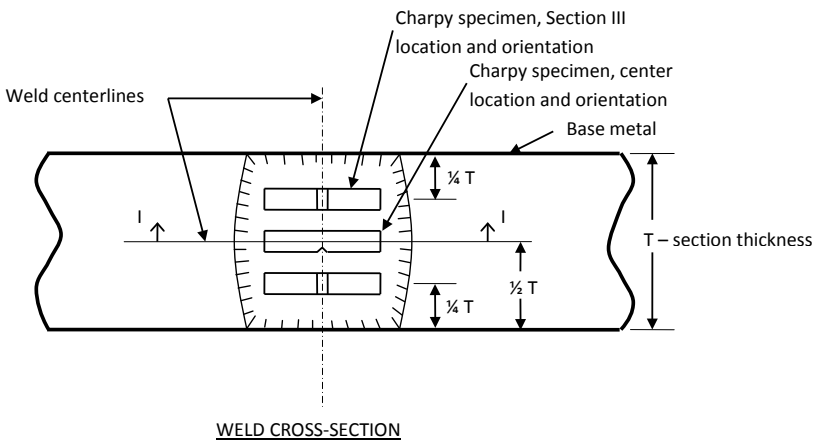
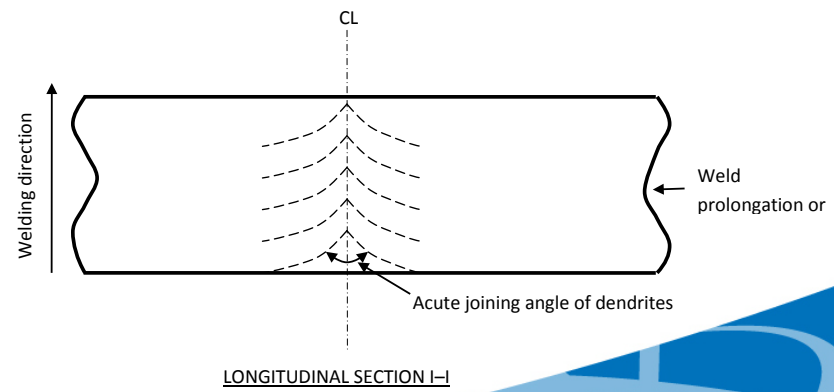
- Issues:
  - The assurance of satisfactory electroslag welds for low-alloy steel and stainless steel can be increased by maintaining a weld metal solidification (dendritic) pattern with a strong intergranular bond in the center of the weld
  - A number of electroslag welding process variables have been shown to influence the weld metal solidification pattern
    - Slag pool depth
    - Electrode feed rate and oscillation
    - Current
    - Voltage
    - Slag conductivity

Electroslag Welding
(RG 1.34)

- Issues (cont'd):
  - If the combination of process variables results in a deep pool of molten weld metal, the crystalline (dendritic) growth direction from the pool sides will join at an obtuse angle in the center of the weld
    - Cracks may develop because of the weaker centerline bond between dendrites





Electroslag Welding
(RG 1.34)

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- How does the RG address the issues?
  - The RG specifies that procedure qualifications include a combination of process variables that will result in a shallow pool of molten weld metal
    - A shallow pool will promote a dendritic growth pattern with an acute joining angle and will result in a strong centerline bond
    - Acceptable welds should show a dendritic freezing pattern with a joining angle of less than 90 degrees in the weld center
  - The RG specifies that tests be conducted to ensure that the acceptable weld metal solidification pattern is obtained and that unacceptable patterns will not result

SS Cladding of LAS Components
(RG 1.43)

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- This RG addresses the presence of intergranular cracking in low-alloy steel under stainless steel weld cladding
- Two types of underclad cracking have been identified:
  - Underclad cracking (or “hot” underclad cracking)
  - Reheat underclad cracking

SS Cladding of LAS Components
(RG 1.43)

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- Definitions:
  - Underclad cracking occurs when high heat input welding process is used on coarse-grain low alloy steel base material. Underclad cracking occurs only in the grain-coarsened region of the base metal heat affected zone (HAZ).
  - Reheat cracking occurs when subsequent weld passes cause cracking in the low alloy steel coarse-grain HAZ.

SS Cladding of LAS Components
(RG 1.43)

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- Issue:
  - Intergranular cracking has been observed in reactor vessels and other components for nuclear systems in varying degrees, depending on the material and the cladding processes

SS Cladding of LAS Components
(RG 1.43)

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- How does the RG address the issue?
  - The RG identifies that the use of fine-grain materials is a method to avoid underclad cracking regardless of welding process used
  - The RG identifies that high-heat-input welding processes that induce underclad cracking should not be used
  - The RG specifies that weld cladding procedures be qualified for use by a performance test to demonstrate that it does not induce underclad cracking
  - The RG identifies that production welding should be monitored to verify compliance with the limitations on essential variables. Otherwise:
    - An examination for cracking should be performed on the production part from which a section of cladding has been removed
    - The cladding procedure should be requalified

Control of Use/Processing of SS
(RG 1.44)

- This RG addresses the control of the application and processing of stainless steel to avoid severe sensitization that can lead to SCC

Control of Use/Processing of SS
(RG 1.44)

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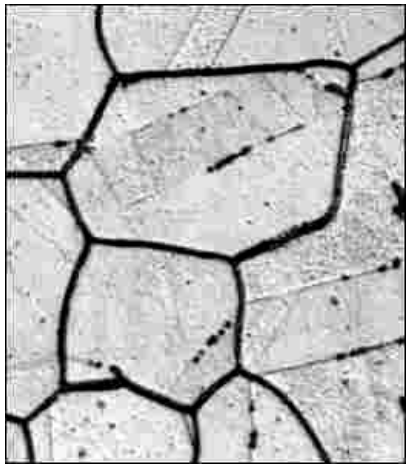
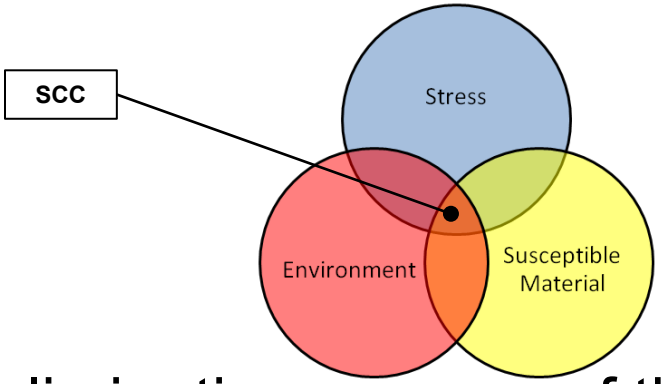
- Definition:
  - Sensitization refers to chrome carbide formation, which reduces the chrome available to provide a passive oxide film that prevents corrosion. When stainless steel is heated in the range of 800 ^{o}F to 1,500 ^{o}F, there is a risk that the chromium will form chromium carbides (a compound formed with carbon) at the grain boundaries with any carbon present in the steel. The grains become depleted in chromium and lose their corrosion resistance.



Sensitized stainless steel

Stress Corrosion Cracking
(RG 1.44)

- SCC is caused as a result of the simultaneous presence of three factors:
  - High tensile stress
  - Corrosive environment
  - Susceptible material



- SCC can be prevented by eliminating any one of the three factors

Control of Use/Processing of SS
(RG 1.44)

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- Issue:
  - Test data and operating experience demonstrate that sensitized stainless steel is significantly more susceptible to IGSCC than is nonsensitized (solution heat-treated) stainless steel

Control of Use/Processing of SS
(RG 1.44)

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- How does the RG address the issue?
  - The RG identifies that material should be suitably cleaned and suitably protected against contaminants capable of causing stress-corrosion cracking during fabrication, shipment, storage, construction, testing, and operation of components and systems
  - The RG identifies that material should be solution heat treated to produce a nonsensitized condition
  - The RG identifies that non-sensitization of the material should be verified using appropriate test procedures
  - The RG identifies, with few exceptions, that material subjected to sensitizing temperature subsequent to solution heat treating and testing should not have a carbon content greater than 0.03 percent

Control of Use/Processing of SS
(RG 1.44)

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- How does the RG address the issue? (cont'd)
  - The RG identifies, with few exceptions, that material subjected to sensitizing temperatures during heat treating or processing other than welding, subsequent to solution heat treating and testing, should be retested
  - The RG identifies that an intergranular corrosion testing should be performed for each welding procedure to be used for welding material having a carbon content greater than 0.03 percent

Control of Preheat Temperature for Welding LAS

(RG 1.50)

- This RG addresses supplementary guidance to ensure adequate control of welding variables in the production welding of low-alloy steels

Control of Preheat Temperature for Welding LAS

(RG 1.50)

- Definitions:
  - Cold cracking refers to cracking that may occur when the steel is hardened (i.e., it undergoes a phase transformation to martensite in the heat affected zone, weld metal, or both). Martensite can exhibit brittle fracture tendencies. This brittle fracture tendency can increase the susceptibility to cracking with higher stresses, such as those experienced with increased thickness of the part being welded.

Control of Preheat Temperature for Welding LAS

(RG 1.50)

- Definitions (cont'd):
  - Hydrogen cracking refers to cracking that may occur as a result of atomic hydrogen absorption and diffusion into and through the region being welded. Greater quantities of hydrogen can be present in the weld region from the dissociation of moisture in hygroscopic welding fluxes or from adsorption on metal surfaces if the welding fluxes and surfaces have not been properly dried before welding.

Control of Preheat Temperature for Welding LAS

(RG 1.50)

- Issue:
  - Cracks may form in the weld underbead areas and heat affected zones if proper preheat temperatures on the base metals are not maintained concurrent with controls on other welding variables

Control of Preheat Temperature for Welding LAS

(RG 1.50)

- How does the RG address the issue?
  - The RG specifies that the welding procedure specification should specify the maximum interpass temperature and minimum preheat temperature used during procedure qualification. This ensures that the parameters used during production welding reflect those used during qualification.
  - The RG specifies that preheating should be maintained until post weld heat treatment is performed or until a post weld hydrogen bakeout is performed. This facilitates the diffusion of hydrogen out of the weld to prevent delayed cracking .
  - The RG specifies that production welding should be monitored to verify that the limits on preheat and interpass temperature are maintained.

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USE OF CONTAINMENT ACCIDENT PRESSURE IN ANALYZING EMERGENCY CORE COOLING SYSTEM AND CONTAINMENT HEAT REMOVAL SYSTEM PUMP PERFORMANCE IN POSTULATED ACCIDENTS SECY-11-0014

Presentation to the Advisory Committee on Reactor Safeguards

February 11, 2011

U.S.NRC
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Presentation Topics

- Background
- Three Issues Requested by Commission SRM:
  - Defense-in-Depth
  - Risk
  - Practicability
- Two Options

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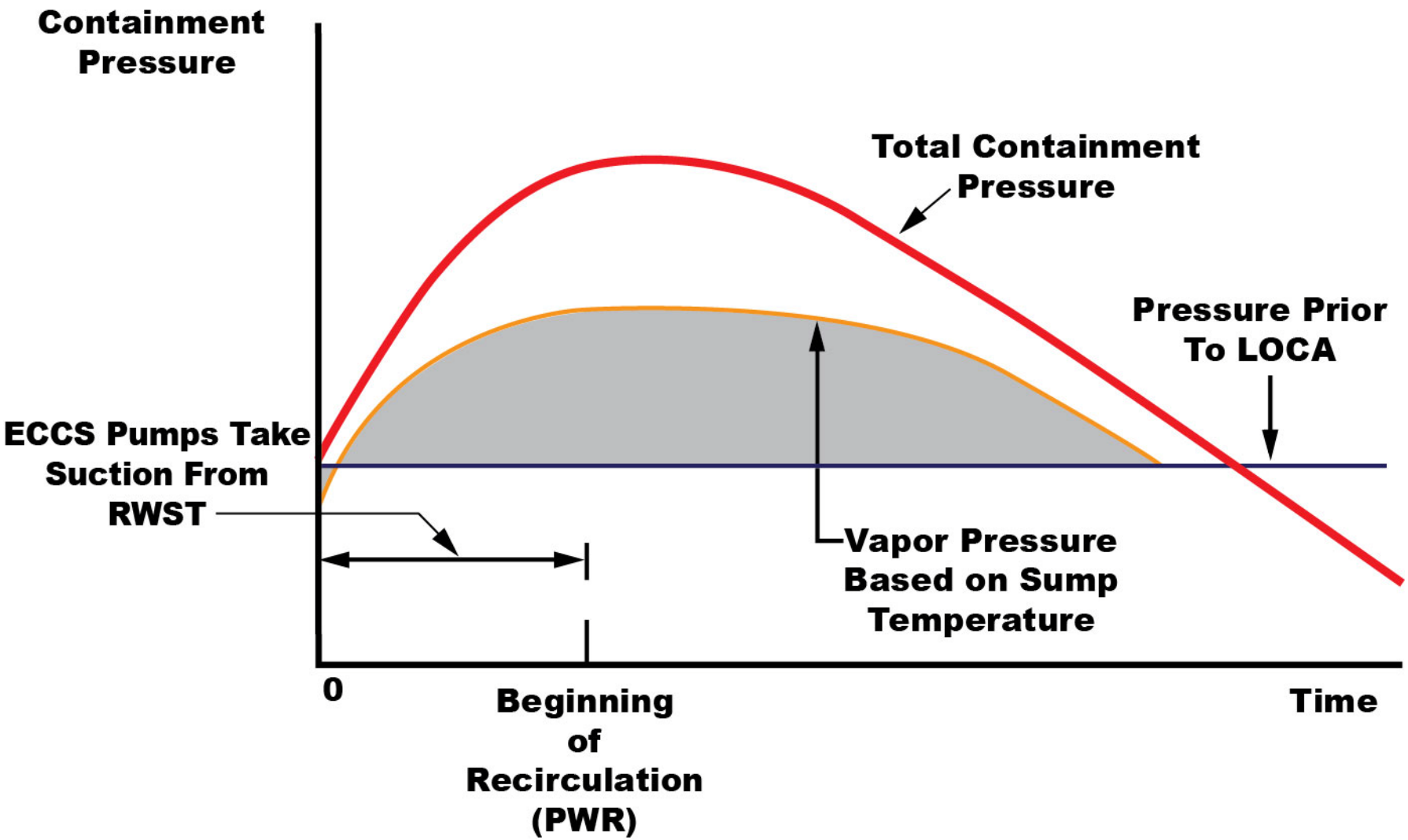
Background

- Staff Requirements Memorandum (SRM) M100609B (6/25/10) directed the staff to discuss, respecting CAP:
  - Areas where it “aligns with the ACRS and disagrees with the ACRS”
  - Defense-in-depth, use of risk information, and whether to assess the practicality of plant modifications to eliminate the need for CAP credit.

Containment Accident Pressure (CAP)



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Defense-in-Depth

- ACRS: maintain the independence of the containment function and the accident mitigation function*
- Staff:
  - Loss of CAP can affect barrier independence
  - Design basis accidents assume containment integrity
  - Regulations do not require independence

*The source of ACRS positions on all 3 issues is the transcript of the NRC Commission meeting with ACRS held June 9, 2010 (ADAMS ML101660107)

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Risk – ACRS

- If hardware modifications are impractical, then the defense-in-depth margins should be relaxed only if the associated increase in risk is small
- Risk assessment should
  - Be plant-specific
  - Consider fire and seismic events
  - Consider operator actions affecting CAP

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Risk – Staff

- License applications that use CAP credit:
  - Typically are not risk-informed (e.g., EPU)
  - Comply with existing regulations
- NRC staff has not identified "special circumstances" that could rebut the presumption of adequate protection of public health and safety
- Therefore, no basis to require risk information for operating reactors

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Risk – Staff (cont.)

- NRC Office of Nuclear Regulatory Research performed generic risk assessment of CAP
  - BWR/3 with a Mark I containment
  - Large LOCA (only case where loss of containment integrity led directly to core damage)
  - Leakage non-detection interval of 1 month assumed (bounding for inerted containment
  - Risk dominated by pre-initiator failures of containment)
- Increase in CDF due to CAP was “very small”

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Practicability to Eliminate CAP

- ACRS: licensees should demonstrate that it is not practical to reduce or eliminate need for CAP before NRC would consider granting CAP
- Staff:
  - The staff evaluates the safety of a licensee's proposal
  - The staff does not judge whether the licensee could have met its objective in some other way

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Option 1 – Status Quo

- Staff resumes work on EPU applications
- Applications requiring CAP would be evaluated consistent with:
  - Current risk review guidance (SRP 19.2)
  - Recently-developed deterministic guidance on CAP based on ACRS recommendations
- New reactor reviews: deviations from guidance reviewed case by case
- Staff guidance documents will be revised to be consistent with current staff practice and Commission direction

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Option 2 – Regulatory Analysis

- Staff resume work on EPU applications
- In parallel, NRC staff will conduct a backfit/regulatory analysis of the use of CAP
- Staff will update the regulatory guidance to reflect the results of the backfit/regulatory analysis and Commission direction

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Conclusion

- Ongoing staff/ACRS dialogue has resulted in
  - Better understanding of the issue
  - Improved guidance on ECCS pump performance
  - Improved understanding of risk significance
- The CAP SECY presents policy issues to the Commission
- The staff is awaiting Commission direction

ACRS Full Committee on Palo Verde Plant License Renewal February 10, 2011

Facts for the Full Committee and for the record:

1. On May 23, 2007 Bonaca wrote Kline, SUBJECT: PROPOSED TECHNICAL BASIS FOR THE REVISION TO 10 CFR 50.46 LOCA EMBRITTLEMENT CRITERIA FOR FUEL CLADDING MATERIALS, ML071490090. Bonaca wrote, "The requirements of 10 CFR 50.46 (a) and (b) limit the amount of embrittlement that may occur as result of a design basis accident. They specify limits for the peak clad temperature, the global oxidation of cladding, and the local oxidation of cladding. There are several deficiencies with the current regulations. The correlation specified for the rates of steam reaction with the cladding is viewed by the technical community as an anachronism." Now, Appendix K to Part 50--ECCS Evaluation Models, Item 5, specifies that the rate of energy release from the metal/water reaction shall be calculated using the Baker-Just equation and § 50.46 Acceptance Criteria, item (b)(1) specifies the peak clad temperature, 2200 degrees.

2. The NRC staff fiercely defends Baker-Just in its Technical Safety Analysis, ML041210109, April 29, 2004, *"The Baker-Just correlation using the current range of parameter inputs is conservative and adequate to assess Appendix K ECCS performance. Virtually every data set published since the Baker-Just correlation was developed has clearly demonstrated the conservatism of the correlation above 1800°F."*

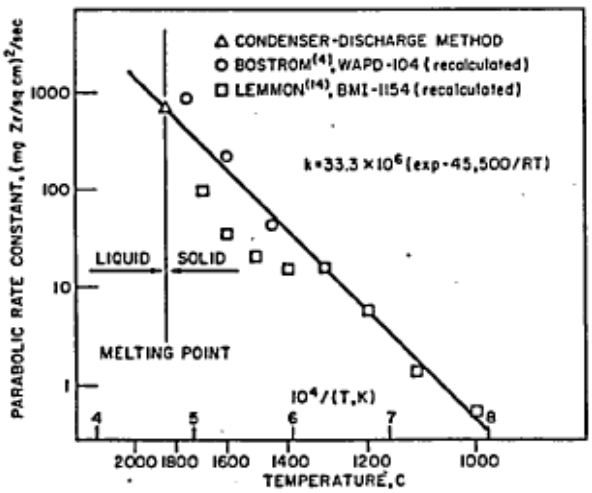
3. The nuclear power industry fiercely defends Baker- Just in its Industry Comments, ML101040678, April 12, 2010, *"The Baker-Just correlation, using the current range of parameter inputs, has been shown to be conservative and adequate to assess Appendix K ECCS performance. Data published since the Baker-Just correlation was developed has clearly demonstrated the conservatism of the correlation above 1800°F"*

4. Contrary to the exceptionally firm consistency between the NEI and NRC appraisals of Baker-Just**,** the pertinent data sets published since the Baker-Just correlation was developed have clearly demonstrated the non-conservatism of the Baker-Just correlation above 1800°F. The NRC has not recognized that investigations that involve heating of single specimens of zirconium alloys in steam do not yield applicable data for the temperature or range of temperatures at which thermal runaway is initiated in LWRs.

5. NRC has apparently never studied Baker-Just (ML050550198) and until April 2010 it did not even have copies of the key references. Figure 16 is copied from page 37 of the Baker-Just report ML050550198.

Figure 16

EFFECT OF TEMPERATURE ON THE ZIRCONIUM-WATER REACTION



Only the Lemmon data includes the pertinent temperature region. The Lemmon report, ML100570218, was not acquired by NRC until April, 2010. Thus, NRC never studied Baker-Just. Figure C-1 is from Lemmon page C-4; the adjacent figure is excerpted from the flow sheet, Figure C-3 on page C-5.

C-4

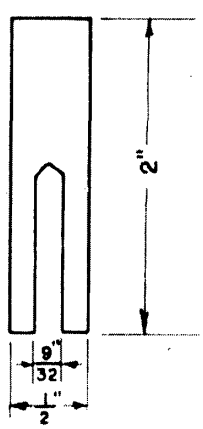
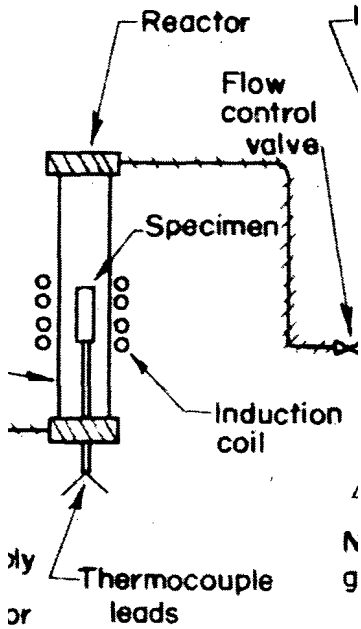


FIGURE C-1. ZIRCALOY 2 SPECIMEN



Lemmon induction heated a zircaloy-2 cylinder, 2” long by 0.5” dia. in steam.

6. It is absurd to license the emergency cooling of tons of zirconium alloy having thousands of square feet of interfacial surface area based on the limited investigations that yielded the Baker-Just equation. Despite this, Appendix K to Part 50--ECCS Evaluation Models, Item 5, specifies that the rate of energy release from the metal/water reaction shall be calculated using the Baker-Just equation and § 50.46 Acceptance Criteria, item (b)(1) specifies the 2200 degrees.

7. Data from multi-rod (assembly) severe fuel damage experiments (*e.g.*, the LOFT LP-FP-2 experiment) show the Baker-Just equation is non-conservative for calculating the temperature at which thermal runaway would occur in the event of a LOCA.

8. Investigations by P. Hofmann et al. at Forschungszentrum Karlsruhe reveal that the Baker-Just equation is non-conservative for calculating the temperature at which thermal runaway will occur in a LOCA. Their report is, Physico-Chemical Behavior of Zircaloy Fuel Rod Cladding Tubes During LWR Severe Accident Reflood, Part I: Experimental results of single rod quench experiments, FZKA 5846, http://bibliothek.fzk.de/zb/berichte/FZKA5846.pdf

On page 5 of 177: *A series of separate-effects tests is being carried out on Zircaloy PWR fuel rod cladding to study the enhanced oxidation which can occur on quenching. In these tests, performed in the QUENCH rig**, single tube specimens** are* **heated by induction** *to a high temperature and then quenched by water or rapidly cooled down by steam injection.*

On gage 12 of 177***: No significant temperature excursion during quenching occurred such as had been observed for example in the quenched (flooded) CORA-bundle tests This absence of any temperature escalation is believed to be due to the high radiative heat losses in the QUENCH rig.***

And in, "CORA Experiments on the Materials Behavior of LWR Fuel Rod Bundles at High Temperatures," NUREG/CP-0119, Vol. 2, Proceedings of the Nineteenth Water Reactor Safety Information Meeting. ML042230460, P. Hofmann et al.

On page 98 of 493: *The critical temperature above which uncontrolled temperature escalation takes place due to the exothermic zirconium/steam reaction crucially depends on the heat loss from the bundle; i.e., on bundle insulation. With the good bundle insulation in the CORA test facility,* ***temperature escalation starts between 1100 and 1200°C (2012 to 2192°F),*** *giving rise to a maximum heating rate of 15 K/sec.*

9. It is amazing that the ACRS has never reviewed Baker-Just in the course of producing its recommendations regarding the initial licensing, the extended licensing and the licensing of power level increases of numerous American light water reactors.

6.3.3 PERFORMANCE EVALUATION

6.3.3.1 Introduction and Summary

10 CFR 50.46 provides acceptance criteria for Emergency Core Cooling Systems (ECCS) for light-water nuclear power reactors [Reference 1]. The ECCS performance analyses described in this section demonstrate that the PVNGS ECCS design satisfies these criteria.

The PVNGS ECCS performance analyses encompass a wide range of Reactor Coolant System (RCS) break locations and sizes, including both large and small break Loss-of-Coolant Accident (LOCAs). The limiting break, which results in the closest approach to 10 CFR 50.46 acceptance criterion for peak clad temperature, is a 0.6 DEG/PD (Double-Ended Guillotine in the Reactor Coolant Pump Discharge leg) as noted in UFSAR Section 6.3.3.2. The limiting break, which results in the closest approach to 10 CFR 50.46 acceptance criterion maximum clad oxidation (or local clad oxidation), is a 0.8 DEG/PD as noted in UFSAR Section 6.3.3.2. For these limiting breaks, the PVNGS ECCS design meets the acceptance criteria of 10 CFR 50.46 as follows:

Criterion 1: Peak Cladding Temperature. ". . .The calculated maximum fuel element cladding temperature shall not exceed 2200°F. . . ." For the limiting break, the PVNGS ECCS performance analysis yielded a peak cladding temperature of 2110°F.

6.3.6 REFERENCES

1. Code of Federal Regulations, Title 10, Part 50, Section 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors."

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