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1 UNITED STATES OF AMERICA
2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE

6 + + + + +

7 WEDNESDAY,

8 AUGUST 20, 2003

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10 ROCKVILLE, MARYLAND

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12 The subcommittee met at the Nuclear
13 Regulatory Commission, Two White Flint North,
14 Room T2B3, 11545 Rockville Pike, at 8:30 a.m.,
15 Graham B. Wallis, Chairman, presiding.

16 COMMITTEE MEMBERS:

17 GRAHAM B. WALLIS, Chairman

18 F. PETER FORD, Member

19 THOMAS S. KRESS, Member

20 VICTOR H. RANSOM, Member

21 STEPHEN L. ROSEN, Member

22 JOHN D. SIEBER, Member

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1 ACRS STAFF PRESENT:

2 SANJOY BANERJEE, ACRS Consultant

3 RALPH CARUSO, ACRS Staff, Designated Government
4 Official5 SAM DURAISWAMY, Technical Assistant ACRS/ACNW
6

7 NRC STAFF PRESENT:

8 RALPH ARCHITZEL, NRR/DSSA/SDLB

9 DR. T.Y. CHANG, RES/DET/ERAB

10 ANTHONY H. HSIA, RES/DET/ERAB

11 JOHN LEHNING, NRR/DSASA/SPLB
12

13 ALSO PRESENT:

14 JOHN BUTLER, NEI

15 DR. BRUCE LETELLIER, Los Alamos National
16 Laboratory
17
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P-R-O-C-E-E-D-I-N-G-S

(8:33 a.m.)

CHAIRMAN WALLIS: The meeting will now come to order. This is a continuation of the meeting of the Thermal Hydraulics Phenomena Subcommittee of the Advisory Committee on Reactor Safeguards which began yesterday. So I don't think I need to read the entire introduction.

I am Graham Wallis, the Chairman of the subcommittee. Subcommittee members in attendance are Tom Kress, Victor Ransom, Jack Sieber, Peter Ford, and Steve Rosen.

Today we are going to consider Regulatory Guide 1.82, Revision 3, entitled "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident."

This looks like a topic which is significant, at least potentially significant, to safety and poses quite interesting challenges, both technically and from the regulatory point of view. So we're looking forward to your presentation.

I invite Tony Hsia to get us started.

MR. HSIA: Thank you, Chairman Wallis, and members of the committee. My name is Tony Hsia from the Engineering Research Applications Branch in the

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1 Office of Research. With me today on my right is
2 Dr. T.Y. Chang, also in the same branch with me. To
3 his right is Dr. Bruce Letellier, a consultant from
4 Los Alamos National Laboratory.

5 Also, I see in the audience we have our
6 colleagues from NRR, and this is a pretty extensive
7 effort. As you have seen reading the background
8 information in the Reg. Guide, it can be traced back
9 -- this issue on sump performance -- traced back to
10 even the early '80s. And we spent a lot of time, very
11 extensive effort, in the late '90s until now.

12 We have worked very closely with our
13 colleagues at NRR. This is a coordinated effort. And
14 just from the outset I would like to state this Reg.
15 Guide 1.82, Revision 3, is applicable to all plant
16 designs, current and future. With the focus --
17 because it's related to GSI-191, our focus will be on
18 PWR designs.

19 So if you can -- if you look at page
20 number 2, we have an overview. This basically
21 encapsulates what we're going to discuss today --
22 background. And we'll go over to the reasons for why
23 we issued Rev. 3 and what Reg. Guides are intended to
24 be used. And also, I'll summarize the activities
25 related to Reg. Guide 1.82, Rev. 3 up to date.

1 Then, T.Y. will take over and discuss the
2 key revisions in this current Reg. Guide and
3 resolution of public comments. He will select the
4 most significant and most numerous public comments and
5 how we responded to those for your consideration.

6 After that, the bulk of the discussion
7 will be the summary of the Reg. Guide as well as a
8 discussion of the accident sequences. And we propose
9 to do it in a tag-team approach. T.Y. will focus on
10 the Reg. Guide itself and what the Reg. Guide says,
11 and Dr. Letellier will get into the technical details.
12 And then, T.Y. will wrap it up regarding the research
13 future activities.

14 Next viewgraph, please.

15 Just a quick summary of where we have
16 been. Back in 1974, Rev. 0 of Reg. Guide 1.82 was
17 available, and in that Reg. Guide we discussed net
18 positive suction head calculation based on a very
19 simple assumption of 50 percent of the screen was
20 blocked to figure out the NPSH performance.

21 And then, USI A-43 was started in January
22 of '79. That focused on the containment emergency
23 sump performance. And additional research was
24 performed until 1985; we have issued a Rev. 1 of the
25 Reg. Guide, which is a guidance based on the

1 resolution of USI A-43, to instead of using a
2 50 percent blockage, we're going to say that's not
3 sufficient. We're going to have 100 percent
4 blockages, most conservative assumption.

5 Starting in the '80s, or early '90s I
6 should say, several nuclear plants started from the
7 Barseback plant in Sweden, and several domestic plants
8 -- mostly BWRs -- ran into the sump -- or I should say
9 strainer, suction strainer blockage events. And that
10 really brought a lot of attention to the agency as
11 well as the industry.

12 Some additional research was done, and in
13 May of 1996 issued Rev. 2. In that, the effort was
14 focused on the revised guidance for the BWRs. And
15 also, NRC issued both in 96-03. That's on potential
16 plugging of the suction strainer in BWRs, and
17 requested licensees to implement measures to ensure
18 that ECCS functions will perform as designed following
19 a LOCA.

20 Then, in the late '90s -- well, in the
21 meantime, additional research was performed, and we've
22 switched attention more from BWRs to the PWRs, to see
23 how the PWRs would perform. In late '90s, I believe
24 it was '96/'97 timeframe, GSI-191 was issued. That
25 focused on sump performance of PWRs.

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1 And that's where we are today. Basically,
2 at that stage, the Rev. 2 stage, we are asking the
3 industry to assume 100 percent blockage unless they
4 can justify through test or analysis that they can
5 have a more realistic estimate.

6 CHAIRMAN WALLIS: Well, 100 percent
7 blockage, does that mean that the pumps just cannot
8 pump any water?

9 MR. HSIA: Assume that 100 percent
10 blockage of the screens.

11 CHAIRMAN WALLIS: That means the pumps
12 cannot pump any water?

13 MR. HSIA: No.

14 CHAIRMAN WALLIS: So we have to assume the
15 pumps are inoperable?

16 MR. ARCHITZEL: That's one of the
17 recommendations at Rev. 2. This is Ralph Architzel.
18 It just means that you're not having 50 percent -- an
19 arbitrary 50 percent assumption. It's a mechanistic
20 assumption that you had blockage and it can be uniform
21 over the surface. You still get water through. It's
22 an analysis done to say that you --

23 CHAIRMAN WALLIS: And you have to show --
24 you assume 100 percent blockage. That means that
25 there is something over the whole surface.

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1 MR. ARCHITZEL: A hundred percent coverage
2 of the surface.

3 CHAIRMAN WALLIS: In order to figure out
4 whether the pumps will work or not, you have to know
5 what that stuff is.

6 MR. ARCHITZEL: Exactly.

7 CHAIRMAN WALLIS: And so you haven't
8 really, with this assumption, given enough information
9 to solve the problem.

10 MR. HSIA: Correct. That's why we're
11 continuing to do research, and that's the most
12 conservative way to do it at that time.

13 CHAIRMAN WALLIS: Well, it isn't really
14 conservative yet, because you haven't said what the
15 blockage consists of. It could be 100 percent of
16 insignificant stuff.

17 MR. HSIA: Could be.

18 CHAIRMAN WALLIS: So it's not really
19 conservative yet.

20 MR. HSIA: Okay.

21 CHAIRMAN WALLIS: Until you say what that
22 stuff is.

23 MR. HSIA: Correct.

24 CHAIRMAN WALLIS: You said it was blocked
25 so much that the pumps couldn't work. That seems to

1 me is a conservative assumption. Otherwise, it
2 doesn't say anything. It just says there is something
3 on the screen everywhere, and that doesn't really say
4 anything until you say what you mean.

5 DR. LETELLIER: I think you'll see in the
6 research efforts that the debris generation and
7 transport tests have, in fact, characterized what
8 types and amounts of material might arrive on --

9 CHAIRMAN WALLIS: Might, yes. Might. But
10 I read in your report there are 13,000 cubic feet of
11 fiber in some of these -- in the air handling
12 equipment, for instance, in the containment. Now, if
13 any one percent of that gets on a screen, it blocks it
14 completely.

15 DR. LETELLIER: There's the potential for
16 100 percent coverage with an attendant head loss
17 associated with that bed.

18 CHAIRMAN WALLIS: Yes, it's all potential.
19 It's all "it might happen." It's not an assumption
20 that lets you calculate anything yet.

21 MR. HSIA: Correct. That's why we at this
22 point have stuck -- continued to gain knowledge.
23 Right now, at this stage, our thought was the plant
24 needed to do plant-specific analysis. Some plants may
25 not have that kind of issue. It depends on how -- the

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1 probability of their break and where they assume the
2 break.

3 So that brings us to where we are today is
4 Rev. 3. And we're here today -- hopefully, we'll --
5 our plan is to have Rev. 3 -- with your approval,
6 we'll issue the Rev. 3 shortly.

7 CHAIRMAN WALLIS: Oh. We can stop it?

8 MR. HSIA: Correct. Correct.

9 CHAIRMAN WALLIS: Thank you.

10 MR. HSIA: Hopefully, that's not the
11 outcome we're here for. The reason --

12 CHAIRMAN WALLIS: It depends on how much
13 blockage we want to insert in your process.

14 MR. HSIA: Correct. And we have to find
15 ways to justify it.

16 CHAIRMAN WALLIS: Okay. Yes, please.
17 Please do that.

18 MR. HSIA: Okay. The reason for issuing
19 Rev. 3 is to contribute to the resolution of GSI-191,
20 to enhance the blockage evaluation guidance for PWR,
21 and to provide guidance to make sure we put out there
22 methods acceptable to the staff, because, like I said
23 earlier, Rev. 2 -- we felt that Rev. 2 of Reg. Guide
24 1.82 was not comprehensive enough to ensure adequate
25 evaluation of PWRs susceptibility.

1 I just want to clarify that Reg. Guides
2 are not a substitute for regulations, and compliance
3 is not required. And we will talk a little bit about
4 alternative methods that -- as a matter of fact,
5 that's one of the --

6 CHAIRMAN WALLIS: That's rather funny.
7 You know, they have this thing that compliance is not
8 required. So that's why I couldn't understand about
9 this whole exercise. Out goes this Reg. Guide, and it
10 looks like a really serious matter. And it's quite
11 likely, it seems, that some -- quite a few plants will
12 not be able to meet all of these requirements in this
13 Guide. So what then happens?

14 MR. HSIA: Okay. Yes. The Reg. Guide
15 points out one or several acceptable methods in --

16 CHAIRMAN WALLIS: But it's also a subpart
17 of the regulations. So what happens when they can't
18 do it?

19 MR. HSIA: If they cannot do it, or they
20 choose not to use the methods described in here, they
21 can come up with their own methods. And that's the
22 time that they have to send it in here. Either way,
23 they have to send it here for --

24 MEMBER KRESS: It's in the regulations
25 that they have to assure that you can do the longer-

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1 term cooling and --

2 MR. HSIA: Yes. I was about to say --

3 MEMBER KRESS: There's a requirement
4 there.

5 MR. HSIA: -- there are requirements in
6 long-term cooling, 50.46.

7 MEMBER KRESS: So it's not like --

8 MR. HSIA: That's a regulation that they
9 have to satisfy. But they don't have to use the
10 method described in --

11 CHAIRMAN WALLIS: But they have to use
12 some method.

13 MR. HSIA: Yes. So like I said, when they
14 chose or they cannot use this Reg. Guide methods, they
15 can come up with their own through experiments,
16 through tests, and then we need to evaluate -- assess
17 that.

18 MEMBER KRESS: They have to satisfy you
19 guys that --

20 MR. HSIA: Absolutely.

21 MEMBER ROSEN: And then would you come
22 talk to us about that, if that unlikely event
23 occurred, someone chose to do it their own way?

24 MR. HSIA: I would like to ask one of my
25 colleagues at NRR if that's -- that's a regulatory

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1 issue. If they come in, you are going to issue an
2 SER. Do you come in front of ACRS? I don't -- I'm
3 not sure they come to you for every plant they come in
4 for -- with different methods.

5 MEMBER ROSEN: Well, it seems reasonable
6 to me that if you're asking for us to agree that this
7 general method should be applicable to everybody --
8 and we do --

9 MR. HSIA: Right.

10 MEMBER ROSEN: -- and somebody else
11 chooses another method, you ought to come in and ask
12 us whether or not the other method is --

13 MR. HSIA: Well, one scenario could be if
14 that method, when they reviewed the alternative
15 methods, they will still check based on this method to
16 see if they are compatible, if they're similar. And
17 if they find there are large discrepancies, they
18 believe they may choose to come in front of the ACRS.

19 But if they conclude it's a different
20 method but it's very similar, and it's technically
21 sound, they may not come in front of ACRS.

22 MR. ARCHITZEL: I guess just for going
23 forward, and a future plant would come in using this,
24 we would review it like Tony is saying. And you'd
25 review when the SER came forward for that plant in the

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1 ACRS. And if an issue arose to that, you'd hear about
2 it, you know, or you'd see it in the SER.

3 For the existing plants, the backfit comes
4 to play -- and not necessarily all of the positions in
5 the Reg. Guide would be imposed on the plants that are
6 out there. There are selected positions that would be
7 imposed.

8 CHAIRMAN WALLIS: So you're saying backfit
9 comes to play, because at the end of this Guide it
10 says, "No backfitting is intended or approved," or
11 something.

12 MR. ARCHITZEL: That's right. So as we go
13 forward, we're not allowed to backfit provisions in
14 this Reg. Guide without going through --

15 CHAIRMAN WALLIS: Well, it just seems to
16 me that --

17 MR. ARCHITZEL: But we will use it --

18 CHAIRMAN WALLIS: -- it may well be that
19 backfitting will have to occur as a result of studying
20 this issue.

21 MR. ARCHITZEL: But the current plan is to
22 ask if -- for the current plants, ask them for
23 information. And that's not exactly a backfit. They
24 have to do an evaluation. So it's the way the generic
25 communication process works.

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1 CHAIRMAN WALLIS: It's putting off today
2 when they have to do something, it seems to me.

3 MEMBER ROSEN: Yes. But it may not be a
4 backfit. It may be -- because they have to provide
5 long-term cooling.

6 CHAIRMAN WALLIS: Yes.

7 MEMBER ROSEN: And that's the field upon
8 which the agency issued a license.

9 CHAIRMAN WALLIS: Yes.

10 MEMBER ROSEN: And if it's now found that
11 the long-term cooling is threatened, or not likely,
12 then it's not a backfit for them to fix it, so that
13 they restore long-term cooling.

14 MEMBER KRESS: It's a backfit, but they
15 don't have to do a regulatory analysis.

16 CHAIRMAN WALLIS: It just bothered me to
17 state that no backfitting is intended. It may well be
18 that backfit is the right thing to do, so it's --
19 dismissing backfit out of hand is not -- didn't seem
20 to me appropriate. Perhaps we'll get to that later
21 on.

22 MR. HSIA: Okay.

23 MEMBER ROSEN: You don't need a cost-
24 benefit analysis, a 51-09 analysis, to --

25 CHAIRMAN WALLIS: But if you don't meet

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1 the regulations for long-term cooling --

2 MR. HSIA: If you don't meet the
3 regulations, that becomes a compliance issue.

4 CHAIRMAN WALLIS: Right. You must do it.

5 MR. HSIA: Right.

6 CHAIRMAN WALLIS: Okay. So perhaps we
7 should go on, then, from there.

8 MR. HSIA: Okay. Viewgraph 5 is a brief
9 history. We were here, briefed the subcommittee back
10 in February '03. As you can see, several of the
11 actors have changed. I wasn't here at the time and
12 neither was T.Y. As a matter of fact, our able staff
13 member is now working for -- for you now, ACRS staff.
14 So, but T.Y. is as competent as B.P., so I'm very
15 pleased.

16 So at that time, we were here, and so was
17 NRR. They discussed GSI-191 and the plans for -- they
18 have issued a bulletin since then, and they are
19 planning to issue a generic letter early next year.

20 The draft Reg. Guide at that time was
21 called DG-1107 -- was issued for public comment from
22 February to April. And we have -- T.Y. will discuss
23 the resolution of those comments.

24 CHAIRMAN WALLIS: I'd like to ask you
25 about resolving public comment. We're going to get to

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1 this in detail. I read the Guide, and I had almost
2 all of the same comments that the commenters had, even
3 though you've already addressed them, you say.

4 So it's a bit of a puzzle. Are public
5 comments resolved simply by you saying, "We've
6 resolved them," or do you have to go back to the
7 public and show that you have answered the question?
8 I mean, are you like the politician who gets one
9 question and answers it with something else, or
10 answers it with something which doesn't really answer
11 it? What's the assurance that this resolution really
12 answers the comments in an effective way?

13 MR. HSIA: Are you saying, how do we get
14 back to the comment --

15 CHAIRMAN WALLIS: No. You say you have
16 resolved public comments. I mean, are you the arbiter
17 of whether or not you have answered the comments
18 effectively?

19 MR. HSIA: In a way, yes, we are. We are
20 doing the best we can to say, "This is how we plan --
21 how we propose to resolve the comments." That's why
22 we're here today.

23 CHAIRMAN WALLIS: Okay. Check on whether
24 or not you have done this right. It's your own
25 professional --

1 MR. HSIA: Correct.

2 CHAIRMAN WALLIS: -- integrity and values,
3 and so on, or maybe the ACRS.

4 MR. HSIA: Exactly. That's why we're here
5 today as well as this is a public meeting. If any
6 public here wants to say, "Hey, you didn't answer my
7 question" or "I don't agree" --

8 CHAIRMAN WALLIS: Okay. That's so they
9 could come back.

10 MR. HSIA: Yes.

11 CHAIRMAN WALLIS: Okay.

12 MR. HSIA: Yes.

13 MEMBER KRESS: That's the way you always
14 did it.

15 MR. HSIA: Yes, correct.

16 MR. BANERJEE: May I just make a comment
17 here, Mr. Chairman. As I understand, the process is
18 when a rule is proposed or a Reg. Guide is proposed,
19 you send out for public comments. When the comments
20 are received, the staff members analyze the comments.
21 And then, when you finalize any document, it goes back
22 out again with your detailed analysis of each comment
23 and the response that the staff is proposing.

24 And if there is any serious problem then,
25 then the public comes back, and either in the form of

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1 a petition or in the form of a letter to the
2 Commission -- so then the -- the process is very
3 clearly marked, and it's a cycle.

4 So the way I understand right now, the
5 staff is coming in front of the subcommittee here to
6 tell their plan to resolve the public comment. If you
7 have any serious doubts or anything, then the staff
8 will go back and then make corrections before they go
9 out for their final product.

10 Isn't that correct, Tony?

11 MR. HSIA: That is correct. And you can
12 see from the fourth bullet on this viewgraph we're
13 here today, and we are -- to make sure we're not --
14 because we say this is not a backfit. That's why CRGR
15 has -- we'll have a meeting with them later on this
16 month.

17 And as you can see, we are coming back;
18 you have another shot at us. I don't mean literally,
19 but --

20 (Laughter.)

21 CHAIRMAN WALLIS: You want a letter to --
22 it seems to me you want a letter in September.

23 MR. HSIA: After September 11th, yes.

24 CHAIRMAN WALLIS: That's where if we have
25 still comments, or we think you haven't --

1 MR. HSIA: Yes.

2 CHAIRMAN WALLIS: -- the comments, we say
3 so, and then you have another shot at resolving them,
4 right?

5 MR. HSIA: Correct. We'll make another
6 attempt, I would say.

7 CHAIRMAN WALLIS: But you're going to
8 issue a 903 anyway?

9 MR. HSIA: We would like to. But
10 obviously, if there's issues we cannot resolve, that's
11 not going to happen.

12 CHAIRMAN WALLIS: Okay.

13 MR. HSIA: And that ends my part of the
14 presentation. I would like to turn it over to T.Y.

15 DR. CHANG: My name is T.Y. Chang, Office
16 of Research.

17 This slide shows that once the majority of
18 the revisions are made, it's made in the PWR sections,
19 because this is the intention of issuing this Reg.
20 Guide. However, we tried to make sure that the PWR
21 sections and the BWR sections are consistent with each
22 other whenever it's appropriate.

23 Another thing is Reg. Guide 1.1 has been
24 subsumed into this current version. So only for some
25 older plants they have to refer back to this Reg.

1 Guide 1.1. For future plants, they refer to Reg.
2 Guide 1.82 now for the NPSH issue.

3 Next slide, please.

4 This is a summary of the public comments
5 we received. We received 89 comments from seven
6 commenters -- four utilities, Westinghouse, NEI, and
7 one individual.

8 And the last bullet, in descending order,
9 are frequencies of comments raised. We have -- the
10 first one we received 13 comments, and the second one
11 eight comments, and so forth. We are going to go each
12 one now.

13 Next slide, please. Yes?

14 MEMBER KRESS: Just a general thought. It
15 seems to me every time we review some of these draft
16 Reg. Guides and rules, and you guys go out for
17 comments and then get them back, 99 percent of the
18 comments come from industry -- utilities,
19 Westinghouse, NEI. Once in a while we get one from
20 the Union of Concerned Scientists, and sometimes an
21 individual.

22 But is that an appropriate -- you know,
23 all we're doing is talking to the utilities, it seems
24 like. How do you distribute? Do you just put in the
25 Federal Register Notice and then --

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1 DR. CHANG: Yes, it's announced in the
2 Federal Register Notice. Anyone can send in their
3 comments.

4 MEMBER KRESS: Anybody can that wants to.

5 DR. CHANG: Right.

6 MEMBER KRESS: This individual, is that a
7 public citizen, or did it -- or do they belong to some
8 organization?

9 DR. CHANG: I think he's a consultant.

10 MEMBER KRESS: Consultant.

11 DR. CHANG: Yes.

12 MEMBER KRESS: It always bothers me that
13 we don't seem to get real public input to these
14 things. We seem to always be -- hear from the
15 industry only.

16 MEMBER ROSEN: People don't vote either.

17 MEMBER KRESS: Yes, that's true.

18 MEMBER SIEBER: Well, people don't get a
19 subscription to the Federal Register. You know, you
20 get about this much stuff, two feet high, every day,
21 because there's a lot of agencies, a lot of stuff in
22 there.

23 MEMBER KRESS: I just wondered if there
24 was a better way to do it, but I can't think of one.

25 CHAIRMAN WALLIS: Well, I would -- yes, I

1 would think not so much the public, but sort of a
2 technical savvy community.

3 MEMBER KRESS: Yes.

4 CHAIRMAN WALLIS: So if somebody who is
5 not part of the system of regulation and licensing,
6 and all of that, were to read this, would it seem
7 believable? Trying to get some view which isn't --
8 doesn't have a motive, profit motive or something.
9 Are we the only people like that?

10 MEMBER KRESS: I don't know.

11 MEMBER RANSOM: Well, the Union of
12 Concerned Scientists, usually they have a motive, too.

13 MEMBER KRESS: No. They have an agenda.
14 Sometimes you can believe them; sometimes you can't.

15 DR. CHANG: Okay. Let me go on.

16 CHAIRMAN WALLIS: Well, we've made this
17 comment many times. I think it is a weakness in the
18 system. These comments always come back from
19 interested parties trying to do something for their
20 own benefit.

21 DR. CHANG: I think that's human nature,
22 right?

23 Next slide. This --

24 CHAIRMAN WALLIS: I don't know what
25 benefit I'm getting out of being here.

1 (Laughter.)

2 MEMBER KRESS: What was the comment -- are
3 you going to go over these comments later?

4 CHAIRMAN WALLIS: Yes.

5 MEMBER KRESS: Okay.

6 CHAIRMAN WALLIS: Let's go on.

7 DR. CHANG: The next one is about
8 conformance issue for current plans. We've got 13 of
9 them.

10 CHAIRMAN WALLIS: I think this is an
11 important issue.

12 DR. CHANG: Yes. For instance, the first
13 comment is how Reg. Guide will be used for the current
14 plans. We mentioned that there is no intention for
15 backfitting for the current plans. It's only used as
16 simply for the evaluation of the long-term cooling of
17 the ECCS.

18 CHAIRMAN WALLIS: No, I'm not sure you can
19 use the Reg. Guide for evaluation methodologies,
20 because my impression is the Reg. Guide says, "Go and
21 do this. Go and do that. Go and see" --

22 DR. CHANG: Well, we have --

23 CHAIRMAN WALLIS: It doesn't say anything
24 about the existence of a methodology for doing it.

25 DR. CHANG: We have staff positions there,

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1 too. Okay? Not only acceptable methods.

2 CHAIRMAN WALLIS: It all seems so vague.
3 It says, "Go and calculate the debris transport."
4 It's not clear that anybody knows how to calculate the
5 debris transport.

6 DR. CHANG: Well, this is not the
7 intention of the Reg. Guide. We have not tried to be
8 prescriptive that people have to follow those steps.

9 CHAIRMAN WALLIS: Do you see the problem
10 I have? You're evaluating methodologies which
11 probably don't exist.

12 MR. HSIA: If I may jump in. Bruce,
13 please. Welcome. Go ahead, Bruce.

14 DR. LETELLIER: Well, first of all, I
15 don't think the Reg. Guide can be applied without a
16 knowledge of the historical research base that goes
17 along with it. And there has been an attempt to
18 document the supporting references. And one
19 suggestion has been that we add citations in the
20 appropriate sections, so that it's not difficult to
21 reconstruct that history for a first-time user.

22 MEMBER KRESS: That would seem to be
23 helpful to the reader.

24 DR. CHANG: Yes. I think that that's the
25 intent of the second part of my presentation is to try

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1 to describe our staff positions in the Reg. Guide and
2 the so-called acceptable methods. And then, Bruce
3 will go into specific ways of how to apply those
4 methods in real cases.

5 So I think that will address your
6 question. Just be patient with us.

7 CHAIRMAN WALLIS: Well, I don't think it
8 helps at all. If you read the Guide, you just pick up
9 at random a section, all insulation, blah, blah, blah,
10 blah, blah, blah, blah, you know, great list of stuff,
11 should be considered the debris source. Models or
12 experiments should be used to predict the size of the
13 postulated debris.

14 DR. CHANG: That's one of the acceptable
15 methods. They can choose to be conservative, to
16 assume the worst --

17 CHAIRMAN WALLIS: But all postulation is
18 an enormous amount of stuff.

19 MEMBER KRESS: Well, they give some
20 guidance in the Los Alamos report on how to deal with
21 that.

22 MR. HSIA: Chairman Wallis?

23 MEMBER KRESS: I think if you reference
24 the Los Alamos methodology in there, it might help.

25 MR. HSIA: Chairman Wallis, this is Tony

1 Hsia from Research.

2 CHAIRMAN WALLIS: Yes.

3 MR. HSIA: This Reg. Guide is not meant to
4 be a manual for anybody who wants to assess their
5 plant vulnerability regarding debris impact on ECCS
6 performance. It is, indeed, a guide. In there later
7 on I hope you will see that we -- like you just read,
8 we have guidance here saying, "You shall do this. You
9 should do that. We recommend that."

10 And many, many of those, if not all, have
11 been documented based -- as a result of previous
12 research and numerous reports, NUREG reports. I just
13 want to mention two very significant ones. One is a
14 knowledge-based report. I'm sure you all have a copy.
15 Another one is an older report, NUREG/CR-6244. Both
16 of those have been peer reviewed, and so this is
17 nothing new, really, to the industry or anybody.

18 CHAIRMAN WALLIS: Well, see, the problem
19 is I don't know how you got this -- this knowledge
20 base. But I read it, and it's so qualitative.

21 MR. HSIA: I'm sorry?

22 CHAIRMAN WALLIS: It describes things, and
23 it describes things you ought to consider. It doesn't
24 say how to do it. It says, "Here's this event in
25 Barseback. This is what happened. Here's this thing

1 in Hyse, Dumphrey, Oktor," or so and so," all these
2 things. It describes it. It doesn't give the
3 impression that there's any way to predict what
4 happened.

5 MR. HSIA: That part, you're correct.
6 That is early in that report. Later on --

7 CHAIRMAN WALLIS: What good is it for
8 predicting anything?

9 MR. HSIA: Later on there are sections
10 into different -- each phase of the accident
11 sequences. There are methods described, a test that
12 was done, and what you can learn from those tests, as
13 well as the analyses that was done, what you can do
14 with those analyses/methods. And that's what we're
15 hoping -- that Bruce will get into that detail as we
16 go along.

17 CHAIRMAN WALLIS: Okay. So we'll get into
18 that detail later.

19 MR. HSIA: Right. The point I want to
20 stress right now is both of those reports I mentioned
21 earlier have been peer reviewed, and discussions we
22 have had --

23 CHAIRMAN WALLIS: Your process must be
24 something like the public comment process, too.

25 MR. HSIA: Well, public comments --

1 anybody in the public, peer review, our field industry
2 experts, or a professional engineer that has expertise
3 in this area. There are technical people who took
4 time to really review all of the reports.

5 And also, we have had several workshops.
6 We have had discussions with the public, with the
7 interested parties. So many of those methods,
8 experiments, analyses, have been discussed before. So
9 I just want to say this is not brand-new to the people
10 who are interested in doing this.

11 CHAIRMAN WALLIS: I just think when you
12 have a peer review you have to have some sort of -- be
13 clear what it is they're reviewing, for what purpose.
14 And a peer review that says, "This is an interesting
15 document" is one thing. A peer review which says,
16 "This document really explains how to make
17 calculations for something with some kind of accuracy"
18 is a really different kind of peer review.

19 DR. LETELLIER: I think you're expecting
20 to see predictive phenomenology models that simply
21 don't exist.

22 CHAIRMAN WALLIS: That's right. Well, in
23 order to do what you want done in the Reg. Guide, I
24 have to have those.

25 DR. LETELLIER: I think the objective of

1 the Reg. Guide is to make a conservative, yet
2 realistic, approximation of the various stages of the
3 accident sequence.

4 CHAIRMAN WALLIS: Okay. Maybe you'll make
5 that case. I want to let you get on to it.

6 DR. LETELLIER: I hope so.

7 CHAIRMAN WALLIS: Yes. I'm sorry to
8 interrupt you, but you were talking about this
9 conformance issue.

10 DR. CHANG: Right, the first bullet. And
11 then, the second comment on the conformance issue is
12 some current plans have different designs as compared
13 to the ones we mention in the Guide. For instance,
14 the multiple --

15 CHAIRMAN WALLIS: Do any of them have
16 floors that slope away from the screens? That seems
17 a strange requirement.

18 DR. CHANG: Yes. I don't know whether --
19 are there --

20 DR. LETELLIER: Not to my knowledge. In
21 fact, there are very -- perhaps one or two at the most
22 that actually have designed drainage systems to return
23 water to the screen.

24 CHAIRMAN WALLIS: In any shower stall or
25 anything, the drain is at the bottom of the slope, not

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1 on the top of the hill. It seems a very strange
2 statement in there. So they certainly have different
3 designs as compared to the RG position in terms of the
4 slope of the floor.

5 DR. CHANG: Yes. We tried to say that --

6 MR. ARCHITZEL: But there are some that
7 have that, and -- but the normal sump would be the
8 lowest point. The accident sumps, there's quite a few
9 that do have the --

10 CHAIRMAN WALLIS: They do.

11 MR. ARCHITZEL: -- slight rise.

12 CHAIRMAN WALLIS: Okay.

13 MR. ARCHITZEL: Certainly, a lot with
14 curbs.

15 CHAIRMAN WALLIS: Okay. So they do.

16 MEMBER ROSEN: This is not an accident,
17 then. The curbs are there for a reason.

18 CHAIRMAN WALLIS: This means that when
19 there are spills of water it goes on the floor and is
20 not drained because the highest point is --

21 MR. ARCHITZEL: No, there's a normal sump
22 that would be the lowest point in the drain, different
23 sumps.

24 CHAIRMAN WALLIS: Oh, okay. Thank you.
25 That's good. That helps.

1 MEMBER KRESS: Multiple sumps don't seem
2 like they're any different to me than one sump. It's
3 just like a bigger one sump. Is that --

4 DR. CHANG: Well, you have two independent
5 sumps in different locations. I think usually --

6 MEMBER KRESS: Yes, but there's a common
7 cause failure, and that's the debris goes to both of
8 them. It's like just having one sump that's a little
9 bigger than this one.

10 MEMBER SIEBER: If your containment is
11 compartmentalized --

12 DR. CHANG: Right.

13 MEMBER SIEBER: -- then you have a
14 different debris field for one --

15 DR. CHANG: That's far away from each
16 other.

17 MEMBER SIEBER: -- than you have from the
18 other.

19 MEMBER ROSEN: You have a longer transport
20 there for the one -- distance to one sump than the
21 other, and that may be important.

22 MEMBER KRESS: I can see that being
23 important.

24 DR. CHANG: But our intention is that this
25 Guide is not just for current plans. It's for future

1 plans as well. So we just pointed out those
2 possibilities for the consideration if future plants
3 are being designed.

4 The third comment is the Reg. Guide
5 appears to favor a particular configuration of screen
6 because of the cartoons we have in the Reg. Guide. We
7 tried to clarify, to change the caption, saying that
8 those are conceptual features -- to indicate that they
9 are conceptual in nature.

10 CHAIRMAN WALLIS: So this Reg. Guide will
11 be used in the first response here, the evaluation of
12 current licensees, methodologies, long-term
13 recirculation cooling, and this will be, then,
14 accompanying some NRR effort to make sure that the
15 plants actually have those capabilities.

16 DR. CHANG: Oh, yes. Oh, yes.

17 Ralph, do you want to talk about the NRR
18 continuing program on this issue?

19 MR. ARCHITZEL: Yes. We were here before
20 at the same time you were. We currently plan -- last
21 time we were here we had a Generic Letter in front of
22 you, and you said, "Put it out quickly." We ended up
23 splitting that after we met with you into a bulletin
24 with the interim actions and a Generic Letter to
25 follow.

1 The Generic Letter will require
2 evaluations and request information to show that they
3 can meet this deterministically. But before -- or
4 what they're going to do that to is not this Reg.
5 Guide. It's going to be -- at the present plan, we
6 plan on looking at industry evaluation guidelines,
7 detailed guidelines, in terms of how you do these
8 evaluations. So that there's more of a --

9 CHAIRMAN WALLIS: But that isn't available
10 yet, is it?

11 MR. ARCHITZEL: It's not available yet.
12 The last plan from NEI we heard was September of this
13 year, and that may not make that date.

14 We would evaluate that and write an SER,
15 and that guidelines it. We're looking towards the
16 middle of next year to complete our evaluation of
17 those guidelines.

18 CHAIRMAN WALLIS: Well, I guess from the
19 public point of view, the issue is how long it's going
20 to take to resolve what's been a long-standing safety
21 issue of impossible importance.

22 MR. ARCHITZEL: NEI approved guidelines
23 are a while off yet. But this would be the yardstick
24 we would use to evaluate those guidelines. This Reg.
25 Guide is used as the evaluation of --

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1 CHAIRMAN WALLIS: Okay. So it's a
2 yardstick. So it better be -- better have units on
3 it, right?

4 MEMBER FORD: Since you don't have a
5 predictive methodology -- I mean, for instance, you
6 cannot predict why Barseback or Gundremmingen, these
7 other stations which have seen pump blockage occur,
8 that a whole list of various variables -- mesh size,
9 debris sources, etcetera, where you have no way of
10 quantifying whether that particular lineup or
11 parameters will give you a real -- give you a problem
12 down the sump.

13 So following on from the previous
14 question, what is your criteria for success or
15 compliance by the utility to this Reg. Guide? This
16 Reg. Guide just lists a whole lot of, "Hey, look out
17 for the slope of the floor, mesh size," etcetera,
18 etcetera. You're just listing all of the variables,
19 but you're not giving any criteria as to the well,
20 which are the most important ones.

21 What defines compliance to the Reg. Guide?
22 Do you understand what I'm saying? There's no
23 quantification.

24 DR. LETELLIER: Well, let me attempt to
25 clarify. First of all, the units, the calibration of

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1 the yardstick, are based on NPSH margin. That is the
2 ultimate condition of compliance -- whether or not a
3 given licensee can accommodate a certain fraction of
4 debris transport and still provide long-term cooling
5 as defined by --

6 MEMBER FORD: But there is no algorithm
7 relating NPSH to all of these other variables.

8 DR. LETELLIER: Well, when we say that
9 there are no predictive models, in large part we're
10 referring to the transport step. Now, we do have test
11 data that describes debris generation. We have test
12 data that describe head loss when the debris arrives
13 on the screen. And those are predictive; they're
14 based on empirical correlations and on some semi-
15 empirical theory.

16 So the various pieces have been quantified
17 to the level of detail that was possible with the
18 resources that we've been given in the past few years.
19 The lack of predictive capability comes in in the
20 variability of input parameters.

21 We're not certain exactly what the
22 conditions of a given accident will be, and we're --
23 we don't have a capability to predict the transport
24 fate of an assumed particle of debris.

25 MEMBER FORD: That's right.

1 DR. LETELLIER: And so, therefore, we're
2 using the test data to make conservative engineering
3 judgments about the connections between each step of
4 transport.

5 MEMBER FORD: I guess I'm putting myself
6 in the shoes of the utility, and saying, "Okay. I've
7 got to meet a certain NPSH quantitative criteria."
8 But I have no idea what -- the things I should be
9 controlling. And I've got this great big list of
10 things, and if you look at your report, the Los Alamos
11 report, there's a huge number of interrelations which
12 no one -- no one -- understands or can predict.

13 DR. LETELLIER: Well, I --

14 MEMBER FORD: So is there going to be a
15 big EPRI program to put a -- to qualify this, so they
16 can react proactively to this problem?

17 DR. LETELLIER: I'd prefer to respond to
18 a specific question regarding lack of predictive
19 capability, and that way we could show you the
20 supporting evidence that would help you make
21 judgments.

22 MEMBER FORD: Okay.

23 DR. LETELLIER: But, in general, let me
24 say that the guidance is intended to demonstrate
25 acceptable methods that range all the way from

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1 100 percent damage, 100 percent transport, 100 percent
2 blockage, all the way down to phenomenology-based
3 engineering judgments about what fractions would
4 actually participate in each step of the process.

5 Of course, the more detail that you have
6 to take credit for, then the more responsibility you
7 have to baseline your judgments on data, testing, and
8 evaluation programs.

9 In fact, when the comment was made by Dr.
10 Wallis about 100 percent inventory being overly
11 conservative, in fact, that was the resolution path
12 taken by the BWRs. As a matter of practicality, they
13 had enough space to redesign their strainers to
14 accommodate that amount of material.

15 CHAIRMAN WALLIS: Well, it couldn't be all
16 the material in the air handling units.

17 DR. LETELLIER: They designed their
18 strainers to accommodate all of the insulation,
19 thermal insulation, in containment.

20 CHAIRMAN WALLIS: Well, 13,000 cubic feet?
21 That's this room full. I don't know, maybe more than
22 this room full. Yes, more than this room full. I
23 can't believe it, that you're going to put all of that
24 on your strainer.

25 DR. LETELLIER: You're referring to filter

1 media in the air handling units and --

2 CHAIRMAN WALLIS: It's in your -- this
3 technical basis. I just -- it just struck me.

4 DR. LETELLIER: Well, keep in mind --

5 CHAIRMAN WALLIS: I don't know what this
6 is, and why it's in the air handling units. But it's
7 in your report that it's there.

8 DR. LETELLIER: Keep in mind that when you
9 consider debris generation, you have to examine the
10 potential source locations. And then you assess the
11 targets that might be impacted by the damage, so --

12 CHAIRMAN WALLIS: I have no idea where the
13 air handler units are relative to where the LOCA might
14 be or why --

15 DR. LETELLIER: And it may vary --

16 CHAIRMAN WALLIS: -- the stuff might fall
17 out in a steam environment or not. But that's
18 something that presumably is going to be calculated
19 using your methods.

20 DR. LETELLIER: The locations may vary
21 widely.

22 CHAIRMAN WALLIS: Yes.

23 DR. LETELLIER: In fact, and it -- I think
24 it's listed there for completeness sake. If a
25 particular licensee knows that their air handling

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1 units are vulnerable to impingement, then that
2 represents a potential debris source that they have to
3 accommodate.

4 CHAIRMAN WALLIS: I wonder if they have
5 any clue about whether they're vulnerable to a
6 shockwave.

7 DR. LETELLIER: By inference of proximity,
8 and based on the test data for damage zones for
9 different types of debris ranging from bare fibrous
10 insulation all the way to encased stainless steel
11 jackets, I think that the industry does have a good
12 impression of what the damage zones are.

13 Now, that's not to say that the database
14 is entirely inclusive. We were able to test the
15 predominant materials, the predominant insulation
16 types. But there are certainly others.

17 CHAIRMAN WALLIS: Well, that's what's --
18 I do see you have these -- you have -- I know you have
19 some good tests on certain kinds of insulation on
20 pipes. But this air handler unit, where is it? I'm
21 sorry to keep on this, but because this is a huge
22 number in your report -- 15,000 cubic feet.

23 Now, is this in sheets of loose stuff in
24 some kind of -- like in my domestic heating system,
25 hot air system? It's a very, very flimsy filter.

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1 DR. LETELLIER: But in general --

2 CHAIRMAN WALLIS: The slightest thing can
3 break that up.

4 DR. LETELLIER: That's true. But in
5 general --

6 CHAIRMAN WALLIS: Is that what they're
7 like?

8 DR. LETELLIER: Yes.

9 CHAIRMAN WALLIS: Then, why are they
10 considered?

11 DR. LETELLIER: But in keeping with your
12 analogy of a home furnace system, you know that those
13 materials, those fiberglass panels, are encased in
14 mechanical equipment. They are shielded, in a sense,
15 by the sheet metal.

16 CHAIRMAN WALLIS: Well, I don't know how
17 they are in the plant.

18 DR. LETELLIER: In fact, that's true in
19 the plants as well.

20 CHAIRMAN WALLIS: So that the utility has
21 to look very carefully at all of those things, like
22 say the air handling units, and say, "Gee whiz, my
23 filters are not very well protected. I'd better do
24 something about it," or something?

25 DR. LETELLIER: That's true. Ultimately,

1 the --

2 CHAIRMAN WALLIS: Do all of these
3 assessments and --

4 DR. LETELLIER: -- judgment falls on them.
5 But keep in mind --

6 CHAIRMAN WALLIS: Eventually, maybe if
7 they don't do it, some NRC inspector will walk around,
8 if they have a walkaround in site containment, and
9 say, "Gee whiz, I can see a lot of loose filter
10 material up in that air filter. This looks like
11 something that might give a problem with sump block
12 issue at" --

13 DR. LETELLIER: Well, the guidance also
14 serves the purpose of audits for the regional
15 inspectors. And so the Reg. Guide provides
16 consistency between the NRC approach and the
17 industry's perspective as well.

18 Keep in mind that the assessment of a
19 given vulnerability may be as simple as proximity.
20 This is outside the damage zone. Therefore --

21 CHAIRMAN WALLIS: We're going to move on.

22 DR. CHANG: Yes.

23 CHAIRMAN WALLIS: But you're putting an
24 awful lot of reliance here on the ability of each one
25 of these licensees to make a proper assessment of all

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1 the sources of debris and what will happen to it.

2 MEMBER ROSEN: That's correct. When we
3 get the guidance from NEI --

4 CHAIRMAN WALLIS: Right. We have to get
5 some guidance. We haven't got it yet.

6 MEMBER ROSEN: No, we haven't got it.

7 CHAIRMAN WALLIS: We have no idea if it's
8 going to be adequate.

9 MEMBER ROSEN: Well, we will presume that
10 they will do a good job as they do on many things and
11 be proud of it and tell us about it.

12 I would observe it's 9:15. That's the
13 close of the discussion on the comments, and I don't
14 think we're quite there.

15 DR. CHANG: Okay. The next issue about
16 overpressure -- in the Reg. Guide, we mentioned that
17 for the ECCS and containment heat removal systems,
18 they should be designed such that the pumps have
19 available sufficient to the NPSH.

20 Assuming no overpressure from -- as
21 compared to that -- before the LOCA -- this is a
22 conservative assumption -- the comment is that this is
23 not consistent with the licensing basis for certain
24 subatmospheric containment plants, because in those
25 plants they have vacuum under the normal operation

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1 condition.

2 Our response is that the original position
3 stays with change -- with some modifications. The
4 modification is that we said for subatmospheric
5 containments, this guidance should apply after the
6 injection phase has terminated. Prior to termination
7 of the injection phase, the analysis should include
8 conservative predictions of the containment
9 subatmospheric pressure and sump water temperature as
10 a function of time.

11 MEMBER KRESS: Why should you give
12 subatmospheric containments this advantage but not
13 give it to the other plants? Why shouldn't an
14 ordinary large dry PWR be able to take the containment
15 pressure prior -- after injection also? If it's good
16 for one plant, shouldn't it be good for the other?

17 DR. CHANG: Well, I think it's consistent.
18 We are trying to be on the conservative side.

19 MEMBER KRESS: Yes, you've been
20 consistent. The subatmospheric plants have been
21 given --

22 DR. CHANG: For subatmospheric plants --

23 MEMBER KRESS: -- an allowance for
24 overpressure.

25 DR. CHANG: Prior to the switchover, they

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1 have to assume conservative predictions for pressure
2 and water temperature as a function of time.

3 MEMBER KRESS: Yes. But it seems to me
4 like if you're going to let the subatmospheric
5 containments do that, you ought to let other
6 containment types do it also.

7 DR. LETELLIER: To be honest, I'm not
8 certain what additional benefit that really adds. If
9 you look at the words that -- we're talking about the
10 switchover to recirculation, between injection and
11 recirculation. And after the injection phase has
12 terminated, the guidance defaults back to the pressure
13 that existed before the --

14 DR. CHANG: They still have to comply to
15 the pre-LOCA condition.

16 DR. LETELLIER: In effect, T.Y. was
17 correct that our -- the staff position has not
18 changed, that we're defaulting back to the Reg. Guide
19 1.1 position, that in order to accommodate a variety
20 of accident scenarios, including loss of containment,
21 it's always conservative to assume the pressure that
22 occurred before the LOCA event.

23 DR. CHANG: Okay. The next one, the next
24 slide, please, is on the screen mesh size. In the
25 original Reg. Guide sent out for public comment, we

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1 have a sentence saying that a site should be smaller
2 than the minimum restrictions found in the systems
3 downstream of the sump, and then later the ECCS or the
4 reactor coolant system components.

5 The comment is that this may lead to very
6 high head loss for -- in current screens, if you use
7 such a small mesh. And also, it may make the screen
8 areas too large to be practical.

9 The second comment on the mesh size is
10 someone suggested that the long thin debris slivers
11 may pass axially through the sump screen, and may then
12 reorient and clog the flow restrictions downstream,
13 such that pump seals -- such as pump seals and
14 barriers in those locations. This shall be considered
15 -- this is the comment.

16 Our response to the first one is that we
17 modified the Reg. Guide to say that the size of the
18 screen pump opening should be determined considering
19 the flow restrictions of systems. We don't say it has
20 to be smaller.

21 And then, the mesh size is -- if the mesh
22 size is impractical to be fine enough to filter out
23 particles of debris that may cause damage to the
24 downstream equipment, then it is expected that
25 modification would be made to the ECCS pumps, or they

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1 can purchase a pump that can handle those small
2 particles.

3 And on the second comment we --

4 CHAIRMAN WALLIS: There is a pump that
5 will do this that's easily accessible and --

6 DR. CHANG: Ralph, do you have any
7 information on that?

8 DR. LETELLIER: We don't have specific
9 vendor information, but we are aware of pumps that are
10 designed to handle high debris loadings. We're not
11 certain that they're qualified for nuclear
12 applications.

13 The point is, in the response to this
14 comment, is that the filter screens have a performance
15 criteria. They are there for a purpose -- to protect
16 downstream equipment. And the vulnerabilities of the
17 downstream equipment should be used to define the
18 performance standards.

19 MR. ARCHITZEL: But I guess to go to a
20 specific example, in the Davis-Besse case, the low
21 pressure safety injection pumps were capable of
22 pumping the fluid that got through the screens. And
23 the high pressure safety injection pump wasn't
24 evaluated, so it is somewhat pump and vendor specific.
25 They did have to modify the high pressure safety

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1 injection pumps for this issue.

2 CHAIRMAN WALLIS: But one of the
3 commenters said that, if these fibers got through,
4 they would tangle up on things like spaces in fuel.

5 DR. CHANG: Yes, that's the second
6 comment.

7 CHAIRMAN WALLIS: They'd be tangling up,
8 and they didn't have to be bigger than the opening in
9 order to start tangling up on these. The spaces
10 themselves are sort of filter or screen. So did you
11 respond to that?

12 DR. CHANG: Yes. I think that's related
13 to the second comment, as I mentioned -- that the last
14 slivers of fiber may pass through the mesh opening
15 axially and get clogged up later on in those small
16 areas like pump seals or bearings.

17 So we agree with the comment, and we
18 modified the Reg. Guide to say that people have to
19 consider those conditions if they have that in their
20 plants.

21 CHAIRMAN WALLIS: Well, you just said
22 consideration should be given to the buildup of debris
23 at downstream locations.

24 DR. LETELLIER: There is currently a
25 research effort in place --

1 CHAIRMAN WALLIS: Very vague.

2 DR. LETELLIER: -- for the next fiscal
3 year to look at screen penetration.

4 CHAIRMAN WALLIS: Well, there's no
5 criterion for anything. I mean, suppose you say,
6 "Yes, I'm going to have my spacers on some of these
7 fuel elements festooned with fiber," so what? I mean,
8 there's nothing here that says how you decide whether
9 or not it's okay.

10 DR. CHANG: Well, in this case, we just
11 bring this to the attention of people there. This is
12 a possibility.

13 CHAIRMAN WALLIS: Well, this whole thing
14 is so vague, you've got to consider all of these
15 things. Are we waiting for some guidance?

16 MEMBER ROSEN: Yes, the guidance from NEI.

17 CHAIRMAN WALLIS: Is that what we're
18 waiting for?

19 MEMBER ROSEN: I think that's the key
20 document.

21 MR. ARCHITZEL: I'd like to point out that
22 NEI guidance deals with the GSI-191 issue. It doesn't
23 deal at all with the downstream blockage effects. No
24 one -- they're not working on that, so this issue,
25 which is, say, blockage in the fuel channels, is not

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1 part of that effort.

2 MEMBER ROSEN: Why not? I mean, isn't
3 that -- the Reg. Guide now clearly says "modified to
4 make that comment."

5 MR. ARCHITZEL: But I'm not saying the
6 Reg. Guide does. I'm just saying it's not part of
7 their current effort.

8 MEMBER ROSEN: Okay. So now that we've
9 had that comment from the public, and the staff has
10 looked at it and put it -- modified the Reg. Guide,
11 now it seems to me incumbent on NEI to deal with
12 what's now going to be in the Reg. Guide. Am I
13 correct?

14 MR. LEHNING: This is John Lehning. I
15 guess it's not incumbent on NEI to deal with what's in
16 the Reg. Guide, but it would be incumbent for each
17 licensee to deal with --

18 MEMBER ROSEN: Right. Well, yes. And the
19 licensees have delegated that to NEI rather than come
20 up with 59 or 69 different solutions, which is
21 logical. So now it seems to me, I mean, you know, we
22 have a coherent system. We have public comment, you
23 respond, you change the Reg. Guide. The utilities now
24 have to deal with what's in the Reg. Guide or come up
25 with alternatives. They don't have to choose to come

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1 up with alternatives.

2 And they hired NEI to come up with a
3 common method they can use. They set up a task force
4 to work with NEI and to make sure that the guidance
5 comes out the way they think is reasonable and
6 responds to the Reg. Guide appropriately. But, I
7 mean, I'm stunned to think that NEI wouldn't now
8 change the Reg. Guide to deal with this comment,
9 because the Reg. Guide -- change the guidance to deal
10 with this comment, because the Reg. Guide is going to
11 have it in it.

12 We have an NEI representative here. He
13 could address that. Would you choose to do that?

14 MR. BUTLER: I don't know what you'd like
15 me to say. I mean --

16 MEMBER SIEBER: You need to use the
17 microphone.

18 MR. BUTLER: John Butler at NEI. Our
19 initial effort did not focus on the downstream
20 effects. Part of the difficulty with addressing
21 downstream effects, it's very design-specific, vendor-
22 specific, part-specific. All we could do without an
23 extensive research effort would be to provide some
24 guidance that probably would not go into a lot more
25 detail than the current Reg. Guide point, things that

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1 plants would need to look at to ensure that they've
2 accommodated in some fashion.

3 But the analyses necessary to demonstrate
4 that their system can accommodate materials that pass
5 through the screens is very pump-specific, design-
6 specific.

7 MEMBER FORD: Could I ask a question?
8 It's more of a procedural and which I don't
9 understand. This Reg. Guide, this NRC Reg. Guide,
10 gives a lot of qualitative requirements -- assess
11 this, consider that.

12 Now, do I understand from the conversation
13 that has just gone on that now NEI is going to issue
14 a guidance to their utilities as to how they're going
15 to respond to NRC's request for assessment? So NEI is
16 going to give the quantitative answer?

17 MEMBER ROSEN: Yes, that's my
18 understanding.

19 MEMBER FORD: Is that true?

20 MEMBER ROSEN: Rather than each utility
21 doing it themselves, they've come together in a task
22 force, an NEI task force, which has been charged with
23 the responsibility of coming up with a set of guidance
24 for that -- for each utility to use --

25 MEMBER FORD: Well, it would close the

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1 circle, then.

2 MEMBER ROSEN: -- to close the circle.

3 MEMBER FORD: How will NRC approve, if you
4 like, the NEI's quantification of these requirements?

5 MEMBER ROSEN: I expect, but I will let
6 them answer for themselves, I expect that they'll read
7 it and write an SER saying that's an acceptable way of
8 meeting the Reg. Guide. Is that correct?

9 MR. ARCHITZEL: Well, it won't be meeting
10 the Reg. Guide. It'll be an acceptable methodology to
11 address this evaluation that would be addressed in the
12 Generic Letter. But it would be an SER.

13 MEMBER FORD: And how long will it take to
14 come up with these quantitative guidance to your
15 members?

16 MR. BUTLER: We're still working toward an
17 end of September schedule.

18 MEMBER FORD: Gosh. If you read this Los
19 Alamos thing here, I'm not an expert in this area, but
20 you're not looking at a three-month research effort to
21 quantify the interactions between all of these
22 variables to meet their qualitative requirements.

23 Am I being dumb here? Am I missing
24 something?

25 MR. BUTLER: No, sir. Let me point out

1 what Bruce pointed out earlier, that you have a choice
2 in assuming a very conservative assumption or taking
3 a more phenomenological approach to -- that requires
4 a little bit more investigation and detail.

5 What we're attempting to do, with the
6 guidance is provide each utility with options in each
7 phase of the event, as to which method they choose to
8 use. If they can accommodate a very conservative
9 approach in terms of the answer that that gives, that
10 is the simplest and most direct way to get an answer.

11 In other instances, they will need to
12 provide -- go with a more phenomenological approach,
13 still probably using some conservative assumptions.

14 MEMBER FORD: Okay.

15 MR. BUTLER: Because there is not a lot of
16 detailed phenomenological research available that they
17 can use. And there's a large variability in the
18 designs that it would be very difficult to do that on
19 a generic basis.

20 So the level of detail that they use in
21 their analysis, the level of conservatism they use in
22 their analysis, will be up to each individual plant to
23 meet their needs.

24 MEMBER FORD: Okay. Thank you.

25 MR. HSIA: This is Tony Hsia from

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1 Research. I would like to add that the advantage of
2 an issue this -- with such a long history was that
3 industry has done quite a bit already, because we --
4 that was evident to me when we attended the workshop
5 back in July in Baltimore.

6 Their plans were to perform analyses to
7 evaluate the debris generation. Their licensee will
8 perform analyses and attempt to figure out a washdown
9 and transport -- washdown from -- you know, with
10 container spray of the debris and transport debris.

11 And I was impressed to see there was one
12 plant who actually had a very extensive plant walkdown
13 and documented why each room has possible debris.
14 That's the -- later on you will see, when we get into
15 detail, that's -- as it turned out, the NRC and the
16 industry has evolved to really look at this whole
17 thing, and back up a step and say you've got to figure
18 out debris generation, you've got to figure out how to
19 move that debris, whatever you have, from your
20 location down -- washed down to the sump. And this
21 transport in the sump, then eventually the possible
22 blockage of screen and suction strainers.

23 So that's the direction everybody is going
24 to. And I hope when we get into the detail, you'll be
25 able to see it better.

1 And I'd also note that Bruce is correct
2 when he said there is no method, he really -- I
3 believe he really meant to say there is no integrated
4 predictive method. In other words, you don't have a
5 code -- let me just put a name out there like a
6 revised RELAP that can include all the debris and
7 predict where they're going to go, and with what kind
8 of force they're going to strike each object. We
9 don't have that tool.

10 So the best we can do is right now, using
11 codes like RELAP, like MELCOR, at different phases of
12 the accident, and then incorporate that with the test,
13 the knowledge we have gained from experiments on how
14 -- what kind of debris, what size, what kind of debris
15 we'll have, and combine that with the plant-specific
16 configuration. With that all put together, that's the
17 best we can predict today.

18 So what he meant is there's no integrated
19 simple tool that can give it a solution just by
20 punching in the numbers.

21 DR. CHANG: Okay. Next slide, please.

22 The next concern is on the leak before
23 break for the resource. The comment is that
24 Section C.1.3.2 requires application of large breaks
25 in essentially all locations in the reactor coolant

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1 system for regeneration.

2 This is consistent with 10 CFR 50.46.
3 This is for the calculation of ECCS capability, long-
4 term capability. You have to postulate the most
5 severe postulated LOCAs. But in our case, for the
6 sake of the generation of the worst debris, we used
7 the same approach as 50.46. In other words, they have
8 to consider the most severe postulated LOCAs.

9 The comment is that this is not consistent
10 with the leak before break position of GDC 4. Our
11 response is there is no change after Reg. Guide. The
12 staff position was documented in a letter to the
13 Westinghouse Owners Group in 2000. The position is
14 that LBB is not applicable to LOCA-generated debris.

15 However, the staff acknowledges that we
16 have received an NEI request to consider alternatives
17 to a double-ended guillotine break for debris
18 generation. For instance, they postulated maybe we
19 can use the fraction mechanics to predict a certain
20 size of break instead of the double-ended guillotine
21 break.

22 This is something in between the two
23 extremes. One is the double-ended guillotine break;
24 the other one is the leak before break. So it's sort
25 of a compromise suggestion.

1 And this is a policy issue which may
2 result in changes to break size used for debris
3 generation. So after we reviewed -- finished
4 reviewing this alternate, what is the status on that
5 now, Ralph?

6 MR. ARCHITZEL: The last was NEI was going
7 to provide some supplemental material to their earlier
8 application. And once we get that, we plan to go with
9 an ANSI policy paper up to the Commission.

10 DR. CHANG: Okay.

11 MEMBER KRESS: Let me ask a technical
12 question, perhaps to Mr. Letellier. How do you
13 pronounce your last name?

14 DR. LETELLIER: Letellier.

15 MEMBER KRESS: Oh, you pronounce the R.

16 DR. LETELLIER: It's been Americanized.

17 MEMBER KRESS: Is the quantity, size, and
18 transportability of debris in the general locale of
19 the break a strong function of the break size, pipe
20 size?

21 DR. LETELLIER: The volume of debris is
22 definitely a strong function of the pipe and size.
23 And the correlations are -- have that as a key
24 parameter -- the pipe diameter.

25 MEMBER KRESS: Okay.

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1 DR. LETELLIER: The amount of debris
2 generated is also a strong function of the damage
3 pressure for the given debris type. As I mentioned,
4 bare insulation to jacketed material to reflected
5 metallic. All of those respond differently.

6 MEMBER KRESS: Okay. That bears on how I
7 think about this large break LOCA and leak before
8 break issue.

9 CHAIRMAN WALLIS: I think it's important
10 in big LOCA -- a big LOCA is a really big debris
11 source.

12 MEMBER KRESS: Yes. But it has a very low
13 probability.

14 CHAIRMAN WALLIS: That's where the
15 argument is about the leak before break.

16 DR. CHANG: All right. The next slide,
17 please.

18 The next comment is on the partially
19 submerged screens, and it's a failure criteria. In
20 the original Reg. Guide sent out for public comment,
21 we have a statement that credit should only be given
22 to the portion of the sump screen that is expected to
23 be submerged at the beginning of recirculation.

24 Allowance should be provided for
25 circumstances in which the level of submergence

1 changes substantially following the beginning of
2 recirculation. This is the comment on our statement.

3 The example cited is it's like using an
4 ice condenser containment, that continually the ice
5 melts and you increase the water level. So if you
6 specify that they have to stick with the water level
7 at the beginning of the switchover, then this is not
8 considered there.

9 The staff position has been modified in
10 the Reg. Guide to say that for partially submerged
11 sumps credit should only be given to the portion of
12 the sump screen that is expected to be submerged as a
13 function of time. So we added this as a function of
14 time. It's not at the switch of -- switchover time.

15 Pump failure should be assumed when the
16 head loss across the sump screen is better than half
17 of the submerged screen height, or the NPSH margin.
18 This addresses Dr. Ford's question about there is no
19 failure criteria there. This is the bottom line.

20 Okay. And originally we have I think --
21 in the revised version, we have one-half of the pool
22 height. Now we change it to the submerged height.
23 It's because in some designs they have a curb there.
24 A curb effectively is a block of the screen, so you
25 have to count the height without the curb.

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1 Next slide, please.

2 MEMBER KRESS: That wording is a little
3 strange to me. You're saying that you should assume
4 the pump fails when the head loss across the screen is
5 greater than one-half of the head loss you would get
6 to exceed the net positive suction head origin, or
7 what? I don't -- I'm not --

8 DR. CHANG: Now which --

9 MEMBER KRESS: I'm looking at the last
10 sentence of your response. It's just -- I'm trying to
11 read it and see what it actually says.

12 DR. LETELLIER: Those are two separate
13 criteria. One is the standard NPSH consideration of
14 cavitation at the pump inlet, at the impeller
15 location. You can't violate that margin.

16 The other criteria is actually a
17 consideration of passing of volumetric flow through
18 the debris bed. The only driving force available is
19 the static head of the water that's sitting in the
20 pool. That's the only way to supply water to the sump
21 well.

22 MEMBER ROSEN: It would just be a dam
23 that's holding back all --

24 DR. LETELLIER: That's right.

25 MEMBER ROSEN: -- the water.

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1 DR. LETELLIER: It's a dam essentially.
2 And on average, your static head is about one-half the
3 pool depth minus the curbing. And so there are
4 actually two separate failure conditions, and I would
5 propose we add the words "whichever is less," the
6 minimum of --

7 MEMBER KRESS: I just think that sentence
8 needs to --

9 DR. CHANG: Yes, whichever is less.
10 That's the intention.

11 CHAIRMAN WALLIS: Actually, they work in
12 combination that -- that you get some drop-in head
13 across the screen, and then you have to worry about
14 NPSH from that lower head. So the two really act
15 together, don't they? They're not independent.

16 DR. LETELLIER: It's actually the minimum
17 of the two. Whichever is lower will be your
18 threshold.

19 CHAIRMAN WALLIS: You have to add the two
20 together. Anyway, you'll sort it out.

21 DR. CHANG: Yes. Next slide, please.

22 The next comment is on the one-eighth thin
23 bed value. I think we are going to go into the thin
24 bed later on, but the comment is that there seems to
25 be no supporting technical basis to have the number

1 one-eighth of an inch there in the Guide.

2 And we made it clear that there is some
3 technical basis in this new --

4 CHAIRMAN WALLIS: So it's not a magic
5 number. It hasn't really any basis except that it
6 worked for certain physics for certain kinds of
7 material. Nothing magic about an eighth of an inch.

8 DR. LETELLIER: It is based on test data.

9 CHAIRMAN WALLIS: No. I mean, it's --

10 DR. LETELLIER: A bed that's thinner than
11 that will fail.

12 CHAIRMAN WALLIS: It depends on the screen
13 and the kind of debris and all sorts of things. But
14 anyway, we'll get to that later.

15 DR. CHANG: Next slide, please.

16 The next one is on the adequate protection
17 after sump on --

18 CHAIRMAN WALLIS: This one is an easy one,
19 I think.

20 DR. CHANG: This is an easy one, I hope.

21 CHAIRMAN WALLIS: We can pass over this
22 one, unless anyone has a question about it.

23 DR. CHANG: The next one? Want to skip
24 this one?

25 CHAIRMAN WALLIS: Well, I had a comment on

1 this.

2 DR. CHANG: Oh, you have a comment.

3 CHAIRMAN WALLIS: In reading the Los
4 Alamos basis -- knowledge basis, it seemed to me that
5 CFD is shown to qualitatively simulate some of these
6 things. But it wasn't really an analytical tool yet.

7 DR. LETELLIER: Again, the use of CFD
8 codes is to provide engineering information about
9 water velocities and what the transport pads would be.
10 CFD is not sufficient for predicting debris behavior
11 in water. Those models don't exist, and it was not
12 the intent to develop that -- those models.

13 CHAIRMAN WALLIS: Well, it says analytical
14 -- it's an acceptable analytical approach to predict
15 debris transport. And you're saying it can't do it,
16 so --

17 DR. LETELLIER: Well, we should clarify
18 that to say when used in combination with test data.

19 CHAIRMAN WALLIS: Ah, okay. Well, good.
20 Thank you.

21 Yes. This earthquake one is probably
22 okay, too.

23 And then we go to slide 17, size of the
24 ZOI. Presumably, Los Alamos has ways to estimate the
25 ZOI that answer this public comment on page --

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1 slide 17.

2 DR. CHANG: Well, our position is that the
3 ZOI should be consistent with the risk-specific damage
4 pressure. In other words, it should extend until the
5 jet pressure decreases below the experimentally
6 determined damage pressure appropriate for each
7 specific debris source. So this is how it is decided
8 -- the size of the ZOI.

9 DR. LETELLIER: Specifically, to answer
10 the question directly, to do the zone of influence
11 correlation scale with operating or design pressure,
12 the answer is no. The test data don't exist in a
13 comprehensive fashion. What does exist are zones of
14 influence as a function of damage pressure for the BWR
15 tests that were performed as part of the BWR
16 resolution.

17 There were limited two-phase blowdown
18 tests conducted as part of this exercise, but not in
19 a comprehensive fashion. What we've done is to
20 account for the difference in the thermal hydraulic
21 conditions and compensate for the difference in energy
22 by reducing the damage pressures. Where for a steam
23 jet, bare, unprotected fiberglass might fail at a
24 damage of 10 psi, we now suggest using a damage
25 pressure of 6 psi.

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1 CHAIRMAN WALLIS: This is a stagnation
2 pressure or what?

3 DR. LETELLIER: That's right.

4 CHAIRMAN WALLIS: Okay.

5 DR. CHANG: Okay. Last slide on the
6 public comment is some samples of other comments. One
7 is on the definitions of NPSH. The one we had in the
8 Reg. Guide before probably isn't too clear, so we
9 quoted the definition from the ANSI document. So it's
10 word by word. It's quoted there.

11 And the second comment is about the
12 chemical reactions in the pool.

13 CHAIRMAN WALLIS: I have a comment on
14 that. I mean, all you're considering is the chemical
15 reactions producing precipitate. But on page 120 of
16 the knowledge base document, it speaks about
17 interaction of high pH water with zinc and aluminum
18 surfaces producing hydrogen. And then, later on, on
19 page 131 or 131, it talks about the generation of
20 hydrogen from high pH water.

21 Now, I've made this point before. When
22 you have bubbles produced on these particles, then you
23 get flotation of the particles. So there are chemical
24 reactions occurring in the pool. There's a continuous
25 bubbling and flotation, rather like the notorious

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1 tanks at Hanford.

2 And this is going to change the
3 floatability of the debris. And this doesn't seem to
4 be considered at all. I mean, I've made this point
5 three or four times in the past, and no one has ever
6 put it into any Reg. Guide or --

7 MEMBER ROSEN: Isn't it a conservatism not
8 to consider that? I mean, if the particles --

9 CHAIRMAN WALLIS: No. Because you have
10 your heavy particle down at the bottom. They throw it
11 away, because it settled.

12 MEMBER ROSEN: Right.

13 CHAIRMAN WALLIS: But if it now reacts
14 with gas and makes bubbles, it floats up and gets
15 transported.

16 MEMBER ROSEN: Right. But it never
17 settles down low enough to go into the pump.

18 CHAIRMAN WALLIS: It does, because the
19 bubbles fall off essentially. It rises to the
20 surface, the bubbles release, and it falls down again,
21 and goes through a cycle of progressing along and
22 flotation --

23 MEMBER ROSEN: Well, ultimately, it comes
24 -- it's removed. The bubble is separated from it.

25 CHAIRMAN WALLIS: Yes, right.

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1 MEMBER ROSEN: But it hits the surface,
2 the bubble separates, and it falls down again. This
3 goes on as long as the chemical reactions go on. You
4 can do it in your kitchen and --

5 DR. LETELLIER: Two comments. Number one,
6 I'm not sure that the Reg. Guide focuses exclusively
7 on precipitation. I think the words are accurate here
8 that it requires consideration of debris generated by
9 chemical reactions.

10 CHAIRMAN WALLIS: But it also talks about
11 -- demonstrates that suspended indefinitely or to sink
12 very slowly should be considered to reach the sump
13 screen. It seems to me that stuff which is liable to
14 have bubbles on it and to go through this dance could
15 be considered to be suspended indefinitely.

16 MEMBER KRESS: I can't believe you're
17 going to produce enough gas in this temperature and
18 condition that it's going to be a significant issue.

19 CHAIRMAN WALLIS: Show us the --

20 DR. LETELLIER: That's my second comment
21 is I'm not sure that the scenario that you portrayed
22 is actually realistic.

23 MEMBER KRESS: Yes. You --

24 DR. LETELLIER: Keep in mind that the gas
25 generation occurs on exposed metal surfaces. There

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1 are not a lot of exposed --

2 CHAIRMAN WALLIS: Flakes of aluminum
3 paint.

4 MEMBER KRESS: Yes. But they don't react
5 -- they're in the water, and this is -- this water
6 temperature is --

7 CHAIRMAN WALLIS: It says it's got NaOH in
8 it, and all kinds of stuff. It's high pH according to
9 the Los Alamos.

10 MEMBER KRESS: It's supposed to be high pH
11 to control the iodine problem.

12 CHAIRMAN WALLIS: That's right.

13 DR. LETELLIER: The inorganic zinc might
14 be a credible debris source where that should be
15 examined.

16 CHAIRMAN WALLIS: Well, I don't know. I
17 just assumed that if it's -- if it is a contributor to
18 the hydrogen source term, there must be quite a bit of
19 gas, because there are other contributors. I mean,
20 it's not negligible. It doesn't take much gas to
21 float a particle. Gas has no density at all relative
22 to the water. So, anyway, this should be there
23 somewhere it seems to me.

24 DR. LETELLIER: I think the focus of
25 hydrogen generation has been on hydrogen deflagration

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1 within containment where your exposed metallic
2 surfaces are impinged by sprays, and the bulk of those
3 metals are not submerged in the pool.

4 CHAIRMAN WALLIS: Well, they're zinc
5 aluminum paints, right?

6 DR. LETELLIER: That's true.

7 CHAIRMAN WALLIS: So they are part of the
8 debris. So I would really appreciate -- and there's
9 aluminum foil in -- crumpled up in this insulation
10 which gets transported, and all that, and it's not
11 something you can just dismiss.

12 The other thing that there was a comment
13 about that I didn't see on to very well was this
14 business of transient debris. It has been raised by
15 this committee, too, that plastic sheeting, duct tape,
16 and stuff, which happens to be there for maintenance
17 purposes or something, or someone left it there, is
18 simply dismissed as being not something you consider
19 because of risk. Somehow it's considered in the risk
20 analysis. It's not considered as relevant to the
21 screen blockage problem. Why is that?

22 DR. LETELLIER: No. In fact, it has been
23 considered and excluded based on transportability.
24 Under circulation --

25 CHAIRMAN WALLIS: That's not the argument

1 used by the staff in dismissing it, in dismissing the
2 public comment. Maybe there's a physical reason for
3 dismissing it. But they say it's all taken care of by
4 risk, so -- which seems to me very strange.

5 I have to find it now. Anyway, we can
6 find it. The transient debris public comment.

7 MR. CARUSO: I'm confused. You said that
8 the sheet material is not transportable?

9 DR. LETELLIER: Not during recirculation,
10 flows typical of recirculation phase.

11 MR. CARUSO: On page 2-1 of the knowledge
12 base, it says, "Transportable sheet-like materials,
13 numerous miscellaneous, relatively transportable
14 materials were found that could essentially behave
15 like a solid sheet of material when they're on a
16 strainer screen." Plastic cloth, duct tape, oil
17 cloth, all this -- I don't understand. Are you saying
18 that this is not transportable?

19 DR. LETELLIER: I hate to mince words.
20 But if you read the recommendation, it says if they
21 are present on the screen, they are of concern.

22 MR. CARUSO: Why are they listed under
23 "transportable," then? There's another category which
24 is relatively non-transportable.

25 DR. LETELLIER: There are debris types

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1 that should be considered. And based on your
2 assessment of the fill-up phase, it would be possible
3 to transport that material to the sump, if, for
4 example, the sump represented a very large recessed
5 volume compared to any other location in the facility.

6 Then, the flows would be preferentially
7 directed towards the screen at a high enough velocity
8 to transport those materials.

9 MR. CARUSO: This is a pretty simple
10 question, though. You said that they are not
11 transportable, but you've got a document here which
12 says -- which has two categories -- transportable
13 sheet-like materials and relatively non-transportable
14 materials. And non-transportable is hammers, bolts,
15 nuts, stuff that I would expect is non-transportable.

16 But then you have a category that's called
17 specifically transportable, and it includes all the
18 stuff that Dr. Wallis is concerned about. Is it
19 transportable, or is it not transportable?

20 DR. LETELLIER: It depends on the velocity
21 regime that you're considering.

22 CHAIRMAN WALLIS: Well, I guess I'm not
23 concerned about it. It's NEI that's concerned about
24 it, because their public comment says the guidance
25 does not address transient debris sources. Personnel

1 perform work within containment, so on and so on.

2 And then, the resolution is dismissal of
3 transient debris sources would be based on risk
4 aspects which have not been otherwise included in the
5 Guide. So they are being dismissed on the basis of
6 risk.

7 DR. LETELLIER: Well, again, I think we
8 should look at the word --

9 CHAIRMAN WALLIS: Physically.

10 DR. LETELLIER: What you read means that
11 if you choose to dismiss these debris, you must have
12 a risk argument to go along with it. I don't think
13 that it implies that those debris have been dismissed
14 with the --

15 CHAIRMAN WALLIS: Well, does it say that?
16 Does the Guide say that? It just says "disagree."
17 The Guide doesn't seem to address the question at all
18 of transient debris sources.

19 DR. LETELLIER: Which question number is
20 that, by the way?

21 CHAIRMAN WALLIS: It's NEI comment
22 number 3.

23 DR. CHANG: I believe in the record we
24 address those things should be considered as to debris
25 -- let me find it.

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1 CHAIRMAN WALLIS: Well, it's something
2 that we're going to need to look at and resolve. I
3 don't think we can spend the time on it now.

4 DR. CHANG: I'll try to find it later.

5 CHAIRMAN WALLIS: I really would
6 appreciate it, some analysis of the hydrogen
7 generation. Even if it's a very small amount, as my
8 colleague says here, then it has to be a very small
9 amount. It's not going to be able to lift up some of
10 these fragments of zinc and aluminum paint.

11 DR. CHANG: On this chemical reaction
12 issue, the comment is that there is no -- there seems
13 to be no publication out there that NRC published
14 reports of study or cited available references. Our
15 answer is that we acknowledge there are no NRC
16 published references pertinent to this issue that can
17 be cited in the Reg. Guide.

18 CHAIRMAN WALLIS: So what I'm looking for
19 is a more thorough statement of, what are these
20 chemical reactions in the pool? Other than just
21 debris-generated, what is their effect on the debris?
22 Not just new debris generated by them.

23 If we have time, Bruce has some slides on
24 the chemical testing, the initial results we have
25 obtained. So we can go them in a little bit.

1 CHAIRMAN WALLIS: If we have time at the
2 end. I think we're going to run over time anyway, but
3 we -- we probably -- we kind of thought we might
4 anyway. It's an important issue, and we don't have
5 enough time. But we don't have to have a very long
6 discussion at the end probably, so I expect we can
7 adjourn before lunch.

8 MR. CARUSO: Before you go to the next
9 comment, can I ask a -- this is a naive question about
10 zone of influence. It looks like you only consider
11 double-ended breaks. You don't consider split breaks.
12 Has anyone looked at split breaks at all, zone of
13 influence for split breaks?

14 DR. LETELLIER: There are correlations
15 available based on the length or the extent of the
16 pressure contour normalized by the orifice diameter.
17 And that would be an appropriate set of data and
18 information to use if you chose to postulate a conical
19 break, like from a fish-mouth orifice.

20 And, in fact, the NEI is faced with making
21 that choice when they propose a postulated break size
22 based on fracture mechanics. In fact, they have a
23 one-sided jet, and not opposing conical jets that lead
24 to a sphere.

25 MR. CARUSO: So they just idealize the

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1 fish-mouth, the split break, into a hole of a certain
2 size.

3 DR. LETELLIER: Yes. Now, keep in mind
4 that the generalization of a --

5 MR. CARUSO: You can do a round hole of a
6 particular size.

7 DR. LETELLIER: That's what I mean.

8 MR. CARUSO: And they don't take into
9 account the geometric effect of a long break as
10 opposed to a round break.

11 DR. LETELLIER: I believe that's correct.
12 Keep in mind they're trying to establish a compromise
13 between the leak before break, which is essentially a
14 zero damage zone, no appreciable pressure release all
15 the way up to the double-ended guillotine. And so
16 they're looking for a middle ground.

17 Now, one other point of clarification, the
18 spherical zone is an assumption for convenience,
19 because we don't have predictive models for jet
20 deflections and recollections.

21 MR. CARUSO: I was just curious.

22 DR. CHANG: And also, in the workshop in
23 July, I heard that if they consider using the fracture
24 mechanics and considered like it's a hole on the pipe
25 and stuff like double-ended guillotine break, then

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1 they use the hemispherical zone -- use a hemispherical
2 zone.

3 MR. CARUSO: Okay.

4 MEMBER KRESS: You're taking the jet cone
5 and finding the pressure that would cause damage to a
6 particular kind of debris out to a certain distance,
7 and that has a volume. And then, my understanding is
8 you're going to make the same volume in a sphere
9 around the pie?

10 DR. LETELLIER: That's correct.

11 MEMBER KRESS: That really seems strange
12 to me. I think -- I could go from no -- lots of
13 debris to no debris with that, because you're
14 shrinking the distance of an influence when you do
15 that.

16 And it seems to me like a more
17 conservative approach would take that distance of the
18 jet influence and draw a sphere at the end of that
19 around the thing, which is a much bigger volume. And
20 that really strikes me as a hokey thing, and it's --

21 CHAIRMAN WALLIS: But it's the basis of
22 the whole model of generation of debris.

23 MEMBER KRESS: Yes. And I'm really
24 surprised that we got this one through.

25 DR. LETELLIER: Keep in mind that the

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1 spherical approximation for a large break LOCA
2 generates a sphere that's over -- between 30 and 40
3 percent of the containment volume. So even under our
4 current --

5 (Laughter.)

6 MEMBER KRESS: That's a lot.

7 DR. LETELLIER: It is. So if you did what
8 you propose and take the maximum radius --

9 MEMBER ROSEN: It would be everything.

10 DR. LETELLIER: -- you would always --

11 MEMBER KRESS: Yes. Well, I could see
12 that would be an issue.

13 MR. CARUSO: I mean, I have a very clever
14 garden hose that allows me to dial in different
15 destruction jets. Okay?

16 (Laughter.)

17 And I can get very different destructive
18 events, depending on how -- what setting I've got it.
19 Either, you know, a good, solid stream -- it even has
20 this wide flat setting that you can use. And if
21 you're an insect, it matters, you know, whether --

22 (Laughter.)

23 -- I have it aimed very carefully, or
24 whether I've got it set on wide destruction.

25 MR. HSIA: That's why our resident

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1 inspector makes sure they don't have a garden hose
2 like yours in the containment.

3 (Laughter.)

4 CHAIRMAN WALLIS: No. But the pipe may
5 have a slit or a hole or -- just like his garden hose.

6 MR. CARUSO: That's why I asked the
7 question. But we don't consider that. We just
8 consider one round hole, and we vary the size.

9 CHAIRMAN WALLIS: Ralph?

10 MR. ARCHITZEL: I just want to make one
11 comment on chemical before you move on. I did want to
12 raise an issue -- it was raised at the workshop -- and
13 that is basically that there's a certain amount of --
14 if you do get a chance to hear it, you may want to
15 listen to it. But the industry was concerned about
16 not moving forward until there's more knowledge in
17 this area, because they don't know how to address the
18 issue.

19 So there is a question about timing and
20 resolution of the whole issue associated with chemical
21 precipitation. So you may not need to get into it
22 today, but I'm just pointing out that the industry is
23 concerned and we had indications that until there's
24 more known there's nothing being done to fix this
25 problem.

1 CHAIRMAN WALLIS: And it's not just
2 precipitation. It's --

3 MEMBER ROSEN: Well, the implication is if
4 we can find something that we don't know something
5 about, we can delay doing anything forever.

6 MEMBER FORD: Do we know if industry is
7 moving forward? You say that industry isn't moving
8 forward, or they want --

9 MR. ARCHITZEL: Well, we have a meeting
10 coming up; we're going to talk to them about it. But
11 the fact is that even our Office of Research isn't
12 taking what's been done any further, so that you can't
13 take what's been done and translate that at the moment
14 into how you do, you know, these complicated analyses,
15 how you factor the precipitation in.

16 MEMBER ROSEN: Let me just be a little
17 more clear, Ralph. This one ACRS member is not
18 comfortable with the idea that all we need to do is
19 find someone who can ask a question that no one knows
20 an answer to about this, and then we won't have to do
21 anything until that question is answered. I'm simply
22 not -- that is not an acceptable way to work on this
23 problem.

24 MEMBER FORD: I didn't quite hear your
25 answer to my question, which relates to what Steve is

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1 saying. Is EPRI being proactive on this, and trying
2 to fill in some of the gaps that -- the quantity of
3 gaps in our knowledge?

4 MR. ARCHITZEL: This is a new issue. I
5 think we've got a meeting scheduled with NEI in
6 September, early September, to try and see --

7 MEMBER FORD: Well, this is --

8 MR. ARCHITZEL: -- will they do some
9 research, if we don't, because you need to tie the end
10 of this together. They may be. I think they will be.
11 I'm not sure they're not.

12 MEMBER FORD: Do they not feel as though
13 it's a high priority item? This has been going on a
14 long time now. They don't see that as a high priority
15 item?

16 MR. ARCHITZEL: This particular issue --
17 chemical precipitation -- is a new twist, something
18 that people didn't know about.

19 MEMBER FORD: Okay.

20 MR. ARCHITZEL: So they're just being
21 presented with this now as well. It wasn't out there
22 before.

23 CHAIRMAN WALLIS: Please present them with
24 the whole question of all the effects of chemical
25 reaction, not just precipitation.

1 MR. HSIA: Tony Hsia from Research. We
2 have been undertaking research on chemical reaction
3 and effective chemical reaction on debris. T.Y.
4 was --

5 CHAIRMAN WALLIS: Well, let me ask you --
6 when you have this borated cooler, and you pour in the
7 sodium hydroxide --

8 DR. LETELLIER: Sodium hydroxide is
9 present in --

10 CHAIRMAN WALLIS: -- it makes sodium
11 borate, or something like that? What do you make?
12 You must make something like sodium borate? What is
13 that?

14 DR. LETELLIER: Sodium hydroxide is
15 present in the reactor coolant as a pH buffer,
16 essentially.

17 CHAIRMAN WALLIS: Well, I'm surprised that
18 you're going to go to a high pH in the pool. It's
19 just because of the iodins, or additional NaOH must be
20 poured in presumably.

21 MEMBER ROSEN: There is during --

22 CHAIRMAN WALLIS: To get the high pH -- in
23 other words, you have a low pH from the boron.

24 DR. LETELLIER: Yes.

25 MEMBER ROSEN: There's also lithium.

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1 DR. LETELLIER: That's right. And the
2 lithium is --

3 CHAIRMAN WALLIS: And all of these things
4 interact in some way in the pool and make things which
5 do things, make it slimy or gooey or something. All
6 of this affects the quality of the precipitate of the
7 stuff which is going to get on the screen.

8 DR. LETELLIER: That's correct. And we
9 are looking at that, and we would be happy to share
10 some of --

11 MR. HSIA: If you could indulge us to go
12 through the presentation, at the end Bruce had some
13 updated information he would like to share with you.

14 CHAIRMAN WALLIS: Okay.

15 MR. HSIA: And I fully agree with Dr.
16 Rosen. I think at this stage we need to move forward
17 with the best knowledge we can, instead of sitting
18 until we solve every single issue, although they
19 important. That's not the right approach from --

20 CHAIRMAN WALLIS: Well, you can resolve it
21 by being very conservative, I think.

22 MR. HSIA: Correct.

23 CHAIRMAN WALLIS: But that might have some
24 real implications for many plants.

25 MR. HSIA: Correct. Correct.

1 MEMBER ROSEN: We already have real
2 implications for many plants. We have a question on
3 whether or not we are going to succeed in long-term
4 cooling. That's a significant issue.

5 CHAIRMAN WALLIS: Which is the last
6 comment. Maybe we can move on to the ACRS comment
7 period.

8 DR. CHANG: Yes. ACRS, in their letter
9 after the last February meeting, ACRS asked a question
10 that -- because of the susceptibility of sump to
11 debris blockage, other alternative solutions should be
12 looked into to ensure long-term cooling. And the
13 staff was asked to invite the public comments on this
14 issue, and we didn't get any comment from the public
15 on this.

16 MEMBER ROSEN: The silence was astounding.

17 CHAIRMAN WALLIS: And actually, it's
18 C.1.2. It's not C.1.1.4. It's C.1.2 -- in my copy of
19 the Guide anyway.

20 DR. CHANG: C.1.1.4 is about the active
21 sump screen system. So we added that to indicate --

22 CHAIRMAN WALLIS: This isn't in response
23 to our comments. C.1.2 is in response to --

24 DR. CHANG: C.1.1.2 --

25 CHAIRMAN WALLIS: This was supposed to be

1 a serious comment, and we think this is a problem. It
2 just may not be resolved by analysis of debris
3 transport and all that stuff. It may require that you
4 ensure long-term cooling if the strainers are blocked.

5 DR. CHANG: Yes. But, again, Bruce has
6 some ideas he wants to share with us --

7 CHAIRMAN WALLIS: We felt this is a very
8 serious --

9 DR. CHANG: -- about this issue. He has
10 some slides. Actually, I think you had a handout.
11 You had -- you have two handouts. The other one is on
12 these alternative solutions.

13 DR. LETELLIER: At this point, there is no
14 substantial information on alternative solutions that
15 we could actually put into the Reg. Guide as
16 beneficial guidance.

17 DR. CHANG: Just some ideas I guess.

18 MEMBER ROSEN: Didn't we see one sitting
19 on the floor there at the workshop? I mean, a self-
20 cleaning strainer.

21 DR. LETELLIER: Yes.

22 MEMBER ROSEN: I don't understand your
23 point that there are no alternative solutions when one
24 was being offered by a vendor.

25 CHAIRMAN WALLIS: Wasn't that the point of

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1 that -- I mean, the ACRS comment was that you might
2 have to get water from somewhere else. Wasn't that
3 really our point?

4 MEMBER ROSEN: Well, yes. But we're
5 flexible enough to realize that maybe even we couldn't
6 perceive an alternative solution that somebody else
7 could. Even us. Even us.

8 MR. HSIA: But with the leadership
9 provided by ACRS members, we would like to say that
10 our position is we, like Bruce will do later on, we
11 will present some alternative suggestions. But it's
12 really up to the licensee is what -- you know, they
13 have dollars involved. We can be sitting here coming
14 up with very creative fixes, but from an economic
15 point of view they need to cover safety as well as
16 their checkbooks.

17 DR. CHANG: Regarding the alternative
18 water sources, this is in the Reg. Guide. They can
19 consider alternative water sources as another
20 alternative, if they have the procedure and the
21 training of the operator, and so forth.

22 CHAIRMAN WALLIS: I think we might move on
23 to the next topic. And I suggest since we're over
24 time -- but I think we're asking questions we would
25 otherwise have asked later in the day, so we may catch

1 up. T.Y. has part of this next presentation.

2 DR. CHANG: Right. It's going to be a
3 tag-team approach.

4 CHAIRMAN WALLIS: If you give your part,
5 and then we have a break before we hear from --

6 DR. CHANG: It's an alternative. I'll
7 give my part, and then Bruce will chip in. So that's
8 the setup.

9 CHAIRMAN WALLIS: I don't think we have
10 time to go through the whole thing before the break.
11 But if you can give your part of it --

12 DR. CHANG: The first --

13 CHAIRMAN WALLIS: -- then break at a time
14 before Bruce comes in and talks about all the
15 technical matters, then perhaps we can get in the
16 break.

17 DR. LETELLIER: We intend to address these
18 topics. There are about five separate issues.

19 CHAIRMAN WALLIS: But it will take quite
20 a long time, won't it?

21 DR. LETELLIER: It will. We could do the
22 first one, as a suggestion.

23 DR. CHANG: So maybe we -- let's take the
24 break now and --

25 CHAIRMAN WALLIS: Take the break now? If

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1 that's what you'd like to do. It's a good break
2 point.

3 MEMBER ROSEN: It's only five minutes
4 before we're scheduled anyhow, so --

5 CHAIRMAN WALLIS: Okay. And then we'll
6 try to catch up. But I think we may have to go after
7 12:00 noon. Just delay lunch. So you've got an
8 incentive to speed up.

9 Okay. So we'll take a break until 10:25.

10 (Whereupon, the proceedings in the
11 foregoing matter went off the record at
12 10:10 a.m. and went back on the record at
13 10:29 a.m.)

14 CHAIRMAN WALLIS: We are on the next
15 section.

16 DR. CHANG: Shall I proceed?

17 CHAIRMAN WALLIS: Yes, please.

18 DR. CHANG: The next topic is a summary of
19 our positions in the Reg. Guide, positions and
20 acceptable methods, and also a discussion from Bruce
21 about how those things can be applied in a real plant.

22 We look at the excellent sequences and it
23 consists of the following: debris sources of
24 generation, then after that you have the debris
25 transport. That includes three types of debris

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1 transport -- the airborne, right after the blowdown,
2 the pipe radiant blowdown, debris is generated, and it
3 can be blown to the containment, and so forth. So
4 this is the airborne debris transport phase.

5 Then, after the containment spray is
6 turned on, you have washdown debris transport phase.
7 And the sump pool debris transport is on the floor of
8 the containment. You have the flow of all the liquid
9 there, and we have to look at the debris transport in
10 that area, too.

11 Then, we have a special slide on the sump
12 pool debris transport, and then, lastly, is the
13 collection of all the debris on the screen and what is
14 the head loss because of that.

15 Next slide, please.

16 Under the debris sources and generation,
17 consistent with the requirements of 10 CFR 50.46, we
18 have the same words, actually. It says that a number
19 of LOCAs of different sizes and locations should be
20 postulated to provide assurance that the most severe
21 postulated LOCAs are calculated. We've added a few
22 words there for the regeneration calculations.

23 The original words in 50.46 is for the
24 ECCS cooling and performance calculation. So our
25 thinking is that for consideration of debris

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1 generation you have to be as severe. You have to
2 consider the most severe postulated LOCAs.

3 And the second bullet is that when we talk
4 about severity, the level of severity should
5 correspond to the postulated break based on potential
6 head loss incurred across the sump pump.

7 So, actually, this is sort of like -- I
8 think Bruce used the word "break to block." You have
9 to consider the block effect to predict where you have
10 to consider the break.

11 Then, zone of influence is one of the
12 methods that can be used to estimate the amount of
13 debris generation by a postulated LOCA.

14 MEMBER KRESS: Now, let me ask you about
15 the first bullet. In Appendix K for ECCS LOCA, they
16 look at the pipe size in postulated, double-ended
17 break here. And the way they vary the pipe size is
18 they look at different pipes that are in the thing,
19 and then -- and break each one of them.

20 Now, the question that I have about that
21 is, you have a combination, then, of location and pipe
22 size, which determines the severity of the break, and
23 then what is around that particular location.

24 What's to prevent a big pipe in a given
25 location from having smaller breaks? And is there --

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1 if a pipe is a certain size, is the double-ended
2 guillotine break the most severe for that pipe? So
3 you don't have to worry about smaller breaks in that
4 pipe.

5 You could do the same thing with -- that
6 they do in Appendix K and just look at different pipes
7 that exist in different locations?

8 DR. LETELLIER: That's the common
9 practice, to assume that double-ended guillotine break
10 represents the maximum orifice that can be created in
11 a given pipe, and implicitly assume that that is the
12 maximum damage that could be created also.

13 You don't need to consider small breaks in
14 large pipes unless you need to do a risk analysis
15 where that may dominate the proportion of events.

16 MEMBER KRESS: Okay.

17 DR. CHANG: And also, we don't limit
18 ourselves to LOCAs only. If a plant -- the
19 recirculation is needed for a high energy line break,
20 such as main steam or feedwater, then those high
21 energy line breaks should be considered as well. And
22 the most limiting conditions for sump operation should
23 be considered.

24 And, lastly, all potential debris sources
25 should be considered within a particular ZOI.

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1 CHAIRMAN WALLIS: That excludes any
2 sources anywhere else, such as this floatable plastic
3 sheet.

4 MEMBER ROSEN: Well, that's for the zone
5 of influence from the break. But the floatable
6 plastic sheet could be someplace else and floated down
7 by washdown, by one of the other mechanisms.

8 CHAIRMAN WALLIS: Is that considered?

9 DR. CHANG: Yes. And when you have latent
10 debris and all that --

11 CHAIRMAN WALLIS: So all that as well.
12 Okay.

13 DR. CHANG: Yes.

14 CHAIRMAN WALLIS: I'm sorry. Because I
15 thought it just meant it should be considered only
16 within the ZOI.

17 MEMBER ROSEN: No, no, no.

18 CHAIRMAN WALLIS: Oh, okay.

19 DR. LETELLIER: These are some of the
20 highlights out of the Reg. Guide. We couldn't address
21 every portion.

22 DR. CHANG: And the next slide, please.

23 Continuation of debris source and sources
24 and generation. In the Reg. Guide was the position
25 that as a minimum those break locations should be

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1 considered. Perhaps the coolant system -- or main
2 steam and main feedwater, if needed -- with the
3 largest amount of potential debris within the
4 postulated ZOI.

5 And the next one is large breaks with two
6 or more different types of debris within the expected
7 ZOI. Breaks in the areas with the most direct path to
8 the sump. I think that's obvious.

9 And then, the last two -- I think they are
10 interrelated. It's about the thin bed effect. So the
11 break with the largest potential particulate to the
12 insulation ratio by weight should be considered.

13 DR. LETELLIER: Now, the next slide tries
14 to address or introduce you to the acceptable methods.
15 Now, we talked about a number of these back in the
16 February subcommittee meeting where I went through a
17 rather exhaustive survey of each phase of the accident
18 sequence. But I felt that it was necessary to -- or
19 useful to reemphasize some points that T.Y. has made.

20 In order to assess so many different
21 suggested break locations, some sort of spatial model
22 or drawings, information about your plant, is
23 essential. And, in fact, at the workshop we saw where
24 the plants are making progress at reconstructing that
25 information where it did not exist before. Some

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1 plants already have three-dimensional CAD inventories
2 of their insulation and piping systems.

3 The methodology that they choose for
4 assessing the various locations is entirely up to
5 them. There is always the conservative approach of
6 100 percent damage, if that's a tenable solution.
7 Otherwise, some sort of mechanized, systematic survey
8 may be necessary.

9 Essentially, we're interested in
10 postulated breaks in all systems that lead to a
11 recirculation requirement. That is the scope of
12 GSI-191, long-term cooling. And so main steam line
13 breaks, for example, or steam tube ruptures can lead
14 to a requirement for recirculation in some plants.

15 The third bullet -- having a definition of
16 break severity that's defined in terms of a potential
17 head loss, that implies a break to blockage transport
18 analysis, even if it's done only crudely with
19 transport fractions -- 50 percent, 70 percent.

20 You have to be able to assess the impact
21 of a postulated break on the eventual head loss.
22 That's the reason, for example, that pipe size alone,
23 as defined for the purpose of cooling capacity, is not
24 the single criteria.

25 CHAIRMAN WALLIS: So that means that if

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1 you have, say, a big pipe, you consider different
2 places where it might break, and you consider if it
3 broke here, there's more debris in that area, although
4 it's got a zone of influence that's humongous no
5 matter where it is. But it would be worse to have it
6 here from the point of view of dislodging stuff.

7 DR. LETELLIER: For small breaks, that's
8 more likely to happen, because the zone of influence
9 is smaller. And in some plants, we've noticed that
10 there is more small piping in the vicinity of problem
11 debris, for example. That's the rationale that we use
12 to add the words for maximum number of debris types,
13 for example.

14 As far as acceptable methods go, we've
15 mentioned the 100 percent criterion, and that's always
16 an option that we won't dwell on. However, there is
17 a precedent in both NUREG-6224, which was the
18 cornerstone document for the BWR resolution.

19 It sets a precedent for a point-by-point
20 break analysis, where we proceed systematically
21 through all of the piping systems and examine many
22 hundreds of potential breaks. That is a method that's
23 familiar to the staff and would be deemed acceptable.

24 Now, that's not to say that this is a
25 requirement for every plant. The spatial details may

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1 be simplified, for example, by considering the plant-
2 specific insulation applications -- predominantly, RMI
3 plants, reflective metallic, may not have to do as
4 exhaustive a search for break locations. They may
5 focus primarily on the areas that include the fibrous
6 material, some residual material. And there's a wide
7 variety of plant configurations.

8 The next slide, 23, points you to some
9 specific references to address the panel's interest in
10 peer review. I think you've got the impression that
11 we have shared our research findings with industry in
12 a participatory fashion for many, many years, both at
13 the local and international levels.

14 It's very difficult to point to examples
15 where a formal peer panel was convened in a formal
16 process. But there have been a number of important
17 opportunities for critique and criticism, and they're
18 listed here.

19 For debris source references, there was an
20 early survey of insulation types used done in 1981.
21 More recently, in response to Generic Letter 97-04,
22 the NEI conducted a plant-wide survey that compiled a
23 list of industry responses to specific questions asked
24 by the staff.

25 And the knowledge base reference will come

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1 up repeatedly as a blanket document. It's the most
2 recent compilation of research findings that has been
3 subject to international critique. And, again, we
4 could look at the comment resolution history and make
5 a judgment whether that was adequate in the
6 committee's opinion. But, in fact, it was open to
7 everyone's input.

8 CHAIRMAN WALLIS: It seems to me that the
9 regulatory process cannot be independent of the
10 knowledge base. If the knowledge base is very
11 precise, you have a certain kind of regulatory
12 process. If the knowledge base is extraordinarily
13 vague, then you're going to have a different
14 appropriate regulatory process.

15 I think one of the things that concerned
16 me was that the -- there seemed to be -- these didn't
17 seem to be the right -- didn't seem to have the right
18 connection. The Guide is asking for all kinds of
19 calculations. The knowledge base doesn't let you do
20 it.

21 If the Guide was more acknowledging that
22 you couldn't do things, and said that you should
23 assume other things, then they might fit together
24 better. I think that's a concern I have.

25 DR. CHANG: The attempt here is trying to

1 establish the link as far as we can in this
2 presentation.

3 MEMBER FORD: But following up on Graham's
4 comment -- this is really a tag-team act here -- this
5 is an excellent source for the utility to go away and
6 find out, well, what sort of debris sources should
7 they be worried about?

8 But practically, surely the debris source
9 that they should be worried about for their specific
10 plant will depend on details of the break, type of --
11 whether it's spherical or what sort of break it is, if
12 it depends on the various transport mechanisms for the
13 specific debris.

14 So you just can't take this by itself. Is
15 that a true statement? And so this knowledge is not
16 enough --

17 DR. LETELLIER: Debris source is --

18 MEMBER FORD: -- to satisfy some of the
19 requirements in your Regulatory Guide.

20 DR. LETELLIER: That is correct. And
21 that's why I emphasized the philosophy of a break to
22 blockage analysis. You have to integrate all steps,
23 all phases of the accident sequence before you can
24 decide whether you've found the most conservative or
25 the bounding event.

1 MEMBER FORD: But I don't see the -- in
2 your report here, knowledge base report, you talk
3 about quite specific -- this, then this, and then
4 this. They're not tied together. Is that true? Is
5 that a true --

6 DR. LETELLIER: That's a fair observation.
7 Now, the document that will come up here shortly,
8 NUREG-6224 represented an integrated analysis of a BWR
9 vulnerability assessment. That's the best template
10 that we have for the end-to-end consideration of
11 effects.

12 There has been an ongoing project in the
13 NRC to conduct a volunteer plan assessment that would
14 have provided a very similar example of how to apply
15 the integrated assessment. Various priorities have
16 pushed that aside for the moment. But I'd have to say
17 that even the volunteer plan assessment relied very
18 heavily on 6224, and that is available.

19 MEMBER FORD: Now, why aren't the
20 utilities doing all of this work?

21 DR. LETELLIER: Ultimately, they will.
22 Ultimately, each utility will have to conduct a
23 similar assessment.

24 MEMBER FORD: I'm talking about the
25 utilities as an industry, as a conglomerate. This is

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1 a generic problem. So why aren't the utilities --

2 DR. CHANG: Well, they are trying to come
3 up with utility guidelines through the NEI. So
4 there's a general document that -- I think they are
5 talking about at the end of September, will they have
6 that document ready for us to review.

7 MEMBER FORD: And the information is
8 there, so they can come up with an integral --
9 integrated approach to this?

10 DR. CHANG: Hopefully.

11 DR. LETELLIER: Their guidance will be
12 based heavily on the knowledge base and what's
13 available in the literature. I guess maybe a personal
14 concern is that the knowledge base is not
15 comprehensive. It does not address all of the
16 materials of potential concern.

17 MR. ARCHITZEL: We'd like to point out
18 that even though we're going to get that schedule now
19 in September, we have had ground rule documents over
20 the last four or five months on some of the areas. So
21 they have been doing something. They've given us some
22 high-level type information as to how they plan to
23 address this. So it's not like they're just starting
24 this month. They --

25 MEMBER FORD: Okay.

1 MR. ARCHITZEL: They have been looking
2 into it.

3 DR. LETELLIER: So let's go on to the
4 associated consideration. The zone of influence --
5 and we've already talked a bit about this. Maybe I
6 should simply ask for questions to clarify our
7 assumptions of the spherical zone of influence.

8 Keep in mind that it is dependent -- the
9 correlations are dependent on the break size, and the
10 damage pressure of the debris type you're interested
11 in.

12 CHAIRMAN WALLIS: Well, let's see. This
13 is a model. Have there been tests that show that
14 using a spherical zone of influence with the sorts of
15 piping you might get and the sorts of pressures you
16 might get and the scales you might get actually work
17 reasonably well?

18 DR. LETELLIER: There have been some tests
19 with double-ended guillotine, with no offset, with
20 complete separation but no offset, that show that
21 opposing cones tend to deflect in a roughly spherical
22 manner.

23 And the argument perhaps more appropriate
24 for the BWRs is there is so much piping congestion
25 that the random deflections will lead to a zone

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1 roughly like a sphere. It's an assumption made for
2 convenience. It does not account for the loss of
3 energy during redirection of the jet. It essentially
4 maps the pressure contour from a free jet expansion
5 into an equivalent volume sphere.

6 CHAIRMAN WALLIS: Why isn't the pressure
7 everywhere -- stagnation pressure, bring it to rest?

8 DR. LETELLIER: These are the stagnation
9 pressures that would occur against a blockage.

10 CHAIRMAN WALLIS: So it must -- there must
11 be some dissipation or something of energy out there.
12 If you typically take a flow coming out of a pipe
13 isentropically, and then bring it back to rest again,
14 it goes back to the pressure it started at. So
15 something must happen to disperse it.

16 DR. LETELLIER: I'm not sure that I
17 understand the question. You're talking about free
18 field expansion and --

19 CHAIRMAN WALLIS: Well, if I take my
20 colleague's garden hose with a pressure of 40 psi, or
21 50 psi, let's say, g, and I direct it at a wall, I get
22 50 psig on the wall, unless there's some kind of
23 losses in the flow.

24 DR. LETELLIER: These are freely expanding
25 gases that are expanding into a lower pressure.

1 CHAIRMAN WALLIS: Yes. But then, when you
2 compress them again, they go back to where they
3 started from, unless there's some dissipative
4 mechanisms.

5 DR. LETELLIER: Well, the dissipative
6 mechanism is partly geometric as you expand.

7 CHAIRMAN WALLIS: Well, I don't think that
8 works out, though.

9 MEMBER KRESS: I don't think you expand
10 isometrically.

11 CHAIRMAN WALLIS: I said it's isentropic.

12 MEMBER KRESS: Yes, it's isentropic.

13 CHAIRMAN WALLIS: There must be some
14 losses there.

15 DR. LETELLIER: Yes. You can't expand
16 isentropically.

17 CHAIRMAN WALLIS: Why not?

18 MEMBER KRESS: Somewhere in between the
19 two.

20 DR. LETELLIER: The damage pressures were
21 actually based on test data where they had witness
22 objects positioned at various points in the jet, so
23 that the damage pressures could be correlated to some
24 of the ANSI and ANS jet models at the -- under
25 acceptable methods at the bottom of this slide, it

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1 lists some of the tools that are available.

2 For example, the industry is interested in
3 redirecting the jet to -- I guess to alleviate the
4 limitation that we're ignoring concrete barriers
5 essentially. There is no jet deflection, no
6 truncation due to walls.

7 But what they would like to attempt is to
8 remap the equivalent pressure volume into the
9 compartments where the break occurs. And to do that,
10 they will need access to tools like the ANSI/ANS
11 model.

12 MEMBER RANSOM: What kind of tool did you
13 say?

14 DR. LETELLIER: There are models available
15 for free jet expansion.

16 MEMBER RANSOM: Free supersonic?

17 DR. LETELLIER: Right. To look at the
18 shockwave generation. Two of those are mentioned by
19 -- reference ANS in the EPRI jet model.

20 MEMBER RANSOM: I guess one of my comments
21 would be the -- you know, a free jet even is very non-
22 uniform in terms of the -- it doesn't have spherical
23 profiles in it. And it actually has shocks in it
24 caused by the ambient pressure and compression on the
25 boundary.

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1 And I'm wondering if actually a better
2 model for the damage is the dynamic pressure, one-half
3 fluid density squared, which varies somewhat from the
4 stagnation pressure. But generally, it's, you know,
5 what dictates drag and --

6 CHAIRMAN WALLIS: Does he know what he's
7 talking about?

8 MEMBER RANSOM: It's something close to
9 the stagnation pressure --

10 CHAIRMAN WALLIS: I think he's talking
11 about the -- that the pressure you measure is the --
12 bringing this stuff to rest on a wall or something.

13 MEMBER RANSOM: Well, it's just the
14 stagnation pressure.

15 CHAIRMAN WALLIS: Well, it's --

16 MEMBER RANSOM: Minus whatever you get in
17 a shockwave basis.

18 DR. LETELLIER: I believe I'd have to do
19 some more homework to give a specific answer to your
20 question about the form of the model. I did want to
21 point out that the precedent for a spherical
22 destruction model was introduced very early, before
23 1985, as part of the USI-A43 resolution, where they
24 postulated zones from complete damage to partial
25 damage to zero damage.

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1 And as data have been added to the
2 knowledge base, this has been refined into a
3 correlation. Again, the correlations are based on
4 pressurized air surrogates for steam. And there were
5 limited tests done for GSI-191 looking at two-phase
6 jet expansion.

7 Unfortunately, the test data that was
8 obtained was not extensive in scope. It was performed
9 for a lower operating pressure and a smaller volume.
10 And so scaling arguments were invoked to compensate
11 for those differences, in order to adjust the assumed
12 damage pressure of each insulation type.

13 CHAIRMAN WALLIS: I'm trying to think
14 about the difference. If you have an explosion, and
15 you get something like an acoustic wave which goes
16 out, and that attenuates with area --

17 DR. LETELLIER: Right.

18 CHAIRMAN WALLIS: -- because it's not the
19 same stuff. I mean, it's a wave going through, and
20 the gas which is out here isn't the same as the gas
21 which was in here. But when you have a flow of stuff
22 coming out of a pipe, it goes out like a hose and it
23 hits something, and unless that flow of stuff loses
24 some mechanical energy on its way, it's going to have
25 the same energy it started with.

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1 DR. LETELLIER: Certainly, there are
2 mixing processes on the boundary of the wave that --

3 CHAIRMAN WALLIS: So I think the spherical
4 thing may well have originated from an analysis of
5 explosion.

6 DR. LETELLIER: The assumption of a
7 spherical zone is a practicality, just based on the
8 uncertainties of deflection in a congested piping
9 environment.

10 CHAIRMAN WALLIS: But if I'm a policeman
11 with a hose trying to control a crowd, I don't want a
12 spherical zone of influence. So, you know, you --
13 it's obviously a big assumption which -- and your
14 reply about the empirical evidence seemed to be that
15 for a certain kind of a break you could make -- map
16 pressures in some way. And it seemed that they were
17 roughly in a spherical pattern around the hole.

18 But did it show that if you used these
19 pressures for damage calculations, you got the right
20 answer, too? The synthesis of the spherical model
21 with the damage, showing that you've really got the
22 right pressure and damage with your model, other than
23 just the pressure itself.

24 DR. LETELLIER: I think there are many
25 acknowledged deficiencies to the assumption. But keep

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1 in mind that the purpose is to estimate or to
2 conservatively estimate the maximum --

3 CHAIRMAN WALLIS: Well, look at Barseback.
4 Barseback had a relief valve or something that popped,
5 sent out jets of steam. Was the damage in the
6 direction in which the jet went, or was it in the
7 sphere? There must be some evidence there. You saw
8 a description in your book here about all of these
9 events. Did anyone go in and say, "These events show
10 that there really was a spherical behavior," or not?

11 DR. LETELLIER: That's a very good
12 question.

13 CHAIRMAN WALLIS: Well, I mean, that's the
14 kind of question I have about all of this. There's
15 the description of things that happened, and then
16 there's somebody's thought model of what might have
17 been a good way to represent it. And what's the
18 connection?

19 MR. HSIA: Chairman Wallis, Tony Hsia from
20 Research. I believe that the -- one of the reasons we
21 proposed the spherical model as an alternative is to
22 take into consideration the conservatism, because if
23 you say the directional -- jet has a certain
24 direction, and hits an object, then the argument would
25 be, well, how do you know it's going to

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1 disorientation? How do you know it's not going to
2 start with the jet going to the 90 degrees from this?
3 So there's no end as far as which direction you should
4 point the jet at.

5 So in order to cover that, we felt the
6 spherical model -- as long as you have a break at that
7 location --

8 CHAIRMAN WALLIS: But we don't think it is
9 conservative, because the sphere attenuates.

10 MR. HSIA: So does the directional jet.

11 CHAIRMAN WALLIS: Yes, but not so much in
12 the direction in which it's going.

13 MR. HSIA: Well --

14 DR. LETELLIER: We have not accounted for
15 the attenuation of an actual spherical release. What
16 we've done is assumed the free jet expansion that does
17 have a characteristic pressure gradient, with no
18 deflection, and we've remapped the equivalent energy
19 into a sphere.

20 CHAIRMAN WALLIS: But if my obnoxious
21 grandson wants to spray his charming cousin with a
22 water jet, he aims the jet at the person. He doesn't
23 put out a spherical jet, which would be useless. It
24 would just be a gentle little mist and sort of around
25 -- it's different.

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1 MEMBER RANSOM: Let me try something and
2 see if I understand what they're doing. It may
3 explain your problem with this, too, Professor Wallis.

4 I think that, you know, the highest mark
5 numbers are found along the centerline of the jet in
6 a free jet. And those are the areas of highest
7 dynamic pressure. And, of course, as you pointed out,
8 the stagnation pressure is going to be constant along
9 that. So it's all equal to whatever it was in the
10 pipe.

11 Now, they have to assume a damage model,
12 and worse damage is going to occur along the
13 centerline of that jet. So I think what they've done
14 is they simply said, "Okay. We're just going to take
15 a hemisphere or a sphere and assume everything in that
16 area is going to be damaged all along the centerline
17 of the jet."

18 CHAIRMAN WALLIS: It doesn't, because they
19 attenuate the pressure. They don't --

20 MEMBER RANSOM: No, no, they don't.

21 DR. LETELLIER: No, we don't attenuate the
22 pressure.

23 CHAIRMAN WALLIS: You don't keep the
24 pressure all the way out to the --

25 MEMBER RANSOM: Well, they do not preserve

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1 continuity and assume the flows through the spherical
2 areas, I don't --

3 CHAIRMAN WALLIS: Well, they do, because
4 the zone of influence is bigger for certain things
5 than others. So there's a bigger pressure closer to
6 the hole than there is further away.

7 MEMBER RANSOM: There's a bigger pressure
8 where?

9 CHAIRMAN WALLIS: Closer to the break.
10 They have a sphere for radiative, reflective, metallic
11 insulation. We need the picture. And then, they have
12 a sphere for calcium silicate and a sphere for
13 fiberglass. This is because the pressures are getting
14 less as they go out from --

15 MEMBER RANSOM: Well, that would be true
16 of the static pressure, but not the stagnation
17 pressure.

18 CHAIRMAN WALLIS: Well, but that's I think
19 the question we have with us.

20 MEMBER RANSOM: Then they've got something
21 screwed up.

22 CHAIRMAN WALLIS: This is an acceptable
23 method.

24 DR. LETELLIER: The final point I'd like
25 to make -- your analogy about a directed jet being

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1 more effective. That depends very much on the
2 uniformity of your target. If you're concerned about
3 a point target at some distance away, the directed jet
4 is more effective.

5 But the compromise, the practical
6 compromise was made that debris targets in congested
7 piping system, they exist all around you. And that
8 it's an acceptable approximation to map a sphere to --

9 CHAIRMAN WALLIS: Well, is it? Because I
10 have the 15,000 cubic feet of fiber measured in the
11 air handling units. And normally they would be quite
12 a long way away from this hole, I think.

13 DR. LETELLIER: And, again --

14 CHAIRMAN WALLIS: But if I had a
15 directional jet aimed at an air handling unit, it
16 would presumably dislodge 1,000 cubic feet of fiber.

17 DR. LETELLIER: I don't think that the
18 data support that. Even stainless steel jacketed
19 fiberglass insulation can be quite robust.

20 CHAIRMAN WALLIS: Not against the
21 stagnation pressure of one of these jets -- 2,000 psi?

22 DR. LETELLIER: Yes.

23 CHAIRMAN WALLIS: Yes?

24 DR. LETELLIER: The damage pressure
25 changes from unprotected fiberglass damage pressure of

1 10 psi. You can achieve 140 psi damage pressure.

2 CHAIRMAN WALLIS: Well, I'm talking about
3 2,000, if we conserve the stagnation pressure, in the
4 extreme case of a directional jet.

5 MEMBER ROSEN: That's a strong jet. Get
6 hit by a 2,000 psi something, there isn't much
7 insulation that could stand up to that.

8 MEMBER SIEBER: Well, with the exception
9 of main steam and feedwater piping, most of the high
10 energy lines are in cubicles where there is a physical
11 boundary surrounding wherever the leak may be. And in
12 that cubicle will be things like reactor coolant
13 pumps, steam generators, other valves, other pieces of
14 piping, small bore lines.

15 And I would think that with all of these
16 obstacles in that small space that the assumption that
17 a single directed jet would -- just wouldn't fit
18 physically.

19 CHAIRMAN WALLIS: Old Faithful is a break
20 in the pipe. And it doesn't have a spherical pattern.

21 MEMBER SIEBER: It doesn't have a lid on
22 it either.

23 CHAIRMAN WALLIS: No. But you know it --

24 DR. LETELLIER: And it doesn't extend
25 indefinitely. There are dissipation processes that --

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1 CHAIRMAN WALLIS: No. But it's a focused
2 jet, and the attenuation of that jet is not anything
3 like as rapid as it is if you work it out from Surrey.

4 DR. LETELLIER: But keep in mind, again,
5 the damage pressures were based on free jet expansion
6 of experimental configurations where you had
7 pressurized air with a perforated nozzle, perforated
8 plate. And so those experiments do incorporate
9 realistic dissipation mechanisms, and we are not
10 taking credit for --

11 CHAIRMAN WALLIS: Was this pressurized
12 air?

13 DR. LETELLIER: It was indeed.

14 CHAIRMAN WALLIS: Because if it's water,
15 then it should keep going the direction it started in.

16 DR. LETELLIER: That's correct, and that's
17 the reason I pointed out the distinction between the
18 two-phase blowdown test. The database is quite
19 limited, but we do understand what some of the
20 discrepancies are. And we've tried to compensate
21 accordingly.

22 Next topic?

23 DR. CHANG: The next topic is about the
24 debris transport. In the Reg. Guide, we stated that
25 debris transport analyses should consider each type of

1 insulation and debris size. And the three types of
2 debris transport should be considered. They are
3 airborne, washdown, and sump pool debris transport.

4 And one conservative approach that is
5 acceptable to the staff is that instead of doing a
6 detailed analysis of those transports, one can simply
7 assume that all debris will be transported and
8 collected at the sump screen.

9 However, if all screens -- if all drains
10 leading to the sump could become blocked, or
11 eventually can be held up -- and that could happen in
12 conjunction with the debris on a screen -- then the
13 consequences could be worse than 100 percent debris
14 transport to the screen. And this scenario has to be
15 assessed as well.

16 So assuming all the debris are transported
17 to the screen may not be always the worst case.

18 CHAIRMAN WALLIS: This is where the
19 plastic sheet may come in, and blocking a drain it --
20 if it were close to the drain already, it might not
21 have to move very far.

22 MEMBER ROSEN: This is where you don't get
23 any water in the sump at all.

24 DR. CHANG: Right.

25 MEMBER ROSEN: Right, right. You just get

1 air into the pipe, right? Do you --

2 DR. CHANG: This is completely blocked.
3 The water level is very low.

4 MEMBER ROSEN: And the valves still get a
5 signal to open, and the pumps get a signal to start,
6 and all you get is air.

7 DR. LETELLIER: That's correct.

8 MEMBER ROSEN: Yes. Yes. That's what's
9 going to -- should be analyzed here, right? That air
10 ingestion?

11 CHAIRMAN WALLIS: Well, it doesn't cool
12 the reactor.

13 MEMBER ROSEN: No. It does worse than not
14 cool the reactor. It completely binds up the whole
15 safety system.

16 CHAIRMAN WALLIS: Well, I think you don't
17 want to inject air into a hot reactor anyway.

18 DR. LETELLIER: If you have no water in
19 the sump, but then you violated your NPSH margin, you
20 have no --

21 MEMBER ROSEN: Right. But I'm saying,
22 couldn't it be worse than that? I mean, now you've
23 got -- the analysis I assume you're asking for here is
24 if you get no water in the sump, what really happens?
25 Including air ingestion into the suction of the ECCS

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1 pumps.

2 CHAIRMAN WALLIS: Maybe the worst might be
3 the --

4 DR. CHANG: There's always some water in
5 the sump. But the sump level may be not as we
6 expected, because --

7 MEMBER ROSEN: There's always water in the
8 sump? How is that?

9 DR. CHANG: Because of the break --
10 flowdown of break flow, and now also containment
11 spray.

12 MEMBER ROSEN: Are you assuming here it's
13 all 100 percent blocked?

14 DR. CHANG: No. The block is the drain --
15 drain blockage.

16 MEMBER ROSEN: Okay. So you're going to
17 get water some other way.

18 DR. CHANG: Right.

19 MEMBER ROSEN: Not through the drains,
20 just washed --

21 MR. ARCHITZEL: I don't think we asked for
22 that to be analyzed, I'm pretty sure. Maybe you don't
23 understand the bullet correctly. You analyze it to
24 prevent it from happening. You don't -- we don't have
25 a design basis accident with the sump inoperable, so

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1 you need enough NPSH, and you fix it if you don't have
2 it.

3 But you don't sit there and analyze the
4 condition where you don't have NPSH, where you have no
5 water in the sump. That's not what we asked utilities
6 to do.

7 CHAIRMAN WALLIS: You just decree it can't
8 happen.

9 MR. ARCHITZEL: We asked them to make sure
10 to analyze it, so it can't happen.

11 DR. LETELLIER: We're using NPSH margin as
12 the threshold of concern. If you've lost margin, then
13 we effectively assume that you have no capacity for
14 long-term cooling.

15 MEMBER ROSEN: What does this statement in
16 the last bullet on the slide that the consequence
17 could be worse than 100 percent transport mean?

18 DR. LETELLIER: If, for example, that you
19 had a screen design that was capable of accommodating
20 100 percent of the debris -- of the insulation
21 inventory, with acceptable head loss across that bed,
22 it would be far worse if you had an alternative
23 condition that blocked all of the drainage paths and
24 prevented water from reaching --

25 CHAIRMAN WALLIS: And you have a dry sump.

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1 DR. LETELLIER: That's correct.

2 CHAIRMAN WALLIS: Right. And that's
3 something that is of concern.

4 MEMBER ROSEN: That's right. And so you
5 have the dry sump. Now I ask, what happens then? I
6 mean, is that a legal question?

7 DR. LETELLIER: If you have no water, you
8 have no margin. And so that's, in effect, a
9 regulatory failure. We're not concerned about the
10 consequences or the progression of that event.

11 MEMBER ROSEN: Okay. So it gets worse,
12 but you don't -- you already lost the game 56 to
13 nothing.

14 DR. LETELLIER: That's right.

15 MEMBER ROSEN: So why do you care if you
16 lose it 65 to nothing?

17 DR. LETELLIER: That may be a legitimate
18 concern for recovery of mitigation options, but not
19 for the purpose of regulatory guidance.

20 MEMBER ROSEN: Okay.

21 MR. ARCHITZEL: That would be in severe
22 accident spaces.

23 MEMBER ROSEN: It's a worse severe
24 accident space consideration perhaps, but it's not a
25 -- we're not talking about that yet.

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1 MEMBER FORD: But is there any mechanism
2 to toss that concern onto some other group? I mean,
3 you're drawing a firewall down this particular
4 situation. And you're saying, "Okay, I'm not
5 considering that part." Well, who does consider that
6 part? It's a communications issue, isn't it? I mean,
7 who is --

8 CHAIRMAN WALLIS: NRR.

9 MEMBER FORD: What?

10 CHAIRMAN WALLIS: NRR.

11 MEMBER FORD: Well, yes. But I'm hearing,
12 "No, we're not going to consider that."

13 MR. ARCHITZEL: I think design basis space
14 in the Reg. Guide. But as far as severe accident
15 goes, we have another branch that looks at -- they
16 include failure of sump for different reasons.

17 MEMBER FORD: That would already be
18 covered. That's already covered.

19 MR. ARCHITZEL: That's assessed outside of
20 design basis accident. We're using this Reg. Guide
21 for DBA analysis. We're not using the Reg. Guide for
22 severe accident analyses. That's another group that
23 looks at -- sump failure is one of the things that
24 happens. How do you mitigate? It's probabilistic,
25 it's a Level 3, it's not our group at all that looks

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1 at that.

2 MEMBER SIEBER: Well, this Reg. Guide is
3 designed to provide an acceptable methodology to show
4 that you comply with the GDCs, which specify that you
5 ought to have recirculation capability. And so the
6 other side of the question is, you know, if you don't
7 comply, of course, you don't comply. And there's a
8 problem; you ought to be shutting down.

9 But if you don't comply in the course of
10 an accident, you're into -- beyond the design basis
11 space and emergency planning and all kinds of things
12 like that -- severe accident.

13 MEMBER ROSEN: So I guess the answer to
14 your question, Peter, is that somebody else will look
15 at the implications of this in severe accident space
16 and consider one of these SAMAs they call them --
17 severe accident mitigation alternatives. And that the
18 SAMGs, the severe accident mitigation guidelines, will
19 somehow take note of this at some point and be
20 revised. Is that what I'm hearing?

21 MR. ARCHITZEL: I'm not sure there's
22 anything active in that area. I'm just saying it
23 currently is an area that's examined by severe
24 accident management guidelines and evaluated. Sump
25 failure is one of those.

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1 For example, when Davis-Besse came up and
2 it was evaluated, you know, the -- what about it -- if
3 the sump had blocked because of this hole in the head,
4 you know? And then, it was evaluated by the PRA staff
5 about, you know, you flood up around a vessel. And,
6 yes, you don't have any recirculation, but you can
7 have cooling that way. It is a potential to get
8 onto --

9 CHAIRMAN WALLIS: My question was purely
10 prompted by essentially a question of procedure.

11 MR. ARCHITZEL: Yes. I don't think
12 there's anything active.

13 CHAIRMAN WALLIS: But someone is looking
14 at it.

15 MR. ARCHITZEL: I don't think there's an
16 active look at this.

17 MEMBER ROSEN: Well, you heard it here.
18 Right, Ralph? Tony? You heard it here that someone
19 thought, well, if it's as bad as that, what can --
20 innocent question, what happens then? And you need to
21 think -- and your answer is, "Well, it's considered in
22 severe accident space." And we tell you, "Okay. Pass
23 that along to the severe accident people."

24 MR. ARCHITZEL: Right.

25 MEMBER ROSEN: Let them do so.

1 MR. ARCHITZEL: Right.

2 MEMBER SIEBER: Yes. But this is not a
3 new issue. That was done 20 years ago -- severe
4 accident --

5 MEMBER ROSEN: That may be the answer that
6 the severe accident people tell us. It's not any
7 worse than something we've already considered, so it's
8 fine. That's okay. I don't want to make a big deal
9 of it. I just want to understand the process.

10 DR. CHANG: To clarify one thing, I think,
11 Dr. Rosen, when you talk about sump, I think there's
12 a confusion of terminology. We use the sump pool as
13 the floor of the containment. I was referring to the
14 sump pool there as there will always be -- there is
15 always going to be some water, whereas the sump you
16 are referring to is the pit. Okay. So the dry pit is
17 a possibility.

18 MEMBER ROSEN: Yes, I'm worried about a
19 dry pit where the suction -- the end of the suction
20 piping is.

21 CHAIRMAN WALLIS: Okay. Can we move on
22 now, then?

23 DR. CHANG: Okay. Bruce, it's your slide.

24 DR. LETELLIER: To discuss briefly what
25 methods are available to assess the transport during

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1 blowdown and washdown, the only method -- systematic
2 method for doing this at the moment is to combine some
3 information about updraft velocities and water
4 drainage pathways with information about transport
5 characteristics of debris types.

6 And the method that's been applied for the
7 BWRs is this logic chart. It's essentially an event
8 sequence that maps the disposition of various debris
9 fractures -- the large pieces, the small pieces of
10 each insulation type throughout containment.

11 We've actually used the code MELCOR to get
12 some impression of the updraft velocity through the
13 various compartments, what portions of the flow expand
14 throughout containment, in order to make some informed
15 judgments about what fraction of debris are
16 transported.

17 CHAIRMAN WALLIS: This is slide 27, then?
18 Is that -- you need to move this one.

19 DR. LETELLIER: My apologies. Thank you.

20 Ultimately, these judgments have to be
21 made from the point of view of conservatism. If you
22 are attempting to rationalize a washdown fraction of
23 five percent, then you need to have supporting
24 evidence to do that.

25 We've done a very detailed examination of

1 our volunteer plant, and we find it difficult to argue
2 for less than 60 percent transport back to the pool.
3 Keep in mind that there is some initial impingement on
4 the floor. Some portion of the debris will impact the
5 floor and be available during pool fill-up.

6 The bulk of the fine debris will be lofted
7 throughout containment, but it will be small enough to
8 be entrained in condensation flows and spray --
9 through spray washdown.

10 So this logic diagram was vetted -- first
11 vetted in 6224 as part of the BWR resolution. I
12 should state that as a cornerstone document the 6224
13 was preceded by a PIRT review, so that they
14 prioritized the appropriate phenomena.

15 The PIRT was reconvened at the end of that
16 study. I'm sorry. I misquoted the reference. They
17 were reconvened to examine the drywell debris
18 transport study, which implemented this method. And
19 so it has had a peer review in that context.

20 Again, a similar statement -- there are no
21 integrated numerical models that are appropriate for
22 transport of specific debris types. We have to
23 combine flow velocity potential with transport
24 characteristics.

25 CHAIRMAN WALLIS: You've said that it was

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1 difficult to argue for less than 60 percent of the
2 debris being transported to the sump? Well, if that's
3 a bottom possibility, maybe 80 percent is more
4 realistic, and you might as well assume 100 percent to
5 be conservative.

6 DR. LETELLIER: The purpose of our
7 examination was largely to offer some recommendation
8 whether that's cost effective to do, whether you
9 choose to construct a phenomenology model to gain that
10 advantage or not.

11 The next slide shows the references that
12 are available. I've already mentioned volumes 1, 2,
13 and 3 of the drywell debris transport study and the
14 application of this method to the BWR resolution.

15 CHAIRMAN WALLIS: So now each plant is
16 going to develop, based on this knowledge base, its
17 own method? I think there's going to be huge
18 diversity unless they fit up with an NEI guidance or
19 something.

20 DR. LETELLIER: I expect that in large
21 portion they will adopt the NEI guidance.

22 DR. CHANG: The next slide is about the
23 sump pool debris transport. We stated that this
24 transport should include debris transport during --
25 for fill-up phase and the recirculation phase, and

1 also, the turbulence in the pool caused by flow of
2 water, water entering the pool from the break flow,
3 and containment spray vent drainage. Those are the
4 water sources.

5 And thirdly, the buoyancy of the debris
6 should be considered also.

7 CHAIRMAN WALLIS: Which includes mixtures
8 of debris.

9 DR. CHANG: Right.

10 CHAIRMAN WALLIS: Including gas maybe.

11 DR. CHANG: For instance, if the debris is
12 not broken down, if there is air trapped, it may be
13 floating. But as the time goes on, if it
14 disintegrates, then it would make -- eventually settle
15 down to the bottom.

16 CHAIRMAN WALLIS: Yes, maybe.

17 DR. CHANG: Yes. So those things should
18 all be considered.

19 Also, the debris that should be considered
20 in the transport analyses are -- that float along the
21 pool surface, that may remain suspended during the
22 pool turbulence, and also those readily accessible to
23 the pool force. So all sorts of debris should be
24 considered in the transport analysis.

25 And I think we got this last bullet right.

1 We said CFD assimilation in combination with
2 experimental debris transport data is an acceptable
3 approach. So we are having to modify the Reg. Guide
4 in this -- in those words.

5 And we also mentioned that alternative
6 methods would be acceptable. I think this is a
7 general statement true for the whole Reg. Guide, if
8 they can be supported by adequate validation of
9 analytical techniques using experimental data to
10 ensure that the debris transport estimates are
11 conservative with respect to the quantities and types
12 of debris transported to the sump screen. Okay.

13 DR. LETELLIER: And the practical
14 applications of this guidance are discussed next on
15 slide number 30. When I made the statement before
16 about 60 percent transport, that was specifically with
17 regard to blowdown and washdown. So we're talking
18 about 60 percent of the generated volume being
19 introduced to the pool or at the floor level.

20 The additional fraction that's lost from
21 pool transport is largely dependent on when and where
22 it arrives in the pool. Debris that's impacted on the
23 floor is subject to fill-up flow velocities, which can
24 be very high, and they are very directional depending
25 on the plant geometry.

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1 That's probably the best opportunity for
2 sequestering debris in quiet sump areas. For example,
3 many containments have opposing steam generator
4 compartments. If a break occurs on one side, the
5 opposite compartment is very quiet and does not
6 participate in directed flows.

7 Some portion of the debris will find its
8 way into those areas. Elevator shafts and, in
9 particular, reactor cavities also represent dead zones
10 with significant potential for holding up debris.
11 Before credit can be taken for those areas, some
12 consideration has to be given to the drainage flow
13 paths.

14 In our volunteer plant, we identified
15 between 8 and 12 locations where you would be dropping
16 between 500 and 1,000 gallons per minute in a fairly
17 localized area. That's a significant source of energy
18 of turbulence in the pool. And so there are phases
19 with regard to the velocity pattern.

20 The picture that's shown is intended to
21 represent the steady state flow velocities where the
22 cylinder in the steam generator compartment is the
23 source of the break, and the sump is near the bottom
24 of the annulus. So this is sort of a steady state
25 configuration that would persist for long term.

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1 MEMBER ROSEN: The red is high velocity or
2 low velocity?

3 DR. LETELLIER: The red is any velocity
4 exceeding .2 feet per second. That's sort of a rule
5 of thumb for transportability of various debris types.

6 MEMBER ROSEN: So anything in the red zone
7 will transport. Anything in the blue/green zones will
8 probably not transport.

9 DR. LETELLIER: That's correct. There is
10 a potential for transport anywhere within the red
11 zone. These patterns are very plant-specific. For
12 example, our volunteer plant has elevated steam
13 generator compartments, so there's essentially
14 concrete inside of these cavities that cannot
15 participate in the sump pool. They're excluded.

16 So, essentially, the annulus is the only
17 volume where debris will reside. And that's a
18 condition that's very vulnerable to additional debris
19 degradation from --

20 CHAIRMAN WALLIS: So if it's in this
21 region of greater than .2 feet a second, it's up in
22 suspension, and it's flying along.

23 DR. LETELLIER: Or it's sliding on the
24 floor.

25 CHAIRMAN WALLIS: And then, when it gets

1 to the blue region, it presumably doesn't instantly
2 fall out. It sort of goes out and makes a pattern
3 downstream, so you have --

4 DR. LETELLIER: There's an opportunity for
5 a drift.

6 CHAIRMAN WALLIS: It's not clear there's
7 nothing in the blue region. It's in the process of
8 falling out there, but there may still be some in
9 suspension.

10 DR. LETELLIER: That's certainly true, and
11 we are more concerned at the moment about the
12 suspended debris than the potential for sliding on the
13 floor.

14 CHAIRMAN WALLIS: Where is the sump in
15 this picture? Do you have that screen in this
16 picture?

17 DR. LETELLIER: At the bottom of the
18 annulus.

19 CHAIRMAN WALLIS: The very bottom of --

20 DR. LETELLIER: There's a bright spot.

21 DR. CHANG: It's sort of green in the
22 center.

23 CHAIRMAN WALLIS: So it's enclosed by the
24 red stuff.

25 DR. LETELLIER: Now, CFD models are one

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1 methodology that the staff is familiar with for
2 estimating the velocity counter. There are
3 alternatives. The NEI is currently looking at open
4 channel network flow models as an approximation to the
5 bulk flow.

6 We are evaluating -- we will be evaluating
7 that as an acceptable method. There is a potential
8 for success. There is a wide range in the fidelity of
9 the models. But in both cases, you have to make
10 assumptions about how you're treating the variability
11 in your input conditions. That's a common question
12 that has to be addressed in both cases.

13 Again, the linear flume test characterized
14 the incipient flow and settling velocities of our
15 major debris types. And that database, in combination
16 with velocity estimates, can be used to estimate
17 transport fractions.

18 As far as the acceptable methods and what
19 debris transport references are available, we've
20 talked about using CFD versus network flow. Again,
21 there are no integrated models specific for debris
22 transport. Logic charts are the best systematic
23 approach to assessing this fraction.

24 We do have peer reviewed articles on our
25 CFD modeling of our scale tank tests that appear in

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1 nuclear technology. But, again, they are very
2 specific interests. They are limited in scope.

3 And, finally, the list of references on
4 slide 32.

5 CHAIRMAN WALLIS: It wasn't clear to me
6 that the CFD modeling was systematically compared with
7 data from the tasks. It seemed to be qualitatively
8 predicting the right sort of thing, but I didn't see
9 a measure of how well it did quantitatively.

10 DR. LETELLIER: They were qualitatively
11 compared using tracer objects to map the velocity
12 zones, and --

13 CHAIRMAN WALLIS: But there isn't the
14 quantitative verification or validation, or whatever
15 you want to call it.

16 DR. LETELLIER: We felt that the pedigree
17 of the codes for doing open channel flow was
18 sufficient, given a qualitative comparison. We
19 observed the same transport behavior of the fine
20 debris as would be predicted by the velocity patterns.

21 MR. CARUSO: Did the people that did the
22 CFD modeling know what the tests -- know the test
23 results?

24 DR. LETELLIER: Of course. They were
25 performed at the same time.

1 MR. CARUSO: Did they know the results of
2 the test before they did the modeling? Was it a blind
3 calculation, or was it an open calculation?

4 DR. LETELLIER: As a matter of protocol,
5 the calculations and the tests were not conducted
6 independently. But as a matter of practice, there
7 were no initial conditions presupposed in the
8 calculation that were defined by the test, except for
9 the volume of water that was introduced and the
10 geometry. I personally performed the calculations,
11 and there was no intent to fine tune the calculations.

12 MR. CARUSO: I'm not asking about intent.
13 I'm asking, did the people that did the calculations
14 know the results of the experiments before they did
15 the calculations?

16 DR. LETELLIER: The answer is no. The
17 calculations were performed before the velocity
18 mapping was done in the tank. And then, the
19 qualitative comparison was performed. There wasn't a
20 rigid protocol followed for blind assessment in that
21 manner. But the calculations preceded the tests.

22 There are a number of references available
23 that describe debris transport. The most current are
24 listed as the NUREG-6882 in the middle, small scale
25 tests for separate effects characterization, and then

1 also 6773, the integrated tank tests that incorporated
2 rotational flows and a scaled geometry.

3 And at the bottom, I mention the peer
4 reviewed articles that appear in Nuclear Technology.

5 DR. CHANG: Okay. The next slide is about
6 sump screen head loss. When you have the collection
7 of those debris at the sump screen, the next step is
8 to consider the head loss.

9 In the Reg. Guide, we have the following
10 positions. For the fully submerged sump screens, NPSH
11 available should be determined from the conditions
12 specified in the plant's licensing basis. But for the
13 partially submerged sumps, both in Appendix A and also
14 in Section C.1.3.4.4, we have the same statement.

15 That is, pump failure criteria should be
16 assumed to occur when the head loss across the sump
17 screen is greater than half of the submerged screen
18 height or the NPSH margin. Either one, whichever is
19 worse.

20 And then, estimates of head loss caused by
21 debris blockage should be developed from empirical
22 data. You have to have -- to do tests on those.

23 CHAIRMAN WALLIS: Do you see, though, what
24 I mean about in the second bullet --

25 DR. CHANG: Yes.

1 CHAIRMAN WALLIS: -- you've got the
2 screen, and it's behaving like a dam, and there's a
3 loss there. And then, you've got the NPSH, and
4 nothing -- isn't the loss across the screen -- doesn't
5 that actually decrease the NPSH as well? It's not as
6 if it's one thing or the other.

7 DR. LETELLIER: Calculations of NPSH
8 generally start at the screen location. They account
9 for the static head above the pump. They don't
10 account for friction losses on flow paths preceding or
11 prior to arrival at the sump. They do account for
12 friction losses in the plumbing in the piping.

13 CHAIRMAN WALLIS: They do account for this
14 loss through the screen, then, don't they?

15 DR. LETELLIER: The traditional definition
16 of NPSH does not account for pressure loss, pressure
17 drops, across the debris bed. That's being
18 incorporated now as a point of comparison. If the
19 pressure drop is greater than this failure criteria,
20 then you will lose NPSH.

21 MEMBER RANSOM: Is it true, then, that
22 you're just calculating the hydrostatic head available
23 at the pump over and above the vapor pressure or the
24 fluid?

25 DR. LETELLIER: Essentially, that's right,

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1 with various regulatory arguments about credit for
2 containment overpressure.

3 CHAIRMAN WALLIS: What's the argument
4 again about this half of submersed screen height?

5 DR. LETELLIER: I need a diagram in order
6 to illustrate. But you can imagine a vertical screen
7 that's only partially submerged.

8 CHAIRMAN WALLIS: All right.

9 DR. LETELLIER: There's water on both
10 sides of the screen, and debris is building on one
11 side.

12 CHAIRMAN WALLIS: All right.

13 DR. LETELLIER: The pump is demanding a
14 constant volumetric flow.

15 CHAIRMAN WALLIS: So there's a drop in
16 level from one side to the other.

17 DR. LETELLIER: Yes, as the debris builds
18 up.

19 CHAIRMAN WALLIS: Right.

20 DR. LETELLIER: But most importantly is if
21 you cannot satisfy the volumetric flow, if there's not
22 enough static head in the pool to force water through
23 the bed, then you will -- your level will drop
24 catastrophically, and you will lose NPSH.

25 The only pressure available to push water

1 through the bed is the static head of the pool. And
2 on average, averaged across the bed, you have
3 approximately one-half the --

4 CHAIRMAN WALLIS: Well, that means you'll
5 simply suck the downstream part dry.

6 DR. LETELLIER: That's correct. As that
7 level drops, you will lose NPSH by definition, because
8 it's dominated by the static head above the pump
9 inlet.

10 MEMBER RANSOM: What's magic about the
11 one-half, though? Is that the limit of the pump's
12 capability?

13 DR. LETELLIER: No. You have no
14 mechanical advantage, because the pressure is equal on
15 each side of the screen.

16 MEMBER RANSOM: No. But what I meant is,
17 the pump only cares about what NPSH is available
18 before it starts cavitating. So is the minimum NPSH,
19 then, roughly half of the available head at the pump
20 inlet?

21 DR. LETELLIER: No. The definition of
22 NPSH from the point of view of cavitation is defined
23 entirely separately.

24 MEMBER RANSOM: I know that. But why are
25 you using the factor of a half?

1 DR. LETELLIER: Because there are two
2 failure mechanisms. You can -- if you lose margin,
3 you may cavitate, or you will cavitate at the pump.
4 One realistic sequence for losing margin is a debris
5 blockage that cannot satisfy the volumetric flow.

6 CHAIRMAN WALLIS: Even with the NPSH
7 satisfied, the pump is working fine.

8 DR. LETELLIER: That's correct.

9 CHAIRMAN WALLIS: It just sucks all the
10 water out, and it can't get back in.

11 DR. LETELLIER: That's correct.

12 MEMBER SIEBER: The NPSH disappeared.

13 DR. LETELLIER: And eventually you will
14 lose NPSH, because your pump is --

15 CHAIRMAN WALLIS: You'll ingest air.

16 DR. LETELLIER: -- not running. You're
17 ingesting water there. That's right. And so we're
18 suggesting that you need to examine the minimum of
19 these two criteria, both the NPSH -- because one leads
20 to the other. If, for example, the one-half pool
21 depth is less than the NPSH margin, if you have less
22 than one -- if you have a pressure drop that exceeds
23 one-half the submerged screen area, you will
24 eventually lose margin. One precedes the other.

25 MR. ARCHITZEL: It's essentially

1 equivalent to the mid-loop operation in PWRs. When
2 you get below mid-loop, you lose it.

3 MR. CARUSO: You have on page 6-2 of the
4 -- do you have a copy of the --

5 DR. LETELLIER: Yes.

6 MR. CARUSO: -- knowledge base there?
7 Page 6-2, you've got sump configurations. What sort
8 of sump configuration are you talking about that would
9 apply here? We all have copies of this. Page 6-2.

10 DR. LETELLIER: None of these figures
11 actually show the water level. But if you look at E,
12 the box type filter that has a vertical screen, the
13 case that we're talking about is where the water level
14 is only perhaps halfway. It has only submerged half
15 of the screen, and the upper portion is open, so that
16 you have containment pressure on both sides of the
17 screen.

18 MR. HSIA: Bruce, can we go to --

19 CHAIRMAN WALLIS: And you can pump it out
20 from the place faster than it can come in through the
21 screen.

22 DR. LETELLIER: That's the motivation for
23 the failure.

24 MR. HSIA: There's a better picture in the
25 Reg. Guide.

1 DR. CHANG: Figure A.3. That shows the --

2 CHAIRMAN WALLIS: 3.6.1. is okay. E is
3 okay, too. You can pump it out faster than it can get
4 in by gravity through the screen.

5 DR. LETELLIER: That's correct.

6 MR. CARUSO: Do you allow them to
7 calculate how it's going to build up and overflow as
8 a function of time? I mean, there's always water
9 pouring in, and gradually the water levels rise. Is
10 that permitted?

11 DR. LETELLIER: I think that was the point
12 of one of the comments that was made. And, in fact,
13 we did --

14 DR. CHANG: Yes. As a function of time,
15 we said, that you can consider this is -- right.

16 DR. LETELLIER: If they choose to do that.

17 CHAIRMAN WALLIS: So you might recover the
18 pump again. I mean, as the water rises.

19 MR. CARUSO: As the water rises.

20 CHAIRMAN WALLIS: If it's not destroyed
21 already.

22 MR. ARCHITZEL: But that was principally
23 for like the plants that start spray very early and
24 don't have that level yet. So they need to have a
25 very -- it's not the full flow rate. It would be like

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1 an ice condenser that's starting to spray early. The
2 water is very low. They started right at --
3 initially. Not all the plants do that.

4 DR. LETELLIER: So we continue?

5 DR. CHANG: Bruce, yes.

6 DR. LETELLIER: So we continue with slide
7 number 34.

8 CHAIRMAN WALLIS: It's the thin bed.

9 DR. LETELLIER: The final step of
10 vulnerability assessment is head loss across the
11 screen, given a presumed debris bed. And the head
12 loss correlations that are -- it's shown generically
13 below the figure, was developed for 6224 and validated
14 against test -- experimental data for a limited
15 combination of debris -- the predominant combinations
16 of fiber, RMI, and particulate.

17 This figure shows the range of head loss
18 on the vertical axis that would be incurred as a
19 function of bed thickness, essentially fiber volume,
20 for a given screen. There are assumptions here of
21 velocity and area.

22 CHAIRMAN WALLIS: It's a very strange
23 curve. You put in more fibers, you get less head
24 loss.

25 DR. LETELLIER: One of the limitations of

1 the correlation is the assumption of a homogenized
2 bed. And if you have a large fiber volume that's well
3 mixed with particulate, it allows greater porosity,
4 more flow area, and so the head loss is lower than if
5 you have a very thin contiguous bed of fiber. The
6 thin bed, one-eighth inch --

7 CHAIRMAN WALLIS: This is with a certain
8 constant amount of particulates and more fiber dilutes
9 than particulates? Is that the idea?

10 DR. LETELLIER: Each curve represents a
11 different mass of particulate.

12 CHAIRMAN WALLIS: Okay. So more fiber
13 dilutes the particulates.

14 DR. LETELLIER: That's correct. So you
15 can see the reason for the minimum.

16 CHAIRMAN WALLIS: It shows that it isn't
17 as simple as you think. And also, the compressibility
18 -- the degree to which the pressure drop across the
19 bed itself compresses the fibers has a big effect
20 here.

21 DR. LETELLIER: And that's accounted for
22 in the correlation.

23 CHAIRMAN WALLIS: Right. But if the
24 fibers happen to be squishier than predicted, they can
25 really clog up the --

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1 DR. LETELLIER: That's correct. And that
2 is a phenomena that we observe in some debris types.
3 Calcium silicate, in particular, tends to reweld into
4 a contiguous obstacle.

5 CHAIRMAN WALLIS: It concerned me a bit
6 about other chemical products produced in the sump
7 that will make this stuff gooier or whatever.

8 DR. LETELLIER: That's true. And if we
9 have time to share the summary of chemical testing,
10 you'll see that we are not confident that the 6224
11 correlation is robust for those debris types.

12 Of all of the steps of the accident
13 sequence, I'd have to say that the head loss has been
14 investigated in the most detail largely due to the
15 amount of work that the industry did to actually
16 design and test the strainer retrofits for the BWR
17 resolution. There is a large body of information that
18 became available at that time.

19 The head loss correlation has been
20 implemented in a PC utility called BLOCKAGE. It's
21 available for use by the public. It actually has some
22 amount of verification and validation that's
23 documented in the user's guide. It did not adhere to
24 a formal software quality assurance plan, but they
25 were conducted separately.

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1 The code results were recorded separately
2 in separate programming language, and then the results
3 were verified. And then, the output from BLOCKAGE was
4 exercised against all available test data to show the
5 validation steps.

6 It's important that the head loss
7 correlation be used with appropriate material
8 properties. And, again, the database is not all
9 inclusive. There are materials out there that have
10 not been tested.

11 It's important that the -- that any
12 alternative correlations be validated through
13 comparable test procedures. The NRC work has
14 established an expectation of quality and level of
15 procedure and attention to detail that should be
16 typical in any alternative method that's proposed.

17 Ultimately, if these head loss
18 correlations are implemented to validate a new test --
19 or, I'm sorry, a new design of the strainer, then
20 performance tests of these designs should be done
21 comparable to what was done for the BWR resolution.

22 The head loss references on page 36 again
23 mention 6224, which I wanted to remind you was
24 actually issued as a draft NUREG. So it was subject
25 to public comment, and the resolution is documented in

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1 the appendix to 6224.

2 DR. CHANG: There are about 80 pages of
3 the resolution of comments in this document, so it's
4 extensively -- being extensively reviewed.

5 CHAIRMAN WALLIS: You don't consider the
6 mechanism where the fibers sort tangle up on the
7 screen? If anybody has cleaned out a drain from a
8 shower, they noticed the hairs, though the screen is
9 pretty coarse. It's very simple. It doesn't take all
10 that many hairs to tangle up around there and block it
11 up.

12 DR. LETELLIER: Yes, certainly. We have
13 demonstrated that the thin bed can be established on
14 screens as large as --

15 CHAIRMAN WALLIS: It's not just a bed. I
16 mean, it can be actually something that goes around
17 the -- extends downstream from the filter itself.

18 DR. LETELLIER: That's true. And it does
19 -- you do incur some amount of head loss because of
20 that, but the greater concern is a contiguous map.

21 CHAIRMAN WALLIS: Right. So are you
22 finished now with your presentation?

23 DR. LETELLIER: So T.Y. has some
24 closing --

25 CHAIRMAN WALLIS: Yes. My colleague Dr.

1 Rosen has to go in about five minutes.

2 MEMBER ROSEN: Yes.

3 CHAIRMAN WALLIS: Do you have something
4 you would like to --

5 MEMBER ROSEN: Yes. Presumably, we'd go
6 around the table at the end and get -- have some
7 committee discussion. I beg your indulgence to just
8 listen to my one comment, and then I have to go.

9 And that is that of all of the -- and I've
10 stayed fairly close to this. I went to the PWR
11 workshop in Baltimore. The committee agreed with me
12 doing it, and I did do it, and you'll soon get my trip
13 report.

14 But the thing that -- the only jarring
15 thing I heard today that was new was that there is no
16 plan by the industry to deal with -- in the guidance
17 with material that goes through the sump subscreen,
18 how one does -- what one does to analyze that. And
19 that seems to me an open circuit in the protocol
20 that's being developed.

21 We'll get to the very end of it, and then
22 that question will be asked, and there will be no
23 answer except -- I don't know what. Maybe John Butler
24 of NEI or someone else could help me with that. But
25 I guess I didn't really hear the answer to that.

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1 That's my input.

2 CHAIRMAN WALLIS: When will we get your
3 trip report?

4 MEMBER ROSEN: Well, it's done, and it
5 ought to be -- I've given it to the staff.

6 CHAIRMAN WALLIS: It might help us with
7 the letter that we're supposed to write to --

8 MEMBER ROSEN: Well, the trip report was
9 rather, you know, brief and preliminary. So I'm not
10 sure it will be much more than you heard here. I
11 think you might just want to, you know, scan it.

12 MEMBER RANSOM: Who did you send it to?

13 MEMBER ROSEN: Sherrie.

14 CHAIRMAN WALLIS: Okay. Well, are you
15 going to finish up?

16 DR. CHANG: Yes, the last one. In
17 closure, I just want to describe the ongoing research
18 activities under Generic Safety Issue 191. There will
19 be a meeting before the end of October this year. We
20 have two test reports coming out. One is the calcium
21 silicate head loss test report. The other one is some
22 very preliminary chemical tests done for the --

23 CHAIRMAN WALLIS: Are you going to test
24 just the kind of chemicals that might be in the sump
25 and at the temperatures that they might be at or --

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1 are you going to test the paints and things that might
2 be there?

3 DR. LETELLIER: We can go through the --

4 CHAIRMAN WALLIS: So we can get on to some
5 of these questions about --

6 DR. CHANG: Yes. Bruce has some slides
7 here.

8 DR. LETELLIER: If you'd like to go
9 through the summary, there's better information.

10 DR. CHANG: And long term is up to end of
11 fiscal year '04. We plan to have a debris sample
12 characterization of PWRs. There we tried to collect
13 sample latent debris from five volunteer plants, and
14 then we tried to do some additional head loss tests on
15 them. And we plan to have HPSI throttle valve
16 clogging study as well. And the --

17 CHAIRMAN WALLIS: Can you do something
18 about this zone of influence issue that seems to be of
19 some concern? And if there's anything you can do from
20 what's already happened in Barseback, and so on, to
21 see, was it a directional jet, or was a spherical
22 thing, or anything that would help to give some
23 realism to the zone of influence model, that would
24 really help I think. I'm suggesting that you do that.

25 DR. CHANG: I don't know if Barseback --

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1 they still have all this information available or not.

2 CHAIRMAN WALLIS: This report lists a lot
3 of things that are described, but then someone should
4 go in and say "ah ha." Now, from what I saw, what the
5 description is, this shows that it is a jet or
6 something -- something you could deduce from it that
7 helps your model.

8 DR. LETELLIER: Those aspects can be
9 revisited. I rather doubt that there will be any --

10 CHAIRMAN WALLIS: But try.

11 DR. LETELLIER: -- new inspiration that
12 comes forth.

13 CHAIRMAN WALLIS: But you have an ongoing
14 contract, do you? You can do this?

15 DR. LETELLIER: I'd be happy to do it. I
16 just need some direction.

17 MEMBER SIEBER: Well, did the Ontario
18 hydrotesting tell you anything? That was actual
19 configurations with varying types of insulation.

20 DR. LETELLIER: Those were free jet
21 expansion for two-phase flow. They were very similar
22 to the air surrogates that were performed for the BWR
23 study.

24 MEMBER SIEBER: So they don't tell you
25 much about energy distribution in a compartment.

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1 CHAIRMAN WALLIS: Didn't the University of
2 New Mexico -- they did a test where they had a pipe
3 with insulation on it, and they took a two-phase jet
4 and directed it at it?

5 DR. LETELLIER: That was actually done as
6 part of the BWR.

7 CHAIRMAN WALLIS: But that's not a
8 spherical jet. That's a directional jet.

9 DR. LETELLIER: That's correct. And it
10 was done for the purpose of measuring the damage
11 pressure, so that we know what the vulnerabilities of
12 each insulation type are.

13 CHAIRMAN WALLIS: Yes. But then, you
14 didn't go back and say, "Now, if we had assumed it was
15 a spherical jet, what would we have got for the
16 predicted pressure."

17 DR. LETELLIER: Had we done that, we would
18 have been taking credit for dissipation that we didn't
19 show.

20 CHAIRMAN WALLIS: Yes. It seems to me
21 that you're doing a test which is at odds with your
22 whole model for zone of influence.

23 DR. LETELLIER: I don't quite understand
24 the comment. We are remapping the equivalent damage
25 volume into a sphere as a practical simplification, in

1 light of the fact that our targets are distributed
2 rather homogeneously throughout containment.

3 CHAIRMAN WALLIS: Well, I guess we'll
4 revisit this again. I'll get back to the firehose and
5 the -- you know, the firehose -- the purpose of the
6 firehose is to go in one place. It's very different
7 from the spherical.

8 DR. CHANG: Bruce, do you want to go into
9 your second subject?

10 DR. LETELLIER: Yes.

11 DR. CHANG: Bruce would like to share with
12 us some of his ideas about other alternatives.

13 DR. LETELLIER: Let me ask the committee
14 what your preference would be and your time
15 constraints. We are --

16 CHAIRMAN WALLIS: Tell us what's important
17 in a short time. We don't have to go -- I don't think
18 my colleagues have to go exactly at 12:00, so we can
19 go at, say, 12:30 or so.

20 DR. LETELLIER: We're here at your
21 convenience. We have two topics that --

22 CHAIRMAN WALLIS: Well, if you had 20
23 minutes, could you tell us the most interesting stuff
24 here?

25 DR. LETELLIER: My personal opinion is

1 that the chemical effects testing is the most
2 interesting.

3 CHAIRMAN WALLIS: Okay.

4 DR. LETELLIER: I think you can browse
5 through the set of handouts on sump operability
6 strategies and see what conceptual concepts that you
7 could put on a table in a brainstorming context. The
8 fact that we're presenting these does not imply any
9 endorsement, practicality, or operability of these
10 concepts.

11 But we hope to show you that the industry
12 is not without options. There are a number of things
13 that can be pursued through --

14 CHAIRMAN WALLIS: We can look at these
15 pictures, and we can sort of see how they might work.

16 DR. LETELLIER: Exactly. That's the
17 intent.

18 CHAIRMAN WALLIS: So now you want to tell
19 us about the chemical --

20 DR. LETELLIER: Give me a moment to pull
21 up the slides. And I apologize, I don't have handouts
22 for you. Those can be provided after the briefing.

23 MR. ARCHITZEL: I've got an ADAMS number
24 if you want it. It's already in ADAMS. It's the same
25 slides you did at the --

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1 DR. LETELLIER: It's a condensed set.
2 This is essentially the information that was presented
3 at the workshop two weeks ago.

4 MR. ARCHITZEL: Workshop slides are
5 available in ADAMS.

6 DR. LETELLIER: Have members of the
7 committee looked at those slides --

8 CHAIRMAN WALLIS: No.

9 DR. LETELLIER: -- already?

10 CHAIRMAN WALLIS: No, I didn't.

11 MR. HSIA: I think it would be more
12 appropriate -- when we are complete with the chemical
13 testing, there will be a report issued, and at that
14 time we can come back, if you choose, to present to
15 you a complete picture.

16 CHAIRMAN WALLIS: But the fact that you're
17 saying there are chemical reactions that produce
18 precipitants indicates to me that there are chemical
19 reactions which produce significant stuff. And it may
20 not always be in the form of nice, dry -- dry-type
21 particulate stuff. It may be gooey or bubbly or
22 something, depending on what's going on chemically.

23 DR. LETELLIER: That's correct. And we
24 can show you the status of our investigations. We've
25 been looking at this for the past three or four months

1 over the summer.

2 We had a rather limited scope to assess
3 the plausibility of these various chemical reactions,
4 exacerbating head loss on the screen. All of this
5 work is also being done at the UNM Civil Engineering
6 Department in their hydraulics lab.

7 The motivation for the work -- you're well
8 aware of concern of the committee regarding gelatinous
9 material observed in TMI. Try to focus on determining
10 where this material came from and if it's a plausible
11 concern for reactor accident sequences.

12 CHAIRMAN WALLIS: Now, this stuff that
13 sprays out from the reactor is borated water. So when
14 it hits the stuff out there in the containment, it's
15 boric acid. When it gets in the pool, it gets diluted
16 with sodium hydroxide. Is that the way I understand
17 it? It gets turned to a high pH in the pool.

18 DR. LETELLIER: Your chemical injection
19 tanks that actually increase the pH -- there are
20 sodium hydroxide injection tanks, and the boron
21 concentration in the RWST is much different than is
22 present in the RCS.

23 CHAIRMAN WALLIS: But they don't inject
24 into the reactor system. They inject into the
25 containment somewhere?

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1 DR. LETELLIER: Yes, they do. They are
2 part of the spray and also the --

3 CHAIRMAN WALLIS: But they don't inject
4 into the RCS. The RCS is borated, acidic, low pH
5 stuff. So the jet that hits the walls is acidic, and
6 then it has a chance to do its acidic reactions. It
7 runs down the wall, and it meets this alkaline stuff,
8 which has come from somewhere else, and the spray,
9 which has fallen down from the roof.

10 MEMBER SIEBER: The reaction actually
11 occurs in the containment atmosphere.

12 CHAIRMAN WALLIS: It can as well. I think
13 it's -- there's some uncertainty. But the jet -- if
14 the jet's direction is certainly acidic, and it
15 sputters acid all over the wall --

16 DR. LETELLIER: That is a detail that we
17 have not examined as yet -- the time dependence of the
18 concentrations. We've looked at more the homogenized
19 solution of the containment pool, what would be -- in
20 particular, how the spray RWST impacts the water
21 chemistry, because keep in mind that the sprays
22 impinge on a much larger area of exposed metal than
23 the break jet.

24 I should state right up front that this is
25 important enough -- we feel it's a very important

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1 issue, and we've convened a peer review panel to take
2 place the first week of September. We're not sure
3 what expectations we should meet through this peer
4 review, but we do have outside experts that are --
5 both represent academia, national laboratories, and
6 the industry, that are not currently participating in
7 the safety -- resolution of the safety issue.

8 We're investigating several tasks. The
9 scope was broad -- look at chemical effects. We
10 focused primarily on the corrosion of exposed metals
11 with subsequent precipitation. There are other
12 chemical effects. One has been postulated this
13 morning -- hydrogen generation that leads to the
14 formation of bubbles. That was not on our list of
15 priorities.

16 CHAIRMAN WALLIS: But it's mentioned in
17 your report.

18 DR. LETELLIER: As I said, it's not on our
19 list of priorities for this limited introductory
20 effort. We were looking at chemical degradation of an
21 existing fiber bed. We're concerned about --

22 CHAIRMAN WALLIS: Well, the simplest thing
23 you can do -- I guess I could ask the staff here to do
24 it -- is it says here that it's already being used to
25 estimate hydrogen source term. So we could simply

1 take the results of what -- that analysis that has
2 been done, find out how much hydrogen there is.

3 DR. LETELLIER: That's true. It could be
4 done as an analytic exercise.

5 CHAIRMAN WALLIS: Find out what that
6 information is. If it's -- it says it's been done.

7 DR. LETELLIER: I will tell you that none
8 of our immersion samples show evidence of bubble
9 formation. Zinc granules, zinc coupons, paint chips,
10 the generation is not --

11 CHAIRMAN WALLIS: So they're used in many
12 FSARs to estimate hydrogen source term.

13 DR. LETELLIER: Yes.

14 CHAIRMAN WALLIS: So they must be there
15 somewhere. Okay.

16 DR. LETELLIER: That's true. And because
17 of that work, we do have estimates of exposed aluminum
18 area, because of that need to track hydrogen
19 generation. We have some idea of plant vulnerability
20 regarding exposure area.

21 MR. ARCHITZEL: I just asked the committee
22 a question on that. If a lot of the hydrogen
23 generation comes off the severe accident source term
24 in the DBA, would that be a factor that we should
25 consider?

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1 CHAIRMAN WALLIS: No.

2 MR. ARCHITZEL: Well, I mean, you assume
3 a certain amount of fuel damage. It's much more than
4 you get in the DBA.

5 CHAIRMAN WALLIS: Is that what's done in
6 the FSAR?

7 MR. ARCHITZEL: Hydrogen generation is
8 coming from the radiolytic decomposition of the water.
9 And if the DBA prevents that, I know we assume that in
10 the DBA. The whole purpose of this exercise -- you've
11 got a DBA, and you've got this -- I mean, there's an
12 opportunity to not consider it based on the fact that
13 you don't -- I know we do consider it for radiological
14 doses.

15 MEMBER KRESS: This thing is to keep from
16 getting these products in there, and I don't --

17 DR. LETELLIER: Exactly.

18 MEMBER KRESS: -- think you want to do
19 that here.

20 CHAIRMAN WALLIS: There's a different
21 question, though. There's --

22 DR. LETELLIER: Hydrogen generation does
23 not precede loss of sump.

24 MEMBER KRESS: No, that's right.

25 DR. LETELLIER: It's not an initial

1 condition from our --

2 MEMBER KRESS: That's right. I don't
3 think you want to do it that way.

4 MR. ARCHITZEL: I don't understand. I
5 guess I'm just trying to -- I guess my point was there
6 is an opportunity to not consider it because you
7 haven't had the core damage.

8 CHAIRMAN WALLIS: No, I don't think you
9 can not consider it. It's a chemical effect. I mean,
10 it says it here -- that the aluminum reacts with --

11 MR. ARCHITZEL: Well, the aluminum --
12 okay. I thought it --

13 CHAIRMAN WALLIS: -- the stuff that's in
14 the sump, and it's going to make -- so it makes
15 hydrogen. So I think you have to consider it.

16 MR. ARCHITZEL: Okay.

17 DR. LETELLIER: We will review that.

18 CHAIRMAN WALLIS: Maybe you can't use the
19 numbers for some other calculation to find out how
20 much hydrogen. So maybe what I'm asking Ralph to do
21 is not very helpful. But at least he can look at it
22 and see if we can learn from it.

23 DR. LETELLIER: A similar issue brings to
24 mind the water chemistry. In a severe fuel damage
25 event, you'll have nitric acid produced because of

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1 radiolytic exposure of air.

2 MEMBER KRESS: Still, you have to have the
3 radiation.

4 DR. LETELLIER: You have evolution of
5 chlorides from cable trays. But, again, those
6 conditions --

7 MEMBER KRESS: That doesn't seem to be
8 part of this.

9 CHAIRMAN WALLIS: We're not looking at
10 radiation here.

11 MEMBER KRESS: Right.

12 MEMBER SIEBER: They're longer term.

13 DR. LETELLIER: Those are longer term, and
14 we've ignored those chemical reactants in our matrix.
15 Schematically, this is the concern that occurs, that
16 the borated solution and sprays impinge on exposed
17 metal surfaces. Metal surfaces are also immersed in
18 the pool, and the metals can be dissolved and
19 suspended as free ions in solution.

20 If you reach saturation -- and these
21 metals are extremely insoluble -- once you reach
22 saturation, there's a potential for precipitation to
23 occur. The formation of metallic hydroxides, for
24 example, shown in the middle panel -- we've confirmed
25 that, yes, you can produce these effects using

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1 background, borated water, and simulated metallic
2 nitrates to induce free metal, dissolved metal. You
3 will generate a precipitant, and it will cause
4 significant head loss.

5 CHAIRMAN WALLIS: When these zinc ions are
6 running around in this low pipe pH -- now it's high
7 pH, isn't it?

8 DR. LETELLIER: Yes, it is.

9 MEMBER KRESS: Aren't these extremely
10 small?

11 CHAIRMAN WALLIS: Is there a hydrogen
12 production mechanism in there?

13 DR. LETELLIER: I'm not sure. We have not
14 addressed --

15 CHAIRMAN WALLIS: But it says in your
16 report that's why --

17 DR. LETELLIER: Well, I don't have any
18 comment. We have not addressed hydrogen generation.

19 CHAIRMAN WALLIS: Let's see if there is.

20 MR. CARUSO: What comes out from the
21 reactor, the spray or -- to create the zinc hydroxide?
22 It's --

23 DR. LETELLIER: In the middle panel,
24 that's the precipitation.

25 MR. CARUSO: Actually, it's the left-hand

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1 panel, the production of the zinc hydroxide I believe
2 generates hydrogen.

3 DR. LETELLIER: That may be true. We have
4 not examined that.

5 CHAIRMAN WALLIS: Well, where does the H
6 go from the water? It presumably gave the OH to
7 the --

8 MR. CARUSO: That's where it goes.

9 DR. LETELLIER: Well, keep in mind that
10 this is strongly buffered solution. There's a lot of
11 sodium hydroxide that's available.

12 CHAIRMAN WALLIS: You're going to sort
13 that out.

14 DR. LETELLIER: Right.

15 MEMBER FORD: I guess the thing that --
16 everything you've said so far is thermal dynamically
17 possible. I'd question the kinetics of the process,
18 whether it's a big deal or not, and --

19 DR. LETELLIER: That's a very important
20 issue. We have demonstrated that each of these
21 separate effects can occur.

22 MEMBER FORD: Yes.

23 DR. LETELLIER: We've demonstrated the
24 linkage between step 2 and step 3. The flocculent
25 material is very transportable. The particulates are

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1 extremely fine. They are extremely small, but they
2 also are hydrophilic in the sense that they bind water
3 molecules into a jelly, into a gelatinous mass.

4 CHAIRMAN WALLIS: What you need to do in
5 your picture is show those green things as zinc and
6 the white things as hydrogen.

7 MEMBER KRESS: That's what they are.

8 CHAIRMAN WALLIS: And then, if you take a
9 physical model, the zinc particles and hydrogen
10 bubbles -- and your picture is very good --

11 DR. LETELLIER: We add the hydrogen
12 bubbles.

13 MR. CARUSO: Does the concrete have any
14 chemical effect?

15 DR. LETELLIER: It certainly does. In
16 fact, we added some calcium carbonate to represent the
17 eroded concrete present in the jet.

18 MR. CARUSO: And what did it do?

19 DR. LETELLIER: Well, we have not done an
20 exhaustive assessment of the parameters of
21 concentration. In general, it increase the pH similar
22 to the sodium. And, in fact, in that respect it's a
23 buffer solution, and it increases the solubility of
24 the metals, dissolved metals.

25 MR. CARUSO: So it probably also depends

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1 on the type of concrete, too.

2 DR. LETELLIER: It certainly would.
3 Containment environments are very dirty. You have a
4 variety of chemicals that are different from our clean
5 test tube, our beaker experiments.

6 The executive summary we have already
7 hinted at. Metal corrosion is credible for the
8 borated cooling water. The UNM test confirmed the
9 literature reported values for room temperature. They
10 are typically reported in units of grams per hour per
11 square meter of exposed metal.

12 But for the elevated temperature, we did
13 oven tests at 80 degrees C, just to represent a
14 substantially higher temperature. We were not able to
15 confirm the reported rates of 11.3 grams per hour per
16 square meter. Those are extremely high rates, and we
17 believe that the kinetics are an important aspect of
18 this inconclusive test at the moment.

19 We are looking at immersion and corrosion
20 in a quiescent beaker that's not subject to flow
21 mechanisms of any kind. And we think that there's a
22 surface catalyzed redeposition of this material. It's
23 not freely released to the solution so that you
24 gradually reach saturation. It's affected by the very
25 high local concentrations near the substrate, and I'll

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1 show you a picture of what that corrosion product
2 looks like.

3 CHAIRMAN WALLIS: Now, in terms of
4 breaking off flakes of paint, does the boron in the
5 water help to loosen up the flakes?

6 DR. LETELLIER: We haven't examined that
7 issue. We are looking at paint as a debris source
8 that's liberated in the zone of influence. The
9 industry guidance and the best available NRC guidance
10 is to assume 100 percent destruction of paints within
11 the damage zone. We have not looked in depth at the
12 chemical effects on those paint chips.

13 We are concerned about the potential to
14 leach the zinc from inorganic primers, because that's
15 a significant reservoir of metal, for example. And we
16 do have some very preliminary tests, qualitative in
17 nature, that I wasn't prepared to present.

18 The second bullet in blue -- we have
19 confirmed that the low solubility of these metals does
20 lead to precipitation if you exceed the saturation
21 threshold, and that the chemical precipitate does lead
22 to a substantial head loss in combination with fiber
23 on the screen.

24 Ultimately, the plant vulnerability
25 depends on the connection between corrosion and

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1 precipitation, and that really needs to be established
2 by an integrated test that we haven't done yet.

3 To get into the details of how the test
4 procedure was conducted --

5 CHAIRMAN WALLIS: Well, let me ask you
6 here. Suppose that these chemical effects are
7 important. We don't seem to have a knowledge base for
8 industry to respond to the question about, do they
9 have a significant effect on their plant? So what's
10 required to get that knowledge base? I would presume
11 NEI isn't going to create it out of nowhere. It's not
12 there.

13 DR. LETELLIER: We're in the process of
14 creating the knowledge base, and our October report
15 will be the first --

16 CHAIRMAN WALLIS: So, again, it's one of
17 these things where you can't do the analysis, because
18 you don't know yet. So we don't do anything.

19 DR. LETELLIER: Well, I'm not sure that's
20 true. I mean, I showed you a corrosion rate that's
21 reported in the literature. It's very high.

22 CHAIRMAN WALLIS: It is.

23 DR. LETELLIER: It will lead to many
24 hundreds of pounds.

25 CHAIRMAN WALLIS: Orders of magnitude

1 bigger than you observe.

2 DR. LETELLIER: Yes. But, in fact, that's
3 the best available evidence at this moment. And the
4 conservative approach is to adopt that corrosion rate
5 with some estimate of exposure opportunity, and assume
6 the connection between corrosion and precipitation.

7 MEMBER FORD: In your knowledge-based
8 report, this one here, you mention in one of the --
9 some of the plants that have seen blockages. Sludge
10 was talked about, in which there was metal corrosion
11 plugs. What metal was it?

12 DR. LETELLIER: Well, in the BWRs that
13 have a suppression pool, the sludge is predominantly
14 iron oxide. It's rust. And, in fact, during the BWR
15 study, that debris source dominated considerations of
16 additional dust that might be present, because there
17 is so much iron oxide.

18 And the correlations were tailored to
19 perform best with that type of debris. There were no
20 considerations of the chemical precipitants at that
21 time.

22 Let's skip to some information about how
23 the precipitation tests were conducted. We started
24 with the ionized water supplemented with our boron
25 concentration, representative of actual plant

1 configurations. It was not done in the detail that
2 you alluded to. It was meant to describe the gross --
3 the bulk mixed concentration.

4 We established a fiber bed in a closed
5 loop test apparatus, and then we introduced a metallic
6 salt in order to force the precipitation to happen.
7 We essentially introduced more -- we introduced enough
8 metal to exceed the saturation threshold, and then we
9 observed the results.

10 MR. CARUSO: Why did you pick those
11 particular chemicals?

12 DR. LETELLIER: We were mostly interested
13 in the metals, because there are exposure
14 opportunities for iron, aluminum, and galvanized cable
15 trays represent zinc. We could also have used copper,
16 lead, etcetera. Those are the vulnerable materials in
17 containment.

18 We use the nitrate as a convenience for
19 introducing dissolved metal. We could prepare a stock
20 solution, essentially.

21 CHAIRMAN WALLIS: Did you have -- you
22 didn't have flakes of zinc paint and stuff in there,
23 but --

24 DR. LETELLIER: Not in these tests.
25 That's correct. These are some of the test samples

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1 that are arrived at from different concentrations of
2 iron and zinc. In the next slide, I'll show you the
3 data that all of these metals --

4 CHAIRMAN WALLIS: We are looking at little
5 buttons of stuff which got eaten by --

6 DR. LETELLIER: We're actually looking at
7 the test samples about four inches in diameter.

8 CHAIRMAN WALLIS: They obviously got eaten
9 by something. They got corroded, didn't they? Isn't
10 that what we're seeing?

11 DR. LETELLIER: No. Let me clarify.

12 CHAIRMAN WALLIS: It looks like artifacts
13 from an archaeological dig or something.

14 DR. LETELLIER: They look like jellyfish.
15 Keep in mind that we introduced clean fiber into a
16 test section that's about four inches in diameter. We
17 put in 100 grams of fiber, which is essentially yellow
18 insulation. And to this test column we introduced the
19 metallic nitrate, induced the precipitation, and we
20 measured the head loss.

21 CHAIRMAN WALLIS: So you made zinc
22 precipitate on the fiber in some --

23 DR. LETELLIER: Yes, we forced it to
24 precipitate.

25 CHAIRMAN WALLIS: And you made this

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1 gooeey --

2 DR. LETELLIER: Yes. These are the test
3 samples of the bed that was recovered from each test.

4 CHAIRMAN WALLIS: -- cookie dough type
5 stuff. Is that right?

6 DR. LETELLIER: Right.

7 CHAIRMAN WALLIS: Well, that's the sort of
8 thing we thought might happen, or could, you know?
9 Needs to be considered.

10 DR. LETELLIER: We can certainly create
11 those conditions in a confined environment. It is
12 plausible.

13 These are the data, head loss being shown
14 on the vertical axis, and the effective concentration
15 of each metal along the abscissa. The blue line shows
16 you the baseline. That's the head loss incurred by
17 the fiber alone, by itself. And then you can compare
18 the margin that was measured.

19 CHAIRMAN WALLIS: It's just like the
20 precipitates from the soap that gum up your drain.
21 It's not just the hairs. It's the other things that
22 get in with them.

23 MEMBER SIEBER: That holds the hair
24 together.

25 DR. LETELLIER: That's right. And that's

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1 an important factor. You should understand that the
2 head loss that we're observing here is much, much
3 greater than you would observe from an equivalent
4 amount of dry particulate. It's much different than
5 the 6224 correlation.

6 The threshold of about 10^{-3} molar is the
7 threshold for the saturation threshold. That's where
8 we first start to observe the effects. The
9 concentration axis really represents additional mass
10 that we've added to the bed, and that's why the
11 pressure -- the head loss trends are consistent
12 between materials.

13 MEMBER KRESS: That's the concentration
14 you would have had if you added that mass and none of
15 it precipitated?

16 DR. LETELLIER: Yes.

17 MEMBER KRESS: Okay.

18 DR. LETELLIER: That's right. But, in
19 fact, all of it precipitated.

20 MEMBER KRESS: Yes.

21 DR. LETELLIER: And all of it arrives on
22 the bed.

23 Now, just to give you some engineering
24 chemistry facts to kind of baseline your understanding
25 about this, first of all, you understand that every

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1 metal has a different molecular weight. But if you
2 look at this block, the threshold for precipitation of
3 about 10^{-4} molar is equivalent to several tens of
4 pounds in a million gallons of water. That's not very
5 much material. And, in fact, most large drives don't
6 have a million gallons.

7 CHAIRMAN WALLIS: The amount of hydrogen
8 needed to float that stuff, because hydrogen is so
9 light, is even less.

10 DR. LETELLIER: Perhaps you're right.

11 CHAIRMAN WALLIS: It doesn't take many
12 models to --

13 DR. LETELLIER: Keep in mind that the
14 precipitation -- the precipitant -- it might serve as
15 a nucleation site for bubbles.

16 MEMBER KRESS: And now that was a log
17 scale on concentration.

18 DR. LETELLIER: Yes.

19 MEMBER KRESS: And so you're going up a
20 factor of 10. Do you have that much available
21 compared to the amount of water you have?

22 DR. LETELLIER: Well, keep in mind, your
23 observation was exactly correct. These are the
24 concentrations that would exist if there was no
25 precipitation. But, in fact, once you reach the

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1 threshold, it does precipitate.

2 MEMBER KRESS: So it's a continuous --

3 DR. LETELLIER: Yes, it is a continuous
4 process. And so this concentration really represents
5 the amount of material that we force on the bed. It's
6 directly proportional to the mass on the bed.

7 MEMBER KRESS: Okay.

8 DR. LETELLIER: Now, in this block, at
9 10^{-3} molar, the amount of material that we actually
10 added to our 10 liter closed loop is very small --
11 fractions of a gram -- .3 grams of aluminum were added
12 to this test volume.

13 And we are actually inducing seven to 10
14 feet of head loss with just a fraction of a gram.
15 That's much, much different than you would expect from
16 an equivalent mass of dry particulate.

17 I did not bring the electron micrographs
18 of the debris bed. But you can see that the
19 precipitant tends to stick or adhere to individual
20 fibers, and it changes the hydraulic flow
21 characteristics of the bed.

22 Dry particulate, by contrast, tends to
23 lodge in the interstitial space and obstruct the flow
24 area. So there's a quite different mechanism going
25 on.

1 Also, our observations of the jelly-type
2 layer give you the impression that it's taking up a
3 much larger volume than would be assumed by those
4 fractions -- fractions of mass. So the precipitant is
5 actually hydrophilic.

6 CHAIRMAN WALLIS: That's what gels do.

7 DR. LETELLIER: Exactly. It binds water
8 molecules into a gelatinous mass.

9 CHAIRMAN WALLIS: Which really makes me
10 feel good.

11 MR. CARUSO: I'll tell you where there's
12 a lot of information about this, and that's in the
13 filtration industry. And I'm -- probably every plant
14 in the United States, every nuclear plant in the
15 United States, has a chemical waste treatment building
16 that has a whole bunch of filters in it with pre-
17 codes, and all sorts of techniques like that to do
18 exactly what you're trying to measure. And the people
19 that sell those machines know all about how this
20 works.

21 DR. LETELLIER: That's exactly right. For
22 the final steps of water quality treatment, for
23 clarification they add an aluminum nitrate coagulate.

24 MR. CARUSO: Flocculents.

25 DR. LETELLIER: Exactly.

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1 MR. CARUSO: And somewhere in every plant
2 there is a chemical engineer that runs that waste
3 treatment plant that knows all about this chemistry.
4 You've just got to get that guy out and talk to the
5 thermal hydraulicist.

6 DR. LETELLIER: But keep in mind this is
7 the kind of chemistry that you do not want inside a
8 containment during accident. So there is a disconnect
9 in the application of their expertise. But you're
10 right; there's a large body of information available.

11 MEMBER SIEBER: It's the same process,
12 though.

13 MR. CARUSO: The same process.

14 DR. LETELLIER: Yes.

15 CHAIRMAN WALLIS: Well, I think you've
16 convinced at least me that this is something that
17 needs to be considered in resolving this issue of
18 some --

19 MEMBER SIEBER: It may go beyond that.
20 This may be the overarching consideration.

21 DR. LETELLIER: Let me introduce one more
22 observation from the tests that are not so conclusive.
23 When we tried to confirm the dissolution rates at high
24 temperature, we assumed that corrosion would happen in
25 a more or less uniform manner until you reached that

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1 saturation, and then the precipitate would form.

2 But, in fact, we never reached saturation.
3 We started to produce a secondary corrosion product
4 that recrystallized on the metallic substrate. And
5 this may be an artifact of our very quiescent beaker
6 where, in fact, you cannot remove the dissolved metal
7 that's free to enter the solution. You're dominated
8 by local concentration effects.

9 But, in fact, the corrosion is evident at
10 high temperature. Shiny zinc granules turn black, and
11 they tend to gain mass, in effect, leading us to
12 suspect that there's a secondary chemical reaction
13 that's binding either nitrogen from the air, dissolved
14 air, carbon from the air, oxygen, something -- and
15 we're working to analyze the composition.

16 CHAIRMAN WALLIS: When they oxidize in
17 this solution, they take the oxygen from something,
18 presumably.

19 MEMBER KRESS: OH.

20 DR. LETELLIER: From the water.

21 CHAIRMAN WALLIS: What's left behind?

22 MEMBER KRESS: H₂.

23 DR. LETELLIER: These corrosion products
24 have a very interesting crystalline structure. There
25 are a couple of different formations. The very -- the

1 small fine platelets that are well organized crystal
2 structure, and there's an alternative which is the
3 large puff balls, for lack of a better word.

4 The compositions of those two crystals are
5 very similar. We've done an electron X-ray spectrum
6 analysis as a byproduct of the electron micrograph.
7 You get an excitation signature from electron shells,
8 and you can look at the X-ray spectrum and identify
9 composition. And we've done some of that.

10 I didn't choose to present it, but it's
11 helping us understand the composition in hopes that
12 we'll pin down the formation -- the mechanism for
13 formation.

14 CHAIRMAN WALLIS: Is this the picture of
15 the black stuff on the tiny zinc particles?

16 DR. LETELLIER: Yes.

17 CHAIRMAN WALLIS: So the size of this is
18 actually still small compared with the particle
19 itself. The size of these --

20 DR. LETELLIER: The scale of the white bar
21 at the top is 20 microns.

22 CHAIRMAN WALLIS: But the size of these
23 growths --

24 DR. LETELLIER: Very small.

25 CHAIRMAN WALLIS: -- barnacles and all,

1 they're very much smaller than the size of the big
2 particle itself.

3 DR. LETELLIER: Yes.

4 CHAIRMAN WALLIS: So it's not as if it
5 grows very big as a result of this.

6 DR. LETELLIER: That's correct. And,
7 unfortunately, this material is quite frangible. It
8 comes off. It's brittle, and it -- depending on
9 further testing, it may represent a new debris source.

10 CHAIRMAN WALLIS: Another concern, you
11 know, might be if it enabled the particles to hook up
12 together or something, if you stick them together,
13 make some other structure.

14 DR. LETELLIER: Perhaps.

15 CHAIRMAN WALLIS: Anyway, very
16 interesting.

17 DR. LETELLIER: So our status to date --
18 we've essentially completed all of the experiments
19 that we had proposed under the current scope, and now
20 we're documenting our results that will be released as
21 a NUREG in the October timeframe.

22 There are significant uncertainties
23 related to corrosion at high temperature. We have two
24 hypotheses that -- either the dissolution is happening
25 so quickly that you reach saturation and immediately

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1 deposit into crystals, or you're dominated by surface
2 chemistry. You have a heterogenous reaction occurring
3 that's dominated by the local concentration.

4 MEMBER KRESS: The 11 grams per hour per
5 unit area, does that come from extrapolating the
6 erroneous curve from lower -- a lower temperature?

7 DR. LETELLIER: I suspect that it might,
8 and that's the reason that we felt it --

9 MEMBER KRESS: You can miss those pretty
10 much, depending on how much of the bottom part of the
11 curve you have.

12 DR. LETELLIER: We felt it necessary to
13 confirm those rates before we proceeded with our
14 assessment of vulnerability.

15 MEMBER KRESS: Yes. But you're quite
16 right. These local effects could -- local
17 concentrations could have a big effect.

18 DR. LETELLIER: And I think we could do a
19 better job of this measurement, corrosion rate
20 measurement, if we had a flowing system.

21 MEMBER KRESS: Yes. Stick a stirrer in
22 your beaker.

23 DR. LETELLIER: Yes.

24 MEMBER FORD: The other thing is that
25 you're using zinc as a -- correlated to zinc chromate.

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1 Although some paints do have metallic zinc in them,
2 not many do. It's not zinc chromate. There's an
3 inhibitor, and so you're merely fooling yourselves by
4 doing your experiments on metallic zinc.

5 But, you know, it would --

6 DR. LETELLIER: We're also concerned about
7 the galvanized cable trays, which represents an
8 additional source of zinc.

9 MEMBER FORD: That would be metallic, too,
10 although not entirely. If it's a more modern plant,
11 it wouldn't be zinc, it would be zinc granules.

12 CHAIRMAN WALLIS: So is there potential
13 here for this thing -- this issue to be sort of
14 resolved by you sending out all of this -- this Reg.
15 Guide, and NEI comes up with a wonderful analysis, and
16 everyone says everything is fine.

17 And then, in a year or two's time, people
18 have done a little more work with this chemistry and
19 have said, "No, it isn't," because the chemical stuff
20 is much more lethal to the screen than all these
21 fibers or in combination with them. Therefore, you've
22 got to start again. Is there a potential for
23 something like that to happen?

24 MR. ARCHITZEL: I'll say that industry
25 said no way. They're not going to go to their VP and

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1 do this with this issue hanging out there. That was
2 what got --

3 CHAIRMAN WALLIS: So nothing is going to
4 happen until the chemical issues are resolved?

5 MR. ARCHITZEL: That was the feedback we
6 got at the workshop.

7 CHAIRMAN WALLIS: That's what we heard
8 from I think Steve Rosen. He said that because you
9 can't understand what's going on, you do nothing.

10 MR. ARCHITZEL: I think that was the
11 comment he made, yes.

12 MR. HSIA: But at this moment, I would
13 like to put a different perspective -- yes, it's true
14 based on the tests we have done so far that there is
15 significant head loss because of the gelatinous
16 material. What we really don't know is how much metal
17 structures or metal parts that could interact with the
18 coolant at lower part of containment.

19 Even the spray comes on -- there are
20 metals up there. We really don't know how long --
21 what the effect is. We know the corrosion will be
22 there, but we don't know whether the corrosion will be
23 carried down and start to react. So there are still
24 a lot of questions.

25 We're not saying at this moment that

1 plants have problems. All we're saying is if you have
2 gelatinous material. So it's very plant-specific.

3 DR. LETELLIER: I'd like to point out also
4 in the handout package on sump operability strategies,
5 on the second-to-the-last page, there is a concept of
6 sacrificial screen area, which might be appropriate to
7 mitigating this problem.

8 CHAIRMAN WALLIS: Yes. There are all
9 kinds of fixes one might devise when one understands
10 enough about what's happening.

11 DR. LETELLIER: Including chemical balance
12 on the lines of phosphate baskets that were introduced
13 for iodine sequestration.

14 CHAIRMAN WALLIS: Right. As long as you
15 don't screw up something else by doing that.

16 DR. LETELLIER: It has to be an integrated
17 safety --

18 CHAIRMAN WALLIS: I think we're coming to
19 the end here. My colleague Dr. Kress has to leave.
20 I'd like to ask him to give us the benefit of his
21 thoughts at this time.

22 MEMBER KRESS: Okay. First off, I do
23 think this is a significant safety issue, and I'm glad
24 to see all of the good technical work that's been done
25 so far.

1 I'm a bit surprised that there is no
2 element of risk-informing this Reg. Guide or risk-
3 informed the rule associated with it. And what I mean
4 by that is I think one could attach probabilities to
5 breaks of different sizes.

6 And if one had, then, an acceptable
7 frequency of these breaks based on the outcome -- and
8 the outcome would probably be as a release of fission
9 products or something in the long-term cooling -- then
10 one might be able to -- if one had an acceptance value
11 on that, one might be able to eliminate many of the
12 break size based on risk considerations, and get down
13 to a size that may be a reasonable size for screens
14 that we may already have.

15 So I'm a bit surprised that I don't see
16 that thinking showing up so far. And along the same
17 vein, I think leak before break would be an input in
18 establishing these frequencies. And I'm surprised not
19 to see that.

20 Another thought is I -- you know, in spite
21 of the comments on reflection off of surfaces, the
22 zone of influence still looks to me like it could use
23 some more thought. I would have guessed, for example,
24 one might have taken the conical shape and just
25 directed it arbitrarily in all different directions

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1 and pick out the direction that gave you the most, or
2 something like that.

3 And I still think it needs some more
4 thought, and I haven't gelled my own thoughts on that.

5 And finally, I think this life stuff you
6 showed on the chemistry has the potential to be a real
7 showstopper. And I think eventually need to put to
8 rest chemical effects.

9 Now, I suspect the kinetics may be too
10 slow for this to be real significant, and so I think
11 it's real important that you get through the kinetic
12 effects and actually pinpoint what the potential
13 danger in that is. But anyway, I think you guys are
14 thinking along the right ways, and looking at very
15 important phenomenon. And I'm glad to see some good
16 technical input going into it.

17 CHAIRMAN WALLIS: Well, that's good, Tom.
18 How about, then, this Reg. Guide -- how does that fit
19 in from the regulatory point of view? Is it going
20 along with all of these -- thinking along the right
21 lines?

22 MEMBER KRESS: You know, I feel a little
23 bit like Steve. I hate to see nothing being done.
24 And the question is, you know, Reg. Guides are usually
25 living documents. You change them, as you learn more

1 and learn more. The question is: when do you stop
2 learning and put out something that's useful?

3 I don't know. That's a regulatory
4 decision, and I don't know if I've got much advice
5 there. But personally, I don't think the Reg. Guide
6 is quite far enough along to be ready to go out. But,
7 you know, I think we need to look at it more and look
8 at the NEI document in combination before we can make
9 that decision.

10 CHAIRMAN WALLIS: Thank you.

11 It's a bit of a chicken and egg situation,
12 isn't it? I mean, you send out the Reg. Guide and ask
13 for all kinds of things, and this may induce people to
14 do the work. Or you can say, well, they're going to
15 adapt the Reg. Guide. We want to see what work they
16 can do before we fit in the Reg. Guide, so the Reg.
17 Guide fits in with it. And you have different
18 strategies that could be adopted there.

19 MEMBER KRESS: Thank you, guys. I have to
20 run.

21 CHAIRMAN WALLIS: Let's see. Tony, do you
22 want to wrap things up, or T.Y., or anyone from the
23 staff?

24 MR. HSIA: The only thing I want to say is
25 thanks for this opportunity. You have pointed us to

1 several important issues we may not have delved in
2 deep enough. We're going to do that, and that's it.
3 I don't have any other concluding comments.

4 CHAIRMAN WALLIS: Thank you.

5 MR. HSIA: Thank you.

6 MR. BUTLER: I feel compelled to make some
7 clarifying statements on what industry is doing to
8 address this issue. I do not want to leave the ACRS
9 with an impression that the industry is not doing
10 anything to address the issue awaiting final
11 resolution on the chemical effects. We are doing a
12 number of actions, what we can do right now with the
13 information we have.

14 We just completed a workshop. We are
15 doing -- individual plants are doing walkdowns to
16 assess their inventory of possible debris sources, to
17 address their layout, to get as much information as
18 they can, such that when they're given a go-ahead to
19 do the evaluation, they can do that.

20 The concern expressed at the workshop
21 mentioned by Tony earlier was that the final
22 resolution, the final fix, it would be very difficult
23 to go to a VP right now and say, "We need to install
24 a 600 square foot passive screen" without knowing the
25 effect of the -- of that solution -- of the chemical

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1 effects on that solution.

2 So without having a little bit more
3 information, we -- you know, we're -- the final
4 resolution may be delayed until we have that
5 information. So what we're going to do is meet with
6 the staff on -- in September to discuss what research,
7 whether it be NRC sponsored or industry sponsored, is
8 necessary to get the answers as quickly as possible.

9 CHAIRMAN WALLIS: Will you have the
10 September -- the guidance you were going to put out
11 ready in September, with this chemical issue as
12 something to be done later? Or what?

13 MR. BUTLER: We're hoping to get that out
14 as -- end of September, maybe a little bit later than
15 that. Whether or not we have the chemical effects
16 addressed in that completely or --

17 CHAIRMAN WALLIS: Okay. So we'll --

18 MR. BUTLER: -- as just a placekeeper --

19 CHAIRMAN WALLIS: We'll have something to
20 look at, then.

21 MR. BUTLER: -- we'll have something to
22 look at, yes.

23 CHAIRMAN WALLIS: As far as the physical
24 effects.

25 MR. BUTLER: Yes. Again, we're not trying

1 to hold this up. In fact, we're trying to speed the
2 resolution up as much as we can, because this is a
3 costly item just to keep following this. So
4 resolution is sought by all parties.

5 Thank you.

6 CHAIRMAN WALLIS: Thank you.

7 So I think I will thank you, presenters,
8 from the staff and from Los Alamos. And I'll turn to
9 my colleagues, yes, for their input.

10 Do you want to start, Peter?

11 MEMBER FORD: Sure.

12 CHAIRMAN WALLIS: Are you ready to go?

13 MEMBER FORD: I thought the Reg. Guide and
14 the associated materials that were given to me, they
15 recognize all of the constituent parameters in the
16 sequence of events leading up to sump blockage and
17 loss of NPSH.

18 I think we recognize all the relevant
19 ones. The only question, of course, is chemical and
20 precipitation. And I agree with Tom; I think that the
21 kinetics of the process may well assure that it is not
22 a major one. It has to be tested.

23 It gives good advice as to how to tackle
24 the analysis of the various specific effects,
25 individual effects, in the debris source and

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1 transport, etcetera. My concern is that there is no
2 quantification of the integrated effects between those
3 various parameters.

4 And the validation of that quantification
5 against what was observed at various plants -- and
6 those plants are itemized in this knowledge base
7 report. And, therefore, I can't see how the licensee
8 can demonstrate that they can avoid the failure
9 criteria that is given in Appendix A.3 or the Reg.
10 Guide.

11 The reality is, however, that it will take
12 I think a fair amount of work by the licensees, NEI,
13 EPRI, or whoever it is, to demonstrate that they can
14 meet those criteria in A.3.

15 I'll be very interested to see what NEI
16 comes up with in September as guidance to their
17 customers. I think that the Reg. Guide should be
18 issued now in its current form, with the proviso that
19 work is done by the industry to resolve these
20 outstanding questions.

21 I don't know how that is done, procedure-
22 wise or procedure process. But I think it is a safety
23 issue, and it should be -- we can't just wait forever
24 for these outstanding questions to be answered.

25 CHAIRMAN WALLIS: Thank you.

1 Jack?

2 MEMBER SIEBER: Okay. I'll be brief.
3 This is Rev. 3 of this Reg. Guide, and I am certain
4 there's going to be a Rev. 4, because I don't think
5 that this represents a complete investigation of all
6 of the effects that are important in the sump blockage
7 issue.

8 I don't know, but my feeling is the
9 chemical effects is an important phenomenon. And I've
10 done some work, but I'm struck by the fact that I
11 think that it may be the overriding effect that's
12 based on some simple things that I've seen in my
13 career.

14 And I think it's important when you do it
15 that you actually, instead of looking, for example, at
16 elemental zinc that you test based on the compounds
17 that you will find in containment, so that you get the
18 right reaction instead of saying, "Well, I tried
19 sodium hydroxide and a coupon of zinc, and I didn't
20 get this," or "it took this long to do it." I would
21 rather see you use zinc chromate and actual galvanized
22 coupons of the same stuff that's in the plant as
23 opposed to trying to simplify the experiment. And so
24 I think that that's an important factor.

25 So the question becomes -- do you issue

1 Rev. 3 now, or do you say, gee, we don't know enough
2 about everything that's important; why don't we learn
3 everything that we can, and then issue some final Reg.
4 Guide? And I guess I come down thinking that what's
5 in the Reg. Guide is not incorrect, even though there
6 are some assumptions that folks can question.

7 But it's not incorrect. It may be
8 incomplete, but I think the industry knows that, and
9 the staff knows that. So when I ponder whether or not
10 it should be issued or not, I guess I come down on the
11 side that it ought to be, with the expectation that
12 research has to continue, and that there will be a
13 further revision.

14 And I don't think that you can resolve
15 with certainty whether plants comply with the three or
16 four general design criteria or not until you know a
17 little bit more about these effects. So that would be
18 my opinion.

19 CHAIRMAN WALLIS: Vic?

20 MEMBER RANSOM: Well, I guess I'd like to
21 support what Dr. Kress suggested, that there seemed to
22 be many opportunities for risk-informing this sort of
23 thing, and as opposed to an Appendix K conservative-
24 type approach that's being taken.

25 It also turns out, coming from the west

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1 and all the irrigation ditches that are around and the
2 paper mills and -- as well as sewage plants, I can't
3 believe that you'd want to rule out or be careful not
4 to rule out solutions which include active trash
5 mitigating schemes as well as inactive ones.

6 I mean, with a system where you can
7 essentially eliminate the problem, I don't know how
8 that factors into a plant. That's another issue.

9 But, and a lot of those schemes, too,
10 would eliminate I think the chemical aspect of the
11 problem, if it exists. So whatever is put in the Reg.
12 Guide I think should allow the freedom to employ these
13 kinds of things, if they desire them. So --

14 CHAIRMAN WALLIS: Well, I think I've
15 already said most of the things I would say in
16 summary. I think I agree with what I've heard from my
17 colleagues. It seems to me it's a question of
18 regulatory strategy. We've put out this Guide saying
19 that all of these things need to be considered, and
20 then say wait for industry to respond.

21 My expectation is that they will not be
22 able to respond very well. And then, the question is
23 up, really, to the NRR folks -- what do you do? What
24 do you do in a situation like this where it does have
25 an effect on safety, where there are -- there's even

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1 -- there's chemical questions which no one really
2 knows the answer to yet, which may turn out to be
3 quite significant in terms of the answers they give.

4 So it's a very interesting example of a
5 regulatory situation where some kind of wisdom is
6 called for on the part of people administering the
7 regulations. And that's really where I think we need
8 some good answers, because you can put out the Reg.
9 Guide as it is and say, yes, it's not perfect, it's a
10 living document, but at least it gets things going.

11 And then we can say industry is going to
12 respond. There's also the actions that NRR is taking.
13 It's being played out. I, for one, will be very
14 interested to see how it does play out, and I can't,
15 though, see a sure route to a happy conclusion for
16 everybody.

17 MEMBER SIEBER: Well, it's sort of
18 interesting -- you know, Section B, which is in every
19 Reg. Guide, is implementation. It sets forth the
20 situations where the Reg. Guide will be used, and it's
21 pretty limited here. I think there's three of them.
22 You know, it's 50.59 things, but it doesn't take the
23 form of some generic communications or a bulletin or
24 anything like that that tells a licensee, "You go out
25 and reexamine your sump." Maybe that comes later.

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1 That's another step in the process.

2 And so I think industry, unless some issue
3 comes up that forces them into this Reg. Guide, they
4 could sit back until such time as NRR decides -- or
5 the Commissioners decide -- you know, we want
6 everybody to demonstrate compliance. And they could
7 do that at any time, and, in fact, an inspector in the
8 plant could do that. He could ask for the licensee's
9 calculations.

10 MR. ARCHITZEL: But imposing the Reg.
11 Guide would be a backfit. They would have to go
12 through CRGR, if it's on more than one --

13 MEMBER SIEBER: That's right. And that's
14 why D is written the way it is, I presume, because the
15 first one talks about new construction, plants that
16 aren't built yet. The second one is application of
17 50.59 and, you know -- and so I can see the strategy
18 just from the words that were used.

19 MR. ARCHITZEL: That's 50.59 comment
20 actually comes from 1985 --

21 MEMBER SIEBER: Yes.

22 MR. ARCHITZEL: -- where the issue was it
23 wasn't cost beneficial. But as you do 50.59 changes,
24 consider that in terms of when you're placing out
25 insulation. But in point of --

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1 MEMBER SIEBER: It comes with an extra
2 factor.

3 MR. ARCHITZEL: Right. It's a little
4 different. It's estranged in the Reg. Guide. But the
5 other point is if the committee considers it
6 appropriate to examine -- I mean, Research is going
7 before the CRGR. You could change this into a
8 potential -- it's a lot different. You could do a
9 cost-benefit.

10 MEMBER SIEBER: Yes.

11 MR. ARCHITZEL: It could be considered
12 differently before the CRGR.

13 MEMBER SIEBER: Yes. So, anyway, to me
14 the strategy is sort of obvious as to what it is
15 you're doing. That's okay. You know, that's the way
16 regulation works. That's the way this agency does
17 things, and I don't see anything wrong with it.

18 CHAIRMAN WALLIS: Okay.

19 MR. HSIA: Let me just put in a couple of
20 new pieces of information. The meeting with CRGR is
21 August 26th, and so -- and the meeting -- we are
22 coming back to the full committee on September 11th,
23 and we are meeting with industry on September 10th.

24 So things are going to happen. Decisions
25 will be made and recommendations will be made by a lot

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1 of different people. So we will keep -- fully keep
2 your staff informed. Therefore, you will be informed.

3 And I'm guessing that you will make a
4 decision on this Reg. Guide after the full committee,
5 is that correct?

6 CHAIRMAN WALLIS: Yes. No decisions are
7 made except by the full committee.

8 MR. HSIA: Okay. So by that time, we'll
9 wait and see, see whether there are other inputs.
10 Maybe it can make your decision a little easier. But
11 in any case, it's not an easy one. We realize that.
12 And we thank you for giving us the time.

13 CHAIRMAN WALLIS: Okay. With that, I'd
14 like to close the meeting, and I will do so. We are
15 now adjourned.

16 (Whereupon, at 12:39 p.m., the
17 proceedings in the foregoing matter were
18 adjourned.)
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This is to certify that the attached proceedings
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in the matter of:

Name of Proceeding: Advisory Committee on
Reactor Safeguards
Thermal-Hydraulic Phenomena
Subcommittee

Docket Number: n/a

Location: Rockville, MD

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Wednesday, August 20, 2003

Regulatory Guide 1.82, Revision 3 - "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident"

15)	Introduction	G. Wallis - ACRS	8:30-8:35 am
16)	Opening Remarks	T. Hsia - RES	8:35-8:45 am
17)	Public comments and resolution	T.Y. Chang - RES	8:45-9:15 am
18)	Summary of RG 1.82 / Discussion of accident sequences	T.Y. Chang - RES / B. Letellier - LANL	9:15-10:15 am
	BREAK		10:15-10:30 am
19)	Suggestions for alternative solutions	B. Letellier - LANL	10:30-11:00 am
20)	Closing Comments	T.Y. Chang - RES	11:00-11:15 am
21)	Committee Discussion	G. Wallis - ACRS	11:15 am-12:00 noon
	ADJORN		NOON

Note:

Presentation time should not exceed 50% of the total time allocated for a specific item.

Number of copies of presentation materials to be provided to the ACRS - 35.

**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MEETING OF THE SUBCOMMITTEE ON
THERMAL-HYDRAULIC PHENOMENA
ROOM T-2B3, 11545 ROCKVILLE PIKE, ROCKVILLE, MD
August 19-20, 2003**

ACRS Contact: Ralph Caruso (301) 415-8065
E-mail: rxc@nrc.gov

- PROPOSED SCHEDULE -

Tuesday, August 19, 2003 - Review Standard for Extended Power Uprates

	<u>TOPIC</u>	<u>PRESENTER</u>	<u>TIME</u>
1)	Introduction	G. Wallis, V. Ransom - ACRS	8:30-8:35 am
2)	Opening Remarks	W. Ruland - NRR	8:35-8:50 am
3)	Development of RS-001	M. Shuaibi - NRR	8:50-9:20 am
4)	Containment Review	R. Lobel - NRR	9:20-9:50am
5)	Mechanical Engineering	K. Manoly - NRR	9:50-10:35 am
	BREAK		10:35-10:50 am
6)	Plant Systems	J. Tatum - NRR	10:50-11:20 am
7)	Risk Evaluation,	D. Harrison - NRR	11:20 am-12:00 noon
	LUNCH		Noon-1:00 pm
8)	Material Engineering	T. Sullivan - NRR	1:00-1:30 pm
9)	Reactor Systems	S. Peters, Z. Abdullahi - NRR	1:30-2:15 pm
10)	Human Factors	R. Eckenrode - NRR	2:15-2:45 pm
	** BREAK**		2:45-3:00 pm
11)	Power Ascension/Testing	K. Coyne, R. Pettis - NRR	3:00-3:30 pm
12)	ACRS/Public Comments	M. Shuaibi - NRR	3:30-4:00 pm
13)	Closing	W. Ruland - NRR	4:00-4:15 pm
14)	Committee Discussion	V. Ransom, ACRS	4:15-5:00 pm
	ADJORN		5:00 pm

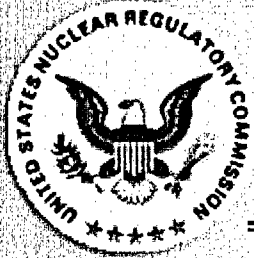


ECCS Sump Operability Strategies

Bruce Letellier

**Design Safety and Risk Analysis Group
Los Alamos National Laboratory**

**ACRS Thermal Hydraulics Subcommittee
Nuclear Regulatory Commission, Rockville, MD
August 20, 2003**



Background for Discussion of “Alternative Solutions”

- Although plant specific responses have not been received, there is the perception that many plants will have to mitigate vulnerabilities
- No formal tasking to investigate mitigation/solution methods
- Proposed strategies offered to stimulate discussion. No claim of practicality, effectiveness, or present NRC endorsement
- Topics represent engineering insights gleaned from GSI-191 research and analysis
- Some proposed strategies may require significant research/test/analysis investment to develop and implement



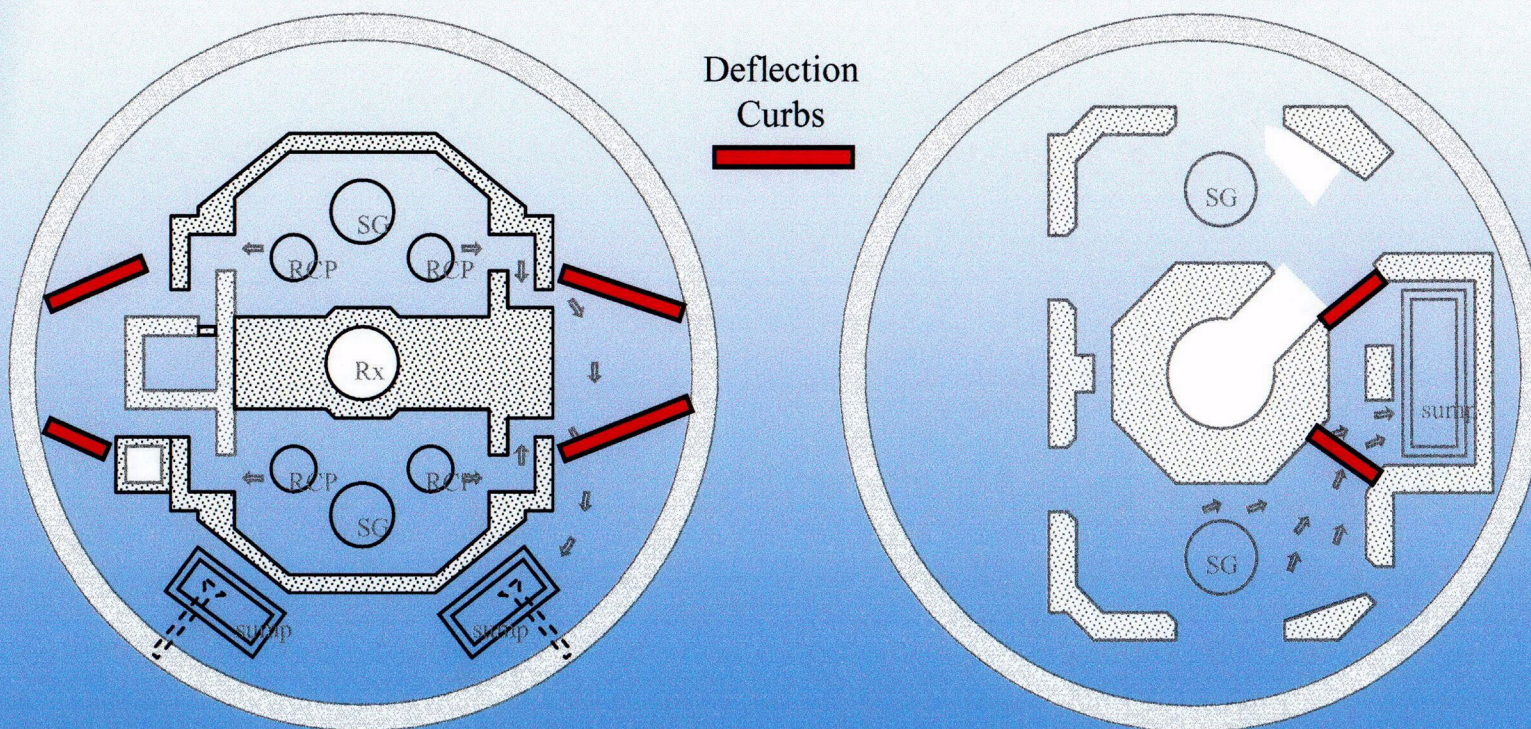
Topics for Discussion

- Debris Diversion During Fill-up
- Sump Screen Design Elements
- Active Debris Removal
- Sacrificial Screen Area
- Integrated Sump Protection Philosophy



Debris Diversion During Fillup

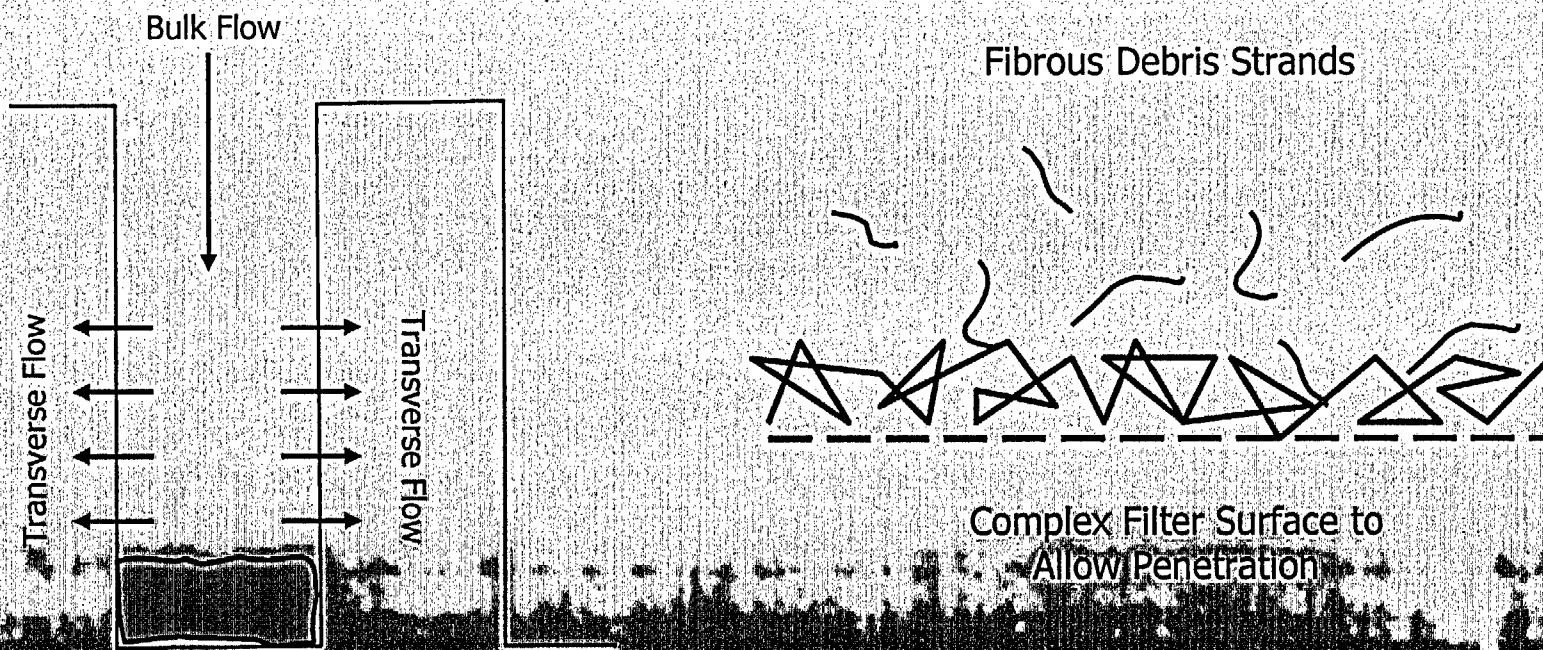
- Debris on the floor during initial spray water drainage may be subject to additional degradation
- Diversion during pool fill up is a good opportunity for long-term capture in quiet pool areas not impacted by spray return





Sump Screen Design Elements

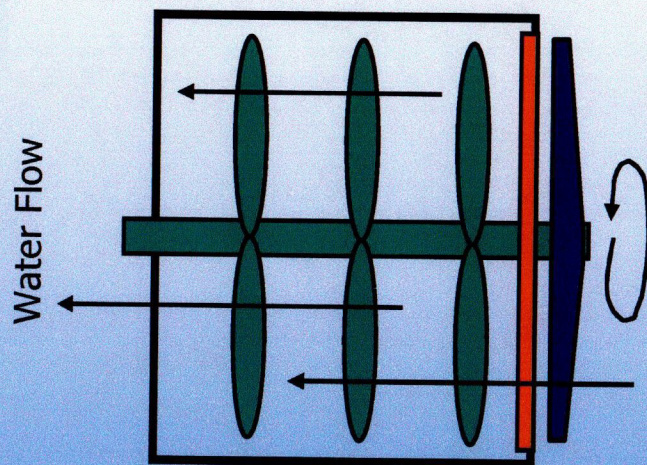
- **Large screen area alone may be insufficient**
 - Transverse flow designs to accommodate large debris volumes
 - Engineered surface to defeat thin-bed formation
 - Crumpled wire mesh or lattice acts as filter medium



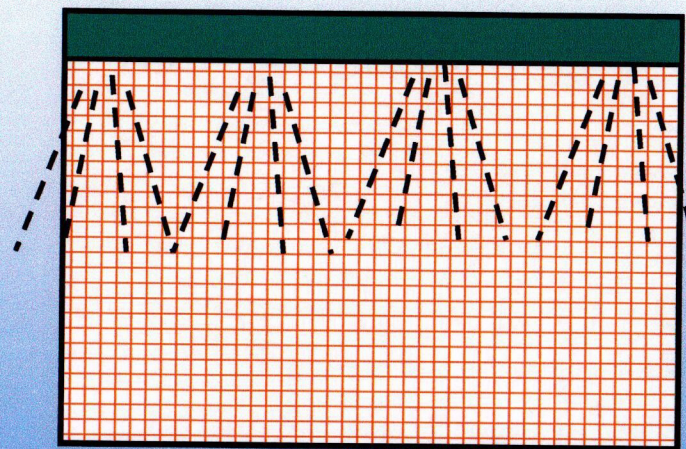


Active Debris Removal

- All concepts should incorporate final debris retention
- Backflush and/or pump cycling
- Continuous or actuated mechanical/hydraulic removal



Flow Driven Scraper

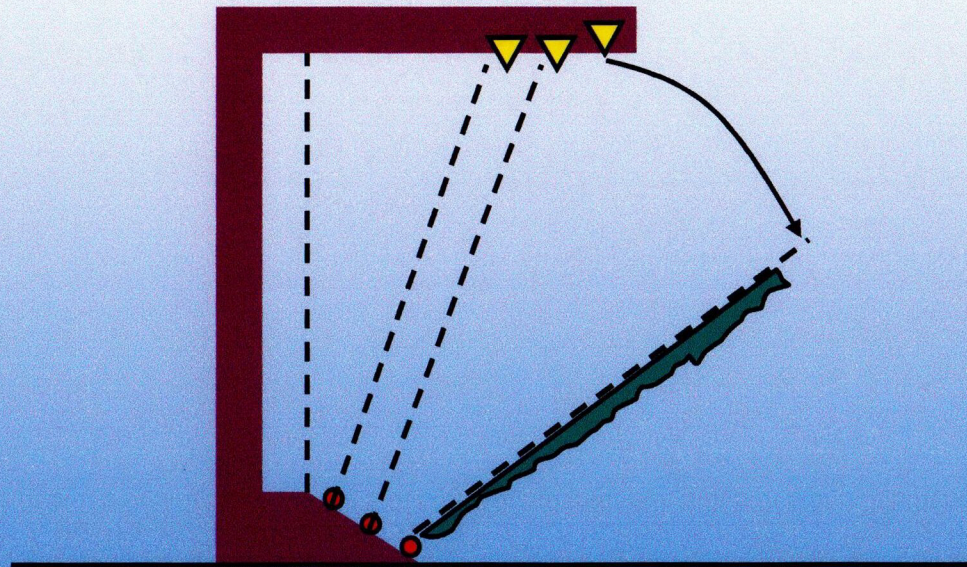


Nozzle Curtain to Divert Debris



Sacrificial Screen Areas

- Take advantage of directed flow toward sumps for permanent debris trapping
- Design screens with multiple layers that can be “removed” or “released” when head loss becomes unacceptable
- Hinge points can be simple channels
- Inner screen can be crenulated vertical surface





Sump Protection Philosophy

- **More water in containment**
 - Procedural modifications to delay recirculation
 - Alternative water sources
- **Careful attention to spray return cascades to design quiet pool zones for long-term debris retention**
- **Plant cleanliness (FME programs)**
- **Sump screen maintenance for proper installation**
- **Casing/banding of vulnerable insulation types**
- **Removal/abatement of vulnerable insulation types**
- **Operator awareness/training of mitigation options**
- **Sump flow diagnostics/instrumentation**



United States Nuclear Regulatory Commission

Regulatory Guide 1.82, Rev. 3 “Water Sources for Long-Term Recirculation Cooling Following A LOCA”

Dr. T. Y. Chang
Division of Engineering Technology
Office of Nuclear Regulatory Research
US Nuclear Regulatory Commission

Dr. Bruce Letellier
Probabilistic Risk Analysis Group
Los Alamos National Laboratory

August 20, 2003



United States Nuclear Regulatory Commission

OVERVIEW

- Background
- Reason for Issuing Rev. 3 and Use of RGs
- RG 1.82, Rev. 3 Activities
- Key Revisions in RG 1.82, Rev. 3
- Resolution of Public Comments on DG-1107
- Summary of RG 1.82 / Discussion of Accident Sequences (NRC/LANL)
- RES Future Activities (GSI-191)



United States Nuclear Regulatory Commission

Background

- Revision 0 – Issued June 1974
 - ☐ NPSH Calculations Based on 50% Blockage of Sump Screen
- Revision 1 – Issued November 1985
 - ☐ Guidance Based on USI A-43 Resolution
- Revision 2 – Issued May 1996
 - ☐ Revised Guidance for BWRs
 - ☐ Requested Licensee to Implement Measures to Ensure ECCS Functions Following LOCA (NRC Bulletin 96-03)
- Revision 3 – Issue September 2003 (Planned)
 - ☐ Revised Guidance for PWRs (GSI-191)



United States Nuclear Regulatory Commission

Reason for Issuing Rev. 3 and Use of RGs

- Contributes to resolution of GSI-191
- RG 1.82 is revised to enhance the debris blockage evaluation guidance for PWRs and to provide guidance of methods acceptable to the staff.
- Research after issuance of Rev. 2 indicated that Rev. 2 was not comprehensive enough to ensure adequate evaluation of a PWR's susceptibility to the effects of debris blockage of debris interceptors.
- RGs are not substitutes for regulations, and compliance is not required.
- Alternative methods different from those in RGs can be proposed and will be considered by the staff for acceptance.



United States Nuclear Regulatory Commission

RG 1.82, Rev. 3 Activities

- Briefed ACRS – 2/03
- Issued DG -1107 For Public Comment – 2/03 to 4/03
- Resolved Public Comments
- Brief ACRS T-H Subcommittee 8/20/03, CRGR 8/26/03, ACRS Full Committee 9/11/03
- Resolve Comments
- Issue RG 1.82, Rev. 3 in 9/03



United States Nuclear Regulatory Commission

Key Revisions In RG 1.82 Rev.3

- Primarily, PWR Sections Revised to Enhance Debris Blockage Evaluation Guidance
 - ☐ Consistent with BWRs Guidance in Rev.2, and,
 - ☐ Insights gained from Research Performed Under GSI -191
- Changes to BWR Sections
(To be Consistent with PWR Sections in RG 1.82, Rev.3, and Staff's Position in Safety Evaluation on BWROG's Utility Resolution Guidance (URG) for ECCS Suction Strainer Blockage, 1998)
- Includes Guidance Previously Provided in RG 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps"



United States Nuclear Regulatory Commission

Resolution of Public Comments on DG-1107

- 89 Comments received
- Comments were from 4 utilities, Westinghouse, NEI and 1 individual
- Comments and concerns raised most frequently
 - ☐ Conformance Issue for current plants (13)
 - ☐ Containment Pressure for Design of ECCS (8)
 - ☐ Screen Mesh Size (4)
 - ☐ Leak-Before-Break for Debris Source (4)
 - ☐ Partially Submerged Screens and Failure Criteria (4)
 - ☐ Basis for 1/8" Thin Bed Value (3)
 - ☐ Adequate Protection from Missiles (3)
 - ☐ Use of CFD and Other Methods for Debris Transport Calculation (2)



United States Nuclear Regulatory Commission

Resolution of Public Comments (con.)

- Conformance Issue for Current Plants (13)

- ☐ **Comments** - How RG will be used for current plants.

Response - D. Implementation made clear that no backfitting is intended or approved. RG will be used in the evaluation of current licensees' methodologies for long-term recirc cooling capabilities of ECCS and CCS following a LOCA.

- ☐ **Comments** - Some current plants have different designs as compared to the RG positions, e.g., multiple sumps.

Response - Section C made clear RG is generic and it may go beyond current designs.

- ☐ **Comments** - RG appears to favor a particular configuration of screens and trash racks for ECCS sump. More advanced design should be allowed.

Response - "Conceptual features" have been added to **Figures 1 and 2**.

C.1.1.1.16 is added to state that it may be desirable to consider advanced strainer designs since they have demonstrated capabilities not provided by simple screen designs.



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Resolution of Public Comments (con.)

- Containment Pressure to be Used for the Design of ECC and Containment Heat Removal Systems (8)

☐ **Comment – C.1.3.1.1** states that ECC and containment heat removal systems should be designed so that sufficient available NPSH is provided to the system pumps, assuming no increase in containment pressure from that present prior to the postulated LOCAs. This is not consistent with the licensing basis for subatmospheric containment plants, which can operate as low as 9 psia air partial pressure.

Response – C.1.3.1.1 has been modified to state that ECC and containment heat removal systems should be designed so that sufficient available NPSH is provided to the system pumps, assuming the maximum expected temperature of pumped fluid and no increase in containment pressure from that present prior to the postulated LOCA. For subatmospheric containments, this guidance should apply after the injection phase has terminated. Prior to termination of the injection phase, NPSH analyses should include conservative predictions of the containment atmospheric pressure and sump water temperature as a function of time.



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Resolution of Public Comments (con.)

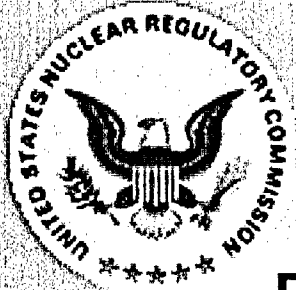
- Screen Mesh Size (4)

☐ Comments -

1. RG states that the mesh size should be smaller than the minimum restrictions found in systems served by ECC sumps. This will lead to much higher pressure drops than current screens and may need screen areas too large to be practical.
2. Long thin debris slivers passing axially through the sump screen and the reorienting and clogging the flow restrictions downstream should be considered.

Response -

1. C.1.1.1.12 is modified to state the size of sump screen opening should be determined considering the flow restrictions of systems served by the ECCS sump, and if mesh size is impractical to be fine enough to filter out particles of debris that may cause damage to ECCS pump seals or bearings, then it is expected that modifications would be made to ECCS pumps or ECCS pumps would be procured that can operate long term under the probable conditions.
2. Agree with comment 2, and a sentence is added to C.1.1.1.12.



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Resolution of Public Comments (con.)

- Leak-Before-Break for Debris Source (4)
 - ❑ **Comment** – RG position in **C.1.3.2** requiring application of large breaks at essentially all locations in the RCS for debris generation based on requirement of 10 CFR 50.46 (the most severe postulated LOCAs should be calculated) is inconsistent with the leak-before-break (LBB) position of GDC 4 of 10 CRF 50, Appendix A.

Response – No change. Staff position was documented in a letter to WOG (6/9/00). Staff position is that LBB is not applicable to LOCA-generated debris. NRC however is in receipt of an NEI request to consider alternatives to a DEGB for debris generation, and this is a policy issue that may result in changes to break size used for debris generation.



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Resolution of Public Comments (con.)

- Partially Submerged Screens and Failure Criteria (4)
 - ☐ **Comment** – RG states that credit should only be given to the portion of the sump screen that is expected to be submerged at the beginning of recirculation. Allowance should be provided for circumstances in which the level of submergence changes substantially following the beginning of recirculation.
 - ☐ **Response** – C.1.3.4.4 has been modified to state that for partially submerged sumps, credit should only be given to the portion of the sump screen that is expected to be submerged as a function of time. Pump failure should be assumed when the head loss across the sump screen is greater than $\frac{1}{2}$ of the submerged screen height or the NPSH margin.



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Resolution of Public Comments (con.)

- Basis for 1/8" Thin Bed Value (3)
 - ☐ **Comment** – This 1/8" thin bed value does not seem to have a supporting technical basis.
 - Response** – C.1.3.2.3 has been modified to reference NUREG/CR – 6224 as the source for the supporting technical basis.



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Resolution of Public Comments (con.)

- Adequate Protection from Missiles (3)

☐ **Comment** – RG states that the trash racks and sump screens should be capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under design-basis flow conditions. Will NRC give consideration to the existence of torturous paths that would prevent direct missile impingement on ECCS suction screens for some PWRs?

Response – C.1.1.1.6 adds a statement that credit for any protection to trash racks and sump screen offered by surrounding structures should be justified.



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Resolution of Public Comments (con.)

- Use of CFD and Other Methods for Debris Transport Calculation (2)

□ Comment – Computational Fluid Dynamics (CFD) simulation method is mentioned by RG as an acceptable analytical approach to predict debris transport within the sump pool. Channel flow method has been used successfully to demonstrate debris transport in both the nuclear industry and other industries, and should be identified as acceptable.

Response – C.1.3.3.4 has been modified to state that alternative methods are acceptable, provided they are supported by adequate validation of analytical techniques using experimental data to ensure estimates are conservative.



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Resolution of Public Comments (con.)

- Clarification on Seismic Event Position (1)

☐ **Comment** – C.1.1.1.8 of RG states that the debris interceptors should be designed to withstand the vibratory motion of seismic events without loss of structural integrity. This section should clarify the possible seismic event concurrent with a LOCA is typically not postulated, however during the 30 days mission time following a LOCA, a seismic event may be possible. This event would create sloshing and hydrodynamic loads on the strainer assembly.

Response – C.1.1.1.8 has been modified to state that the debris interceptors should be designed to withstand the inertial and hydrodynamic effects that are due to vibratory motion of a safe shutdown earthquake (SSE) following a LOCA without loss of structural integrity.



United States Nuclear Regulatory Commission

Resolution of Public Comments (con.)

- Basis for Size of ZOI (1)
 - ☐ **Comment** – Does NRC intend to scale the size of ZOI for debris generation based on the operating pressure or design pressure for a particular system, or based on the specific total energy of the process fluid for that system?

Response – 1.3.2.2 has been modified to state that the size of ZOI should be consistent with the debris source (insulation, fire barrier material, etc.) damage pressures, i.e., the ZOI should extend until the jet pressures decrease below the experimentally determined damage pressures appropriate for the debris source.



United States Nuclear Regulatory Commission

Resolution of Public Comments (con.)

- Samples of Other Comments

- ☐ **Comment** – NPSH definition is not clear

Response – Def. from ANSI/HI 1.1-1.5-1994, "ANS for Centrifugal Pumps for Nomenclature, Definitions, Applications and Operation" was quoted in Section B, PWRs, and Appendix A, "Guidelines for Review of Water Sources for Emergency Core Cooling."

- ☐ **Comment** – C.1.3.2.6 of RG requires consideration of debris generated by chemical reactions in the pool. Does NRC intend to publish results of study or cite available references?

Response – The staff acknowledges that there are no NRC published references pertinent to consideration of these chemical reactions that can be cited in the RG.

- ☐ **Comment** – In a letter to the staff after the 2/03 meeting, ACRS raised the concern that "The staff should evaluate the possibility that strainers may prove to be so susceptible to debris blockage that alternative solutions may be required to ensure long-term cooling. The staff should invite public comments on this matter."

Response – The staff has added C.1.1.4 to address the possible need for alternative solutions and has specifically invited public comments on the matter in the Federal Register Notice. No comment on this matter was received.



United States Nuclear Regulatory Commission

Summary of RG 1.82 / Discussion Of Accident Sequences

- Debris Sources and Generation
- Debris Transport
 - ☐ Airborne Debris Transport
 - ☐ Washdown Debris Transport
 - ☐ Sump Pool Debris Transport
- Sump Pool Debris Transport
- Sump-Screen Head Loss



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Debris Sources and Generation (C.1.3.2)

- For debris generation calculations, a number of LOCAs of different sizes and locations should be postulated to provide assurance that the most severe postulated LOCAs are calculated.
- Level of severity corresponding to postulated break should be based on potential head loss incurred across the sump screen.
- "Zone of Influence" (ZOI) can be used to estimate amount of debris generated by a postulated LOCA.
- In some designs, postulation of break locations in main steam (MS) and main feedwater lines (MF) may be needed to determine the most limiting conditions for sump operation.
- All potential debris sources should be considered within the ZOI.



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Debris Sources and Generation (Con.)

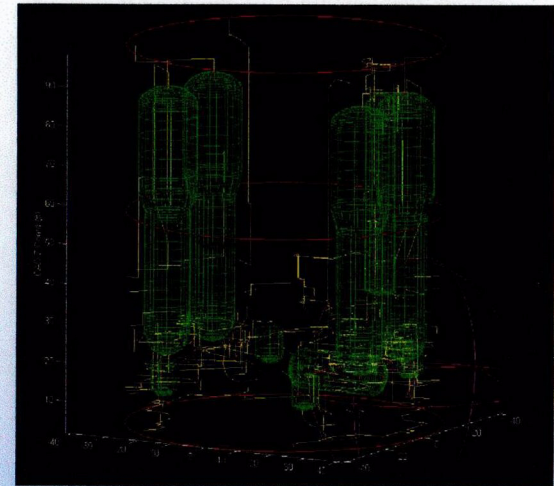
- As a minimum, break locations should be at:
 - ☐ RCS (and MS, MF if needed from licensing basis) with the largest amount of potential debris within the postulated ZOI
 - ☐ Large breaks with 2 or more different types of debris within the expected ZOI
 - ☐ Breaks in areas with the most direct path to sump
 - ☐ Medium and large breaks with the largest potential particulate to insulation ratio by weight
 - ☐ Breaks that generate fibrous debris that could create the "thin-bed effect" at sump screen



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Debris Generation – Break Location

- Spatial model/drawings of plant piping essential unless 100% damage of insulation inventory is assumed
- Breaks in all systems that lead to recirculation requirements
- Break severity defined in terms of potential head loss implies “break-to-blockage” transport anal.
- Acceptable Methods:
 - BWR precedent for assumed 100% damage of insulation inventory
 - Precedent for point-by-point break analysis set by NUREG/CR-6224, BWR resolution audits, Volunteer Plant Study, existing commercial analysis tools
 - Spatial model details may be simplified by considering grouping of insulation type, location, etc.





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Debris Source References

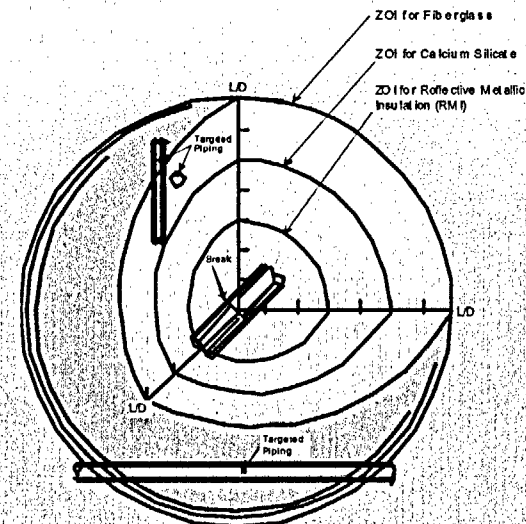
- NUREG/CR-2403 "Survey of Insulation Used in Nuclear Power Plants and the Potential for Debris Generation," 1981.
- NEI-Conducted Plant Survey
 - NUREG/CR-6762, Vol. 2, "GSI-191 Technical Assessment: Summary and Analysis of U.S. Pressurized Water Reactor Industry Survey Responses and Responses to GL 97-04," 2001.
- Section 2 of Knowledge Base Report describes sources of debris including past history of debris removed from plants.
 - NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," 2003.



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Debris Generation – Zone of Influence

- Shock wave and jet pressures should be the basis for estimating the amount and size distribution of debris
- Jet pressures should be determined by analysis or experiment
- Material-specific damage pressures should be determined by experiment with default total damage. Data base *not* all inclusive



Note:
L = Distance from break to target
D = Diameter of broken pipe

Acceptable Methods:

Pressure-equivalent spherical damage zones without truncation

- NUREG 6224, BWROG URG and NRC's Staff Evaluation of URG

Pressure-conserved deflected damage zones with analysis or experiment

- Original calculation of jet pressure contour volumes using ANSI/ANS and EPRI jet models



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Debris Generation References

- A three-zone spherical destruction model was introduced before 1985.
 - NUREG-0897, "Containment Emergency Sump Performance," Technical Findings Related to Unresolved Safety Issue A-43, 1985.
- The three-zone spherical model was adapted for the NUREG/CR-6224 study.
 - NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris," 1995.
- BWROG URG
 - NEDO-32686, Rev. 0, "Utility Resolution Guidance for ECCS Suction Strainer Blockage," 1996.
 - NRC-SER-URG, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Bulletin 96-03 Boiling Water Reactor Owners Group Topical Report NEDO-32686, 'Utility Resolution Guidance for ECCS Suction Strainer Blockage,'" Docket No. PROJ0691, 1998.
- The parametric evaluation employed a spherical ZOI model.
 - NUREG/CR-6762, Vol. 1, "GSI-191 Technical Assessment: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance," 2002.
 - NUREG/CR-6762, Vol. 3, "GSI-191 Technical Assessment: Development of Debris-Generation Quantities in Support of the Parametric Evaluation," 2001.
- Methodologies summarized in NUREG/CR-6808



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Debris Transport (C.1.3.3)

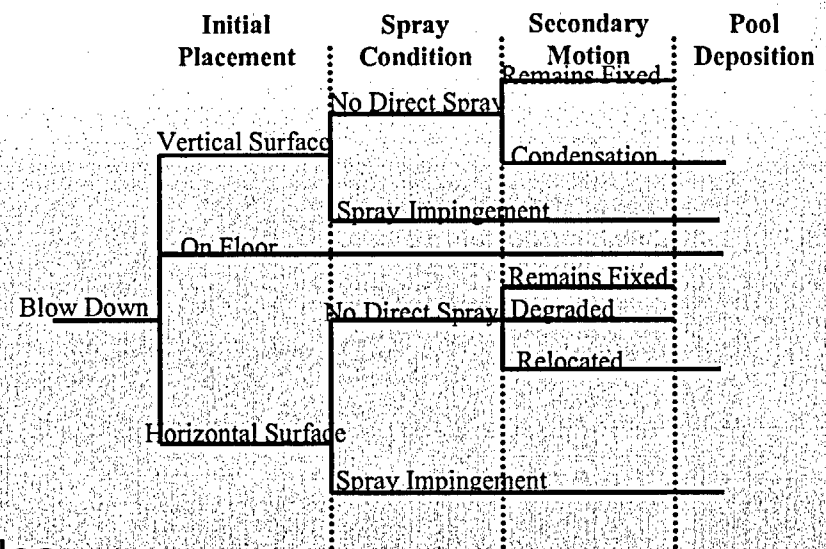
- Debris transport analyses should consider each type of insulation and debris size.
- 3 types of debris transport should be considered for debris sources to the sump screen: airborne, washdown, and sump pool debris transport.
- In lieu of performing analyses for airborne, washdown and sump pool debris transport, it could be assumed that all debris will be transported to the sump screen.
- If all drains leading to the sump could become blocked or inventory holdup could happen with debris on screen, the consequence could be worse than 100% transport, and should be assessed.



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Transport – Blowdown/Washdown

- Debris initially dispersed by depressurization flow with inertial impaction and eventual settling
- Spray impingement and drainage
 - Scavenge remaining airborne
 - Direct wash of structures/equip
 - Entrainment/Trapping during drainage (BWR data on gratings)
 - Erosion from direct spray impingement and drainage cascades



- Acceptable Methods:
 - No integrated numerical models specific for debris transport
 - Debris disposition charts with fractions based on data/judgment as peer reviewed by BWR Phenomena Identification and Ranking Table (PIRT)



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Airborne/Washdown Debris Transport Refs

- BWR Drywell Debris Transport Study provided transport methodology with BWR results adaptable to PWR (the BWR PIRT panel study was reconvened to peer review the methodology and results).
 - NUREG/CR-6369, Volume 1, "Drywell Debris Transport Study," U.S. Nuclear Regulatory Commission, 1999.
 - NUREG/CR-6369, Volume 2, "Drywell Debris Transport Study: Experimental Work," 1999.
 - NUREG/CR-6369, Volume 3, "Drywell Debris Transport Study: Computational Work," 1999.
- BWROG URG provided BWR Guidance that could support PWR resolution.
 - NEDO-32686, Rev. 0, "Utility Resolution Guidance for ECCS Suction Strainer Blockage," 1996.
 - NRC-SER-URG, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Bulletin 96-03 Boiling Water Reactor Owners Group Topical Report NEDO-32686, 'Utility Resolution Guidance for ECCS Suction Strainer Blockage,'" Docket No. PROJ0691, 1998.
- Methodologies summarized in NUREG/CR-6808 knowledge base.



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Sump Pool Debris Transport (C.1.3.3)

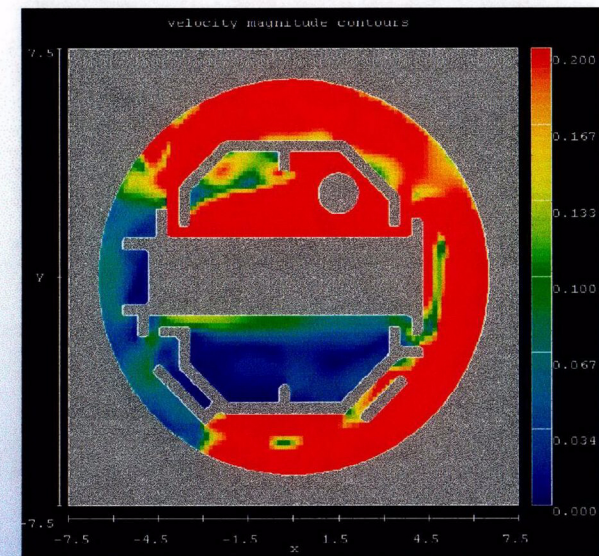
- Containment sump pool debris transport should include: (1) debris transport during pool fill-up phase and recirculation phase; (2) the turbulence in the pool caused by the flow of water, water entering the pool from break overflow, and containment spray drainage; and (3) buoyancy of the debris.
- Debris should be considered in the transport analyses are: (1) debris that would float along the pool surface; (2) debris that would remain suspended due to pool turbulence; and (3) debris that readily settles to the pool floor.
- CFD simulation in combination with the experimental debris transport data is an acceptable approach to predict debris transport within the sump pool. Alternative methods are acceptable provided they are supported by adequate validation of analytical techniques using experimental data to insure that the debris transport estimates are conservative with respect to the quantities and types of debris transported to the sump screen.



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Transport – Sump Pool

- Debris washed down in spray drainage vulnerable to degradation and transport (integrated tank test examples)
- Debris on floors sequestered during fill up from spray drainage generally not vulnerable to degradation or transport
- Steady-state velocity patterns with break flow and spray drainage identify stable zones for long-term debris retention
- Linear flume tests characterized incipient flow and settling velocities for major debris types
- Computational Fluid Dynamics, Sheet-flow approximations of fillup, and Open-Channel Network Flow models of steady-state velocity patterns provide a basis for informed decisions regarding transport fate
- Uncertainties in location and timing of debris entering pool limit the need for a high fidelity model of debris transport





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Transport – Sump Pool

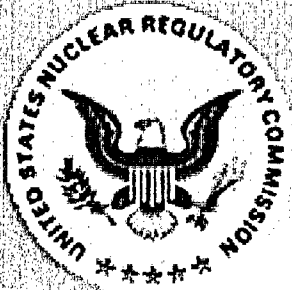
- Acceptable methods:
 - CFD or simplified sheet-flow analysis of fill up patterns
 - CFD or network flow analysis of steady-state flow patterns
 - No integrated transport models specific for sump-pool debris transport
 - Transport logic charts based on conservative judgment and data
 - Incipient flow velocities of debris and area fractions above threshold
 - Peer reviewed articles on CFD modeling of scaled tank tests
 - Logic chart to combine calculated flow velocity with test data.



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Sump Pool Debris Transport References

- **During the resolution of USI A-43, sump pool analyses were performed and a few small scale tests were conducted.**
 - NUREG-0897, "Containment Emergency Sump Performance," Technical Findings Related to Unresolved Safety Issue A-43, 1985.
- **Some BWR resolution data applicable to PWR (e.g., debris settling data).**
 - NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris," 1995.
 - NUREG/CR-6368, "Experimental Investigation of Sedimentation of LOCA-Generated Fibrous Debris and Sludge in BWR Suppression Pools," 1995.
- **NRC has conducted small-scale tests to provide data to support debris transport models.**
 - NUREG/CR-6882, "GSI-191: Separate-Effects Characterization of Debris Transport in Water," 2002.
 - NUREG/CR-6773, "GSI-191: Integrated Debris Transport Tests In Water Using Simulated Containment Floor Geometries," 2002.
- **NRC has evaluated important processes and phenomena.**
 - LA-UR-99-3371, "PWR Debris Transport in Dry Ambient Containments—Phenomena Identification and Ranking Tables (PIRT)," 1999.
 - LA-UR-99-5111, "PWR Debris Transport in Ice Condenser Containments - Phenomena Identification and Ranking Tables (PIRT)," 1999.
 - Testing as documented in NUREG/CR-6882 and NUREG/CR-6773
 - Phenomena summarized in NUREG/CR-6808 knowledge base
- **Peer reviewed Nuclear Technology articles**
 - Maji, et al., "LOCA-Generated Debris and Their Transport Characteristics," vol 139, Aug 2002.
 - Maji, et al., "Transport Fractions of LOCA-Generated Debris in Scaled Containment Geometries," (forthcoming)



United States Nuclear Regulatory Commission

Sump-Screen Head Loss (C.1.3.4)

- For fully submerged sump screens, NPSH available to ECC pumps should be determined using the conditions specified in the plant's licensing basis.
- For partially submerged sumps, Appendix A of this guide states that NPSH margin may not be the only failure criterion. In this case, credit should only be given to the portion of sump screen that is expected to be submerged as a function of time. Pump failure should be assumed to occur when the head loss across the sump screen is greater than $\frac{1}{2}$ of the submerged screen height or the NPSH margin.
- Estimates of head loss caused by debris blockage should be developed from empirical data based on the sump screen design, postulated combination of debris, and its approach velocity. The thin-bed effect on head loss should be considered.

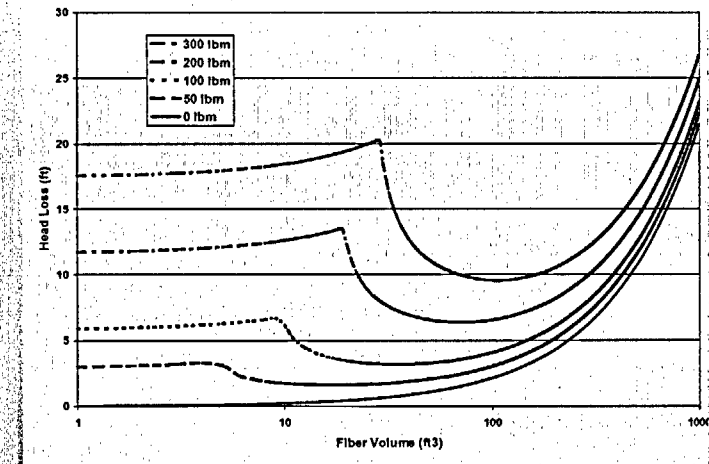


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Sump-Screen Head-Loss

- UNM testing confirmed that 6224 head-loss correlation is robust for vertical screens and square mesh for specific debris types
 - Not applicable for high loadings of Cal-Sil or chemical precipitants
- Tests and reports provide an example of analytical technique. Material testing *not* all inclusive
- Correlation implemented in BLOCKAGE PC-utility
- ½ submerged screen depth failure criterion for partially submerged screens unique to PWR

NUREG 6224 Head Loss Analysis



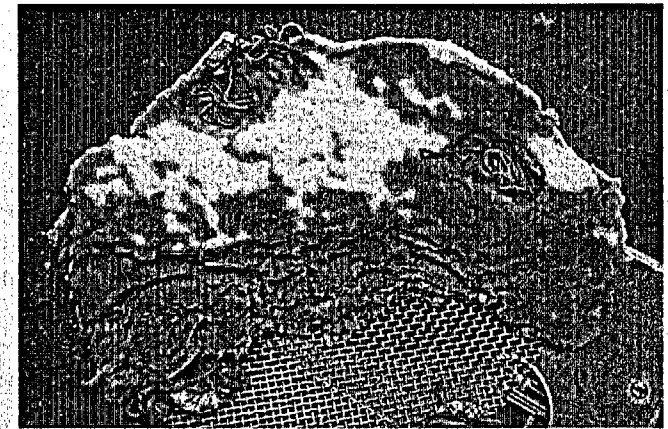
$$\frac{\Delta P}{\Delta L} = \alpha(\epsilon)\mu U + \beta(\epsilon)\rho U^2$$



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Sump-Screen Head-Loss

- Acceptable Methods:
 - Application of the 6224 correlation *with* appropriate material properties
 - BLOCKAGE or similar implementation
 - Validation of alternative correlations through comparable test procedures
 - Performance tests of screen designs comparable to BWR resolution



Cal Sil + Fiber Debris Bed



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Sump Screen Head-Loss References

- BWR Resolution Research
 - NUREG/CR-6224 head loss correlation
 - NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris," 1995.
 - NUREG/CR-6367, "Experimental Study of Head Loss and Filtration for LOCA Debris," 1995.
 - BWROG Research
 - URG
 - SER-URG
- NRC PWR Research
 - Calcium Silicate head loss report (forthcoming)
- Head loss testing and analyses summarized in NUREG/CR-6808 knowledge base



United States Nuclear Regulatory Commission

RES Future Activities (GSI-191)

- Near Term (before 10/03)
 - ☐ Cal-Sil Head Loss Test Report
 - ☐ Chemical Test Report
- Long Term (up to 9/04)
 - ☐ Debris Sample Characterization for PWRs
 - ☐ Additional Head Loss Tests
 - ☐ HPSI Throttle Valve Clogging Issue
 - ☐ International Workshop, Feb/March 2004, Albuquerque, NM
- All RES activities scheduled to be completed by end of FY 04