

NUCLEAR REGULATORY COMMISSION

ORIGINAL

Title: Advisory Committee on Reactor Safeguards
Materials and Metallurgy Subcommittee
Steam Generator Action Plan

Docket Number: (not applicable)

PROCESS USING ADAMS
TEMPLATE: ACRS/ACNW-005

Location: Rockville, Maryland

Date: Wednesday, September 26, 2001

Work Order No.: NRC-032

Pages 1-166

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MATERIALS AND METALLURGY SUBCOMMITTEE
STEAM GENERATOR ACTION PLAN

(ACRS)

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WEDNESDAY

SEPTEMBER 26, 2001

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ROCKVILLE, MARYLAND

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The ACRS Materials and Metallurgy

Subcommittee met at the Nuclear Regulatory Commission,
Two White Flint North, Room T2B3, 11545 Rockville
Pike, at 8:31 a.m., Dr. F. Peter Ford, Chairman,
presiding.

COMMITTEE MEMBERS PRESENT:

DR. F. PETER FORD, Chairman

DR. MARIO V. BONACA, Member

DR. THOMAS S. KRESS, Member

DR. DANA POWERS, Member

DR. WILLIAM J. SHACK, Member

DR. JOHN D. SIEBER, Member

1 ACRS STAFF PRESENT:

2 NOEL F. DUDLEY,

3 ACRS Cognizant Staff Engineer

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I-N-D-E-X

	<u>AGENDA ITEM</u>	<u>PAGE</u>
1		
2		
3	Opening Remarks by the Chairman	4
4	Introductory Remarks by Mr. Sullivan	6
5	Presentation by M. Banerjee on Status of	8
6	Steam Generator Action Plan	
7	Presentation by Steve Long on	23
8	Status of Action Plan DPO Issues	
9	Presentation by Ted Sullivan on NEI 97-06	26
10	Presentation by Kenneth Karwoski on	70
11	Overview of South Texas Steam Generator	
12	Tube Integrity Issues	
13	Presentation by Joseph Muscara on SG	105
14	Action Plan	
15	Presentation by Charles Tinkler on	135
16	Overview of Severe Accidents	
17	Presentation by Stephen Bajorek on	145
18	Thermal Hydraulics	
19	Presentation by Christopher Boyd on	153
20	CFD Predictions	
21		
22		
23		
24		
25		

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

(8:31 a.m.)

CHAIRMAN FORD: The meeting will now come to order. This is a meeting of the ACRS Subcommittee on Materials and Metallurgy. I am Peter Ford, Chairman of the Subcommittee.

ACRS Members in attendance are William Shack, Mario Bonaca, Thomas Kress, John Sieber, and Dana Powers, and hopefully Steve Rosen.

The purpose of this meeting is to discuss the status of the staff's Steam Generator Action Plan and South Texas, Unit 2, steam generator tube leakage, and to decide what further ACRS reviews should be scheduled.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate the proposed positions and actions, as appropriate, for deliberation to the full Committee. Noel Dudley is the Cognizant ACRS staff engineer at this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on September 11th, 2001.

A transcript of the meeting is being kept, and will be made available as stated in the Federal

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1 Register Notice. It is requested that speakers first
2 identify themselves and speak with sufficient clarity
3 and volume so that they can be readily heard.

4 We have received no written comments or
5 requests for time to make oral statements from members
6 of the public regarding today's meeting.

7 The staff issued the Steam Generator
8 Action Plan on November 16, 2000. The Action plan
9 consolidated half a dozen or more staff regulatory
10 activities related to steam generator tube integrity.

11 The staff updated the Action Plan on May
12 11th, 2001, to include items associated with the
13 differing professional opinion associated with steam
14 generator tube integrity.

15 After hearing the staff's presentation, we
16 will develop recommendations on what activities we
17 want to review and comment on, and when we should
18 schedule those reviews.

19 We will now proceed with the meeting, and
20 I call upon Maitri Banjeree, of the Division of
21 Engineering, Office of Nuclear Reactor Regulation, to
22 begin.

23 DR. SHACK: Before we start, Mr.
24 Chairman, I should mention that I have a conflict of
25 interest here because Oregon is doing work on steam

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1 generators for the NRC.

2 CHAIRMAN FORD: A;ll right.

3 DR. POWERS: Is that why they keep falling
4 apart all the time?

5 CHAIRMAN FORD: Oh, I'm sorry.

6 MR. SULLIVAN: My name is Ted Sullivan,
7 and Maitri is the next speaker. I will just take a
8 minute and spent a little bit on the introduction to
9 give you a little bit more information on what we are
10 going to be doing this morning.

11 Maitri is our first speaker, and she is
12 going to be giving an introduction to the steam
13 generator action plan, and basically tell you what
14 some of the early activities were that led to the
15 development of the action plan, and what it considers,
16 and what it doesn't consider.

17 One of the major elements in that action
18 plan is NEI 97-06, which is our steam generator
19 regulatory framework initiative that we have been
20 working on for quite some time.

21 So I am going to get up after Maitri and
22 give a presentation on the status of that, and the
23 issues that we are currently dealing with that are
24 holding us up from completing that initiative.

25 After the break, Joe Muscara is going to

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1 give a presentation on the DPO related issues in the
2 action plan. His focus is not going to be going
3 through the entire set of issues in that portion of
4 the plan.

5 Rather, he is going to focus more on the
6 near term activities. We thought that would be of
7 more benefit. And then after that, Ken Karwoski is
8 going to do two things. Basically, he is going to
9 discuss two of the action plan items related to the
10 DPO that are NRR responsibilities, as opposed to
11 research.

12 And then he is going to transition into a
13 discussion of what has been going on in the past
14 couple of intervals related to the South Texas use of
15 voltage based repair criteria.

16 And I agree with what you had to say in
17 terms of the objective. I think that we are not going
18 to get into a tremendous amount of detail, as we are
19 covering a lot of material here. So I think it would
20 be good to decide what additional briefings you would
21 like.

22 And certainly in the area of NEI 97-06, we
23 are prepared to get into more detail if you are
24 interested in a subsequent briefing.

25 DR. POWERS: And in what phase of the

1 briefing will we discuss the iodine spiking issue?

2 MR. SULLIVAN: It should be covered in the
3 DPO portion, but Joe, can you address that?

4 MR. MUSCARA: I will have one view graph
5 on the status of the operation.

6 DR. POWERS: Okay. An in-depth
7 discussion, I can tell. This is an easy issue to
8 solve, Joe.

9 MR. MUSCARA: That's what they tell me.

10 CHAIRMAN FORD: Thank you, Ted.

11 MR. KARWOSKI: The first question is are
12 you related to Sanjo Banerjee?

13 MS. BANERJEE: Not that I know of.

14 MR. KARWOSKI: Okay. Then you are okay
15 then.

16 MS. BANERJEE: That's reassuring. My name
17 is Maitri Banerjee, and I am the NRR lead project
18 manager for the steam generator action plan, and I
19 will provide you a short background and overall status
20 of information on the action plan. Can everybody see
21 this slide?

22 All right. Here is a historic overview of
23 the --

24 DR. POWERS: History begins with an IP2?

25 MS. BANERJEE: And of significant actions

1 taken, and that led to the issuance of the steam
2 generator action plan, and this kind of explains
3 itself.

4 The purpose of the plan. As Chairman Ford
5 pointed out the plan was originally issued in November
6 of 2000, and it was issued keeping the NRC performance
7 goals in mind, and in maintaining safety in the IP2
8 area, and renewing public confidence, and also using
9 NRC and stakeholder's resources effectively and
10 efficiently.

11 And the purpose of the plan is to direct,
12 monitor, and track NRC's activities to completion so
13 that we get to an integrated steam generator
14 regulatory framework.

15 DR. POWERS: Can I ask what an integrated
16 regulatory framework means?

17 MS. BANERJEE: Well, I am going to defer
18 answering that question to Ted Sullivan, who is going
19 to talk about NEI 97-06 activities that are going on.

20 DR. POWERS: Well, maybe you can give me
21 an idea of what we are integrating with what.

22 MR. SULLIVAN: My name is Ted Sullivan,
23 and I think what we are trying to do is to make sure
24 that all of the various elements involved in ensuring
25 tube integrity are integrated into a steam generator

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1 regulatory framework that considers more than just,
2 say, inspection and repair issues.

3 But that goes beyond that into all the
4 other disciplines that are involved in ensuring tube
5 integrity. Disciplines related to doing risk
6 assessment, and the research that is developed that
7 feeds into that, and that sort of thing. I think that
8 is the general idea, and the radiological issues.

9 MS. BANERJEE: Do you have any other
10 questions? If not, the action plan consolidates a
11 number of activities, including Indian Point 2 Lessons
12 Learned Task Group Report, and the OIG report that was
13 issued subsequent to that, and then it was revised in
14 May to incorporate the steam generator DPO related
15 issues.

16 And obviously the milestones related to
17 the staff review of NEI 97-06 is in there, and we will
18 make revisions in the future to incorporate milestones
19 for resolution of GSI 163.

20 We also anticipate revisions to
21 incorporate GSI 188 and Draft Guide 1073.

22 CHAIRMAN FORD: Could I just for clarify?
23 The resolution of the steam generator DPO, that is
24 essentially the output from the ad hoc committee,
25 subcommittee from ACRS?

1 MS. BANERJEE: Yes, that's correct, from
2 the NUREG requisition. The steam generator action
3 plan also includes some non-steam generator related
4 issues that came out of the OIG report. They had
5 issues in the EP area, and also that task group's
6 report.

7 And the second bullet is sort of a
8 disclaimer. It says that the action plan doesn't
9 address any plan-specific reviews or industry efforts
10 related to voltage-based tube repair criteria.

11 CHAIRMAN FORD: Is there a reason for that
12 disclaimer? Why the disclaimer?

13 MS. BANERJEE: I guess these are plan-
14 specific issues that are not addressed in the action
15 plan. The action plan is basically what came out of
16 the Indian Point 2 lessons learned task group, and
17 what came out of the OIG report subsequent to Indian
18 Point 2, and also the DPO related issues.

19 And so we didn't go into addressing
20 Generic Letter 95-05, any kind of industry work being
21 done in that area, or any kind of plant-specific
22 licensing work related to voltage-based tube repair
23 criteria.

24 CHAIRMAN FORD: But surely as you go
25 through the action plan, which is your calculations,

1 experiments, and studies, there has got to be a
2 feedback into what the plant is actually doing.

3 MS. BANERJEE: Ultimately, yes.

4 CHAIRMAN FORD: And so when does that
5 occur? That second bullet is saying, hey, we stopped
6 short of actually calibrating our calculations against
7 what is in fact happening. Isn't that a over
8 simplification of what that statement is saying?

9 MR. SULLIVAN: I think what we were trying
10 to say is that there is a lot of plant-specific
11 reviews that are going on. They continually go on.

12 They might have to do with ultimate repair
13 criteria that we maybe reviewing, and what we are
14 basically saying is that they are tracked in other
15 systems, and so we weren't going to track them in the
16 action plan.

17 And then related to the second half of
18 that, they are a number of issues that industry has
19 been asking us to take on, their proposed
20 modifications to GL 95-05, and that in a sense would
21 be relaxations.

22 And the staff's view was that the priority
23 effort should be on the action plan when resources are
24 available, and we will get back to taking those kinds
25 of reviews on. So for the second half of that, it was

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1 really more of a priority of resources matter.

2 MS. BANERJEE: Thank you, Ted. This slide
3 presents an overall status of the action plans.
4 Currently, we have 40 major items, milestones, in the
5 action plan, 11 of which consist or came out of
6 DPO.

7 And 20 of the 40 major milestones are
8 completed, and there is one milestone with a schedule
9 to be determined. This has to do with how we
10 communicate risk to the public.

11 The agency has done some work in the area
12 of communication plan and currently NRR is looking at
13 ways to improve that. And that is the overall status.

14 This slide lists some of the significant
15 activities in the action plan. A regulatory summary
16 was issued in November of 2000, with experience from
17 Indian Point 2 and ANL, and a number of issues were
18 raised by both task groups, and the OIG related to
19 steam generator inspections, GSI inspections.

20 And in response to that the base line
21 inspection procedure was revised. It focuses on the
22 steam generator ISI inspector, in terms of how the
23 licensee is going condition monitoring, and how they
24 are meeting the performance criteria, versus looking
25 at any current testing.

1 A risk informed significance determination
2 process is being developed for ISI inspection results,
3 and NRC's findings related to that, and with inspector
4 training, we will be providing written material,
5 written packages, for inspector training related to
6 the new inspection program in October.

7 And formal training will be provided to
8 the regional inspectors in February. In terms of
9 steam generator tube leakage, technical guidance is
10 being developed and will be provided to the regions
11 some time in the very near future.

12 And this has to do with helping the
13 regional inspectors oversight of PWRs with steam
14 generator tube leak, and help them understand the role
15 of the primary to second leaking monitoring in
16 assuring steam generator tube integrity.

17 And in the area of steam generator
18 performance indicators, we have done some review, and
19 a decision was made not to add any new PI related to
20 steam generators.

21 And our next bullet has to do with
22 conference calls during outages. The NRR staff will
23 continue doing the conference calls with the licensees
24 during -- the selected licensees during the outages,
25 and we will docket the telephone summary.

1 And we will also formally review their ISI
2 results report, which sometimes is called the 90-day
3 report. A steam generator workshop was held with
4 stakeholders in February, and the regulatory
5 information conference also had discussions on steam
6 generator issues.

7 The next slide is a continuation of this
8 slide. Both the task group and the OIG made
9 recommendations for some improvements to NRR's process
10 for license amendment reviews, and changes were made
11 in response to that.

12 As I mentioned before, NEI 97-06, Ted
13 Sullivan will provide a detailed discussion on that.
14 Subsequent to Indian Point 2, as you all know, the
15 staff stopped its review of NEI 97-06, and we
16 recommenced in January of this year.

17 And so a lot of activities are going on in
18 that area. And then a web page was developed and
19 being maintained for internal and external access.
20 And risk communication, that has already been
21 mentioned on what we are doing.

22 And milestones for ACRS' recommendation on
23 the DPO, and we have a much more detailed presentation
24 by Jim Muscara as Ted mentioned; and the last bullet,
25 as I mentioned before, are future activities.

1 CHAIRMAN FORD: Is there a particular
2 reason why this NEI 97-06 was put on hold?

3 MR. SULLIVAN: Dr. Ford, I am going to be
4 getting into that. I plan to cover your question.

5 CHAIRMAN FORD: Okay.

6 MS. BANERJEE: This slide is on the
7 management of the action plan. We will formally
8 document completion of each major milestone, and we
9 will be coordinating a resolution of issues with
10 external and internal stakeholders. Like all of our
11 meetings with NEI, they are open to the public.

12 And the status of the milestones are
13 updated, and a complete copy of the milestones is
14 maintained in NRR's Director's Quarterly Status
15 Report, and an abbreviated version in is the CTM.

16 The CTM is updated monthly and the QSR is
17 updated quarterly. And the overall management of the
18 action plan is the responsibility of the projects in
19 NRR. This completes my presentation.

20 CHAIRMAN FORD: Maitri, as I look through
21 all the milestones and their completion dates,
22 starting back from the earliest of these action plans,
23 a tremendous number of them are way, way behind, a
24 year behind in completion. Is there a reason for
25 this?

1 MR. SULLIVAN: When you say behind, do you
2 mean delayed or do you mean scheduled for some time?

3 CHAIRMAN FORD: Well, in these lists here,
4 I see the targeted completion date, and you are way,
5 way beyond. Like NEI 97-06, there is just one, but
6 there are many others.

7 MS. BANERJEE: Like DPO has a lot of
8 milestones.

9 CHAIRMAN FORD: Well, I am just putting
10 this in general. All of them are way, way behind on
11 schedule. Is there a particular reason for this
12 delay?

13 MS. BANERJEE: As far as I can tell, some
14 of the actions are a little bit behind, but in terms
15 of scheduling those milestones into the distance or
16 future is because of all the activities that needed to
17 be completed before we can get there.

18 And that is a considerable amount of work
19 that needed to be done, especially in the area of the
20 DPO recommendations.

21 CHAIRMAN FORD: So it is manpower and
22 dollar constriction on completing those?

23 MR. SULLIVAN: I think that is true, along
24 with all the other work that was already in place
25 before we developed the action plan.

1 CHAIRMAN FORD: Okay.

2 MR. SULLIVAN: I think the major delays
3 are in the NEI 97-06. A number of other items -- you
4 are right -- they did slip, but usually on the order
5 of not too many months; and the DPO work, I wouldn't
6 characterize it as having been slipped.

7 The schedules were based on the research
8 plans that were pretty much in existence when the ACRS
9 report came out.

10 CHAIRMAN FORD: Okay. Thank you.

11 MS. BANERJEE: Any other questions?

12 DR. POWERS: I am curious about the train
13 of reasoning that went about to decide that there
14 would be no performance indicator for steam generator
15 tubes.

16 And I am perplexed in this area because I
17 remind myself that steam generator tube rupture
18 accidents are risk dominant for a number of plants;
19 and bypass accidents in general are risk dominant.

20 And seldom do you have a more direct
21 indicator of risk than steam generator performance.
22 So what was the rationale that went about not having
23 a PI for steam generator performance?

24 MS. BANERJEE: The way I understand it is
25 that the staff considered three potential Pis. One

1 had to do with tube degradation, and one had to do
2 with integrity of the tube integrity; and another one
3 had to do with primary to secondary leakage.

4 The purpose of a PI is to give you only
5 indications of things going south, and in the case of
6 the first two, they are only information or new
7 information is only available during outages, which
8 happens every 18 to 22 or 24 months.

9 So the staff concluded after a lot of
10 consideration that it doesn't really provide you with
11 an indicator in all cases. And then in terms of
12 primary to secondary leakage, the relationship of the
13 steam generator performance with the leakage is not
14 very clearly established, and we don't even know that
15 it could be established.

16 Because like in the case of Indian Point
17 2, we have not seen a tremendous amount of leakage to
18 happen before an event occurred. So considering all
19 of that, a conclusion was made that at this point we
20 don't have a real good parameter which we can use as
21 an early indicator of problems. Does anybody on the
22 staff want to add more to that?

23 MS. KHAN: I think that summed it up
24 pretty well. By the way, my name is Cheryl Khan, and
25 I work in materials in the chemical engineering branch

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1 in NRR.

2 But that pretty well sums it up as far as
3 the main viewpoints, and as Maitri indicated, the
4 first two that she mentioned didn't really fit the
5 typical type of performance indicator, the parameters.

6 It needs to be an ongoing parameter that
7 you are monitoring continuously; and with respect to
8 the third one, as she indicated, leakage is not
9 necessarily correlated to the real condition of what
10 is going on, and to generate as far as how significant
11 the issue is.

12 And in fact the issue may be more
13 significant compared to the leakages. So it was not
14 felt that that really was an appropriate term to
15 monitor a performance indicator.

16 The ones that we took beyond that was that
17 what the performance indicators would have provided to
18 us was the capability to take some type of actions if
19 there were signs of degradation occurring in the steam
20 generators or issues of significance occurring in the
21 steam generators.

22 And so the way that we tried to address
23 that is through the inspection process in lieu of
24 using performance indicators, because it is typically
25 an either/or.

1 And so through the inspection process the
2 intent is that there are periodic inspections that are
3 being performed under in-service inspection procedure,
4 and it incorporates with the in-service inspection
5 program, as well as steam generator inspection
6 activities.

7 And there are -- there is a means, that
8 dependent on the outcome both of the inspection, the
9 NRC's inspection, as well as what the licensee is
10 finding, that there is the potential to take immediate
11 action, meaning further NRC inspection and
12 involvement.

13 And we felt that was more appropriate,
14 because that is when the degradation and issues would
15 be clearly identified, and then we would be able to
16 take immediate action if they were significant enough.

17 DR. POWERS: So from that I conclude that
18 the first decision was that since we couldn't get
19 information, except for every 18 months or every
20 outage, we would take no PI at all.

21 And that the second one is that because
22 the correlation between leakage and tube condition,
23 which is good enough for the alternate criteria, is
24 not good enough for monitoring the plant?

25 MR. SULLIVAN: Excuse me, but what do you

1 mean by good enough for alternate repair criteria?

2 DR. POWERS: Well, it's used. The
3 correlation is used as part of the alternate repair
4 criteria.

5 MR. SULLIVAN: I think that one of the
6 factors that we considered in terms of primary to
7 secondary leakage was that the information that was --
8 we had originally proposed that we go down that road
9 and look, and what we were advised was that it wasn't
10 necessary to put this in as a performance indicator in
11 order to get that information.

12 We get that information on a daily basis
13 from plants that are experiencing leakage. And we are
14 involved in it in the sense that the regions will
15 typically inform us of when the leakage is increasing,
16 and they are going to have phone calls with licensees,
17 and we get involved in those phone calls.

18 So we really felt that adding a
19 performance indicator in this arena wasn't really
20 going to substantially add to our ability to conduct
21 oversight.

22 MS. BANERJEE: That is one thing that the
23 resident inspectors review in their daily status
24 inspections.

25 CHAIRMAN FORD: Thank you very much.

1 MR. LONG: This is Steve Long, and I am in
2 NRR in the risk assessment group, and I just wanted to
3 add something on the relationship for the performance
4 indicators and the parameters we measure.

5 When the reactor is operating the only
6 thing we are really getting information on is leakage
7 during normal operation. We don't know what the
8 leaking would be if there was an off-normal condition
9 because the off-normal condition isn't there.

10 So it is very hard to relate a very small
11 operational leakage number to anything that will help
12 us figure out what the actual risk at that time is.
13 When we shut down the plants and inspect the plants,
14 then we have good information.

15 And the thing that was not mentioned here
16 that I want to add is that at that point, if there are
17 findings of degradation, we are developing a
18 significance determination process for those findings.

19 Those actions go into the action matrix,
20 like the performance indicators go into the action
21 matrix, for making a decision about how we are going
22 to inspect and regulate the plant.

23 So instead of having a performance
24 indicator that is being updated every three months,
25 and that only be tied to an observation every three

1 months that is not necessarily in any quantitative way
2 tied to the risk, we decided to go with the
3 determination of significance of inspection findings
4 when something is determined not to be needing the
5 performance -- you know, the performance on tube
6 integrity, leak tightness and structural integrity,
7 and that sort of thing.

8 But that information is still going under
9 the action matrix, just like a performance indicator
10 would, and we are still making regulatory decisions on
11 that information. It is a timeliness thing.

12 DR. POWERS: And we don't have a SDP for
13 these findings right now?

14 MR. LONG: That is one of the action
15 matrix -- excuse me, but that is one of the action
16 plan items, and where that stands at the moment is we
17 are just signing out a review of what needs to be
18 done, and some suggestions that are going down to the
19 branch that is responsible for implementing that into
20 procedures. So that is in the process.

21 DR. DUDLEY: Do you have a feel for when
22 that might be available for ACRS review?

23 MR. LONG: It is supposed to be in ADAMS
24 now, but we had a little glitch. It is going to be in
25 ADAMS by the end of the month I promise.

1 DR. POWERS: Yes, but when can we get it?

2 MR. SULLIVAN: I previously introduced
3 myself as Ted Sullivan, and I am going to be talking
4 about NEI 97-06.

5 DR. KRESS: And you are still Ted
6 Sullivan?

7 MR. SULLIVAN: Yes. We have had a number
8 of briefings with the ACRS, and I am going to actually
9 go through that towards the end of this view graph a
10 little bit.

11 I had gone over this, but I thought it
12 would be worth it to spend a very brief time on some
13 background, starting with something that I think we
14 have started all these briefings with, which is to
15 state that the current requirements, particularly as
16 imbedded in the text specs, are prescriptive and out
17 of date.

18 They go back to the '70s. These
19 requirements are not focused on the key objective of
20 ensuring tube integrity for the entire period between
21 in-service inspections.

22 Rather, they are inspection and repair
23 oriented, and they don't focus on the time that steam
24 generators can operate between inspections and
25 maintain safety margins.

1 And recognizing that the staff began
2 initiatives in probably the early '90s, beginning with
3 a rule making initiative in the mid-1990s that turned
4 out not to be a vehicle that we could use.

5 We briefed the ACRS on that in '96, and
6 several times in 1997. We discussed with the ACRS in
7 1997 a change in strategy to a generic letter. We
8 proceeded down that path for probably a year or a
9 year-and-a-half.

10 And at the same time as that was going on,
11 NEI was developing its 97-06 steam generator program
12 guidelines initiative, and I believe in the '98 or
13 early '99 time frame -- I think the '98 time frame --
14 we began discussions with NEI regarding putting the
15 generic letter on hold, and switching our focus to a
16 new regulatory framework based on NEI 97-06.

17 Throughout a lot of 1999, we held meetings
18 and discussions with NEI and other industry
19 counterparts on a generic change package that was
20 being developed. The generic change package is kind
21 of a centerpiece of proposed technical specifications.

22 And we had reached some tentative
23 agreement on drafts of the generic change package in
24 late '99, and NEI then went through its process of
25 issuing it. It was issued on February 4th of 2000,

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1 shortly before the Indian Point-2 tube rupture, less
2 than two weeks before that.

3 I think as Maitri mentioned, we suspended
4 are review after the Indian Point-2 rupture for
5 basically two reasons. One was that our resources
6 were devoted or diverted to Indian Point-2 recovery.

7 A lot of staff resources went into
8 reviewing the restart plans and the operational
9 assessment that Con-Ed was producing and working on.
10 Prior to that, we were reviewing and participating in
11 NRC inspections related to the Con-Ed steam generator
12 inspections.

13 And also some of our staff was diverted to
14 the lessons learned task force. So that was sort of
15 reason number one. Reason number two was that we
16 really wanted to wait and see what came out of the
17 Indian Point-2 lessons learned, and factor them back
18 into the review.

19 So we didn't want to really make a false
20 start. It wasn't that we had a lot of time that we
21 were sitting anyway. The two things came together
22 nicely, but we did deliberately indicate to various
23 constituents that we weren't going to do the review,
24 or commence the review, until the lessons learned
25 study was finished and until we had a chance to look

1 at it.

2 DR. SHACK: Ted, every time we look at a
3 license renewal with a steam generator and we look at
4 GALL, everybody seems to be using 97-06. So that
5 means that they are under a dual sort of system. They
6 use 97-06 for their own tracking and monitoring
7 purposes, and yet they still meet their tech specs
8 also? Is that the way that the system is working now?

9 MR. SULLIVAN: That's correct. Licensees
10 have all committed in a manner that I think Jim Riley
11 could elaborate on if you want, but it is basically an
12 internal industry arrangement that every PWR licensee
13 is committed to implement NEI 97-06 for a couple of
14 years now. And I think it was at the first refueling
15 after January of 1999.

16 DR. SHACK: Now, how many PWRs are
17 actually running under 95-05? That is, at least for
18 their tube support plate degradation, and they are
19 really controlled by 95-05 rather than the old 40
20 percent through wall kind of thing.

21 MR. SULLIVAN: For that mode of
22 degradation, yes. If the controlling document is tech
23 spec amendment dealing with 95-05, and it is on the
24 order of a dozen plants, I am not sure if that is
25 accurate.

1 DR. SHACK: So there is still 600 mil
2 anneal plants that don't use 95-05?

3 MR. SULLIVAN: Yes, there are quite a
4 number, probably on the order of about two-thirds of
5 them, I guess. I mean, I think about half of the
6 plants have replaced roughly, and so that is on the
7 order of about -- between 30 and 35.

8 DR. SHACK: Yes, I was just looking at the
9 Mil Anneal 600 plants, yes.

10 MR. SULLIVAN: And that is what I am
11 talking about. About half still have Mill Anneal 600,
12 and half have replaced, and a dozen of that 30 to 35
13 reactors use generic letter 95-05 for ODSCC tubes or
14 plates.

15 The staff review of the generic change
16 package when we commenced that review included a
17 consideration of issues associated with the lessons
18 learned report.

19 A regulatory issue summary of 2022, which
20 Maitri mentioned, but I will just elaborate very
21 briefly to say that it described technical issues that
22 came out of the staff review of Con-Edison's Indian
23 Point-2 restart assessment, as well as an operational
24 assessment of Arkansas Nuclear Unit-2.

25 And that basically led to a mid-cycle

1 inspection. It was not exactly mid-cycle literally.
2 It was sort of late cycle inspection, an additional
3 inspection, during the summer of 2000.

4 And then we have also considered the DPO
5 action plan issues that were developed in response to
6 the ACRS report. I will go over this briefly as it is
7 nothing new.

8 And even as far back as the rule making,
9 our intent was to put in place a new regulatory
10 framework that has these features that are in bold.
11 That is, that it is performance based, and it
12 establishes performance criteria for ensuring tube
13 integrity and leaking integrity under normal and
14 accident conditions.

15 So I am going to elaborate a little bit
16 more on that later when I get into a brief discussion
17 of performance criteria. Performance criteria are in
18 terms of parameters that are measurable and tolerable.

19 The framework is supposed to be flexible,
20 in that the methods for meeting the performance
21 criteria are up to the licensee. It should be
22 adaptable to changing mechanisms and technology which
23 a prescriptive framework would not be.

24 And it is risk-informed to ensure that no
25 -- that there is no significant increase in risk

1 associated with operational steam generators.

2 CHAIRMAN FORD: If you could just go back
3 to that last slide.

4 MR. SULLIVAN: Sure.

5 CHAIRMAN FORD: Industrial parlance, would
6 you say that this is a stretch goal given the fact
7 that you no longer -- that you don't currently have
8 Pis, forced steam generators as I understand for
9 reasons that were just enunciated.

10 So this is really a wish list, and if I
11 look at the timing on your latest action plan, the one
12 that takes into account the NUREG 17.40
13 recommendations, you are looking several years out.
14 You are looking 2, 3, 4 years out --

15 MR. SULLIVAN: Well, in terms of the
16 framework --

17 CHAIRMAN FORD: before you can have this.

18 MR. SULLIVAN: In terms of the framework,
19 not exactly. I will try and capture the time frame
20 that we have in mind. In terms of the framework
21 itself, we are -- and as I will discuss a little bit
22 later, we are probably not going to completely capture
23 the performance-based element.

24 We will incorporate it, but it won't be
25 strictly non-prescriptive. We still have to work this

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1 through with NEI, and that is -- our current target
2 date for completion is April, and that is probably
3 optimistic.

4 CHAIRMAN FORD: After discussing it with
5 NEI?

6 MR. SULLIVAN: Well, our target date for
7 reaching resolution of NEI 97-06 is April, and I am
8 saying that may be optimistic. After we reach
9 resolution, which will entail some things that I am
10 going to talk about later having to do with issuing a
11 generic safety evaluation and so forth, the individual
12 plants have to send in tech spec amendments to put
13 this in place.

14 The tech spec amendment process could take
15 up to an additional year. So just that alone could
16 potentially take a year-and-a-half to two years. In
17 terms of the risk issues, I don't think we will
18 consider that we fully understand or more completely
19 understand risk until the other issues associated with
20 what I refer to as the 3.X items in the action plan
21 are completed.

22 And the action plan has 1.X, and 2.X, and
23 3.X items. The 1.X are steam generator related, and
24 the issues that came out of the lessons learned
25 report.

1 The 2.X items are the non-steam generator
2 related items that came out of the report; and the 3.X
3 items are the ones that basically relate to the ACRS
4 report on the DPL. So I am not sure if I have
5 confused things by that answer.

6 CHAIRMAN FORD: And I am sure it is
7 because of my lack of understanding of this whole
8 process. But standing back, as I understand it, we
9 have got a whole lot of reactors out there with steam
10 generators that are demonstratively cracking.

11 We are not too sure how to quantify the
12 progress of this cracking because of monitoring
13 discrepancies or restrictions, et cetera, and modeling
14 restrictions all go into this NUREG 17.40.

15 We don't have any Pis to tell us right now
16 on an ROP basis as to how we are doing. And what you
17 are just saying is that this is the wish list of where
18 you want to go, but it is going to be the middle of
19 next year before we have got the NEI thing reviewed,
20 and 97-06 reviewed, and signed off.

21 And the information for this is not going
22 to be around and approved without being used legally
23 if you like until another 5 or 6 years. So what
24 happens in the meantime? What is our backup plan?

25 MR. SULLIVAN: The intent is to put into

1 place a new regulatory framework which I am going to
2 cover in subsequent slides and describe in subsequent
3 slides.

4 CHAIRMAN FORD: I'm jumping in. Sorry.

5 MR. SULLIVAN: And the intent is to get
6 that in place for every PWR within about a year-and-a-
7 half, assuming -- and that schedule is contingent on
8 reaching resolution of the outstanding issues with NEI
9 and the industry. I noticed Jim Riley from NEI is
10 interested in adding to what I have been saying.

11 MR. RILEY: Hi, I am Jim Riley from NEI,
12 and I am NEI's project manager for steam generator
13 issues. I think a real important aspect of what we
14 are doing here is Ted's illusion to an NEI initiative
15 that is set in place.

16 So even though the regulatory framework
17 isn't there right now, and we are all working towards
18 it, the fact is that the plants are inspecting their
19 steam generators to a performance based program based
20 on NEI 97-06, which involves basically all these
21 things that Ted is talking about, the differences, and
22 we don't have the tech specs in place yet that give
23 the regulatory aspects of what we are doing some
24 substance.

25 But in fact the plants are all committed,

1 all the PWRs, to implementing NEI 97-06 and its
2 guidelines that are associated with it.

3 DR. POWERS: And Indian Point-2 was one of
4 those plants that followed this 97-06?

5 MR. RILEY: That's correct. I would like
6 to point out though that at the time that Indian
7 Point-2 did their inspection previous to their problem
8 was 1997, and at that point in time they had not
9 implemented 97-06 because it wasn't in place at that
10 time.

11 CHAIRMAN FORD: Could I ask my colleagues
12 have we seen 97-06?

13 DR. POWERS: Yes.

14 DR. SHACK: Yes.

15 DR. SIEBER: Before you take that slide
16 down, on the second bullet there, how does one
17 determine whether the value of some parameter is
18 tolerable or not tolerable?

19 MR. SULLIVAN: The basic concept there is
20 that we have in place concepts -- and as Jim said, in
21 NEI 97-06, of being implemented -- related to specific
22 performance criteria.

23 For example, the structural integrity
24 performance criteria is that there should be a factor
25 of safety of three times normal operating pressure

1 against burst, and 1.4 times main steam line break
2 pressure.

3 In terms of measuring, the basic concept
4 is that you have a qualified NEI sizing technique, you
5 assess -- and with suitable uncertainties, you assess
6 the condition of the tubes against that criteria.

7 If you don't believe that you have a
8 sufficient understanding of NDE uncertainties, the
9 approach is to prioritize the tubes that are most
10 damaged by this degradation mechanism and do institute
11 testing against those factors of safety, and determine
12 whether or not the performance criteria are being
13 satisfied.

14 In terms of tolerable, the basic concept
15 there is to set the performance criteria such that
16 there is some leeway that if the performance criteria
17 aren't satisfied, you are not falling off a cliff in
18 terms of safety.

19 And in terms of leading to spontaneous
20 tube ruptures or being vulnerable to main steam line
21 break. Do you want to add to that?

22 MR. MURPHY: Yes, I can add to that. This
23 is Emmitt Murphy from the Materials and Chemical
24 Engineer Branch of NRR. I might also add that when
25 considering appropriate performance criteria, we did

1 consider the available information on risk.

2 And we considered some of the findings in
3 NUREG 15-70 pertaining to risk, and which also
4 included an early look at tube rupture accident
5 sequences and their impact on risk.

6 And the conclusion based on the
7 information available at the time was that for plants
8 maintaining margins at the performance criteria that
9 were being proposed that there was not a significant
10 risk issue at that point.

11 So whether you were just slightly below
12 the performance criteria, or you were right at the
13 performance criteria, there is not going to be -- you
14 don't cross a critical risk threshold.

15 DR. SIEBER: Thank you.

16 MR. SULLIVAN: I think one of the major
17 elements of the NEI 97-06 generic change package is
18 the revision to the text spec that is being proposed,
19 and we have worked quite a bit with industry to sort
20 of get on the same page on this issue, and on this
21 part of the change package we are all in agreement on.

22 And that is that it would contain
23 basically three new elements that I have outlined on
24 this view graph. The first is to revise the existing
25 operational leakage tech spec downward from this

1 standard of 500 gpd, which is in the improved
2 standard, to 150 gpd, which a lot of plants already
3 have in their tech specs.

4 And then secondly there would be a new
5 limiting condition for operation, entitled, "Steam
6 Generator Tube Integrity," and that would have a
7 surveillance requirement to verify that the structural
8 integrity and accident leakage integrity performance
9 criteria are met in accordance with the steam
10 generator program.

11 And then a new administrative text spec
12 called "The Steam Generator Program," which I am going
13 to talk about on the next view graph. The new
14 administrative tech spec basically has four elements,
15 or maybe five, but over five different elements.

16 It starts out by saying that a steam
17 generator program shall be established and implemented
18 to ensure tube integrity and performance criteria are
19 maintained. It goes on to require that condition
20 monitoring assessments of the as found condition of
21 tubes be performed to verify that the tube performance
22 criteria that I mentioned previously, the structural
23 integrity and the accident leakage integrity
24 performance criteria, are being maintained.

25 Then it goes on to say that licensees have

1 to use NRC approved performance criteria, even though
2 those performance criteria are located in the industry
3 steam generator program, they have to be ones that are
4 reviewed and approved by the NRC, either generically
5 or plant specifically.

6 And in a similar fashion, the tech spec
7 goes on to say that licensees can only use approved
8 tube repair criteria, and NRC approved repair methods,
9 whether they are again approved generically or plant
10 specifically.

11 And the last section of this tech spec
12 deals with tube inspection reports, and that is not on
13 the view graph, and that has to do with when reports
14 have to be submitted, and what triggers their
15 submission, and what they are to contain.

16 As I mentioned, the details of a steam
17 generator program would be located outside of the tech
18 specs. The tech specs basically say what I just went
19 through.

20 As Jim Riley indicated, licensees -- well,
21 actually this isn't what Jim indicated. This is
22 something different. As part of submitting the
23 generic change package, licensees will commit to
24 developing the steam generator program in accordance
25 with NEI 97-06 guidelines.

1 The difference here between this and what
2 Jim Riley said is that this is a commitment to us, as
3 opposed to an internal industry commitment. The top
4 tier of 97-06 guideline document provides general
5 guidance for a performance based programmatic strategy
6 for ensuring tube integrity.

7 And it includes the elements that I have
8 towards the bottom of the view graph. It includes
9 performance criteria, tube integrity assessment, in-
10 service inspection elements, tube repair limits and
11 repair methods, and leakage monitoring.

12 Not the details, but a description of
13 those elements of a program, and it is our intent to
14 review NEI 97-06 for endorsement as part of the NEI
15 97-06 generic change package.

16 CHAIRMAN FORD: And all of these, the sub-
17 bulleted performance criteria and in-service
18 inspection, the metrics for all of those come out of
19 the latest action plan that we have got, the
20 integrated NRR for such programs?

21 MR. SULLIVAN: No.

22 CHAIRMAN FORD: Where do the metrics come
23 forth? For instance, in the in-service inspection or
24 leak monitoring? Well, specific data and specific
25 numbers?

1 MR. SULLIVAN: The specific approaches are
2 in guideline documents that I am going to talk about
3 on the next page. In terms of inspection, for
4 example, since you mentioned that, there is a
5 guideline document that contains details on matters
6 such as what sort of degradation to look for, what
7 sort of probes to use.

8 CHAIRMAN FORD: All right.

9 MR. SULLIVAN: What type of qualifications
10 the inspectors need to have. In terms of limits,
11 limits are in the performance criteria that the
12 inspection program will develop the information to
13 apply through integrity assessments to determine
14 whether or not the performance criteria are being
15 satisfied.

16 Actual limits are in the guidelines with
17 respect to primary to secondary leakage monitoring and
18 the actions that need to be taken.

19 CHAIRMAN FORD: I understand.

20 MR. SULLIVAN: So I mentioned NEI 97-06 as
21 a top tier guideline, but here are subtiered
22 guidelines that are on this view graph, and I thought
23 I would give you a little bit of a flavor of the age
24 of those documents, because they do vary quite a bit.

25 The steam generator examination

1 guidelines, and examination being another word for
2 inspection, currently licensees are using Rev. 5,
3 which came out in 1997, and Rev. 6 is being developed.
4 And I am going to talk about Rev. 6 a couple of view
5 graphs hence.

6 I believe those guidelines first came out
7 in the '80s. They have been around quite a lot time.
8 The tube integrity assessment guideline is the most
9 recent, and I believe that came out in February of
10 2000. So that is only a little over six months old,
11 in terms of it actually being issued to licensees.

12 The in-situ pressure test guidelines has
13 been around about a year longer than that. The
14 guidelines for monitoring primary to secondary leakage
15 came out I believe in the early '90s. I think they
16 are up to Rev. 2 of that.

17 The water chemistry guidelines we believe
18 came out or first came out in the late 1970s. And the
19 EPRI sleeve and plug assessment guidelines have been
20 around for 4 or 5 years.

21 DR. BONACA: I have a question. Going
22 back to actually slide seven, when you talk about
23 performance criteria in '97 or '96, and this is more
24 for information, could you give me a feeling for what
25 is involved in that performance criteria?

1 Is it just simply the number of tubes, or
2 leakage, or is it also for example the prediction or
3 the ability to predict?

4 MR. SULLIVAN: There are three performance
5 criteria. The operational leaking is probably the
6 easiest because that already exists. The structural
7 integrity criterion says that no tube should have --
8 I don't know if this is literal in this, but this is
9 actually something that we need to discuss further
10 with NEI.

11 But the gist of it is that no tube should
12 have less than a margin of three against bursts, and
13 the margin of three is against normal operating
14 pressure, and 1.4 against main stream line break.

15 The accident leakage integrity criterion
16 is again something that you have to calculate, and the
17 idea of it is that under accident conditions the total
18 primary to secondary leakage under accident conditions
19 should not exceed one gallon per minute. Does that
20 answer your question?

21 DR. BONACA: Yes. I guess what I am
22 looking for is there some element that measures the
23 ability of the inspections to predict, for example,
24 the growth of the number of defects, as well as the
25 severity of the indications?

1 Is there anything, any element, that does
2 that in this program?

3 MR. SULLIVAN: Well, I think I can address
4 that, and if I can't, maybe Emmet can add to it. I am
5 trying to figure out where this comes up or whether I
6 have already covered it.

7 I think I already covered it when I talked
8 about in-situ, and talked about the administrative
9 tech spec requires that licensees perform condition
10 monitoring of as found condition of the tubes.

11 In a similar fashion, while it is not
12 embedded in the administrative tech spec itself, the
13 bases as it is currently written in draft in NEI 97-06
14 talks about the basic understanding that licensees
15 perform what is called operational assessments.

16 And I had talked about that previously in
17 the context of risk 2022, where licensees do
18 predictions through calculational techniques, which
19 would involve things like growth of degradation, to
20 determine how far out in time they can operate and
21 still maintain those safety margins.

22 DR. BONACA: Well, the reason that I am
23 asking the question is that to me that is an element
24 of performance that I don't measure in leaking, but I
25 have a statement on the part of the utility that

1 performs these inspections that says based on what we
2 do, we predicted that we will not have more than X-
3 number of additional tubes, nor more than this number
4 of severe laceration.

5 Now, if I get to the next cycle and I find
6 that these predictions are good, it gives me
7 confidence in the process. I could say that that is
8 a good performance element in their program if
9 conversely they come back and they are totally off,
10 and there is a much faster growth, and they cannot
11 predict, and I would expect that I would measure that
12 as an element of performance in their ability to
13 support programmatically the steam generators.

14 Do you see where I am going? I am trying
15 to understand how that --

16 MR. SULLIVAN: One of the reporting
17 requirements that I didn't mention is that when
18 licensees don't satisfy their performance criteria,
19 they have to report that to us on a pretty short
20 schedule. I am not sure exactly what the timing is.

21 And our intent if that were to occur would
22 be to devote additional resources over what we planned
23 to understand what is going on with that particular
24 plant, and to work with the licensees.

25 They may not express it exactly the same

1 way, but to work with the licensees to make sure that
2 we agree with what their plans are for the next
3 operating interval.

4 In the case of ANO-2, we had observed that
5 they didn't satisfy performance criteria on a number
6 of occasions going back as far as, I think, 1992. And
7 ANO-2 had been on several occasions between then and
8 when they replaced their steam generators last
9 October, I believe, had done a number of mid-cycle
10 inspections.

11 They had planned to only do one mid-cycle
12 inspection in their last operating interval, and
13 basically because of disagreements that we had with
14 the licensee, they agreed to do two mid-cycle
15 inspections.

16 So it is not formalized in terms of some
17 sort of performance indicator or performance monitor,
18 but it is where we devote our resources when we
19 observe that licensees are having problems.

20 DR. BONACA: I still feel that performance
21 criteria here focuses -- or I thought, focused
22 specifically on the performance of the steam
23 generator. I think that I would like to look at
24 elements of the steam generator program, and among
25 those there is also this ability of predicting the

1 future leakage and somewhere they must be, and I am
2 sure that NEI --

3 DR. SHACK: But you do that, right,
4 because he has to do the performance assessment which
5 sort of predicts where he is going to be. And then he
6 does the condition monitoring to find out how well his
7 prediction worked.

8 I was curious that when he misses that
9 prediction, there is a discussion of why he missed it,
10 and the result is a change in his assessment
11 procedures, or the mid-cycle inspection, or that is a
12 kind of an ad hoc thing that you go through when the
13 two don't agree?

14 MR. SULLIVAN: Right. I mean, one way to
15 put it is that we don't typically review operational
16 assessments. That's not something that we do in
17 detail, particularly in headquarters.

18 But if there is a missed performance
19 criterion, we would at least review elements of the
20 operational assessment, and maybe not take it under
21 formal review, but in the sense that we would want to
22 approve it.

23 But we would probably ask that it be
24 submitted, and we would ask the licensees to give us
25 briefings on what their understanding is of why they

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1 missed it, and what their corrective actions are.

2 DR. BONACA: It seems to me that if you
3 really miss it -- I mean, what you are trying to do in
4 this performance is to predict if you really meet in
5 fact this criterion leakage, and accident leakage, and
6 so on and so forth, all through the period of
7 operation that they are allowed to go before
8 inspection.

9 And if your predictive models are
10 incorrect, then you are violating this criterion by
11 definition, simply because they have no basis and no
12 foundation.

13 So there has to be some -- and you are
14 right. The real problem or has to be a fundamental
15 element of performance, I think.

16 MR. RILEY: This is Jim Riley again of
17 NEI. Let me see if I can explain how the whole
18 process fits together. There is really three
19 assessments associated with the steam generator
20 inspection.

21 The first is called the degradation
22 assessment, and that is done prior to the inspection.
23 And the utility takes a look at what has transpired in
24 their steam generator to this point, and evaluates
25 what kinds of degradation they have going on, and

1 where it is going on, and they plan their inspection.

2 They figure what they are going to see,
3 and they plan what probes they are going to use, and
4 what places in the steam generator they are going to
5 look, et cetera.

6 And that's all based on previous history
7 and anticipated degradation. They then do their
8 condition monitoring, which is the actual inspection
9 of the steam generator. They look at what they
10 actually have in place.

11 If they find in their condition monitoring
12 that things are going on that they did not predict in
13 their degradation assessment, they revisit the
14 degradation assessment during the inspection to see
15 does this affect my inspection plans, and do I need to
16 look in new places, and do I need to use different
17 kinds of probes, and what do I need to do to account
18 for this.

19 When they finish their condition
20 monitoring, the last thing they do is an operational
21 assessment, and that is a prediction forward. If they
22 look at what they have got, and what growth they
23 experience, and they predict as Ted indicated how far
24 can I operate and still be able to ensure that I will
25 meet my performance criteria when I next shut down and

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1 inspect.

2 And that process repeats itself the next
3 time they shut down and do a degradation assessment.
4 So there is a feedback mechanism that makes sure that
5 they are accounting for what they are seeing with
6 respect to what they are predicting, and influencing
7 their inspection program accordingly.

8 MR. SULLIVAN: Okay. I am going to kind
9 of shift focus in a sense for the rest of the
10 presentation and start to try to give you some
11 insights into what is currently going on with NEI
12 97-06 and some of the problems that we have been
13 encountering.

14 At the time that we made the transition
15 from the generic letter and fully understood where we
16 were going with respect to setting up a regulatory
17 framework that was based on an industry initiative, it
18 had not been our intent to review and endorse the
19 subtier guidelines that I put up a couple of view
20 graphs ago, the detailed subtier guidelines.

21 Based on the guidelines that were
22 available at that time, we expected significant
23 enhancements to industry efforts to ensure tube
24 integrity under this program.

25 The staff's expectation was that the

1 guidelines would be sufficiently well developed to
2 lead to improved tube integrity performance under the
3 new framework, bearing in mind that we didn't have all
4 the guidelines. They had not all been issued at that
5 time.

6 And we had expected, and continue to
7 expect, that the guidelines will evolve over time in
8 response to technology changes, lessons learned from
9 operating experience, and results from various
10 studies.

11 The staff developed a couple of concerns
12 more recently though, and in just this past year, and
13 I will try to lay out without getting into too much
14 gory detail how they came about.

15 The first one is related to an action plan
16 item having to do with conducting a steam generator
17 workshop, which we did in February of this year. And
18 in that workshop some of the industry representatives
19 discussed draft revisions to the EPRI steam generator
20 examination guidelines, Rev. 6 basically, to permit
21 inspection intervals for steam generators with
22 improved materials, which we didn't have an issue with
23 in particular.

24 But we noticed that at least that draft
25 has since been revised substantially, but the draft

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1 had inspection intervals that would go significantly
2 beyond Rev. 5, as well as what is in the tech specs.

3 And bear in mind if this has not been
4 clear that the approach under the new frame work would
5 be to lift the maximum intervals between inspections
6 that is in the tech specs, and rely on the performance
7 based strategy instead.

8 In one scenario, as I have on that second
9 bullet, it would have permitted inspection intervals
10 ranging to 22 full power months. I am not trying to
11 put that there as characterizing the proposals. I
12 want to put out kind of one of the extremes that was
13 in that proposal, at least that we considered an
14 extreme.

15 We also began to have concerns about
16 condition monitoring being implemented, and these grew
17 out of questions that we were asking licensees in our
18 outage phone calls about their bases for performing
19 in-situ testing of tubes.

20 We had some concerns that at least in our
21 view that in-situ testing wasn't being performed as
22 routinely or under situations that we think they
23 should have been performed, at least in some cases.

24 And I am not saying that they weren't
25 being performed. Lot of utilities did institute tests

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1 last outage, but there were some plants that generated
2 some concern in our minds who weren't performing any.

3 These concerns basically could be
4 characterized as concerns whether or not the tube
5 integrity performance criteria would continue to be
6 met, and whether conditions not meeting the
7 performance criteria would be detected.

8 DR. SHACK: What control do you have when
9 they do a tube test that they pick the worst tube? I
10 mean, I can always pass it by picking the right tube
11 to test.

12 MR. SULLIVAN: Right. Well, if the key
13 work is control, we don't have any. But we have I
14 think some influence. Usually when it is evident --
15 well, first of all, we only pick the licensees for
16 phone calls that we think have the most degradation,
17 or that we are particularly curious about.

18 For example, we are going to have a phone
19 call with Turkey Point-3 this season. They have got
20 improved materials, but they have been operating for
21 quite a long time.

22 We go over the results, and licensees
23 generally characterize their worst tubes, and that
24 gives us a sense for whether we agree or want to
25 discuss further the in-situ testing that they are

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1 going to do.

2 They also frequently provide us with lists
3 of any current measurements, bearing in mind that
4 there is uncertainty, but they give us those
5 measurements in tables that they are using themselves,
6 and they tell us which tubes they are going to test.

7 We have had occasion, and one that comes
8 clearly to mind --

9 DR. SHACK: But you see that list before
10 they do the tests?

11 MR. SULLIVAN: Yes, generally before.
12 Does that answer your question or should I elaborate?

13 DR. SHACK: That answers my question.

14 MR. SULLIVAN: We have had some influence
15 in the past. And in the case of ANO-2, for example,
16 in the '98 or '99 time frame, there were four tubes
17 that we questioned why they weren't going to test.

18 They indicated that they thought they were
19 unbrellaed by previous tests. We had given the
20 uncertainties and we didn't agree with that. They
21 subsequently ended up testing all four tubes, and
22 discovered that one of them was at least questionable,
23 or inclusive, regarding whether or not they could
24 conclude that they had satisfied the performance
25 criteria.

1 Okay. What I wanted to say that is that
2 out of the latter concerns having to do with the in-
3 situ tube testing, we took on kind of an initiative if
4 you will to spend more time studying those portions of
5 the EPRI guidelines dealing with condition monitoring,
6 and generated a number of concerns.

7 Those concerns are developed in a letter
8 that we sent to NEI. They knew that it was coming.
9 We had had some discussions with them, and it is dated
10 August 2nd.

11 My understanding is that you were provided
12 with that many sometime last week. I'm sorry that we
13 didn't get that to you sooner. The issues relate to
14 industry practice that exist under the current
15 regulatory framework.

16 But these are not brand new issues. They
17 are concerns that we have recently generated in our
18 own minds. But they are existing -- they would exist
19 under the new framework, assuming that we were to go
20 forward with the new framework, which is our intent.

21 These are not issues that we think we can
22 settle in a real court time frame, and that's why I am
23 talking about it in this kind of context. We don't
24 think that the existence of these issues, particularly
25 given the remarks that Emmet just last made, would

1 reduce assurance of tube integrity or increase risk
2 under a new framework, assuming that the inspection
3 intervals don't increase relative to the current
4 requirements.

5 And I am going to get into that in a
6 little bit, as that is not quite as hard and fast as
7 that may make it sound. In kind of a parallel
8 fashion, at least in terms of the bottom line of this
9 view graph, we have reviewed most of the industry
10 responses to issues identified for the industry in the
11 NRC IP-2 lessons learned study.

12 I am sure that you have glanced at that at
13 least and noticed that there were quite a number of
14 issues in there for industry, as well as for the NRC
15 staff.

16 And likewise for the review that we have
17 done, we included some write-ups on those industry
18 sponsors in that same letter that I just mentioned of
19 August 2nd.

20 These issues primarily relate to EPRI
21 guidelines and some of the issues overlap what I have
22 been discussing in terms of condition monitoring and
23 inspection intervals. But some of them go beyond
24 that.

25 A number of those issues still remain

1 unresolved, including the issues that extend beyond
2 condition monitoring and inspection intervals. But
3 likewise, those issues exist under the current
4 framework and will likely continue to exist under a
5 new framework.

6 And we don't think that the existence of
7 those issues reduce assurance of tube integrity or
8 increase risk under a new framework. Again, assuming
9 inspection intervals don't increase relative to
10 current requirements.

11 And again I will repeat that is pretty
12 hard and fast, and I am going to explain that a little
13 bit more in the last two view graphs. So, in terms of
14 conclusions, pending resolution of these guideline
15 issues, the staff has concluded preliminarily that it
16 can proceed with review and approval of a generic
17 change package provided that there are licensing
18 restrictions on inspection intervals.

19 And what I mean by that is that we would
20 have in mind that the generic change package
21 incorporate agreements with industry on appropriate
22 prescriptive intervals for inspections that would be
23 tailored to the specific material in the tubing, Mill
24 Annealed 600 thermally treated and Inconel 690
25 thermally treated.

1 And then the idea behind the words
2 licensing restrictions would be that changes to those
3 agreements would be likewise to performance criteria
4 and repair methods, either generically or plant
5 specifically, they would need to be approved by the
6 NRC. That is the proposal that we are working on with
7 industry right now.

8 DR. POWERS: I got a little confused. You
9 said Mill Annealed, and then you said thermally
10 treated. Did you mean just thermally treated?

11 MR. SULLIVAN: No, I meant three different
12 materials. I'm sorry.

13 DR. POWERS: Oh, so three different
14 things.

15 MR. SULLIVAN: The Mill Annealed 600,
16 thermally treated 600, and the thermally treated 690.
17 With this approach, we believe that the generic
18 package -- I'm sorry. The generic change package
19 would reduce the assurance of tube integrity only in
20 cases where longer inspection intervals than currently
21 permitted would be implemented without adequate
22 justification.

23 That is just another way to say what I
24 have just been saying. I think the rest of this,
25 except for the last bullet, is kind of repeating what

1 I just said. I wanted to go on to a different concept
2 to kind of tie a little bit of this together.

3 And to note that on the last bullet that
4 we are working with industry to establish a protocol
5 agreement resolving outstanding technical issues. It
6 would formalize an approach for interactions between
7 NRC and industry when resolving technical issues that
8 exist and that will continue to arise.

9 This is not just something to settle NEI
10 97-06, but it would be a long term protocol. Examples
11 of the types of issues that we currently would deal
12 with under that protocol would be the lessons learned
13 issues, and the condition monitoring issues that we
14 have been talking about, the risk 2022 issues, and
15 that sort of think, and any new issues that might come
16 up over time.

17 DR. POWERS: Could I go back to the next
18 to the last bullet.

19 MR. MURPHY: Yes.

20 DR. POWERS: And you say you were
21 exploring alternatives with the industry, particularly
22 for improved tube materials.

23 MR. SULLIVAN: I think what we mean there
24 is that the proposal that we most recently have been
25 discussing with industry would require that -- and

1 correct me if I am wrong, Jim, but the Mill Annealed
2 600 tubing plants would basically have to inspect
3 every refueling outage.

4 And longer intervals that follow a more
5 elaborate scheme, depending in part on what the
6 material is, and how long the plant has been
7 operation, would have maximum intervals longer than
8 that, up to three intervals between inspections, or
9 three outages or three cycles of inspections.

10 DR. POWERS: This is what I am struggling
11 with, is that -- well, it is very simple. People say
12 690 is a better material. As far as I can tell, that
13 is what they thought about 600, too.

14 I mean, do we have any confidence that
15 this material is really that much better, and that it
16 is not going to start cracking?

17 MR. SULLIVAN: Well, I think that there is
18 a lot of evidence in this country that 690, which has
19 been in plants for close to 10 years, is performing
20 much better than the Mill Annealed 600. But I am not
21 sure if that is what you are driving at though.

22 DR. POWERS: Well, what I am going to say
23 is that 10 years ago we probably could have said the
24 same thing about 600. Well, maybe not. Maybe it had
25 to be 20 years ago. But at some time we would have

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1 said that.

2 MR. SULLIVAN: We would have said that at
3 the outset, but the Mill Annealed 600 tubing started
4 performing badly from the very outset. I mean, plants
5 were in their first inspection and performing their
6 inspections after the first -- maybe you can elaborate
7 on this more, Emmitt. You were there at the time.

8 MR. MURPHY: Well, in fact -- this is
9 Emmitt Murphy again. In fact, plants developed leaks
10 during the first operating cycle of operation just as
11 an illustration of how quickly the problems developed.

12 DR. BONACA: Well, that was much to do
13 with chemistry.

14 MR. MURPHY: Well, I can think of one case
15 where the crack involved was primary water cracking
16 that occurred in the first operating cycle.

17 DR. POWERS: I guess what I am driving at
18 is how does one go about arguing that 690 allows you
19 to go three operating cycles between inspections?
20 Now, it seems to me that if you can say, well, it has
21 operated for 10 years, and no problems. That's a
22 pretty good argument for longer cycles.

23 I mean, if it is that empirically based,
24 then it is pretty inarguable. The trouble that I see
25 is the potential for it just suddenly starts leaking

1 because of this long induction period it takes for
2 cracks to suddenly show up on the detection device.

3 MR. MURPHY: This Emmitt Murphy again, and
4 I think we shared that concern, and I think that some
5 of the operations that we are exploring with the
6 industry here that would provide opportunities for
7 materials, for plants with the newer tubing material
8 to implement longer inspection intervals.

9 And that these prescriptive limits on
10 cycle length would give us the level of assurance
11 maintaining the tube integrity margins set that we
12 have historically enjoyed, and certainly can do better
13 than that hopefully by virtue of the expected and
14 improved performance of these new materials.

15 MR. SULLIVAN: Another thing that I might
16 add is that the plants -- you know, this is a little
17 bit of an elaborate strategy, and we have not tried to
18 get into particulars here.

19 But I think if you take some of the plants
20 with Inconel 690 that have been operating the longest,
21 the current proposal wouldn't allow them to go three
22 cycles. The current proposal would allow them to go
23 two cycles, which is basically what the current text
24 specs already allows.

25 So it would only be -- I mean, the basic

1 idea is that the licensees do a pre-service inspection
2 at the first refueling outage, and they would have to
3 do another inspection to monitor for things that --
4 you know, like wear.

5 That in loose parts, you can't just say,
6 well, that is not going to happen. And then they
7 would move on to a strategy of three cycles. I think
8 that it factors that in, as well as being based on
9 some of the empirical observations that we have had.

10 MR. RILEY: If I could say something
11 again. This is Jim Riley again from NEI. Another
12 consideration that we have put into our guidelines
13 again is this degradation assessment that I mentioned
14 the last time.

15 The plants, even though they wouldn't have
16 to inspect every outage under our scheme, would be
17 required to do a degradation assessment every outage,
18 and that degradation assessment needs to take a look
19 at what has been happening at their plant, as well as
20 what has been happening in other plants around the
21 industry and around the world.

22 And if there are things going on in these
23 other plants with Inconel 690 that wasn't anticipated,
24 that has to be taken into account and it has to be
25 taken into account from the perspective of how well it

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1 pertains to their design steam generators, their
2 materials, their chemistry, et cetera.

3 But if they feel that this is challenging
4 what otherwise would have been their inspection
5 interval, they need to be reacting accordingly.

6 DR. POWERS: It is an encouraging thought,
7 but what is discouraging is when I look at the
8 assessments under the maintenance rule, one of the
9 areas that the licensees found most challenging was
10 the ability to take into account experience within the
11 industry, and not at their own facility.

12 So, pardon me, but I would be just a
13 little skeptical that they will -- that in the
14 assessment that they won't be looking for ways to
15 argue what is going on some place else just doesn't
16 relate to my plant.

17 MR. RILEY: That's difficult to argue. I
18 mean, obviously it depends on an individual plant, but
19 I will say this. That there are plenty of information
20 available to the licensees, in terms of what is going
21 on elsewhere.

22 We have an industry organization that
23 meets three times a year and shares operating
24 experience. We have a steam generator degradation and
25 steam generator database that EPRI maintains that

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1 keeps track of what is going on at different places,
2 in terms of tube degradation, and tube pulls, and tube
3 information, et cetera.

4 We have organizations within the industry
5 that do reviews of steam generator programs at various
6 -- well, they rotate through all the plants, and do an
7 evaluation of how well they are conducting their
8 program with respect to what the requirements are in
9 NEI 97-06 and other places.

10 And we have internal peer reviews that are
11 done between organizations, and all these things are
12 intending to look at how a particular utility is
13 conducting its steam generator program with respect to
14 the norm and the expectations.

15 And sharing with plant management cases
16 where they feel that they are not meeting the industry
17 standards on these issues.

18 MR. SULLIVAN: One thing that I might add
19 for what it is worth is that over the years when a new
20 degradation mechanism is identified, or not
21 necessarily a mechanism, but a new location, and we
22 learned about it in a phone call.

23 And we might be on the phone call at the
24 same time, or the next day, or whatever, with a
25 similar plant, and we would bring it up in the phone

1 call, and I can't remember a single time that the
2 licensees weren't already aware of it.

3 And I think as Jim indicated, the
4 networking is pretty strong, and had modified their
5 inspection plans to look for it if it was applicable,
6 just in the "for what's it is worth department."

7 CHAIRMAN FORD: Can I just ask a question,
8 more on a technical management aspect? Do I
9 understand that right this instant, in terms of
10 monitoring the performance of the steam generator
11 tubing, that we are essentially using NEI 97-06
12 procedures, regardless of how they stand within the
13 regulatory framework right now?

14 And that in very short order that you are
15 going with this generic change package, which is based
16 on NEI 97-06, but with modifications associated with
17 its memo that you sent out on the 2nd of August?

18 And that would give some regulatory aspect
19 to approval if you like. It may not have gone through
20 all the sign-offs, et cetera, et cetera, that you may
21 have to do. But essentially you have got regulatory
22 approval for the NEI 97-06 procedures, et cetera, and
23 that is in the short term.

24 MR. SULLIVAN: Yes.

25 CHAIRMAN FORD: And for the longer term,

1 as we go through the question of brisk assessment of
2 the delta-LOCA and the delta-LERFs, and modifications
3 to your current understanding of those parameters, and
4 that will come out in later years as a result of this
5 joint NRR research program. How I got the sequence of
6 events right?

7 MR. SULLIVAN: I think that's correct, and
8 then depending on what comes out of that, we may have
9 to factor it back into our understanding, and/or our
10 regulation of the steam generator programs.

11 CHAIRMAN FORD: Now, is it appropriate
12 therefore in the short term, if you are going to have
13 this model one of this generic change package in
14 place, is it appropriate to have a presentation to
15 this subcommittee -- and let's say in December -- so
16 that we understand at least the technical pros and
17 cons of this process?

18 MR. SULLIVAN: I think it is a good idea.

19 CHAIRMAN FORD: And I stress the technical
20 aspects. For instance, what the pre-inspection
21 assessment methodology is, and what is the
22 uncertainties in it, et cetera, so that we understand
23 the impacts on safety.

24 MR. SULLIVAN: I think coming back for
25 another presentation is a good idea. The only thing

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1 that comes to mind is that we are also making a
2 presentation to the Commission on December 4th. So we
3 want to make sure that we don't have a conflict there.

4 CHAIRMAN FORD: I have no idea what the
5 constraints of this particular aspect is --

6 MR. SULLIVAN: As a concept, I think it is
7 a good idea, and we did anticipate that you want more
8 technical details than what we are talking about
9 today.

10 CHAIRMAN FORD: Okay.

11 MR. SULLIVAN: This is just kind of an
12 introduction.

13 DR. DUDLEY: Just thoughts. Would it be
14 more appropriate for an ACRS presentation before or
15 after the presentation made to the Commission?

16 MR. SULLIVAN: Can I get back to you on
17 that later? I would like to talk to my colleagues.

18 DR. DUDLEY: Yes, that is something that
19 you need to work out.

20 CHAIRMAN FORD: But this is a joint
21 NEI/NRR?

22 MR. SULLIVAN: Yes. Sure. We will have
23 to coordinate with Jim, of course. I can't speak for
24 them.

25 CHAIRMAN FORD: Excellent.

1 MR. SULLIVAN: But they have been willing
2 in the past to come and make presentations like this.

3 MR. RILEY: Jim Riley again. We would be
4 happy to join your presentation on the technical
5 aspects of the program.

6 MR. SULLIVAN: Okay. I just have a couple
7 of comments. I have kind of covered this, but I just
8 wanted to make sure that it is clear that we do plan
9 to develop a safety evaluation on this whole generic
10 change package.

11 The vehicle for issuing it would be a
12 regulatory issue summary, and the proposal would be to
13 put it out for public comment before we finalize it.
14 There are some specific reasons that we want to do
15 that that we can get into now or in the next
16 presentation.

17 Our target date had been the end of next
18 month, and we clearly see that we are not going to
19 make that. We are hoping that we can get this done in
20 April of 2000, although I have to admit that was kind
21 of an arbitrary projection that we could get it done
22 within about six months.

23 We are still working with NEI on technical
24 issues, as well as the regulatory issue having to do
25 with regulatory controls. And so I am not sure just

1 how optimistic or achievable the April date is.

2 And as I mentioned before, this same sort
3 of data is contingent on coming to terms with this in
4 the pretty near term, because there are a lot of steps
5 that we need to go through, in terms of things like
6 issuing a risk for public comment, and finishing the
7 safety evaluation, and so forth. So that concludes my
8 presentation.

9 CHAIRMAN FORD: Thank you very much. I
10 would like to put this on hold for 15 minutes, and I'm
11 sure that on hold isn't the right word, but we will
12 take a tea break.

13 (Whereupon, the meeting was recessed at
14 10:08 p.m. and resumed at 10:25 p.m.)

15 CHAIRMAN FORD: Okay. We are back in
16 session, and we are reversing the order. Ken is going
17 first, and Joe is coming second. So, Ken will be
18 talking about the South Texas project.

19 MR. KARWOSKI: I am going to stand during
20 this, just because I need to point to some of the
21 stuff on the view graph. My name is Ken Karwoski, and
22 I am with the Materials and Chemical Engineering
23 Branch in NRR.

24 My presentation is broken into two parts.
25 The first part will be the overview of the South Texas

1 steam generator operating experience, and the second
2 part will get into the last part of the presentation,
3 which is some of the issues on the -- with respect to
4 the differing professional opinion.

5 So the slides are in the opposite order
6 that I had anticipated. So we will skip the first two
7 slides, and I will come back to those at the end of
8 the presentation, and I will start with South Texas.

9 South Texas is a four loop pressurized
10 water reactor. It has a model E-2 steam generators
11 and there is about 4,900 tubes in each of those steam
12 generators. They have Alloy 600 mill annealed tubing,
13 with the exception that there is 15 tubes in one of
14 the steam generators that is made of Alloy 600
15 thermally treated.

16 They did that, I believe, to test for
17 whether or not this material would be any better.
18 They have three-quarter inch diameter tubes, which is
19 important for generic letter 95-05. The tubes are
20 supported at various elevation by drilled holes
21 stainless steel tube support plates.

22 That is a little different than most of
23 the mill annealed plants. Actually, it is the only
24 plant in the country that has drilled hole stainless
25 steel tube support plates.

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1 The bulk of the plants that use generic
2 letter 95-05 have carbon steel drill holes tube
3 support plates, and I will talk a little bit about
4 that later on.

5 DR. POWERS: What is the potential
6 difference between the stainless steel and the Alloy
7 600, the electrical-chemical potential differences?

8 DR. SHACK: There's not much.

9 DR. POWERS: But just about everything is
10 though.

11 DR. SHACK: Well, it is certain less than
12 carbon steel.

13 MR. KARWOSKI: But the key with the
14 stainless steel, which I will get into, is that it is
15 less corrosion resistant in a steam generator
16 environment. So what you have with the carbon steel
17 tube support plates is those tend to corrode and tend
18 to fill the crevice with magnetite, which tends to
19 impact the tubes, and actually cause corrosion-induced
20 bending.

21 The stainless steels are less susceptible
22 to corrosion in the steam generator environment, and
23 you don't get that type of corrosion product build up
24 in the crevice which could restrict leakage and can
25 bend the tubes.

1 There have been other plants in the
2 nuclear industry, particularly Doel 4 and Tihange 3,
3 which ave these types of tube support plates. The
4 steam generators at those plants have been replaced.

5 At South Texas the tubes have been
6 hydraulically expanded into the tube sheet, and the
7 expansion transitions were shortened to reduce
8 susceptibility of corrosion.

9 R-1 and 2 of the steam generators went
10 through a U-bent heat treatment to also reduce the
11 susceptibility of corrosion of the R-1 and 2 U-bends.
12 South Texas, coming on line later, implemented several
13 enhancements to their steam generators in order to
14 reduce the susceptibility of the tubes to --

15 DR. SHACK: Well, it is awful late for a
16 Mill Annealed plant though?

17 MR. KARWOSKI: I think they started
18 commercial operation in like '89, but when they
19 ordered their steam generators and when they planned
20 that, I don't have that information.

21 But, yes, in the overall sequence of
22 events, if you look at some of the earlier
23 replacements, they were thermally treated in the early
24 '80s. And so I am speculating that they must have
25 ordered them.

1 DR. SHACK: They must have decided that
2 they didn't need to do that.

3 MR. KARWOSKI: Yes. Of particular
4 interest here is that in their pre-heater area, they
5 expanded several tubes as a result of a concern of
6 tube wear that had been observed in Westinghouse Model
7 D steam generators, and I would just point this out
8 there because they have observed some corrosion there
9 or some damage at that location.

10 And that is because of the cross-flow of
11 velocity of the feed water entering the steam
12 generator. South Texas has a T-hot of approximately
13 625 degrees fahrenheit, and that is one of the higher
14 ones in the country, which just exacerbates some of
15 the corrosion problems that they may be observing.

16 At the end of Cycle 8, which was in March
17 of 2001, they had approximately nine effective full
18 power years on their steam generators, which is not a
19 lot of time.

20 The primary degradation mechanism is
21 actually oriented outside diameter stress corrosion
22 cracking at the tube support plates, the focus of
23 Generic Letter 95-05.

24 I just briefly want to discuss some of the
25 other degradation mechanisms that they have been

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1 observing. They have detected some free span outside
2 diameter stress corrosion cracking, primarily
3 associated with dings.

4 I use the term "dings" because instead of
5 corrosion-induced denting, it is more damage as a
6 result of fabrication.

7 DR. POWERS: What is the gap width for
8 this drill hole plate in the tube wall roughly?

9 MR. KARWOSKI: I think the exact value is
10 proprietary, but it is on the order of less than a
11 tenth of an inch for the normal support plates. They
12 have a flow distribution baffle, which I think is on
13 the order of a tenth of an inch, which has an enlarged
14 tube hole opening.

15 And that is the first support plate
16 elevation, and in general they have not observed as
17 much degradation at that location than they have at
18 the higher locations, where the diametrical clearance
19 is less.

20 DR. POWERS: What I am trying to
21 understand is that because we don't have this included
22 hole in the plate are we getting what would be crevice
23 type chemistry changes in there, in that hole region?

24 MR. KARWOSKI: Can I answer that a little
25 later on?

1 DR. POWERS: Sure.

2 MR. KARWOSKI: But that is one of the
3 theories that might be happening with respect to the
4 operational leakage. But I will touch upon that later
5 on.

6 So they have had free spanaxial outside
7 diameter stress corrosion cracking, and they have also
8 detected some free span volumetric indications, and
9 they have detected some of these over the course of
10 the last cycle or the cycles prior to that.

11 CHAIRMAN FORD: I wonder if you could just
12 mention -- and maybe you will mention it later on, but
13 the question of the difference between the stainless
14 steel and the carbon steel floor plates, the fact that
15 there is generally less corrosion product, and
16 therefore that would have an impact on leak rates.

17 MR. KARWOSKI: I will get to that in
18 probably 3 or 4 more slides.

19 CHAIRMAN FORD: Okay. Good.

20 MR. KARWOSKI: New mechanisms that they
21 observed during the March 2001 outage, they detected
22 some indications that the hot leg expansion
23 transition, that's not unusual for a plant with Alloy
24 600 Mill Annealed.

25 The indications were primarily OD. They

1 did find some ID indications of one ID indication.
2 The licensee speculates that the shop cleaning may
3 have been effective in reducing some of the ID
4 cracking.

5 Some of the dings in their steam generator
6 are basically separated by about three-quarters of an
7 inch, which is the thickness of the tube support
8 plate.

9 They believe that as they inserted the
10 tubes into the steam generator that there was some
11 bending moment that caused what they called paired
12 dings. At one of those paired dings, they observed
13 circumvential cracking at one location and axial
14 cracking at the other.

15 They found a Row-1 new bend indication,
16 which was outside diameter stress corrosion cracking.
17 They also found cracking at the U-Bend transition, and
18 they found a volumetric indication at the expansion
19 transition of one of those tubes expanded in the pre-
20 heater.

21 Most of these degradation mechanisms are
22 common among plants with 600 Mill Annealed tubing.
23 The licensee has currently plugged about 9 percent of
24 the tubes. Their licensing basis limit, I believe, is
25 10 percent. The are scheduled to replace in December

1 of 2002 at the end of the present cycle.

2 DR. SHACK: Do they sleeve or do they just
3 plug every one?

4 MR. KARWOSKI: I think they just plug.

5 DR. SHACK: With respect to the voltage
6 based repair criteria, I did mention that that is
7 their primary degradation mechanism, and they first
8 implemented Generic Letter 95-05 during Cycle 7, which
9 was in the '98-'99 time frame.

10 They were approved for a one-volt repair
11 criteria at that time. As a result of that amendment,
12 they analyzed for 15.4 gallons per minute primary to
13 secondary leakage during a steam line break to
14 demonstrate that the off-site builds consequences
15 where acceptable.

16 And during this review that the staff
17 approved that limit. Cycle 8, the licensee also
18 implemented the one volt repair criteria, and in Cycle
19 9, which is the cycle that they are presently
20 operating in, they recommended a 3 volt repair
21 criteria.

22 That repair criteria had been used at
23 Braidwood and Bryon, and evasively what it involves is
24 demonstrating that the motion for the tube support
25 plants is limited such that the degradation at the

1 support plate will not be exposed during a steam line
2 break.

3 And which allows them to go to a larger
4 voltage limit because the probability of burst will be
5 less.

6 DR. SHACK: Now, I noticed that South
7 Texas gets the benefit from IRB technology, as well as
8 the three volt limit. Did Braidwood and Bryon get the
9 IRB technology, or did they just live with 00 votes.

10 MR. KARWOSKI: By the IRB, the indications
11 are that that methodology, although the value of what
12 we assigned to those --

13 DR. SHACK: The probabilities, the 10 to
14 the minus 5?

15 MR. KARWOSKI: Right. Both South Texas
16 and Braidwood, and Bryon had to model URDs in their
17 methodology to account for the potential that a tube
18 attempts to burst, but can't because of the presence
19 of the plate, and therefore the leakage could be
20 higher. Braidwood and Bryon had to model that and
21 South Texas also.

22 DR. SHACK: They got to use 10 to the
23 minus 5th, first, and then two, as well as the three
24 volts? When we say the three vote criterion, I never
25 realized that you got a double-benefit.

1 MR. KARWOSKI: Okay. Let me take a step
2 back. When you implement this methodology,
3 essentially by locking the support plate in place, you
4 have essentially -- for an axial crack, you basically
5 prevented it from fully opening or fully achieving
6 burst because of the diametrical clearances.

7 Because of that the probability of an
8 axial rupture, that could be on the order of 10 to the
9 minus 5th. I don't recall what the actual number is,
10 but they basically modeled what the probability is for
11 a burst given the amount of displacement of the plate.

12 In addition, they have a correlation which
13 they say, okay, now that I can potentially go to
14 higher limits, what is the probability that I tear
15 this tube and get a circumvential break?

16 And that's how they would -- they would
17 generate a limit for that. The industry would claim
18 that that limit, that you could tolerate 10 volt
19 indications, and the staff said 3 volts based on that
20 correlation.

21 And so they also modeled the probability
22 that you would get a circumvential failure of the tube
23 at the location. So there is two parts of that
24 methodology.

25 Now, the URDs, that is basically a leakage

1 model aspect, and basically in the leaking
2 correlation, basically they don't have indications
3 which try to burst and actually leak excessively.

4 So as part of the three volt amendment,
5 Braidwood and Bryon embarked on a testing program to
6 figure out, okay, how that I have got these higher
7 voltage limits, if this tube starts to open up how
8 much will it leak given that the plate is there.

9 And that is what the URDs do, is that it
10 is another leakage correlation that is tacked on above
11 the normal free span leak rate correlation. So in
12 Cycle 9, basically in February or March of this year,
13 we approved this 3 volt criteria, and the licensee
14 expanded tubes at tube support plates 2, 3, and 4 in
15 order to limit the motion.

16 They only chose these low support plates
17 because that is where most of the degradation is
18 occurring. And I will talk a little bit more of how
19 they actually implemented that repair criteria during
20 this last outage.

21 During their past cycle, Cycle 8, prior to
22 implementing this 3 volt repair criteria, the licensee
23 was observing primary to secondary leakage in all four
24 steam generators, for a total of about --

25 DR. SHACK: Excuse me, but can I just --

1 this IRB is confusing me again, because as I read this
2 thing, when they do what I thought was a 95-05
3 methodology, which ignores the restricting from
4 bursting, they exceed the 10 to the minus 2
5 probability of failure.

6 Then they have to go to the IRB thing, and
7 that gets them down to 1 times 10 to the minus 3. So
8 it is not an additive thing. They don't use the 3
9 volt criteria for the plates that are locked; is that
10 the way that I am interpreting this?

11 MR. KARWOSKI: For the plates that are
12 locked, basically they say how far will the plates
13 move, or could they potentially move, and if I were to
14 expose a crack of that length throughout that plate,
15 and for all the plates in the steam generator which
16 have applied that criteria, what is the probability of
17 burst of that axial crack.

18 DR. SHACK: Okay. So that is saying that
19 we understand the movement of this plate well enough
20 that 10 to the minus 5th is the product of the
21 probability that the tube will burst without the plate
22 times the probability that it will be uncovered,
23 right?

24 MR. KARWOSKI: It is more of just the
25 materials issue. It is just that you have to

1 understand how much the plate is going to move. So
2 that aspect is in there.

3 You have to know how much of the crack
4 will be exposed or could potentially be exposed,
5 because we are postulating that the crack is at the
6 tip of the support plate, and as the support plate
7 moves it exposes the entire flaw over that length.

8 DR. SHACK: But they had to calculate that
9 probability somehow from their fluid mechanics
10 calculation.

11 DR. KRESS: They just assumed it happened.

12 MR. KARWOSKI: But they assume all -- they
13 calculate the maximum displacement of the plates.

14 DR. KRESS: And then they assume it
15 occurs.

16 MR. KARWOSKI: And then they assume it
17 occurs over the entire plate, and so basically they
18 are saying, okay, I have exposed -- I think in their
19 case they postulated that -- or they determined that
20 it would meet something on the order of .15 inches.

21 And so they said .15 inches for every tube
22 at that plate. They didn't say that the plate is
23 going to move .15 inches here, and .12 inches here,
24 and .02 inches here. They just assumed that the
25 maximum displacement for every intersection.

1 DR. KRESS: How did they make that
2 determination? Do you know?

3 MR. KARWOSKI: The determination of how
4 much it would move?

5 DR. KRESS: Yes.

6 MR. KARWOSKI: That is by thermal
7 hydraulic modeling.

8 DR. KRESS: So you don't have a
9 probability associated with that then?

10 MR. KARWOSKI: There is no probability
11 associated with that.

12 DR. KRESS: So the probability of the
13 materials isn't --

14 MR. KARWOSKI: Right.

15 DR. SHACK: So what you are saying then is
16 that if I uncover a tenth of an inch, say, I can
17 somehow calculate then the probability that he burst
18 will be 10 to the minus 5?

19 MR. KARWOSKI: Yes. I think in general
20 they say less than 10 to the minus 5.

21 DR. SHACK: And how do I do that?

22 MR. KARWOSKI: Well, basically you have a
23 crack that extends outside the plate, and so the plate
24 is constraining the crack, the bolt of the crack.
25 Let's assume it is a three-quarter inch long crack for

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1 simplicity.

2 And I move the plate .15 inches, and so I
3 have got 6/10ths of an inch crack within the plate,
4 and .15 inches outside.

5 DR. SHACK: Do I do this on a mechanistic
6 fracture mechanics basis rather than on a voltage
7 basis?

8 MR. KARWOSKI: Yes. Yes. Basically, how
9 much support does the plate give, and what the vendor
10 would argue is that the plate basically -- that the
11 length of the exposed crack is what is dominating the
12 probability of burst.

13 So basically you can say, well, what is
14 the probability of a .15 inch long flaw bursting. It
15 is based on mechanistic and it is not voltage. It is
16 not voltage.

17 CHAIRMAN FORD: So can I have just a time
18 sanity check here? We are required to have a letter
19 on the DPU issue at the next ACRS meeting. How long
20 do you think at this current rate of progress do you
21 think it will take? Can you be finished by 11
22 o'clock?

23 MR. KARWOSKI: Yes.

24 CHAIRMAN FORD: Provided that we don't ask
25 too many more questions.

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1 MR. KARWOSKI: Right.

2 CHAIRMAN FORD: Okay.

3 MR. KARWOSKI: Okay. So they were
4 observing leakage in all four steam generators, and
5 when they came into the outage, they did a secondary
6 side pressure test, where they filled the secondary
7 side up with water, and pressurized it to something on
8 the order of 600 pounds.

9 And then they monitored for leakage on the
10 primary side of the tubes, and looked for drippage
11 from the tubes. What they found was that none of them
12 were leaking excessively, but there were some tubes
13 approximately that were damp.

14 The leakage was attributed to outside
15 diameter stress, corrosion, cracking, at the support
16 plates, and that is important because no other
17 domestic plant has ever observed operating leakage as
18 a result of cracking at the tube support plate
19 locations.

20 And that gets back to various theories of
21 why we haven't observed leakage, and one of the
22 theories is that as the carbon steel support plates
23 corrode, they form magnetite, and the magnetite gets
24 into the crevices and impinges -- well, impinges isn't
25 the word.

1 But it forms magnetite and the magnetite
2 fills the crevice, and it will start denting the tube
3 and basically or essentially would seal the crack.
4 That is one theory.

5 So that the crack tries to leak, and it is
6 not very porous, and it doesn't get out. That is one
7 of the theories that has happened. And the stainless
8 steel tube support plates situation in South Texas,
9 you don't have that magnetite filling the crevice, and
10 you have might scale on the outside of the tube, and
11 still have a crevice.

12 And so you are still observing the
13 corrosion, but in this case it is not impeding the
14 flow of the crack. That is a theory. As I mentioned
15 before, South Texas, too, is the only domestic plant
16 with stainless steel tube support plates, drilled hole
17 stainless steel support plates.

18 And Doel-4 and Tihange-3 had that. Doel-4
19 had exhibited leakage coming from the support plates
20 during a similar secondary side pressure test in the
21 early '90s.

22 Because of the concerns on operational
23 leakage, although the licensee was authorized to
24 implement a three vote repair criteria, they
25 preventively plugged down to approximately 1-1/2 volts

1 because of those concerns.

2 They did some depth-sizing of some of
3 these flaws to determine which ones that they thought
4 may have been most likely to leak, and they prevently
5 plugged those.

6 After the outage and these results became
7 available, the license submitted their 90 day report.
8 It is basically a summary of inspection activities
9 primarily related to Generic Letter 95-05.

10 The staff reviewed that report and we
11 identified several issues that we asked the licensee
12 to address. And the issues are on this view graph,
13 and I would just like to illustrate them.

14 One of them is the ability to predict end
15 of cycle conditions, which I believe was one of the
16 concerns raised earlier this morning. There are two
17 things that we look for during these reviews, and that
18 is the number of indications predicted, reasonable,
19 and is the severity, and in this case is the voltage
20 of the indications reasonable.

21 What this table shows is that it shows the
22 four steam generators and also the total, and it shows
23 the three cycles where they implemented the voltage-
24 based repair criteria.

25 For each one of these cycles, they show

1 the projected number of indications that they
2 determined, and then the actual. In this first cycle,
3 you will notice that they under-predicted the actual
4 in one of the four steam generators, but in general
5 they were conservative, with the exception of Steam
6 Generator C.

7 DR. POWERS: And before I leap to that
8 conclusion, I guess I would ask you how many
9 indications were in these steam generators that they
10 failed to detect?

11 MR. KARWOSKI: This actual number does not
12 include any account for the probability of detection.
13 So this number here and the assessments that they do
14 is basically assuming that you are finding the more
15 severe flaws.

16 And that the flaws that you are not
17 detecting are not of structural leakage significance
18 even now, and that they would not be of structural
19 leakage significance at this point. This number does
20 not account for that.

21 DR. POWERS: Okay. But if I take my
22 probability of detection at .6, and they then do it
23 for everything?

24 MR. KARWOSKI: Right. But this is more of
25 a condition monitoring assessment. This number here

1 would be -- would include the .6 from the prior cycle,
2 but yes, you are right. The value of .6, remember, is
3 to account for two things.

4 It is not only to account for indications
5 which we missed during the inspection, but also for
6 new indications which may develop or initiate over
7 that cycle. So to adjust these by .6 in a condition
8 monitoring system --

9 DR. POWERS: It is not quite fair, but to
10 adjust it by some number is fair.

11 MR. KARWOSKI: Yes, but what we would
12 argue is that what they missed is probably not --

13 DR. POWERS: I don't think you can do
14 that. I mean, I think you have a database that says
15 there are flaws of substantial size --

16 MR. KARWOSKI: That's true.

17 DR. POWERS: And you have a plant up in
18 New York where that is definitely true.

19 MR. KARWOSKI: That is true. That is
20 true. So this number does not include any -- it is
21 basically what they found in the steam generator
22 during that inspection, and it does not account for
23 any improbability of detection.

24 CHAIRMAN FORD: All those numbers, the
25 right or actual numbers, should be multiplied by 1.4

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1 or whatever the number is?

2 DR. POWERS: I don't think it is quite
3 fair to do it that way.

4 MR. KARWOSKI: No, no.

5 DR. POWERS: As he pointed out the .6
6 counts for other things. But there is some number
7 that they should be multiplied by.

8 CHAIRMAN FORD: Correct.

9 MR. SULLIVAN: And that multiplication
10 factor is used in the projections forward.

11 MR. KARWOSKI: Right. So to arrive at
12 these projected numbers, what they did is they took
13 the actual, and divided by .6, and subtracted off the
14 number that they repaired, and that's how many they
15 got.

16 The purpose of this is just to show the
17 number of indications and the probability of
18 detection, and you need both the numbers and the
19 severity of the degradation.

20 DR. SHACK: So when we see these cases
21 where the actuals exceeded the projected that is
22 extremely distressing

23 MR. KARWOSKI: Let me phrase it this way.
24 In general, for Generic Letter 95-05, one of the
25 criticisms that the industry has always said is the

1 POD of .6 is excessively conservative, excessively
2 conservative.

3 So when you typically look at these 90 day
4 reports, you typically see numbers like that. In the
5 case of South Texas --

6 DR. POWERS: You see numbers like C.

7 MR. KARWOSKI: Right. And if you just
8 look at the total numbers, you start saying that
9 things are getting pretty close, and if you look at
10 the last cycle, they under-predicted the number of
11 indications in two of the four steam generators.

12 Now, that may not be bad in and of itself,
13 because if I am just finding a bunch of low voltage or
14 indications which have no structural or leakage
15 significance, that may not be a problem.

16 But this is just one piece of the puzzle.
17 Next, the next graph addresses the severity of the
18 indications, and basically it is a similar table to
19 the previous one.

20 It shows the steam generators, and as
21 voltage goes up the severity of the indication
22 increases and we compare it projected to actual. And
23 in general if you just look at the totals, in this
24 case they under-predicted the number of larger voltage
25 indications in the first cycle, but the number was

1 minimal.

2 The second time they also under-predicted
3 and the same thing for this third cycle. As a result
4 of this, we are pursuing discussions with the licensee
5 to ask them to address it.

6 And in the interest of time, this last
7 view graph just shows that the average growth rate,
8 that if you look at Cycles 6, 7 and 8, the growth rate
9 has been increasing the average growth rate, and that
10 pretty much is supported by the previous table.

11 There are some other issues that we have
12 asked the licensee to address regarding leakage
13 observations. During the inspections, they had done
14 some in-situ pressure testing, where they insert a
15 device inside the tube, and pressurize it to determine
16 whether or not it is going to leak and/or burst.

17 And they observed some leakage during
18 those tests, and given that the in-situ tests are
19 typically done on the worst tubes, from the
20 information that we were provided, it doesn't seem
21 like those results indicate or could account for all
22 the operational leakage that they observed.

23 And so we have asked them to take a look
24 at that. So basically the last view graph, here the
25 next step is that we post these issues to the

1 licensees, and they are monitoring for operational
2 leakage.

3 And there has not been any observed
4 presently and the licensee plans to replace their
5 steam generators at the end of the current cycle.

6 DR. BONACA: Well, you started to say
7 something about after you looked at the severity of
8 indication, because of this, we asked the licensee --
9 and then you didn't complete the phrase.

10 MR. KARWOSKI: We have asked the licensee
11 that in light of these results, basically tell us why
12 the methodology is working for your plant. What
13 confidence do you have that we will be able to
14 actually project what is going to be on this steam
15 generator at the end of the next cycle.

16 DR. BONACA: Well, it seems to me that
17 they are under-predicting both, in terms of severity.

18 MR. KARWOSKI: That's true, and in some
19 cases that may not be a concern. If I am calculating
20 leakage of a 10th of a gallon per minute during
21 accident conditions, and I have under-predicted the
22 number of severity, that may not be a problem in and
23 of itself.

24 But in this case, they are, and in one of
25 their generators they are projecting leakage which is

1 approaching that 15.4 gallon per minute.

2 DR. BONACA: Plus, there are a number of
3 indications that are going so fast and that is really
4 what we are transmitting. And at that point you begin
5 to wonder about when do you get to that point where
6 you have a critical change in the leakage, for
7 example.

8 MR. KARWOSKI: Right.

9 DR. SHACK: Now, when they do the
10 operational assessment what will they use for the
11 average growth rate? Will they project that
12 increasing curve, or will they use the observed --

13 MR. KARWOSKI: They will use the
14 methodology that is called for them to use, and the
15 most conservative over the last two cycles, which I am
16 assuming was the last cycles, and so they will use the
17 observed.

18 And the reason for showing you the tables
19 of the -- of what I will call the increase in growth
20 rate is that that is certainly one of the issues that
21 the staff would like addressed, which is, is the
22 methodology working.

23 And that is basically the reason or could
24 be a reason why they have under-predicted the severity
25 of some of those indications. At this point, I would

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1 like to move to the second part of the presentation,
2 which basically addresses two of the ACRS'
3 recommendations on the differing professional opinion.

4 The two recommendations that I want to
5 discuss are the seven-eighths inch diameter leak rate
6 database, and the recommendation with respect to flaw
7 growth.

8 With respect to the seven-eighth inch
9 diameter leakage database, the ACRS indicated that the
10 database needs to be greatly improved to be useful,
11 and that the staff should consider requiring a near
12 term expansion of that database.

13 The staff agrees that the seven-eighth
14 inch database does not exhibit as strong a correlation
15 as the three-quarter inch. To refresh everybody's
16 memory the three-quarter inch database has
17 approximately 50 pull tubes, and about half of which
18 come from pull tubes.

19 The seven-eighths inch database on the
20 other hand only has approximately 30 data points, of
21 which only around 25 percent, or seven or eight data
22 points are from pull tubes.

23 So the staff agrees that this seven-
24 eighths database has a weaker correlation. With
25 respect to whether or not the expansion of the

1 database will actually improve the correlation, as
2 part of getting ready for this presentation, I tried
3 to do that assessment by looking that as they added
4 data over the course of several years, and what has
5 happened in general.

6 And based on a very simplistic evaluation,
7 which I did, it looks like the correlation is staying
8 the same, or maybe getting slightly worse. So even
9 though they added data, it has not necessarily made
10 the correlation better.

11 But the correlation in 95-05 does address
12 how to handle it if the correlation -- you know, if
13 there is a correlation or if there isn't any
14 correlations.

15 With respect to adding more tubes, the
16 staff recognized when they issued Generic Letter 95-05
17 that the limited data then -- and it is still
18 recognized as it is now, that the results as part of
19 the methodology that licensees committed to a tube
20 pull program, either the one that is in the generic
21 letter, or an industry developed the tube pull
22 program.

23 And with this protocol the utilities
24 periodically pull tubes, and the focus of those pulled
25 tubes is for seven-eighth inch diameter tubes is the

1 leakage database. They need more data and the
2 industry recognizes that.

3 With respect to -- with the exception of
4 this commitment, there is really no other regulatory
5 vehicle and the methodology to require removal of
6 additional tubes. But the staff will continue to
7 monitor the effects of additional data as more data is
8 added as a result of these tube pulls.

9 The next recommendation that I want to
10 talk about is flaw growth. The recommendation was
11 that the staff should establish a program to monitor
12 the predictions of flaw growth for systematic
13 deviations from expectations, and that the staff
14 should develop a database on predictions, and observe
15 voltage distributions.

16 As part of Generic Letter 95-05, we asked
17 the licensees to submit the data to the NRC to permit
18 putting together -- or to permit the staff to do these
19 comparisons of predicted and observed voltage.

20 And I think that the South Texas example
21 that I just went through is one of those cases where
22 we do look at that when we do those reviews to
23 determine whether or not there is something that we
24 need to follow up on.

25 So we have and we will continue to review

1 the 90 day reports with that recommendation in mind.
2 That was the reason for requesting that information to
3 be provided to the licensees.

4 We recognize that it is an empirical
5 approach and we need to continually assess how well we
6 are doing with respect to our predictions. The staff
7 is formalizing the review of inspection summary
8 reports, which the 90 day reports are a subset of, in
9 conjunction with the steam generator action plan, Item
10 1.10.

11 And there have been instances where the
12 predictions have been non-conservative, and South
13 Texas is one of them.

14 DR. POWERS: As part of this
15 formalization, you are going to explain how to use a
16 probability of detection to adjust the numbers that
17 are sent to you, right? I mean, you have got to deal
18 with the probability of detection issue don't you?

19 MR. KARWOSKI: Right.

20 DR. POWERS: Okay. One of the ways of
21 dealing with it is to say that I am not going to deal
22 with it, but I think that would be fairly
23 unsatisfactory.

24 MR. KARWOSKI: We can definitely look at
25 it as -- and whether or not it gets into formal review

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SEPTEMBER 26, 2001

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

1 or whether or not that is more detailed guidance --

2 DR. POWERS: Well, how do you handle it?

3 MR. KARWOSKI: Yes, we need to realize
4 that there are some indications which you can miss.

5 DR. POWERS: I think Westinghouse put
6 together a pretty nice story on what the probability
7 of detection is for what we needed in this context,
8 and which strictly is a probability of detection.

9 CHAIRMAN FORD: There is a question of
10 probability of detection, but the efforts that you are
11 doing in this area is combined in our own research,
12 and is in the 3.6 of the NUREG program. That's in
13 addition to this one isn't it?

14 MR. KARWOSKI: I am not -- with respect to
15 the database, the database is basically a regulatory
16 issue; whether or not research plans that I am doing
17 additional testing under these model boiler or
18 laboratory produced specimens that could supplement
19 the database, if they develop any of that type of
20 data, would gladly include in the correlation if it is
21 applicable.

22 With respect to the flaw growth, I don't
23 know if research is going anything on this issue. The
24 recommendation was more looking at how the
25 predictions, compared to what we observed in the

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1 field. And so it gets more into how well is my
2 operational assessment performing.

3 CHAIRMAN FORD: I am not surprised that
4 you are not firming up on your correlation, and just
5 adding more uncontrolled data or bad data is not going
6 to improve your correlation plan.

7 MR. KARWOSKI: Right. But that's --

8 CHAIRMAN FORD: You can have as many bad
9 data points as you like, but that is not going to help
10 you.

11 DR. POWERS: I think they made a case for
12 the pulling and that it wasn't doing too much to it,
13 and a case gets made when you say, gee, the three-
14 quarter inch data gets pulled just the same way, and
15 it doesn't look all that bad.

16 What is there so unusual about the seven-
17 eighths, and it is kind of hard to imagine that there
18 is something different about pulling one.

19 CHAIRMAN FORD: So as we go down this
20 path, and then you realize that you are not going to
21 improve the correlation factors, what is your fall
22 back?

23 MR. KARWOSKI: I don't necessarily want to
24 say that we won't improve the correlations, but --

25 CHAIRMAN FORD: I guess at this point that

1 you had better recognize it that you probably won't.
2 So what is your fall back?

3 MR. KARWOSKI: Well, if the statistical
4 criteria are not met to demonstrate that there is a
5 correlation, the Generic Letter 95-05 methodology says
6 that if you can't demonstrate that, then you need to
7 calculate your leak rates in accordance with the
8 following procedure, which basically says that the
9 leakage is independent of the voltage observed.

10 So there is a methodology that already
11 accounts for that, because back then when we were
12 doing the 95-05, some of these databases didn't have
13 a correlation, and so we had to deal with that back
14 then. So there is a fall back in the methodology.

15 CHAIRMAN FORD: And thank you very much
16 indeed. At this point, is that your presentation?

17 MR. KARWOSKI: That's it.

18 CHAIRMAN FORD: Thank you very much.
19 Mario has to leave at 11:30, and the next talk is by
20 Joe, and who should be talking about some of the
21 further DPO issues and the new research program.
22 Mario, before you go, would you like to make any
23 comments on what you have heard so far?

24 One of the issues that we have to address
25 is what is the next action as far as this subcommittee

1 is concerned, and we are going to write DPO a letter
2 for the next ACRS meeting, and we have suggested that
3 in the November-December time frame that we have a
4 presentation by NEI/NRR on the 97-06.

5 Do you have any comments on what you have
6 heard so far?

7 DR. BONACA: The only one that I mentioned
8 before regarding performance, and the issue of
9 prediction that has already been discussed now. That
10 is the only point that I think we want to stress is
11 important.

12 And also this consideration of what do you
13 include in the predictions. I mean, what should you
14 consider a multiplier to that.

15 CHAIRMAN FORD: Thanks so much. And you
16 like the idea of having a meeting in the November-
17 December time frame?

18 DR. BONACA: Yes. I would like to see if
19 and when we have a new presentation that there would
20 also be more focus on the objectives of this
21 integrated plan.

22 I mean, one thing that I was left with was
23 that I think I understood the objectives of the NEI
24 program, and while clearly stated, for the integrated
25 plan I heard that the objective was to integrate the

1 activities.

2 And still I think it would be nice to have
3 a statement somewhere of what is the purpose of
4 reintegrating all these activities. We understand it
5 generally, but often times if you state what the
6 objectives are, then it focuses better on the plan
7 itself.

8 And I would have liked to have seen that
9 in a statement at the beginning of the presentation.

10 DR. KRESS: Our obligation is just to have
11 a letter on the DOP issues?

12 DR. BONACA: Yes, for right now.

13 DR. KRESS: And some of the other things
14 that he is talking about would be just a briefing?

15 CHAIRMAN FORD: A briefing to this
16 subcommittee in November or December.

17 DR. BONACA: That's right. That is just
18 a suggestion for the briefing, yes.

19 DR. DUDLEY: I would like to think that if
20 we did do a review of the 97-06 letter that the
21 committee would comment back to the staff on it in the
22 letter in December.

23 DR. KRESS: Combine in the same letter as
24 the one on the DOP issues?

25 CHAIRMAN FORD: We are going to do that

1 next week.

2 DR. KRESS: Oh, you are going to do that
3 next week?

4 CHAIRMAN FORD: Yes, if we have enough
5 information, and if we don't have enough information,
6 we can't comment.

7 DR. KRESS: Okay.

8 CHAIRMAN FORD: Okay. Thanks very much.

9 MR. MUSCARA: Thank you, Peter. My name
10 is Joe Muscara, and in June of this year the EDO sent
11 a letter to the ACRS transmitting the action plan that
12 included DPO issues.

13 That plan is updated monthly and is
14 available to you. So the status is really available
15 within that plan. So what we thought we would do for
16 this meeting was to more or less concentrate on the
17 near term milestones.

18 So we will try and cover some of the work
19 that has completed in the past year, and address work
20 that will be going on for about the next year. In the
21 presentation, I will start off discussing some of the
22 issues related to materials, engineering, and
23 inspection.

24 And then Charlie Tinkler will give us an
25 overview of the severe accidents and thermal

1 hydraulics work; and Steve Bajorek will discuss some
2 thermal hydraulics calculations for predicting the
3 loads during a steam line break.

4 And Chris Boy will provide us some input
5 on some CFD calculations that have been conducted
6 recently. Under 3.1 of the action plan, the history
7 of crack propagation in steam generator tubes under a
8 steam line break condition, and we have planned some
9 work in this area to essentially start in the new
10 calendar year, 2002.

11 What we will be doing there initially is
12 to obtain some loads, including cyclic loads, during
13 the MSLB from thermal-hydraulic calculations, and this
14 will be covered in a bit more detail later.

15 At the same time there has been an
16 analysis conducted, and we have submittals in this
17 area, and so we will also plan on reviewing those
18 submittals, and try to obtain some of the loads from
19 those.

20 We will put together what we think will be
21 the bonding loads experienced by the tubes during the
22 MSLB, and based on that we will calculate the crack
23 growth, if any, for a range of crack types and sizes
24 using the loads as determined above.

25 CHAIRMAN FORD: The crack growth is just

1 tearing, and not sub-critical crack growth?

2 MR. MUSCARA: That's right. We will
3 assume that we have some existing cracks, and then we
4 have the accident, and then we will determine whether
5 these cracks propagate or not.

6 As far as the ranges of crack sizes,
7 clearly we would like to look at initially at a crack
8 that is stable under normal operating conditions. But
9 it would be unstable under the steam line.

10 So with this largest crack, we can one
11 that will still not propagate a leak. And then we
12 will take that crack size and determine whether that
13 would propagate under the steam line break conditions.
14 But we will look at a range of crack sizes.

15 CHAIRMAN FORD: Will we be coming back to
16 discuss some of the details? For instance, what -- as
17 I understand it, calculating the delta- P s by some of
18 the existing hydraulic codes is not necessarily an
19 easy thing.

20 MR. MUSCARA: Right.

21 CHAIRMAN FORD: So will we be discussing
22 some of the technical challenges and back up if we
23 can't meet those challenges?

24 MR. MUSCARA: Right. The discussion that
25 follows will address that issue.

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1 CHAIRMAN FORD: Okay. Good.

2 MR. MUSCARA: Another approach that we
3 will take is to also estimate the loads that are
4 required to propagate existing cracks. And based on
5 that we can determine some margins, and what is the
6 margin over the MSLB loads.

7 In fact, if we find that we have large
8 margins, then we really don't feel that we need to
9 refine the thermal-hydraulic calculations. If in fact
10 the margins are not so large, then we have to refine
11 the calculations again, and that will be discussed
12 later.

13 And having conducted these analyses, and
14 we will be using existing procedure for evaluating the
15 burst and leakage, and mostly burst in this case, we
16 will then conduct some tests to validate these
17 analyses.

18 So then the tests will then take into
19 account not only the pressure stress, but also the
20 bending loads and the cyclic loads, and that work will
21 be done at the beginning of '03.

22 CHAIRMAN FORD: Again, the question of the
23 movement of the plates and things of this nature.
24 This is again a fairly -- in calculating these loads,
25 it is not a trivial exercise at all?

1 MR. MUSCARA: Right, and so again what we
2 are doing there is we will do some of our own
3 calculations, and the thermal-hydraulics will be
4 described, and we will look at what the industry has
5 provided us.

6 And we will come up with some upper bound
7 estimates, and then we will use those loads to
8 determine what happens to cracks. And if we find that
9 we have small margins, then we will need to do
10 additional work to refine the analysis.

11 And another item that is covered in the
12 operating plan, and also of course addressed in the
13 ACRS report was damage progression by jet impingement,
14 and this is jet impingement both under severe accident
15 conditions and jet impingement from a steam line
16 break.

17 Last year, in October, about this time of
18 the year, we presented some information on the jet
19 impingement work under severe accident conditions to
20 the ACRS, and at that time we were more or less agreed
21 that jet impingement from severe accidents from the
22 aerosols are not really a problem. There is very
23 little erosion that goes on.

24 And the ACRS suggested that we may want to
25 look at a somewhat longer term test. Our initial

1 tests were 10 minutes, and we have conducted some
2 additional tests based on the recommendation.

3 DR. BONACA: Let me just ask a simple
4 question. Going to page four, you have or you
5 mentioned that starting in 2003 that you will have a
6 test on the tubes under pressure and axial bending.
7 Why are you waiting so long?

8 I mean, wouldn't you want to have results
9 as you do calculations, and that mostly likely,
10 especially in doing hydraulic calculations, you raise
11 a question insofar as the modeling, and whether or not
12 certain effects are being properly modeled.

13 MR. MUSCARA: Well, the test that I am
14 talking about is mechanical tests to validate our
15 analysis. The analytical methods have been developed
16 and proven over many years. So we don't believe that
17 the validation tests are going to give us a different
18 result.

19 Our main emphasis is going to be using the
20 procedures already developed, and in most cases it
21 will be a flow stress model for essentially the
22 failure criterion. We will also be using some
23 fundamental analysis on the structural side.

24 DR. BONACA: It is only a test, and it
25 going to be purely --

1 MR. MUSCARA: It is a validation test just
2 to confirm that the analysis was proved.

3 DR. BONACA: And that is dealing with
4 tubes and some force applied to.

5 MR. MUSCARA: Right. The tests that we
6 have conducted so far in the models that we have
7 developed have been mostly pressure stress. So we
8 want to add to those pressure stresses some of the
9 bending loads.

10 And with the bending loads and axial loads
11 one might see with the support plates moving what the
12 tubes are doing in terms of support plates.

13 DR. BONACA: And you said that this
14 analytical method or models that you are going to use
15 already are credible for this kind of test?

16 MR. MUSCARA: Yes. We conducted back in
17 the '80s 800 tests with different types and sizes of
18 flaws to predict failure of these tubes.

19 DR. BONACA: And so you are talking about
20 the analysis now, and I am talking about the analysis.

21 MR. MUSCARA: Yes. Well, based on those
22 tests, we developed analytical procedures and those
23 have been validated. And tests have been conducted in
24 other parts of the world that confirm those methods.

25 DR. BONACA: And these are analyses as you

1 mentioned are computer codes that you are going to use
2 to perform these analyses?

3 MR. MUSCARA: Most of the analysis will be
4 under stresses, and the evaluation of MSLB, which is
5 a parameter that describes the stress on the ligament
6 of the crack.

7 DR. BONACA: I guess I am asking because
8 I am kind of surprised, and I just didn't know that
9 you already had all this information, and models
10 available, and they were not being used to address
11 this issue of main steam line break.

12 MR. MUSCARA: Frankly, if you consider
13 axial flaws, for example, and we think that this might
14 propagate under steam line break conditions, I don't
15 believe that is credible.

16 I mean, these tubes have got so much
17 toughness, and it would need to have so much pull to
18 propagate those flaws that the tube would fail as if
19 the flaw wasn't there, and it would take a great load.

20 Now, the other conditions are when we
21 would have circumvential cracks, and in those
22 conditions it would be somewhat a little bit
23 different. I still believe that based on the work
24 that we have done that it is going to take a great
25 load to open up these cracks enough to cause a major

1 failure.

2 For example, we find that cracks that are
3 270 degrees around the tube all the way through still
4 will not open up and give you a large leakage. So I
5 guess that part of the reason that we haven't done
6 these tests is because that we have felt from an
7 engineering feeling that the steam line break loads
8 will not propagate these kinds of cracks.

9 And with respect to cyclic loads, yes, we
10 have some cyclic loads, but how long are these loads
11 going to be on there. Again, I don't think we have
12 enough cycles to affect the growth of existing cracks.
13 But we will do the work and see where we are.

14 On the jet impingement work as I
15 mentioned, we have work that is ongoing on both the
16 aerosol impingement and from a steam line break. The
17 work on the aerosols was conducted at the University
18 of Cincinnati with Professor Tabakoff, and the jet
19 erosion tests have been conducted at Argonne National
20 Lab.

21 And I think I mentioned that the rest of
22 the items we have conducted tests now of up to 30
23 minutes for the aerosols. Dr. Ford, if we are
24 stressed for time, I could skip the view graph here.

25 DR. POWERS: My feeling is that you can

1 skip over the erosion results.

2 MR. MUSCARA: Well, I guess the final
3 outcome of that is that the 30 minute test did not
4 provide us any different data. We still have very low
5 rates, about 2 mils per hour with just nickel, and
6 about 5 mils per hours with nickel, plus aluminum.
7 And these are much more severe conditions than the
8 actual aerosols.

9 DR. POWERS: And I kind of assumed that
10 was the results that you were going to get.

11 MR. MUSCARA: In fact, the data was really
12 indistinguishable from the prior data. All right.
13 And some results that we haven't shown are test
14 results on the jet impingement and steam line break
15 conditions.

16 Here essentially we have run some tests
17 with the different sized holes, but concentrating on
18 the 1/32nd inch hole. There is a specimen spot weld
19 to the leaking tube, with a stand-off distance of
20 about a quarter-of-an-inch. So the leaking tube
21 impinges on this group.

22 We conducted tests as a function of
23 temperature, and we find that the most degradation is
24 obtained at about 280 degrees centigrade, which is
25 about the cold leg temperature, and where you don't

1 expect to see cracks.

2 And then the amount of erosion decreases
3 as the super heat goes up, and so as the temperature
4 goes up. So we are getting some flashing and not as
5 much penetration.

6 The greatest amount of penetration we had
7 was about 25 percent of the wall over a two hour test
8 period. And we will move now on to some comments on
9 the NDE. There was a comment in the ACRS report that
10 using a constant POD may not be the best thing.

11 We have been doing work in this area for
12 a number of years, and last year again I described
13 work on a mock-up. We have now some results, and I
14 think I will go into showing some of the results from
15 the round-robin analysis of the mock-up.

16 CHAIRMAN FORD: Joe, I asked the question
17 to Ken Karwoski about the interrelationship between
18 the work being done by research on this item, and it
19 being transitioned into use. Can you make a comment
20 on that?

21 MR. MUSCARA: Well, let me give a little
22 bit of background. We issued this work about 5 or 6
23 years ago, and at that time I was looking for a
24 physically based model that we could use for doing the
25 operational assessments.

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1 The big concern was that we were using for
2 the voltage based criterion, and it is empirically
3 based, that there is no physical reason why it should
4 give us good correlations.

5 Voltage does not relate to crack size.
6 Therefore, it cannot relate to crack growth, and crack
7 growth cannot relate to burst pressures. Generally as
8 the voltage goes up, the crack size goes up, but there
9 is a general correlation.

10 What is not true is that for low voltage
11 that it is not just small cracks. We are going to
12 have big cracks that have a low voltage. So in my
13 mind what was needed was something that was more
14 robust and more physically based.

15 So at that time we conducted an
16 operational assessment. We needed to know the
17 probability detection so that we can take into account
18 the flaws that were missed during inspection, and we
19 needed to know something about cracking issues and
20 what happens during the cycle.

21 And of course we needed to know crack
22 growth grade, and not based on voltage, but based on
23 some physical parameters. And so at that time we set
24 up work to learn more about these items.

25 And one of the key areas of work then was

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1 the probability of detection. So by the time the ACRS
2 had their comment, we already had done a considerable
3 amount of work trying to develop POD as a function of
4 different parameters.

5 And also this data is available. It is
6 available for us, and it is available for the
7 industry, and it can be used as people see fit. We
8 tried to conduct these tests in a realistic way. We
9 are using procedures that are used in the field, and
10 we tried to limit the entire inspection processes
11 conducted in the field.

12 We have done the degradation assessment,
13 and we have the right techniques, and qualified
14 techniques, and qualified people doing the
15 inspections.

16 We have a five-person team that has done
17 the inspections, and so we have tried to reproduce as
18 much as possible the process that goes on in the
19 field. With respect to the tubes and the division
20 itself, the same thing.

21 We developed a fairly comprehensive mock-
22 up with different conditions of dents, and corrosion
23 products, and transitions, and realistic flaws,
24 developed in the lab with realistic flaws from the
25 point of view of signal, and so we believe that we

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1 have a reasonable test.

2 And we do have now some results that may
3 be POD to some other factors besides the --

4 CHAIRMAN FORD: Am I missing something?
5 That although you have this data, it is not being
6 used?

7 MR. MUSCARA: Well, this data is just
8 evolving. In research, the main emphasis is to
9 develop also a code that can be made available to the
10 NRC staff so they can do their own independent
11 operational assessments. POD is one input to this
12 code, and precision crack code would be another code.

13 So that code is under development and the
14 data is becoming available, and our first topical
15 report will be published before the end of this year
16 providing these results.

17 And of course the results have been made
18 available, and we have reviewed the draft reports, and
19 so we are aware of the information.

20 CHAIRMAN FORD: So we are ahead of the
21 ball game here on this particular result?

22 MR. MUSCARA: Yes, I think so.

23 DR. POWERS: The ad hoc committee -- I
24 think you have to understand that the NRR staff has a
25 different set of problems. They need to detect and

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1 then they need to predict, and they need to predict
2 what kinds of things show up in between the two.

3 What the ad hoc committee was concerned
4 was about was using a constant POD with respect to
5 carbon stone was that as the technology for sampling,
6 for inspecting tubes improved, and as the technical
7 understanding improved, you wouldn't be able to
8 correct things, and take into account, and it is a
9 draconian thing.

10 So when we moved to something that was
11 more easily corrected, and that is all that this
12 research is doing, and it was basically an endorsement
13 of this research.

14 MR. MUSCARA: In fact, the Generic Letter
15 95-05 made some comments at that time, and they in
16 fact did say that they felt that the voltage raised
17 criterion is acceptable for now, but we should be
18 moving towards more physically based criterion.

19 And the ACRS said that, and so based on
20 that also we felt a need to develop this kind of data.
21 The results were that the upper left figure shows the
22 POD is a function of depth, and for flaws at the tube
23 support plate, both for the OD and the ID.

24 Quickly, we noticed that the ID flaws are
25 more easily detected if the POD is higher, and that is

1 reasonable because we get in general larger signals
2 from the ID than from the OD. There is not as much
3 penetration of the ID currents.

4 In the next view graph we are showing a
5 similar plot, but with respect to voltage, and we see
6 here that the role is reversed. What I need to
7 mention is that once the voltage gets considerably
8 high, all the POD get to be about the same.

9 But for lower voltages, we are getting a
10 better correlation with the OD flaws. At one point,
11 for the ID flaws, we also had the dents. So many of
12 the flaws at the support plate that were originally
13 from the ID also had a dent.

14 That means that we had a signal which was
15 not very clean. Now, because the inspector looks at
16 the signal rise on the plane to a vertical position
17 for calling it a crack, and because there is a dent
18 signal, and because ID flaws only have a small range
19 of phase angle shift, the signal does not rise very
20 much, and can also be buried in the noise.

21 So in this case the ID flaws showed a
22 lower POD than the ID flaws. But this shows in
23 general that we can plot that POD is a function of the
24 depth of the flaw, and POD is a function of the
25 voltage.

1 And the bottom graph essentially shows POD
2 for the tube sheet section, where we have a couple of
3 tube sheet flaws also with the tube transition, the
4 role transition being present that complicates the
5 signal.

6 Besides looking at the flaw size, flaw
7 size and voltage by itself, a very useful parameter to
8 plot the PODs as a function of MLSB, and again MLSB
9 describes the stress at the ligament of the flaw. It
10 directly relates to the burst pressure.

11 So here we can relate POD as a function of
12 a structural integrity parameter, and we noticed that
13 the POD gets to be reasonably high if LIDSCC parameter
14 of greater than 2.3 would correspondence to a flaw
15 that would fail at 3 delta-P. So the POD for cracks
16 that are at 3 delta-P can be fairly high.

17 And just to show it from the view graph
18 and to make an other point that even though our
19 results are qualified, what we noticed for certain
20 conditions, such as the tube sheet, and the top two
21 graphs, we are plotting the results on a team-by-team
22 basis. The others were combined results.

23 And we noticed that the teams more or less
24 cluster fairly close together for those two examples,
25 but in other cases -- for example, the free span,

1 where the teams are not use to looking at the flaws of
2 the free span, they find lots of flaws on top of the
3 tube sheet and support plates, and not so much at the
4 free span.

5 And also for the support plate for the
6 LIDSCCs, there is quite a bit of scatter in the team
7 performance. The good team is quite good, and the
8 number of teams right there is sort of an average.

9 But there is always a team that does not
10 perform as well, and again I would like to stress that
11 these are teams that are commercial teams, and they
12 are qualified, and they are conducted in inspections
13 in a manner that is similar to what they do in the
14 field.

15 And if anything of course they know that
16 they are under test conditions, and so this is under
17 best performance.

18 CHAIRMAN FORD: And the lines on these
19 grants -- I'm sorry, but what are they?

20 MR. MUSCARA: They are just a different
21 team. The assemblies are a team and also the line is
22 also a team. So we had 11 teams participating in this
23 round robin.

24 CHAIRMAN FORD: Oh, I see.

25 DR. POWERS: The best team and the worst

1 team had to change lines, and everybody else --

2 MR. MUSCARA: And it is just a logistic
3 thing. So we are showing you essentially the variance
4 between the best and the worst team. I mean, this is
5 very useful data when we are doing probablistic
6 analysis.

7 So I think more or less we have addressed
8 the issue for ACRS as to other methods may be useful,
9 and we already have data in this area. There is one
10 item that I would like to cover --

11 CHAIRMAN FORD: I'm sorry, but I am
12 violating my own principle of not asking questions,
13 but if you would go back to the bottom right-hand
14 slide, the IDSCC tube support plate and the biggest
15 scatter. Is that purely because the cracks are on the
16 ID and the eddy can't pick those up for some reason or
17 other?

18 MR. MUSCARA: No, because one thing is
19 they are doing quite well if you look at the green
20 light.

21 CHAIRMAN FORD: Yes, but the scatter.

22 MR. MUSCARA: Well, yes, the scatter, but
23 what is the complicating factor of course with these
24 flaws is that there is a role transition, and that
25 role transition provides a fairly large signal.

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1 CHAIRMAN FORD: Oh, so you have a float
2 between the --

3 MR. MUSCARA: It is a complicated signal,
4 although --

5 DR. SHACK: But this is the tube support
6 plate there though?

7 MR. MUSCARA: I'm sorry? Oh, yes, this is
8 the ID with the dent. So you do have considerable
9 noise, and some things do better than others. I think
10 here again that it is a matter of -- there may be a
11 signal there as a matter of calling it a crack.

12 And because the signal is more and doesn't
13 have a large shift-in phase, and there is a
14 complicated noise signal, it still is difficult for
15 the inspector to notice it to call it a crack. They
16 may confuse it as being part of the noise signal. But
17 the good inspectors do quite well.

18 And this next view graph is not really at
19 all to do with materials. I see that Jack Hays is in
20 the back of the room and he can answer any questions
21 on this.

22 This is the item on the item spiking. We
23 have conducted an assessment of the ADAMS and Atwood,
24 and Adams and Sattison spiking data this summer, and
25 I understand that this review has been completed.

1 And the plant having a response to the
2 ACRS comments by December, and our evaluation of this
3 will be published for public comment around February,
4 and then based on the public comment, there is a final
5 position that will be put together.

6 I understand that after we evaluate our
7 position on this issue that we could be willing an
8 able to provide a presentation to the ACRS on that
9 position before it goes out for public comment.

10 So I think this is something that is up to
11 you if you want to hear about this or not after we
12 have assembled a position on it.

13 DR. POWERS: Comments are always the same.
14 That is more work than it would take to solve the
15 problem completely. Do it the way that you want to,
16 but that is an awful lot of work for a problem that I
17 think is susceptible to a technical resolution.

18 MR. MUSCARA: Jack, do you want to
19 respond? No? Okay. Well, I am almost finished,
20 because the next view graph is milestones and is
21 fairly far into the future, but there will be work
22 going on next year in this area, and I know that Peter
23 will be interested in this.

24 So I decided to discuss this a little bit.
25 Now, we are planning on conducting some tests to

1 better understand the crack initiation and crack
2 growth. And we are taking the comments from the ACRS
3 to heart. We want to conduct tests under realistic
4 conditions of stresses, temperatures, and environment.

5 That means that we need to evaluate better
6 what goes on in crevices. As far as the tests
7 themselves, they are not defined yet, but we may be
8 using model boilers so that we can reproduce the
9 thermal hydraulic conditions and the crevice
10 conditions, and therefore, have the appropriate
11 crevice chemistry.

12 We may have to measure the crevice
13 chemistry, and we may just run tests and evaluate the
14 cracking behavior, and then measure the crevice
15 chemistry at the end when we are not at operating
16 conditions anymore. But it is very difficult to
17 instrument these crevices.

18 So there are a number of ideas that we are
19 considering. The work is not defined, but we will be
20 looking at crack initiation, and crack growth, and
21 using tubular specimens, along with other types of
22 specimens.

23 And hopefully under realistic fuel
24 conditions, and the idea here again is not necessarily
25 to develop the mechanisms, but to develop data that

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1 will be useful for our code for doing the assessments,
2 the operational assessments. And we need crack
3 initiation data and crack code data.

4 DR. POWERS: A couple of questions, Joe.
5 As people move to 690 are you going to be testing 690?

6 MR. MUSCARA: Yes, thank you. We will be
7 testing 690, along with the 600. The idea here is
8 that we have a great deal of information on the
9 behavior of 600 in the field.

10 So we will be conducting tests with 600
11 mill anneal, and 690 thermally treated, so that at
12 least we know the behavior in the laboratory; and then
13 knowing the behavior of 600 in the field, hopefully we
14 can extrapolate the behavior of 690.

15 It may be well that on 690 to just make a
16 couple of comments. Now, 690 is susceptible to
17 cracking in different environments. It has cracked in
18 the laboratory, and cracks in environments that are
19 not overly aggressive. It cracks in neutral solutions
20 and sulfates, and in copper, and in lead.

21 So what we want to do is with respect to
22 690 to evaluate the range of conditions under which
23 this material is susceptible so that we can get a
24 better idea about its behavior in the field.

25 In addition to this, we have had Professor

1 Staley working on crack initiation. This work was
2 just started about a year ago, and he is modeling
3 this. But we have also been looking at some of the
4 field data.

5 When we look at the data for 600 mill
6 anneal, and we consider the cracking that we are
7 experiencing these days, and not necessarily the
8 caustic cracking that we got in the early days.

9 We will consider cracking at the support
10 plate and crevices. Well, 600 mill annealed has taken
11 10 years before it experiences this kind of cracking.
12 So the fact that 690 has gone 10 years doesn't give me
13 that much more comfort yet.

14 We know that in the laboratory that it
15 behaves better, and I do believe that it will behave
16 better, but I don't know whether it will last 40
17 years. But through this work hopefully we will get a
18 better feeling for the behavior of 690, as compared to
19 600.

20 DR. POWERS: Another thing that I noticed
21 -- and as you say, trying to instrument to understand
22 what is going on in crevice corrosion -- and probably
23 because it is small, and things just don't fit in
24 there -- I noticed that within the corrosion community
25 there are people -- I mean, crevice corrosion is not

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1 peculiar to nuclear plants. It is a lot of places.

2 But there are people who are trying to
3 develop what they call scaling laws for crevice
4 corrosion. In other words, to do experiments that are
5 scaled where you can instrument, and then you try to
6 find out how does that scale down to the real
7 crevices. Are you paying any attention to that kind
8 of work?

9 MR. MUSCARA: Well, actually there is work
10 also going on related to steam generators. Jesse
11 Lumpson at Rockwell Science Center is doing some work
12 for EPRI, and he has been doing work for a number of
13 years having a typical crevice.

14 And he has done quite a good number of
15 studies himself, but also this crevice model has been
16 taken to a plant in Japan, where they are conducting
17 tests using the coolant from the plant.

18 So they are developing good model data,
19 and we will take advantage of that. My feeling is
20 that we will still need to run some model boiler
21 tests, where we reproduce the crevice under thermal-
22 hydraulic conditions, and see how the materials
23 behave.

24 We will try to research it as much as
25 possible. Some of the things that we can certainly

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1 get are temperature, and maybe potential, and maybe
2 MPH. It would be interesting to be able to get
3 chemical species, and that is a harder problem.

4 EPRI is working on it and they may in fact
5 by the time we are ready to do something have some
6 solutions on how to do that experimentally. But one
7 thing that we can fall back on is what is in the
8 crevice after we have shut down the system. That will
9 give us a clue as to what was there in the operating
10 conditions.

11 CHAIRMAN FORD: I have a couple of
12 questions, Joe. On Task 3.8, that relates to the
13 whole question of how can you correlate a bonding, a
14 linear correlation of voltage of this type, with non-
15 linear performance, time dependent performance, of the
16 cracking phenomena?

17 That latter part would come out at 3.10,
18 and how are you going to from a management point of
19 view compelled in this information in 3.8?

20 MR. MUSCARA: From 3.10 and also from the
21 inspection work. My belief truly is that the voltage
22 does not track crack size or crack code. The linear
23 literature is not with crack code, but with voltage
24 code, which is meaningless.

25 So we happen to have a linear correlation.

1 We didn't try to make a scatter code really. There is
2 quite a bit of scatter, and so I don't know whether it
3 is linear or what it is.

4 But I think my point is that there should
5 not be a correlation there with crack growth, but we
6 will find a correlation with actual flaw sizes.

7 CHAIRMAN FORD: So as we look down the
8 time, and if what you say is correct, which I think it
9 is, should we not be looking for another spectrum
10 methodology which is more related to the physics?

11 MR. MUSCARA: Yes, and I think in general
12 that we are doing that in our program, and we have
13 come up with some fairly good techniques for sizing
14 flaws. I presented the slides here and some reports
15 are being published on this.

16 But we have come up with a very good
17 technique for characterizing flaws, and particularly
18 the flaw profile. And from that we can get directly
19 MSLB, and we have been able to predict the bursts of
20 these tubes from the flaw profile and from the MSLB
21 correlations.

22 EPRI is also working on different
23 techniques for better characterization flaws, and the
24 industry has moved towards other plugging criteria.
25 For example, at the tube support plate crack and the

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1 idea with dents. This is an area where they are using
2 the profile of the flaws.

3 They are getting away from voltage and
4 using the actual profile to determine the burst
5 pressures. And I believe that is a direction to go
6 into, and I think we are moving in that direction.

7 CHAIRMAN FORD: And industry is responsive
8 to these?

9 MR. MUSCARA: Well, that is what industry
10 is proposing, and utilities have come in with an
11 ultimate criterion.

12 CHAIRMAN FORD: Now what sort of time
13 scale are we talking about for this more physically
14 realistic inspection?

15 MR. MUSCARA: Well, I think the
16 characterization methods that we have now -- in fact,
17 EPRI is a member of our IC program, international
18 cooperation. And they are aware of this process that
19 we have developed for sizing flaws, and we are
20 exchanging information, even to the point where we are
21 going to turn over the algorithms.

22 CHAIRMAN FORD: Are we talking about six
23 months, a year?

24 MR. MUSCARA: Again, right now this is a
25 laboratory tool, and so in order to develop for the

1 industry more work needs to be done to make it more
2 user friendly.

3 And once it is in the hands of someone who
4 wants to turn it into a field system, we are talking
5 over a year or so. But again besides their own work,
6 there are other things that are coming up. For
7 example, this probe for doing better detection and
8 probably better characterization of flaws.

9 We are evaluating that, and that is
10 something that is almost industry ready. They have
11 done a lot of work getting data from plants, and we
12 are also incorporating them into our round robin
13 exercises. So we are evaluating that advance in
14 technology.

15 So technology is advancing, and I think to
16 the point where we can start making use of the actual
17 parameters of the flaw. They should be profiled and
18 length in depth, and then we can more accurately
19 predict failure.

20 CHAIRMAN FORD: I have one more technical
21 question, and then we should discuss the ACRS type
22 actions that we have to take. On this one here, Joe,
23 how do you take into account that we just don't know
24 what is a good heat and what is a bad heat?

25 MR. MUSCARA: That's true, but what we

1 will probably do is catch bad heats, and work on the
2 bad heats so that at least we will be conservative on
3 what we find. If we get a good heat, we will be
4 testing forever and get no data.

5 CHAIRMAN FORD: Yes, I understand that,
6 and so your strategy on this is that we will go for
7 the worst case scenario and just happens to have by
8 chance some good heats?

9 MR. MUSCARA: Frankly, I have not thought
10 too much about doing heat variability in this work.
11 We will probably wind up doing several heats, but
12 probably not a tremendous amount of heats.

13 And again the idea generally would be to
14 find some susceptible heats, where we can do our work
15 to evaluate different parameters on cracking.

16 CHAIRMAN FORD: Okay. Joe, thanks very
17 much.

18 MR. MUSCARA: So I guess now we will have
19 the discussion on thermal hydraulics.

20 MR. SULLIVAN: This is Ted Sullivan from
21 the staff. I would like to make one additional
22 comment. I think you started to touch on it when Joe
23 was mentioning that this is a laboratory tool, and it
24 is being made available to the industry.

25 But in terms of making a transition to

1 applying that to ODSCC as a substitute for the
2 voltage, first of all, you have got to get industry --
3 I don't know who the you is, but industry has to be
4 interested in basically making another proposal to the
5 staff, and developing it to the point where it is a
6 suitable substitute for the staff.

7 And it has to happen -- if something like
8 that were going to happen one of two ways, either the
9 industry has to take it up and make a proposal in the
10 room, or the staff would have to make a safety case
11 that this sort of thing needs to be done.

12 And I don't think it is our view that it
13 would be easy to make any sort of safety case, but
14 that sort of transition needs to be conducted.

15 CHAIRMAN FORD: Okay.

16 MR. TINKLER: Joe described for you some
17 of the work being done by the Division of Engineering
18 and Technology in the Office of Research. I am going
19 to summarize the work that is being done in the
20 Division of Systems Analysis Regulatory Effectiveness
21 in the Office of Research that primarily addresses the
22 issues related to severe accident and design basis
23 thermal-hydraulic conditions that create at least in
24 part some of the loading conditions on the steam
25 generator tube.

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1 Be advised that all three divisions in the
2 Office of Research actually are contributing to this
3 initiative. The Division of Risk Analysis and
4 Applications is also heavily involved with NRR in
5 integrating this analysis into our understanding of
6 risk that are posed by steam generator tubes, both
7 from the standpoint of initiating events on the design
8 basis, as well as the risk from severe accidents.

9 Oh, and I am Charlie Tinkler, and I will
10 be followed by Steve Bajorek, who will talk to you
11 about our current thinking on the thermal hydraulics
12 questions related to support and steam generator tube
13 loads.

14 Chris Boyd will also describe in more
15 detail some recent analysis that he has completed on
16 the staff to address the details of mixing in the
17 steam generator and the steam generator tube --

18 CHAIRMAN FORD: If I could just give you
19 some guidance. WE have another meeting beginning at
20 one o'clock, and I guess the members would really like
21 some lunch. So if we can try and finish the whole
22 thing by say, 20 by 12:00 at the latest, and bearing
23 in mind that the information that we want to get a
24 feeling for right now is whether the recommendation in
25 NUREG 17-40 are being incorporated into this joint

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1 proposal.

2 MR. TINKLER: Okay. This is a list of the
3 major recommendations of the ACRS Ad Hoc Subcommittee
4 on the DPO. They are going to be addressed in this
5 presentation and that are covered by the work in our
6 division.

7 We want to develop a better understanding
8 of the behavior of the steam generator tubes under
9 severe accident conditions specifically addressed by
10 Steam Generator Task 3.4.

11 The evaluation of the -- and ACRS also
12 recognizes that we evaluate the potential for
13 progressions of damage to steam generator tubes during
14 the rapid depressurization caused by a main steam line
15 rupture. That is the more traditional thermal-
16 hydraulic issue, and that is specifically addressed in
17 the action plan under Item 3.1.

18 To address the severe accident response of
19 steam generator tubes, and general hydraulic boundary
20 conditions in the reactor coolant system, and
21 corresponding component behavior in the steam
22 generator tubes, we have four basic parts to this
23 research.

24 We have the system level code analysis,
25 and the system using SCDAP/RELAP. That is where we

1 model the core, the RCS, the steam generator tubes,
2 and all the other related components.

3 We are relying in part now on
4 computational fluid dynamics code analysis and
5 modeling, principally the FLUENT code, to model the
6 single phase natural circulation and mixing in the
7 steam generator tube bundle.

8 It gives us a much better portrayal of the
9 spacial dependencies and resolutions of temperatures
10 within the system. We are assessing again the 1/7th
11 scale test data.

12 These are the tests that were sponsored
13 originally by EPRI in the 1980s, and later co-
14 sponsored with the NRC as a mock-up of a steam
15 generator -- of two steam generators and a reactor
16 vessel.

17 The tests were designed and conducted
18 primarily by Westinghouse personnel, and so
19 occasionally you will hear them referred to as the
20 Westinghouse 1/7th scale test.

21 We are also contemplating conducting some
22 new experiments to investigate conditions that weren't
23 addressed in those original 1/7th scale tests that
24 have been raised in the DPO and raised by the ACRS,
25 and I will talk about those briefly.

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1 Under 3.4, we have a multitude of subtasks
2 that address a lot of the technical issues related to
3 severe accidents. These are some of those technical
4 issues. Some of these have their own separate
5 subtasks in the action plan.

6 Plant design differences. We have done
7 the bulks of our calculations for the SERE (phonetic)
8 design, which was the original basis for our tube
9 integrity analysis for NRR.

10 We started looking at -- and we have done
11 calculations for other plants, and we are now focusing
12 our attention on the Zion-like geometry, and that has
13 a number of advantages.

14 It is representative of a bigger group of
15 plants, and it also allows for a little better
16 comparison with some of the industry analysis, because
17 the industry analysis more often is done for a Zion-
18 like geometry.

19 And we have plant sequence variations, and
20 we typically focus on station blackout type sequences,
21 where one steam generator is also depressurized. The
22 steam generators have all boil dried, and the core has
23 become uncovered, and now we have super-heated steam
24 circulating through the loops.

25 Now we have a counter-current flow that we

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1 are primarily concerned about because for most of our
2 calculations we predict the loop seal for the red
3 coolant pumps is filled.

4 So we get counter-current flow out through
5 the hot leg, and through the steam generator, and to
6 one-third to one-half of the steam generator tubes,
7 and returning through the remaining portion of the
8 tube bundle, and back along the bottom of the hot leg
9 to the reactor vessel.

10 This task is to look at variations on that
11 sequence, and to look at the effects of reactor
12 coolant pump seal leaking, and to look at leakage from
13 PRVs or safety valves to see if there are variations
14 on the sequence that pose some unique challenge.

15 In response to past ACRS comments, we are
16 conducting a more rigorous uncertainty analysis to
17 look at the influence of mixing parameters and other
18 phenomenological issues in this calculation as part of
19 the system analysis.

20 The ACRS raised in its ad hoc subcommittee
21 report, and we recognize the importance of loop seal
22 clearing in this analysis. The effect of clearing the
23 loop seals is to have unit-directional flow through
24 the steam generator tube bundle, and not get the
25 benefit of return mixing through the coolant portion

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1 of that flow.

2 So it typically predicts higher
3 temperatures. It is normally associated with slightly
4 depressurized sequences, and so we looking at those
5 two effects combined. The effect of tube leakage on
6 inlet plenum mixing --

7 DR. POWERS: Are you going to be able to
8 resolve the issue of loop seal clearing just with
9 analysis?

10 MR. TINKLER: We think so. We know that
11 we have to present more analyses and our rationale to
12 the committee on this matter, but we believe that is
13 the case, and we understand the comments that have
14 been raised, and we understand the concerns about
15 small delta-P clearing loop seals.

16 We understand that, and we have work to do
17 on that, but right now we expect to address that
18 analytically. The effect of tube leakage on other
19 plenum orientation, and this is the notion that if you
20 have tube leakage up in the bundle that it will
21 disrupt the mixing in the inlet plenum that was
22 observed in the 1/7th scale test.

23 So you won't get quite as an efficient
24 mixing and you get perhaps channel flow or tunnel flow
25 up through the inlet plenum, and that can create a

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1 locally hotter plenum.

2 And hot leg/inlet plenum orientation. The
3 1/7th scale test looked at a proto-typic Westinghouse
4 steam generator, where the hot lay comes in low on the
5 inlet plenum. The CE designs have a hot leg
6 orientation that comes in a little higher on the inlet
7 plenum.

8 And so it is a little closer to the tube
9 sheet, and so the argument there is that the mixing
10 path lends a shorter -- you might not get effective
11 mixing in the inlet plenum and the tubes will be
12 exposed to higher temperatures.

13 These are areas that we expect -- that are
14 well-suited to CFD calculation, but they also would
15 benefit from additional testing, and we are
16 considering that.

17 The things that we have to be mindful of
18 are the scaling issues associated with these kinds of
19 tests, and the need to run them with a denser fluid,
20 like SF6, and that poses a problem in some facilities.

21 There are a host of instrumentation
22 issues, as well as costs. Tube to tube variations.
23 When we do air calculations with control volume codes,
24 we have relative coarse nodalization of these volumes.
25 And inlet plenum is basically three control volumes.

1 Now, that's okay if you are using the
2 empirical models developed by the experimenters, but
3 if you want to hope to model the response of tubes or
4 clusters of tubes in a 3,000 tube bundle, you need
5 finer resolution.

6 So we were looking to see if the analysis,
7 as well as perhaps additional testing, to get more
8 insights on that. And fissure pipe deposition. This
9 relates to the risk impacts.

10 The ACRS has commented in the past that we
11 might not be taking full credit for those severe
12 accidents where tube leakage or tube rupture occurs.
13 The fact that that tube bundle and the upper internals
14 of steam generator will serve as a mechanism for
15 deposition of aerosols. These radioactive aerosols
16 wouldn't be transported off-site

17 Now, there is testing that is planned in
18 the Artis facility in Switzerland, the Paul Shearer
19 Institute is conducting tests where they have a mock-
20 up of steam generator tube bundle, and they are
21 looking at the deposition of aerosols under their
22 severe accident conditions or a range of conditions.

23 Here is 3.4, the near items. We are doing
24 system level analysis to look at sequence variations
25 to look at the effect of reactor coolant pump seal

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1 leakage, and to look at issues associated with safety
2 valve leakage, and to look at the effect of tube
3 bundle leakage.

4 And we are looking at the effect of tube
5 bundle leakage from a systems standpoint, and not a
6 local CFD level. We are also looking at alternate
7 steam generator depressurization. Typically, we do
8 these calculations with the pressurizer loop steam
9 generator being the one that is blown down and
10 depressurized.

11 And we have calculations being done
12 looking at the other three loops to see if it makes a
13 difference, and we are also looking to see to the
14 extent that we clear loop seals in some of these
15 calculations.

16 We have done the calculations where we are
17 halfway between a draft report and a final report, and
18 so we are not quite ready to talk to you about these
19 results, but we will in upcoming subcommittee open
20 meetings.

21 Our next task is to reevaluate some of the
22 SCDAP/RELAP modeling and simplifications of
23 assumptions, things like radiation heat transfer and
24 the hot leg; and some of the loop seal clearing issues
25 we hope to address in this.

1 It might also give us a vehicle for
2 looking at some of the comparative items between
3 industry calculations and our calculations.

4 Subtask 3.4e.1, benchmark of the CFD
5 methods. That is the FLUENT against the 1/7th test
6 data, and this work was just recently completed on
7 schedule in August. Chris Boyd will talk to you about
8 it in more detail.

9 Lastly, design basis and thermal
10 hydraulics. This was to address the issues in the DPO
11 that were raised by the depressurization by blowing
12 off a relief valve, or a main steam line break. That
13 is just a cryptic summary of the kinds of loads.

14 Steve Bajorek will just describe to you a
15 little more of our thinking at this point on how we
16 are going to tackle that issue, and he is next.

17 MR. BAJOREK: Good morning, or good
18 afternoon, I guess now. My name is Steve Bajorek, and
19 I am also a member of the SMSA branch, and relatively
20 new to that branch.

21 What I am going to talk about are some of
22 the issues pertaining to generating the hydraulic
23 loads that we are going to need to evaluate the blow
24 down forces on the steam generator. The work that we
25 are doing initiates from two different contentions.

1 I have listed them both here, and both
2 arise due to the uncertainty in what are the hydraulic
3 loads and forces that result across the tube sheet,
4 and across the tubes during the break, and the rupture
5 of the main steam line break, or potentially another
6 relatively large pipe connected to the secondary side
7 of the system.

8 By way of background, I think it is useful
9 to think of the high pressure depressurization of a
10 system into two overall segments. We can think of the
11 first phase; that while this fluid is primarily
12 subcooled, and while the depressurization waves
13 propagate through the system at a sonic velocity, and
14 then another phase of that depressurization once those
15 waves have dissipated, and the system depressurizes
16 primarily dependent upon the break flow and the size
17 of the break.

18 This is an issue that is actually of
19 fairly well-studied in the initial design of a reactor
20 system from the point of view of the primary; whether
21 you have rod drop or not, or whether you will have
22 grid crushing within the core, is dependent on your
23 design and how you evaluate the breaks to the primary
24 system to take a look and track the depressurization
25 waves as they move through the loops, and through the

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1 core, and potentially move the core barrel from one
2 side of the downcomer to the other.

3 A good analysis of that type of event
4 tracks the waves at sonic velocity, and incorporates
5 a fluid structure interaction between the core barrel,
6 which is the primary component of interest in that
7 type of an analysis, and generates the delta-Ps from
8 one side of the downcomer to the other side that we
9 give to the structural analysis so that they can
10 perform a structural analysis and tell us whether the
11 rods are dropped, or whether the core barrel deflects.

12 We have a similar situation now that we
13 need to address on the secondary side. Now, I think
14 the reason why that has not received as much attention
15 as the hydraulic forces that develop on the primary
16 side has to do with the rate at which those waves move
17 through the primary or through the various systems.

18 For the primary system Tcold -- and C
19 stands here for the sonic velocity, and this is at
20 about 550 degrees fahrenheit, at typical Tcold at
21 pressure, moves through the system at a little bit
22 greater than 1,000 meters per second.

23 If you think of the primary system full of
24 sub-cooled liquid early in the transient, this wave is
25 certainly capable of moving through the loops in the

1 core on the order of a couple of dozen times, and
2 interacting with waves which move throughout other
3 parts of the primary system, generating fairly complex
4 loading across the core barrel or the steam generator
5 divider plate, and other things that need to be looked
6 at.

7 And causing some of those components to
8 move. And we need to start thinking about what that
9 type of analysis or evaluation does now over on the
10 second side. But it is important to keep in mind that
11 the most important physical parameter which determines
12 the velocity of that wave is its density.

13 And in the primary system, typical
14 conditions are that we are seeing velocities a little
15 bit later than a thousand meters per second. On the
16 secondary side, the velocity that we might find in
17 saturated liquid at about 900 psi, just a little bit
18 less than what we would see on the primary system, the
19 difference being the difference in the density.

20 However, in the vapor space, that velocity
21 drops significantly to roughly half of its value. Now
22 when you do a thermal-hydraulic evaluation of the
23 primary system, that analysis to take a look at the
24 interaction of the waves goes for on the order of
25 milliseconds, because what happens is that as soon as

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1 we start to form some voids within the system, those
2 waves are dissipated very rapidly.

3 And the interaction of the waves becomes
4 a no, never mind, in the analysis. It is something
5 that will probably help out the structural evaluation
6 here on the steam generators secondary side. That is
7 not to say that those loads are going to necessarily
8 be small, because there will still be a fairly
9 significant shock to the tube sheet and resulting
10 motion.

11 Now, because the steam generator either
12 has significant voids through the bundle region at a
13 steady state, or has an interface at no load
14 condition, the most significant pressure wave that is
15 going to cause motion of the tube sheet and transient
16 stresses on other components within the steam
17 generator is going to be this initial wave that moves
18 through the steam generator.

19 We won't have much in the way of
20 reflection or interaction, with the exception of the
21 fact that we have more voids on the interior of the
22 steam generator, and sub-cooled fluid in the
23 downcomer, and so conceivably we could see a wave
24 moving down the steam generator downcomer, and
25 reaching that portion of the tube sheet earlier than

1 we would in the interior of the bundle.

2 So our initial approach -- and we have got
3 to admit that we are in the very initial stages of
4 developing a plan of attack at this point -- is to try
5 to develop relatively conservative hydraulic loads
6 that we can give to $\Delta P(t)$ for them to apply to
7 their finite element model, and to determine the
8 bending stresses and other stresses that they get out
9 of that type of an analysis.

10 Our approach is first going to try to use
11 what I will call glorified hand calculations to
12 determine, one, what is the initial time at which that
13 depressurization wave reaches the tube sheet and
14 various parts of the steam generator base, and augment
15 that with track 3-D calculations to look at the later
16 stages of the blow down of the steam generator
17 secondary side.

18 Now, during that phase of the accident
19 something like a TRAC or RELAP should give us a
20 reasonable depressurization. I would not expect it to
21 do a credible job during this very initial part, where
22 you have to TRAC the sonic wave and the interactions
23 that it has with the various components.

24 That's why our initial plans are to try to
25 get something that is conservative with the hand

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1 calculation, and augment it with the TRAC-M
2 calculations, and give that to the finite element.

3 And if you can come back and tell us
4 whether we have lots of margin, or there is a little
5 bit of margin on that. If the answer comes back that
6 we have just a very small amount of margin, the next
7 part of our evaluation would be to replace the hand
8 calculation with something better.

9 That would not necessarily be TRAC-M. I
10 think we have to look at that closer and make up our
11 minds whether it could or could not do that. The
12 tools that might be available to us to analyze this
13 are the things like the multiplex code that is used by
14 Westinghouse to evaluate the subcool blow down on the
15 primary side.

16 The staff a number of years ago to my
17 recollection did have access to a code, and I think it
18 might have been called SLAM, to take a look at that
19 type of a scenario on the primary side.

20 That might be a better starting point than
21 trying to force the TRAC-M to give us that type of
22 sonic wave depressurization. But we would go along
23 that path if we were to find that we wouldn't have
24 enough margin and structural analysis, and then make
25 a decision on what would be a more appropriate tool.

1 If necessary, then look at some
2 experimental testing to try to augment our code
3 validation at that point. At that point, if we had
4 such limited margin, that might also be a good time to
5 go back to the vendors and use perhaps their tools to
6 try to evaluate the same type.

7 CHAIRMAN FORD: Thanks very much indeed.

8 MR. TINKLER: Thank you.

9 MR. BAJOREK: I have more slides than
10 eight minutes, but I am just going to go through them
11 quickly. Charlie covered a lot. This Charlie
12 described, and I am just going to show this as the
13 thermal-hydraulics of interest that we are going to
14 focus on in this small subtask that I am carrying on.

15 I want to make this point before I start,
16 and that is that the SCDAP/RELAP code is what we are
17 relying on to get our thermal-hydraulic results to
18 pass on to the materials people.

19 The tube temperature predictions that the
20 tubes are subjected to come out of that code, and they
21 are influenced directly by mixing parameters. So I am
22 making the point that we are going to use SCDAP/RELAP
23 and that gives temperatures that are affected by
24 mixing parameters, and these mixing parameters are
25 fixed in the code, and they are determined from the

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1 1/7th scale testing principally and other tests if
2 possible.

3 So these mixing parameters are what I am
4 going to focus on. The advantages of CFD. I just
5 give this slide to show an example that we are about
6 four orders of magnitude more cells, on the order of
7 hundreds of thousands, to a million, versus 10 to a
8 hundred.

9 Less expensive experiments as you pointed
10 out, and we are going to have a direct resolution of
11 mixing. We are not tuning the code. We are using the
12 most appropriate turbulence models from an academic
13 point of view, and then just letting the code go.

14 So again no fixed mixing parameters. We
15 are extending the data with CDF, or we will to full-
16 scale, full-pressure, full-temperature steam, and then
17 we can look at this inlet geometry effects and tube
18 leakage effects that Charlie mentioned.

19 DR. KRESS: Do we have options in the
20 fluid code or for what turbulence parameter, different
21 options for turbulence parameters?

22 MR. BOYD: We have different turbulence
23 models, and several to choose from, and then within a
24 turbulence model, you can then tune that to the data.
25 We are not doing that type of tuning. We are kind of

1 using industry standard coefficients.

2 We don't really have data to do that kind
3 of tuning, and we are not tuning to get the answer we
4 have from the 1/7th scale test. We are just letting
5 it fly.

6 DR. KRESS: Are you choosing one option,
7 or are you --

8 MR. BOYD: We chose several options just
9 to look at the differences. In the end, they did not
10 make a lot of difference. The one that we chose was
11 the second order of Reynolds Stress Turbulence Model,
12 which is for this type of flow, it is -- I guess on
13 paper it would be the appropriate model, as opposed to
14 a two equation K-epsilon model.

15 So in this type of flow field, I guess we
16 chose the academically appropriate, and in all the
17 selections that we made there wasn't a large
18 difference. It did not affect these types of
19 parameters.

20 This is a quick slide to show the CFD
21 approach versus a lumped parameter. The top picture
22 shows the hot leg, and I guess that is not really
23 showing up, but what you see is a full counter-current
24 flow profile, with velocity vectors and temperature
25 profiles.

1 And on the right in a lump parameter code,
2 SCDAP-RELAP, there is just two pipes with a single
3 temperature, and you have mass flow and temperature.
4 In the inlet plenum, this is the SCDAP-RELAP
5 nodalization in the middle on the right, and you will
6 see the three mixing volumes.

7 Flow comes in and based on the mixing
8 fraction, it either goes to a mixing volume, or it
9 passes up through to the tubes, to again a fixed
10 number of tubes.

11 With the CFD predictions, we are going to
12 calculate the mixing implicitly with the code, and
13 then as far as the tubes go, this is something that we
14 will add a benefit to our predictions.

15 In the SCDAP-RELAP predictions, you are
16 going to get one temperature and a number of tubes and
17 up-flow that is predetermined. And in the CFD
18 predictions, we will get the number of tubes
19 calculated implicitly, and then we will also get tube
20 to tube variations.

21 So we will know not just the average
22 temperature going into the tubes, but what the peak
23 average ratio is.

24 DR. KRESS: On your counter-current flow,
25 what do you do at the reactor end?

1 MR. BOYD: At the reactor end, initially
2 I put the core in there, and I just had a heat source
3 and let it go, and it picked up that counter-current
4 flow. I had a lot of uncertainty in my core model
5 obviously.

6 I was using a lot of core options, and I
7 cut that off, and at this point I just put on the end
8 of the hot leg a mass flow in.

9 DR. KRESS: You just put it at one end?

10 MR. BOYD: That's right.

11 DR. KRESS: And that stuff going out just
12 disappeared?

13 MR. BOYD: It is called a fixed pressure
14 boundary there.

15 DR. KRESS: A fixed pressure boundary?

16 MR. BOYD: Yes. And I did a lot of
17 variations with different velocity profiles, and all
18 sorts of things to match the mass flow given in the
19 test results.

20 DR. KRESS: And you had to specify the
21 profile specification?

22 MR. BOYD: That's right, and I found that
23 my profile specification wasn't all that significant.
24 By the time that it got to the steam generator end of
25 the hot leg, it had dissipated anything that I had put

1 in.

2 So, CFD is going to provide an improved
3 understanding of the 1/7th scale data. We have got
4 these tests, and obviously what went on in the tests
5 was fine, but we have a limited view of the tests from
6 the limited instrumentation.

7 So we can fill in some of the gaps with
8 CFD, and then we can extend to full-scale. One of the
9 big questions is does scale affect the mixing
10 parameters, and that is something that we are looking
11 to address right now.

12 At that point, when we have gone to full-scale,
13 we have answered that question among others, and then
14 we can start looking at the effect of tube leakage and
15 how that affects these inlet plenum flows, and mixing
16 parameters, and the effect of the inlet geometry
17 variations, like the CE plants with the hot leg
18 entrance closer to the tube sheet.

19 And again we will get implicitly out of
20 this tube to tube variations that then would give some
21 understanding of what the hottest tube really is.

22 The schedule. Validate the technique by
23 looking at the 1/7th scale. That is our best
24 available data set. That has been done and in general
25 the answer is that the code picks up all the relevant

1 physics and does a pretty good job.

2 At this point, we are sensitivity studies,
3 and extending the predictions to full-scale, using a
4 kind of best estimate conditions out of a SCDAP-RELAP
5 analysis.

6 Again, what is the effect of scale, and
7 then we are going to complete additional studies on
8 tube leaking and inlet geometry variations, as well as
9 other sensitivity studies.

10 And just to give a quick view. This is
11 the mesh that we that was used for the 1/7th scale.
12 It's a symmetry model, half of the hot leg in the
13 plenum and tubes. All the tubes in that test, 216,
14 were modeled individually.

15 We won't do that at full-scale, and we
16 will come up with a model for the tubes. But that
17 gives an idea of the resolution. There are several
18 hundred-thousand cells just in the inlet plenum alone.

19 There are some qualitative results. This
20 is the first thing that hits you when you -- well, all
21 of the qualitative flows predictions are correct. In
22 other words, a sloping interface in the hot leg, and
23 a plume that rises and dissipates fairly quickly into
24 the inlet plenum, and about a third to a half of the
25 tubes in up-flow.

1 The temperature of the tubes reaching the
2 given values in the test, and by the time it reached
3 the top of the tubes. All these kinds of qualitative
4 features were matched by the CFD predictions. This is
5 quantitative data, but I'm just talking qualitatively
6 there.

7 When we go to the actual mixing parameters
8 of interest, this table shows some of the results.
9 These are the tests of most interest. In general,
10 what you saw was about a 10 percent deviation.

11 If you look at the Westinghouse data
12 carefully, you will determine that the uncertainty in
13 that data is around 10 percent or more. The one big
14 variation was the number of hot tubes.

15 We were 23 tubes over, which is about 10
16 percent of the tube sheet, and we are currently doing
17 some sensitivity studies to determine what boundary
18 conditions or condition in our model might affect that
19 to see if we may have a problem.

20 And all the hot average temperatures, and
21 mass flows, and things like that, were all pretty
22 close, and in this particular run we had a 15 percent
23 difference in the recirculation ratio, which again I
24 believe is in the uncertainty of the data.

25 So as a quick look, what I get out of this

1 is that the code can do this type of analysis, and
2 that the results are pretty close. This is the tube
3 sheet flow, and this is the number that I mentioned,
4 10 percent over-predicted.

5 The dark region on the tube is from the
6 data. There is two lines there because the data had
7 an uncertainty, and not every tube was instrumented.
8 So somewhere in that range is where the boundary
9 between where up-flow and down-flow in the tube sheet
10 occurred.

11 And then the outer dashed line represents
12 the FLUENT predictions. On the right, I give the peak
13 temperatures. The peak thermal-couple in the data
14 read 59 degrees celsius in this case. These again are
15 cold tests done with SF6.

16 The maximum predicted value from FLUENT
17 was 61.5 degrees, and that was on the center line.
18 The data did not have any center line thermal-couples.
19 If you look off-center line, it would be more
20 consistent with the data. I had a max prediction of
21 58.5, which was pretty close to the measured value.

22 So as a summary, the CFD predictions are
23 generally within 10 percent of its 1/7th scale data,
24 and that is generally within the experimental
25 uncertainty. There was a fair amount of uncertainty.

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1 There was no mass flows directly measured in the
2 tests.

3 They had to infer that from energy
4 balances, and some of these energy balances were
5 inferred from small delta-Ts. So this added to the
6 uncertainty.

7 The phenomena observed during the tests
8 were all predicted by the CFD code in a qualitative
9 sense, and so the general flow features are there, and
10 work on full-scale predictions is proceeding now, and
11 I think we have a high degree of confidence in our
12 technique, and so when we go to full pressure, full
13 temperature steam, there is not going to be as much
14 uncertainty.

15 So this benchmarking exercise has been
16 very valuable, and I think this is just a restatement
17 of that. The CFE technique has been demonstrated to
18 be applicable, especially for predicting these mixing
19 parameters, which are kind of average values.

20 And this work provides this high degree of
21 confidence, and we are going to go to full-scale
22 analysis, and at full-scale, then we will spend our
23 time doing the tube leakage and geometry variations,
24 and our sensitivity studies. I am just a few minutes
25 over.

1 CHAIRMAN FORD: Thank you very much
2 indeed. I would ask for any comments from the members
3 here. We have on our schedule for the next ACRS
4 meeting next week -- we are charged with a letter
5 relating to the DPO.

6 And essentially hopefully saying that the
7 recommendations that were in 17.40 are being followed
8 in the new NRR research plan. That is hopefully what
9 the letter would say. Is that correct?

10 DR. KRESS: The intent is to address that,
11 yes.

12 CHAIRMAN FORD: Okay. Could we have some
13 comments to help the staff and research as to how they
14 would appropriate their time for the 30 minute
15 presentation that they would have in that one hour?

16 DR. KRESS: I would like the approach
17 where they are listing what the ad hoc committees'
18 recommendations were, and then to say how we are
19 addressing them in the plan. That would work very
20 well. I certainly would want to have the full
21 committee see this CFD stuff, and that addresses some
22 of the --

23 DR. SHACK: But we will never get through
24 it in 8 minutes.

25 DR. KRESS: But that addresses some of the

1 real issues that the staff may have.

2 DR. POWERS: The plans are sufficiently in
3 the works, and I don't see why the subcommittee
4 chairman can't just summarize it.

5 DR. KRESS: I think that is probably right
6 there.

7 DR. POWERS: Well, all you are going to do
8 is say the staff has plans to address this issue, this
9 issue, this issue, and this issue.

10 DR. KRESS: And they look like good plans.

11 DR. POWERS: And in 9 out of 10 cases,
12 they have great plans, and in one case, I haven't got
13 a clue.

14 CHAIRMAN FORD: The one question I have
15 got, Dana, because I know nothing at all about it, is
16 the thermal-hydraulics codes. Are you all feeling
17 that these are the right approaches?

18 DR. POWERS: The one thing I know is that
19 if you put two thermal-hydraulicists in a room, the
20 one thing they cannot arrive at is a conclusion. What
21 I would say is why don't we have the subcommittee
22 chairman draft a summary, and put it up for the rest
23 of the committee, and say we are addressing the issues
24 that have been raised, because there is no more
25 content than really that that they are addressing.

1 I mean, most of these things are in the
2 works, and they are working on it, and then allow the
3 speakers on this CFD stuff and the counter-current
4 flow, because that implies so many things other than
5 the steam generator tube --

6 DR. KRESS: And Dr. Wallis hasn't heard
7 that.

8 DR. POWERS: Well, more in the context of
9 here is some research that is going on now, and here
10 is where we stand, and more as an update of general
11 interest than just a DPO issue.

12 CHAIRMAN FORD: And that you think will be
13 enough sufficient information to allow George to sign
14 his name to a letter saying essentially that the
15 recommendations from the ad hoc committee, and
16 therefore the ACRS, are being followed?

17 DR. POWERS: Are being addressed, yes.
18 They are taking them into account. That is what we
19 were asked, and they know them better than I do.

20 CHAIRMAN FORD: So the answer could be
21 yes?

22 DR. POWERS: Yes.

23 CHAIRMAN FORD: Just one word.

24 DR. POWERS: Yes.

25 CHAIRMAN FORD: So you are asking me to

1 stand up in front of the ACRS committee and summarize
2 what we have heard today, and then for general
3 information to have the thermal-hydraulic guys
4 specifically get up and talk?

5 DR. KRESS: As an alternative, if that is
6 uncomfortable to you, you could ask one of these guys
7 to summarize.

8 DR. DUDLEY: Just from a public holding,
9 and a presentation in a public meeting, at a full
10 committee meeting to write a letter from, I think it
11 would be more appropriate if the staff presented a
12 summary, and then it would also save the subcommittee
13 chairman the effort of pulling that together.

14 DR. POWERS: But a summary presentation.

15 DR. KRESS: Yes, a summary presentation.

16 DR. POWERS: I think the committee as a
17 whole is going to be very interested in what they are
18 doing with this counter-current flow issue because it
19 has been around since the dawn of time, and there has
20 been lots of concern about it for a variety of things.
21 And let that talk go on at length.

22 DR. SIEBER: And also the tube sheet --

23 DR. POWERS: Well, that one is
24 interesting, but I think that we are fixing to work on
25 this. I think we can hold that one off until they

1 have got some more results.

2 CHAIRMAN FORD: Could I suggest the
3 following? Who is going to stand up and say I am the
4 project leader for this and this is a problem, and
5 where you are going, and this action plan, the joint
6 NRR/research plan, is feeding into that overall
7 thrust.

8 Just one draft, and one slide saying this
9 is where we are going in general, and I am quite ready
10 to stand up and say this is in line to go along with
11 your line. Here is the action plan, and here are the
12 actions in the NRR/research program, and these are the
13 ones that we specifically recommended, et cetera.
14 Does that sound fair?

15 DR. POWERS: Yes.

16 CHAIRMAN FORD: Is that clear?

17 DR. POWERS: All right.

18 CHAIRMAN FORD: All right. We are
19 adjourned.

20 (Whereupon, at 12:30 p.m., the meeting was
21 concluded.)

22

23

24

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CERTIFICATE

This is to certify that the attached proceedings
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