

# **Official Transcript of Proceedings**

## **NUCLEAR REGULATORY COMMISSION**

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                              Regulatory Policies and Practices

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

REGULATORY POLICIES AND PRACTICES SUBCOMMITTEE

+ + + + +

WEDNESDAY

OCTOBER 18, 2017

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B3, 11545 Rockville Pike, at 8:30 a.m., John W.  
Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

MICHAEL L. CORRADINI, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

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JOY L. REMPE, Member

GORDON R. SKILLMAN, Member

MATTHEW SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

HOSSEIN NOURBAKHS

ALSO PRESENT:

ANDREA D. VEIL, ACRS Executive Director

NATE BIXLER, Sandia National Laboratories

KEITH COMPTON, RES

HOSSEIN ESMAILI, RES

ED FULLER, RES

TINA GHOSH, RES

TREY HATHAWAY, RES

SALMAN HAQ, RES

DONALD HELTON, RES

WILLIAM ORDERS, NRR

EDWARD ROACH, NSIR

PATRICIA SANTIAGO, RES

AMY SHARP, RES

TODD SMITH, NSIR

CASEY WAGNER, Dycoda LLC

KIMBERLY WEBBER, RES

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

8:31 a.m.

CHAIR STETKAR: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Regulatory Policies and Practices Subcommittee.

I'm John Stetkar, Chairman of the Subcommittee Meeting. And you're not.

Members in attendance today are Ron Ballinger, Matt Sunseri, Dick Stillman, Dana Powers, Mike Corradini, Jose March-Leuba, Dennis Bley, I forgot you, Charlie Brown, and Joy Rempe.

Hosseini Nourbakhsh is the Designated Federal Official for this meeting.

The purpose of today's meeting is to discuss the State-of-the-Art Reactor Consequence Analyses Project for the Sequoyah Integrated Deterministic and Uncertainty Analyses.

Today we have Members of the NRC Staff and Sandia National Laboratories to brief the Subcommittee.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act. That means that the Committee can only speak through its published letter reports.

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1           We hold meetings to gather information to  
2           support our deliberations. Interested parties who  
3           wish to provide comments can contact our office  
4           requesting time after the meeting announcement is  
5           published in the Federal Register.

6           That said, we set aside ten minutes for  
7           spur-of-the moment comments from members of the public  
8           attending or listening to our meetings. Written  
9           comments are also welcome.

10           The ACRS section of the NRC public website  
11           provides our charter bylaws, letter reports and full  
12           transcripts of all full and Subcommittee meetings,  
13           including slides presented there.

14           The rules for participation in today's  
15           meeting were announced in the Federal Register on  
16           October 10, 2017. The meeting was announced as an  
17           open meeting.

18           No written statement or request for making  
19           an oral statement to the Subcommittee has been  
20           received from the public concerning this meeting.

21           A transcript of the meeting is being kept  
22           and will be made available as stated in the Federal  
23           Register Notice.

24           Therefore, we will request that all  
25           participants in this meeting use the microphones

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1 located throughout the meeting room when addressing  
2 the Subcommittee.

3 The participants should first identify  
4 themselves and speak with sufficient clarity and  
5 volume so that they can be readily heard.

6 We have a bridge line established for the  
7 public to listen into the meeting.

8 To minimize disturbance, the public line  
9 will be kept in a listen-in-only mode, and I'll open  
10 it at the end of the meeting for public comments.

11 To avoid disturbance, I request that all  
12 attendees and everyone else in the meeting room put  
13 your electronic devices like cell phones, beepy things  
14 and whatever, in the off or noise-free mode.

15 Now, I'll proceed with the meeting, and  
16 I'll call upon Pat Santiago of the NRC Office of  
17 Nuclear Regulatory Research to begin today's  
18 presentations. Pat?

19 MS. SANTIAGO: Thank you, good morning.

20 We appreciate all the feedback that we got  
21 from the Subcommittee Members in the May of 2016  
22 Subcommittee Meeting, as well as the June meeting of  
23 this year.

24 And we worked the last few months to  
25 address all the comments that we received.

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1                   On this second slide, I want to talk a  
2                   little bit about our schedule.

3                   Our Sequoyah Analyses is going to be  
4                   published as a NUREG/CFR report, and it's due to the  
5                   Commission November 30th. And we'll be sending it to  
6                   the NRC Publications Branch at the same time.

7                   We're relying on the ACRS Members to  
8                   service our peer reviewers and we're requesting a  
9                   letter documenting your review. To facilitate that  
10                  process, we're briefing the full Committee in November  
11                  of this year.

12                  And this works well with our schedule  
13                  since the NUREG is due to the Commission November  
14                  30th. So, we appreciate your support for that.

15                  We hope to be able to address any final  
16                  comments from today's Subcommittee meeting in the next  
17                  few weeks, but as you can see from our schedule, any  
18                  additional analysis would not be documented in this  
19                  report.

20                  Rather, we could possibility add  
21                  additional clarifications on what was done within the  
22                  scope of this study. And time to include it within  
23                  the NUREG will be submitted for the Commission, and  
24                  for publication.

25                  Also, separately, much of the same team is

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1 in the process of updating the Surry Uncertainty  
2 Analysis. And currently, that NUREG report is due to  
3 the Commission June of 2018.

4 Previously, the Subcommittee had indicated  
5 that you may not need to review the updated  
6 Uncertainty Analysis.

7 However, we can discuss whether you'd like  
8 the team to come back with the updated Uncertainty  
9 Analysis next year.

10 MEMBER BLEY: Pat?

11 MS. SANTIAGO: In addition to that --

12 MEMBER BLEY: Pat? Excuse me. Can you  
13 say something about the extent of that update?

14 And is it to make things at least  
15 methodologically consistent with what's been done  
16 here?

17 MS. SANTIAGO: Okay, so the Sequoyah  
18 Update or the Surry --

19 MEMBER BLEY: The Surry Uncertainty.

20 MS. SANTIAGO: We'll talk a little bit  
21 about that --

22 MEMBER BLEY: Is that in the presentation?

23 MS. SANTIAGO: Okay, yes.

24 MS. GHOSH: So, there are a couple of main  
25 things.

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1 CHAIR STETKAR: Move a little closer,  
2 please.

3 MS. GHOSH: Is this better?

4 You're aware of some of the major updates  
5 we made to the Sequoyah Analysis between last year and  
6 this year. Some of them are very relevant to Surry as  
7 well.

8 All of the safety valve parameters are  
9 important for Surry too, because of the induced steam  
10 generator tube rupture in that case.

11 And so for a different reason but still  
12 very important. So, we definitely wanted to make that  
13 update.

14 So, basically, all of the relevant updates  
15 in the Sequoyah Analysis in the last year, we are  
16 implementing in Surry, and that will change the  
17 results somewhat.

18 The other thing is at the Subcommittee on  
19 Surry, we got some comments from Bill Shack and others  
20 on our steam-generator tube rupture modeling. So,  
21 right now, we are currently in the throes of updating  
22 that modeling.

23 So, we've gone and gathered more  
24 information, talk to more experts, and we're in the  
25 process of updating that modeling. So, those are the

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1 two main areas.

2 MEMBER BLEY: Well, since you brought up  
3 that last one, are you going to talk about the reason  
4 why you don't have any steam-generator tube rupture in  
5 the Sequoyah Analysis?

6 Is that part of your presentation?

7 MS. GHOSH: No, we had tried -- okay, so  
8 we did not address induced steam-generator tube  
9 rupture.

10 MEMBER BLEY: So, you don't have to update  
11 it?

12 MS. GHOSH: For Sequoyah. No, that was  
13 not within the scope of the study, and we tried to  
14 make that clear in the introduction that we did not do  
15 that.

16 MEMBER BLEY: You made it very clear.  
17 What wasn't clear was why the scopes are different,  
18 why you didn't do it here and you've done it there.

19 And now you're going back and redoing it  
20 over on the other plant.

21 MS. GHOSH: That's what we say in the  
22 Sequoyah study, is look at the Surry study for  
23 insights on tube rupture because --

24 MEMBER BLEY: Yes, you do.

25 MS. GHOSH: -- because those should be

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1 consistent. The scope of the Sequoyah study was really  
2 focused on containment issues.

3 MEMBER BLEY: You say that kind of at the  
4 end, that's where the focus was, but you don't say  
5 anything about why.

6 Is there a simple why, or it was just the  
7 way the scope was set up?

8 MS. GHOSH: You know, at the time --

9 MEMBER BLEY: This was added in to look at  
10 an ice condenser, I guess.

11 MS. GHOSH: Yes, when we went to the  
12 Commission and said we should finish this third pilot  
13 study for these reasons.

14 Some of the big motivators at the time  
15 were still doing the post-Fukushima regulatory  
16 actions, and we wanted to make sure we weren't missing  
17 anything in terms of hydrogen challenges for the ice  
18 condenser containment.

19 So, that was a major focus of this third  
20 plant. It was really focused on the unique aspects of  
21 the containment.

22 MEMBER BLEY: This kind of makes sense  
23 but, at least to this reader, it didn't jump off the  
24 page at me.

25 In fact, we're focused on the containment

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1 as kind of an afterthought at the end. It's like we  
2 didn't do these things but that's because we're  
3 focused on the containment.

4 So, you didn't really introduce it with --

5 MS. GHOSH: Ah, okay.

6 MEMBER BLEY: -- why you're doing this.

7 MS. SANTIAGO: I would re-look at the  
8 Executive Summary. I think that's an important point,  
9 to make sure that it's clear why we did what we did.

10 MEMBER BLEY: Maybe it is, but it wasn't  
11 clear to me.

12 MEMBER REMPE: Let's go a bit further.

13 If you had looked at it -- and since you  
14 are doing it at Surry, maybe you have some insights on  
15 what would have happened if you had looked at  
16 Sequoyah, especially with the Level 3.

17 It's a Westinghouse plant, right? Is  
18 there something you think you might be able to say?

19 For example, you did -- most of the time,  
20 as I recall, and Don's in the audience and he can  
21 correct me, but when they were doing the Level 3, they  
22 decided, well, because it's a Westinghouse plant, it  
23 wouldn't have been a big deal, except for if you had a  
24 loop seal that was about 480 gallons per minute.

25 And do you think you might have the same

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1 kind of conclusions that they had in the Level 3? And  
2 then, there's only that one sensitivity study you did,  
3 where you did have that high of a loop seal leak.

4 And I'm just wondering if you can kind of  
5 make some comments in your Executive Summary, if  
6 you're updating it, that could be based on engineering  
7 judgment from all the ongoing evaluations you've done.

8 And the only place I think you might want  
9 to think about acknowledging it makes a difference is  
10 how what happens with this 480 gallon-per-minute leak.

11 Because instead of talking about the  
12 containment failure, you might have had a bypass. And  
13 it looks like that someone is agreeing with me by --  
14 up and down.

15 But anyway, it seems like there's some  
16 things you might want to go a bit further and say that  
17 it's probably -- again, you guys should say it, not  
18 me. But maybe it won't be that important except for  
19 that one case.

20 MS. GHOSH: That's a good comment. We can  
21 modify it. We can work on modifying it.

22 CHAIR STETKAR: I have to be cognizant of  
23 time. We have a 12:00 p.m. hard stop today.

24 We shouldn't try to speculate about  
25 differences between Surry and Sequoyah because they

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1 are difference plants. Period. They're different  
2 plants.

3 So, trying to speculate about lessons  
4 learned at Sequoyah based on what we know for Surry is  
5 against what we should be doing.

6 These are plant-specific studies and a  
7 conditional probability of a high-dry-low situation.  
8 And Sequoyah could be substantially different than  
9 high-dry-low.

10 At Surry, we don't know that, and that's  
11 the important insight from SOARCA, is that you must do  
12 plant-specific and site-specific, integrated,  
13 uncertainty analysis.

14 MEMBER REMPE: But then I would argue with  
15 you, sir, that the Executive Summary is really coming  
16 up with conclusions that may not be valid for a large  
17 lead rate.

18 CHAIR STETKAR: That's correct.

19 MEMBER REMPE: And again, the Vogtle  
20 analysis did something based on generic knowledge  
21 about --

22 CHAIR STETKAR: We're not talking about  
23 Vogtle here.

24 MEMBER REMPE: That's true, but again, I  
25 think you may want to -- without trying to extrapolate

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1 things from other plants, you may have some  
2 conclusions that are not valid for this particular  
3 plant --

4 CHAIR STETKAR: That's right.

5 MEMBER REMPE: Because you did not  
6 consider the consequential steam-generator tube  
7 rupture.

8 So, something needs to be acknowledged in  
9 that Executive Summary on the downsides of not  
10 considering it.

11 CHAIR STETKAR: It's fair game to talk  
12 about the Executive Summary for this study.

13 And the Executive Summary should, in my  
14 opinion, clearly delineate what was done, why it was  
15 done, what was not done, and why it was not done.

16 MEMBER REMPE: And what are the downfalls  
17 of not doing it? I would go a bit further on  
18 potential downfalls of not doing it, because some of  
19 the conclusions may not be valid because they had a  
20 limited scope.

21 And they should have some acknowledgment.  
22 And without extrapolating, they could say, hey, we've  
23 done a bunch of analyses and this may be important,  
24 you may have to do it plant-specific to determine it.

25 But I think you need to have some caveats

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1 in your conclusions. Okay?

2 CHAIR STETKAR: Okay, good. Pat, we kind  
3 of interrupted you midstream. Pick up the ball.

4 MS. SANTIAGO: One other thing that may  
5 help some of this discussion, actually, is we plan on  
6 doing -- basically, after the Surry RAY's done, we  
7 want to work on a compendium of important insights  
8 that we've gained from the three Uncertainty Analyses.  
9 And we're going to publish that as a summary NUREG as  
10 well.

11 But I do what to point out that in each of  
12 the SOARCA studies, each bottom study during Sequoyah,  
13 we do say that this is a site-specific study, and you  
14 may have to look at the specific site and other  
15 designs of other plants.

16 CHAIR STETKAR: And I think that whenever  
17 you come to that sort of general insight, NUREG or  
18 whatever, we would be very interested in seeing that.

19 Because I'm very concerned about trying to  
20 make the entire pressurized-water nuclear power  
21 industry look like Surry, and the entire boiling-water  
22 industry look like Peach Bottom. And the entire ice-  
23 condenser plants look like Sequoyah.

24 So, trying to develop broad generic  
25 insights from these very site-specific, plant-specific

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1 studies is dangerous and misguided. And that's on the  
2 record.

3 So, that's why I'd be really interested in  
4 strength seeing that Overall Insights study.

5 MS. SANTIAGO: Okay, and maybe when we do  
6 the Surry, we can give you an outline of what our  
7 plans are for that compendium.

8 CHAIR STETKAR: Yes, that would be good.

9 MS. GHOSH: Can I just make one quick  
10 clarification?

11 I don't think the point is to try to draw  
12 some broad-brush -- you know what, the main issue is  
13 just to make something that's more practical than  
14 having -- I mean, at this point, we have like 1900  
15 pages of Uncertainty Analyses.

16 And people go in and they'll pluck out  
17 what they need, but we get a lot of complaints about  
18 just how much material you have to go through to pick  
19 out that nugget.

20 So, we're trying to make something that's  
21 a little bit easier to digest in one place, rather  
22 than having to go to the library and dig through all  
23 that material.

24 CHAIR STETKAR: Pat? Since you still have  
25 the ball to carry.

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1 (Laughter.)

2 MS. SANTIAGO: Next slide, I did want to  
3 compliment the team members that worked on this  
4 because they worked very hard and diligently on this  
5 particular project, at the same time that they're  
6 working on the Surry Uncertainty Analyses and other  
7 projects, as you heard me talk about on October 3rd,  
8 when the Division of Systems Analysis briefed.

9 So, I did want to thank them all. Dr.  
10 Tina Ghosh and Doug Osborn were the co-leads. Doug  
11 Osborn's from Sandia National Labs.

12 We have a handful of folks in the audience  
13 to help us answer any questions as we brief, as well  
14 as those on the phone line.

15 On the last slide, I just wanted to talk a  
16 little bit about the meeting today, and the focus is  
17 going to be on the Sequoyah draft report.

18 Since our last June 6th Subcommittee  
19 Meeting, there's two significant additions that we've  
20 added to this draft report.

21 The first change is the new introductory  
22 material in Section 4 on accident progression, which  
23 was presented in June by Hossein Esmaili. And at that  
24 time, it wasn't included in the report.

25 We don't plan to brief on that material

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1 since we did brief in June, but I just wanted to  
2 mention that.

3 The second addition is a new Appendix I  
4 in the draft report, which documents the supplemental  
5 Uncertainty Analyses that was focused on a range of  
6 safety valve parameter values where an early  
7 containment failure is possible.

8 Dr. Trey Hathaway will present this work  
9 today.

10 After's Trey's presentation, the team will  
11 walk through Member comments and discuss how they were  
12 investigated and addressed in this new draft report  
13 that we provided you last month.

14 And lastly, we'll seek the Subcommittee  
15 Members' feedback on how we should focus our  
16 presentation to the full Committee in November, since  
17 we'll only have 90 minutes at that particular meeting.

18 And I'll now turn it over to Trey and my  
19 Staff to present.

20 CHAIR STETKAR: Pat, thanks. A couple  
21 things.

22 First of all, in your introductory  
23 remarks, you characterized the ACRS's role in this  
24 project as providing a peer review. I personally take  
25 issue with that.

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1           The ACRS has not performed a peer-review  
2 service. We do not delve into the depth of technical  
3 details that is implied by a full-scope technical peer  
4 review.

5           We focus on integration, we focus on  
6 consistency, we focus on high-level issues related to  
7 technical scope content, things like that.

8           But by no means do we perform a peer  
9 review service in the way that those words are  
10 typically understood throughout the industry, and  
11 throughout the Staff.

12           So, I would appreciate it if you don't  
13 characterize what we're doing as a peer review.

14           MS. SANTIAGO: Okay, so for Surry and  
15 Peach Bottom, we did have a full, complex, external  
16 peer review group.

17           And so for Sequoyah, based on knowing what  
18 the comments were for that and addressing all of that,  
19 we have guidance that says we can use or ask the ACRS  
20 to support review of the next document, which was  
21 Sequoyah.

22           So, I apologize for suggesting it's a peer  
23 review.

24           It's an internal review, I guess, that we  
25 would like to have a letter from the Committee, so

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1 that we can accompany or send it to the Commission  
2 about the same time as the report is going to the  
3 Commission.

4 So, thank you.

5 MEMBER BLEY: I have to add a little bit  
6 to what John said. We're giving the some kind of  
7 oversight in this study as we did to the others.

8 To imply that we're providing any sort of  
9 detailed technical review of the sort you'd had from  
10 your peer reviews is just wrong, and we don't do that.  
11 And you ought to not tell people that that's what ACRS  
12 has done for you.

13 CHAIR STETKAR: Also, please don't  
14 characterize this as an internal body. We are not  
15 internal to the NRC, we are an independent advisory  
16 committee.

17 MS. SANTIAGO: I forgot the right words.

18 CHAIR STETKAR: Are you going to discuss  
19 the Executive Summary?

20 I didn't see your slides until this  
21 morning, so I haven't had a chance to look through  
22 them.

23 Are you going to discuss the Executive  
24 Summary at all?

25 MS. SANTIAGO: We weren't planning on it.

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1 CHAIR STETKAR: Okay, let me ask one  
2 general question and just get it out on the table, and  
3 kind of think about it.

4 As I read the Executive Summary and a few  
5 of the Chapters that have the new material in the  
6 current version of the report, I found kind of a  
7 different tenor from the previous version of the  
8 study.

9 And the difference seemed to be more  
10 emphasis on comparisons between the current version of  
11 the study, and what I'll characterize as the April  
12 2016 version of the study that we saw a year and a  
13 half ago.

14 There's a lot of comparative stuff saying,  
15 well, we had this in the April 2016 version, and look,  
16 the same trends are here, but the results are  
17 different.

18 That obviously had to be a conscious  
19 decision because it's pervasive throughout the new  
20 material.

21 Why do you feel it's necessary to compare  
22 the results, insights, conclusions, models, and so  
23 forth from this current version of the study, to an  
24 outdated, non-technically-supported interim version of  
25 the study?

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1 I mean, when I've done projects in the  
2 past and have made mistakes in the middle, I don't go  
3 back and say, hey, I made a mistake but, look, you  
4 know, this other stuff is all the same.

5 I just don't see the benefit of it. You  
6 changed models, you changed uncertainty distributions;  
7 those changes made a difference.

8 Why go back and say, well -- I mean, there  
9 are statements that say, well, the uncertainty  
10 distribution moved the results around but, look, the  
11 general trends would have been the same.

12 That's obvious. You can present that same  
13 level of insights and conclusions, just given the  
14 results of the current study.

15 It's obvious to a reader that if a  
16 pressurizer safety valve sticks open, big, early, it's  
17 not a good day.

18 You don't need to compare that to the fact  
19 that it used to stick open more, bigger, in a previous  
20 version of the study that was found to have some  
21 technical questions.

22 So, I'm not sure, because it was a  
23 conscious decision. The only reason I bring it up is  
24 why was that decision made to compare and contrast to  
25 the previous version of the study?

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1           Because to me, it was not only from a  
2           philosophical perspective that I tried to mention  
3           here, it was actually distracting.

4           MS. GHOSH: Okay, so I think we understand  
5           your comment.

6           I mean, as to answering the why, I think  
7           in part, we've put out this big study, it's publicly  
8           available. It's going to be forever in Adams and --

9           CHAIR STETKAR: When you say this big  
10          study, you mean the 2016 version of the study?

11          MS. GHOSH: Yes, because it was out there.  
12          It was the first time we did this with the ice  
13          condensers. A lot of people had looked at it.

14          So, maybe it was in recognition that  
15          people might have been familiar with last year's  
16          study. But I understand your comment and I think we  
17          can take a look at --

18          MEMBER CORRADINI: I have a slightly  
19          different opinion than my colleagues. It's your  
20          study, you can do whatever you want. Then you'll get  
21          criticized for it.                   So, my view of it is  
22          that John's saying if you were reading it today, this  
23          would be his reaction.           And another way to do it  
24          is to write the Executive Summary in such a manner  
25          that nobody had seen anything before, and say, oh, by

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1 the way, we had a draft version.

2 Go look at Appendix blah-blah and you'll  
3 be able to compare and contrast in blah-blah, but  
4 don't do it in the main body.

5 One, it detracts from what I assume you  
6 think is better. And two, it would confuse the reader  
7 that never took the time or the energy to read the one  
8 before.

9 But that's your style, it's your report.

10 MEMBER BLEY: And it sounds very  
11 defensive.

12 We would have certainly asked and we would  
13 have expected in this presentation you would do those  
14 sorts of things and show us what changed.

15 But I agree with John and, I think, with  
16 Mike.

17 CHAIR STETKAR: Certainly, as I read it,  
18 quite honestly, because I read the Executive Summary  
19 first, it's the first thing you come to, and quite  
20 honestly, it's what most folks will pay most attention  
21 to.

22 So, I wanted to kind of see what flavor of  
23 information was in there.

24 I found it very, very distracting in the  
25 Executive Summary. Once I got past that, it is

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1       infused in parts of Chapter 4 and in Chapter 7 in the  
2       results.

3               There, because those are -- well, Chapter  
4       7 is kind of summary of results, so that's a companion  
5       to the Executive Summary. But Chapter 4 is more of a  
6       technical detail thing and I was less confused by it  
7       there.

8               But I think Mike's idea of pointing to an  
9       Appendix that compares and contrasts it -- I  
10      understand the desire to capture the differences and  
11      draw insights from the differences.

12              But, anyway, you've heard our comments.

13              MS. SANTIAGO: That's a good comment,  
14      thank you.

15              CHAIR STETKAR: And with that, I don't  
16      know who's -- Tina?

17              MS. GHOSH: Trey.

18              CHAIR STETKAR: Trey, you're up.

19              DR. HATHAWAY: Okay, what I'm going to  
20      present today is the third results of this sort of  
21      Focus Study that we performed kind of after the full  
22      UA --

23              CHAIR STETKAR: Is your mic on?

24              DR. HATHAWAY: I've got it here.

25              CHAIR STETKAR: You're just a very soft-

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1 spoken person.

2 DR. HATHAWAY: Sorry about that.

3 CHAIR STETKAR: Scream at the mic.

4 DR. HATHAWAY: So, the point of this was  
5 to really try to reinforce the conclusions and the  
6 study.

7 We knew we only had a very few number of  
8 early containment failures so we wanted to kind of  
9 focus in on this region of ventures to see if it  
10 reinforced conclusions of the full UA.

11 So, that's what I'm going to present to  
12 you today. Also, kind of see if it provided any  
13 additional insights, focusing in on this region.

14 So, the Figure on the right is the results  
15 of the 2016 UA, and we just kind of -- we were drawing  
16 conclusions -- not drawing conclusions, we were trying  
17 draw insights from these previous analyses, all the  
18 analyses that were performed to really hone in on what  
19 region of interest led to early containment failure.

20 And the reason we chose this is because we  
21 did have -- well, I'm presenting this because we had  
22 fewer early containment failures than the current  
23 study.

24 So, what you see here, the Figure on the  
25 right, plots the number, the total number of

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1       pressurizer safety valve cycles plus the open area  
2       fraction.

3               The points in blue represent the -- excuse  
4       me, all the points represent the various individual  
5       realizations, the Monte Carlo realizations. And the  
6       points in red represent cases that had an early  
7       containment failure.

8               And what you see is those sort of cases  
9       that begets early containment failure kind of housed  
10      in this region of cycles greater than 0.3 and less  
11      than 65, is what was chosen.

12              Really, my particular interest was less  
13      than hot leg failure, try to have a dent before hot  
14      leg failure.

15              So, yes, again, we were trying to use the  
16      previous studies to inform what we were going to look  
17      at for this sort of focused look.

18              So, we took the current model and just  
19      sort of used the identical distributions as before,  
20      except for two.

21              We bounded the distribution for the open  
22      area fraction to 30 percent, and then we also  
23      constructed a distribution based off the sample data  
24      from the previous study to try to focus in on this  
25      range of 165 cycles.

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1           For this focused look, originally, it was  
2           for whether or not we had early containment failures.  
3           So, we limited the calculation to 15 hours, and that  
4           was just really to -- again, this was informed by  
5           previous studies.

6           Previous studies indicated that the early  
7           containment failures were before 15 hours. The model  
8           was identical to the previous study.

9           The only difference is there was this  
10          minor error in the study having to do with the fabric  
11          seal pressure.

12          That was corrected; it was a formatting  
13          error on a text file that was written so that was  
14          corrected for this study.

15          MEMBER CORRADINI: So, I'm going to ask a  
16          general question and you can address it whichever way  
17          you want. But I've been looking through the new  
18          version, and again, I could be missing it.

19          I'm just looking for data, test data, that  
20          helps decide if this is realistic, optimistic, or  
21          conservative.

22          I'm assuming you were trying to buy us at  
23          conservative, but I'm looking for safety-valve test  
24          data.

25          DR. HATHAWAY: While this particular study

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1       wasn't looking at --

2                   MEMBER CORRADINI:  No, I know you weren't.  
3       I'm just looking for a reference that tells me to go  
4       look over here.

5                   So, your distribution of fraction of valve  
6       open after how many cycles bounds it, or represents  
7       it, or whatever.

8                   MS. GHOSH:  So, from the perspective of  
9       having the potential for early containment failure,  
10      we're looking at a more conservative range for this  
11      two-dimensional sample space.

12                   Because that black box is basically what  
13      we're sampling, and that only represents about four  
14      percent, four or five percent, of the entire sample  
15      distribution.

16                   But it's in that four or five percent  
17      where the early containment failure is possible.

18                   So, we're artificially constraining it to  
19      explore this area where you can get early containment  
20      failure.  But it's only a small percentage of the  
21      total sample distribution, which is --

22                   DR. HATHAWAY:  Okay, yes.

23                   Again, this was to really try to focus in  
24      on the full study and just look at that region where  
25      early containment was most probable to really see if

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1       there were any additional insights.

2                   CHAIR STETKAR:   Trey, your slides, I read  
3       through this, I see what you're trying to do and what  
4       you did.   But I got confused a bit.

5                   Your slides don't have the Figures that  
6       I'm going to talk about, and the Figures I'm going to  
7       talk about right now are Figures I-2 and I-3 of the  
8       report, that develop the values and the range of  
9       values that you sampled from for this study.

10                  I got confused by those because they do  
11       not, to me, anyway, seem consistent with the numerical  
12       values that are used in the main body of the study.  
13       So, I'd like somebody to explain to me where I'm  
14       wrong.

15                  In particular, I look at your fifth-order  
16       polynomial fit to the valve failure rate for the valve  
17       data in Figure I-2.

18                  And I noticed the first term is 3.26 times  
19       10 to the -2, which, to me, ought to be the mean value  
20       for the conditional probability that a valve sticks  
21       open on the first demand.

22                  If I'm wrong about that, please tell me  
23       because that's kind of fundamental.

24                  Because in the main body of the report, we  
25       don't use that value.   We use a value of 2.65e to the

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1 -2, not 3.26. So, I'm curious why the first-order  
2 term is 3.26 versus 2.65.

3 The next-order term for failure is per  
4 demand. If I use just a linear model, it's 1.83e to  
5 the -3, and in the main body of the report, we use a  
6 value of 2.23e to the -3 for the demand.

7 So, the shape is -- the intercept at zero  
8 is slightly different and the shape is somewhat  
9 different.

10 So, somebody fit a fifth-order polynomial  
11 to stuff that ostensibly uses data from the main body  
12 of the report, and I can't draw that link.

13 Now, why is that important? Well,  
14 overall, I'm not sure, but it's certainly going to  
15 affect the number of samples in different regions.

16 The second -- let me get through the  
17 second part of it.

18 The second part of it is when you do the  
19 differentiation of that curve to get the density  
20 function in Figure I-3, that density function does  
21 indeed start out at 1.83e to the -3, at a value of 1.

22 Now, that's actually at a value of one-  
23 plus because if you differentiate the delta function  
24 on the first demand, you get infinite. So, you can't  
25 do that.

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1           So, I want to make sure that the actual  
2           sampling used the correct probability for failure on  
3           the first demand, that it didn't use 1.83e to the -3,  
4           that it used something between 2 and 3e to the -2 in  
5           the actual runs that you made.

6           Why is that important? Because that's  
7           going to force more earlier failures.

8           Certainly, a lot more earlier failures  
9           than might be implied by the density function here in  
10          I-3.

11          So, if somebody could confirm to me where  
12          the numbers came from, and in particular, when you did  
13          your sampling?

14          Give me assurance that you used something  
15          on the order of two or three times ten to the -2 for  
16          the probability that it fails on the first demand?

17          The first demand, number one, not 1.83e to  
18          the -3.

19          I'd be a lot happier.

20          DR. HATHAWAY: I'll try to address your  
21          comment, I'll take a look at the comments, I can look  
22          at them.

23          But the distribution extended well past  
24          what I fit, because I was interested in just this  
25          range. I think that's what I said.

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1 I was interested in the range of 0 to 250.  
2 So, I was really trying to get a fit to the data in  
3 that range.

4 The problem is, as you extend past that  
5 range, the shape of the distribution is different. It  
6 starts to curve.

7 CHAIR STETKAR: You're starting to talk  
8 about somebody who really likes to do curve-fitting.  
9 I'm asking you a more fundamental question. I'm  
10 asking a question that your first term says 3.26e to  
11 the -2.

12 In the main body of the report, there's a  
13 table that says the mean value for failure on the  
14 first demand is, and I've lost it again, --

15 MEMBER BLEY: It's about 3 --

16 CHAIR STETKAR: It's about 2.65. Now,  
17 it's about 3, but why is the value different? And the  
18 first term is also different.

19 So, why didn't you use the values that are  
20 tabulated, and then you can do all of your fifth-order  
21 polynomial curve-fitting, whatever you want to do, and  
22 extrapolate out?

23 It's the same mathematical problem, it's  
24 just a different curve, and I don't know why it has to  
25 be different. It's the same lambda.

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1                   MEMBER BLEY: You make a big, and I think  
2 reasonable, case that it's a different failure rate  
3 for the first actuation than for the rest?

4                   CHAIR STETKAR: Yes.

5                   MEMBER BLEY: So, you have --

6                   CHAIR STETKAR: And that's what's used in  
7 the study. That's what's used in the real study.

8                   MEMBER BLEY: Yes.

9                   CHAIR STETKAR: This is supposed to be  
10 something that focuses on the first, nominally, 65 or  
11 so demands, and tries to force samples within that  
12 regime, that are consistent with the first study,  
13 given the fact that the first study extends -- uses  
14 all three valves.

15                   I mean, the first study, the baseline  
16 study if you want to call it, that is very elegant in  
17 the way that it characterizes the valves and multiple  
18 failures, and things like that.

19                   But the intent of this shouldn't be to  
20 develop different failure rates.

21                   MS. GHOSH: So, I think we're going to  
22 take your comment and re-check the numbers after this  
23 meeting, because we're not going to be able to resolve  
24 it right here.

25                   CHAIR STETKAR: Yes.

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1 MS. GHOSH: So, we understand the comment.

2 The one thing I will say, I don't think we  
3 should attribute too much precision to all of this,  
4 because our main focus was to make sure we were within  
5 this range of sampling where we could get early  
6 containment failure.

7 So, in terms of the high-level insights  
8 that we can draw from this study, we feel that we  
9 accurately explored the two-dimensional sample space.

10 There may be some discrepancies between  
11 the exact frequency and in parts of the sample space.  
12 We'll have to go back and check that.

13 CHAIR STETKAR: Tina?

14 MS. GHOSH: Yes?

15 CHAIR STETKAR: I get it.

16 But you spend a lot of time in the  
17 Appendix, like a couple of paragraphs, and this plot,  
18 saying you fit a fifth-order polynomial because, well,  
19 if you tried to fit a fourth-order polynomial, you had  
20 a little bit of different glitches when you did the  
21 differentiation.

22 So, you had to fit a fifth order. If you  
23 wanted to use a simple model, why don't you use the  
24 linear model? Failure on demand at time zero plus  
25  $\lambda X$ . It would have been a straight line.

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1           The differentiation is pretty good; it's  
2           got the same value at every demand. That's a real  
3           simple model.

4           It's not as elegant, it doesn't have this  
5           nice curvy shape to it.

6           MS. GHOSH: I understand that.

7           CHAIR STETKAR: But it's pretty simple in  
8           the sense of we're just trying to get an approximation  
9           and focus on this range of what might be important in  
10          that range.

11          MR. FULLER: Ed Fuller, from the Office of  
12          Research.

13          I want to make a comment on what John was  
14          saying because it was an issue that we encountered  
15          years ago, when I worked at Pole Star, doing a  
16          steam-generator tube integrity risk assessment for a  
17          variety of plants.

18          And we looked at operational data and test  
19          data at the time, to come up with some notion of  
20          whether or not there was a distinct difference between  
21          what would happen on the first demand versus all the  
22          rest.

23          And we concluded that at the time, anyway,  
24          most of the time when the data was pertaining to one  
25          demand right away failure, it was due to some

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1 maintenance errors.

2 And so I think, my own view is, take what  
3 John said and refit, starting with Demand 2; exclude  
4 the first demand from your Focus Study.

5 CHAIR STETKAR: The main report does that,  
6 and it does it in -- I tend to be not the most  
7 pleasant person in the world -- but in a very elegant  
8 way, the main body of the report.

9 The way it treats three individual demands  
10 -- three individual valves, sequential demands,  
11 sampling of the number of cycles to failure, is a very  
12 elegant model.

13 The only questions that I had on this  
14 Focus Study was the values that are used to plot that  
15 curve.

16 And then as a separate, non-related error,  
17 a question to make sure that you did use that initial  
18 demand failure for sampling for Demand 1 in the Focus  
19 Study.

20 DR. HATHAWAY: I don't know if this will  
21 clear this up or not --

22 CHAIR STETKAR: It's a factor of ten  
23 higher.

24 DR. HATHAWAY: In the UA, it was two  
25 distributions. It has one on the first sample and

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1       then it has one on the second.

2               What I'm trying to do by using the data is  
3       fit to that so it convolves those two distributions  
4       together.

5               CHAIR STETKAR: But your curve I-2 shows  
6       the concept of what's in the baseline study.

7               It shows a delta function at one, which  
8       corresponds to the conditional probability that it  
9       fails on the first time.

10              And then it shows some sort of shape in a  
11      accumulative form as you accumulate demands.

12              Now, the shape of that curve kind of  
13      depends on the model that you use, and the slope of  
14      that curve depends on the failure rate that you use  
15      per successive demand.

16              The same failure rate is used for each  
17      successive after the first, in the baseline model.

18              And depending on -- it's not a linear  
19      model if you account for the accumulative effects from  
20      failures.

21              But in a simple term, you could use a  
22      linear model, especially over the first 50, 60, 70  
23      demands or so. This didn't.

24              And then when you differentiate this  
25      curve, you'd better account for that delta function at

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1 one.

2 And if you're not, you've got a real  
3 problem because you're ignoring a factor of ten or so,  
4 or more than a factor of ten, conditional probability  
5 that it fails on the first demand, which is, indeed,  
6 much more closer to the regime that you're trying to  
7 test in this Focus Study.

8 You're trying to see how sensitive the  
9 results are to earlier failures with a large open  
10 area.

11 MEMBER BLEY: Just maybe Figure I-3, which  
12 is the density function, was drawn without showing the  
13 delta function either.

14 CHAIR STETKAR: That's the reason why I  
15 ask it. It could be.

16 MEMBER BLEY: Maybe it's just the way you  
17 drew the Figure, and you didn't show that three minus  
18 two, right, at one.

19 That's kind of what John was hoping you  
20 would say.

21 CHAIR STETKAR: Yes, I was really hoping  
22 you would say, well, of course we used the three minus  
23 two for the first demand. Or two and a half minus  
24 two, or whatever it should have been.

25 But I didn't hear that.

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1 MS. GHOSH: If you go to Figure I-4.

2 CHAIR STETKAR: I-7?

3 MEMBER BLEY: I-4?

4 MS. GHOSH: Yes, if you have that.

5 It has the actual sample then successful -  
6 - we were showing this for a different reason, to show  
7 that there wasn't a huge dependence in terms of the  
8 completed runs.

9 But at least to the first order of  
10 magnitude, we did sample that first demand higher.

11 CHAIR STETKAR: You did? I'm trying to  
12 pull it up right now.

13 MS. GHOSH: But I think in terms of the  
14 larger question of the exact numbers, we'll have to  
15 get back to you on that and we'll double-check.

16 MEMBER BLEY: Somehow, I'm not seeing it.

17 CHAIR STETKAR: Yes, I mean, if I had seen  
18 it in that Figure, I would have probably mentioned it.  
19 Yes, I'm not seeing it here.

20 MS. GHOSH: So, maybe we can talk during a  
21 break. We should probably move on and we can get back  
22 to you on that.

23 MEMBER BLEY: Are you sure you meant I-4?  
24 Okay.

25 BB: I know there's a bunch of --

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1 CHAIR STETKAR: Turn your mic back on,  
2 Tina. Don't --

3 MS. GHOSH: Sorry, the bottom right of  
4 that six-figure -- there's a bunch of charts in that  
5 Figure.

6 Yes, I apologize, I meant to release all  
7 of them. Maybe we'll catch up later, and we can move  
8 on. Yes? Yes, sorry.

9 MEMBER BLEY: Thanks.

10 DR. HATHAWAY: So, we ran the models, and  
11 what we really looked at is when we constrained our  
12 distributions to this small portion of the sample  
13 space, where early containment failure was the most  
14 probable, we got about that 17 percent of our  
15 realizations resulted in early containment failure.

16 And looking at it, about 15 percent of the  
17 realizations, the BOC core conditions had an early  
18 containment failure of 16 percent of the MOC and 19  
19 percent of the EOC.

20 So, the table on the right shows just the  
21 statistics for the various realizations. The mean of  
22 the BOC was about 6 hours, the mean of the MOC was  
23 about 6.6, and the EOC is about 6.6.

24 And what you also see is the BOC's kind of  
25 constrained closer to the mean, where the MOC and the

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1 EOC are spread out further.

2 And we'll see this a little later on when  
3 we look at the cesium iodine release rates as a  
4 function of time.

5 CHAIR STETKAR: Trey, I don't know where  
6 to ask this so I'll ask it now, and tell me if I  
7 should ask it later. Let me get my notes here.

8 See, you see this number 17 percent? 17  
9 percent of the realizations in the Focus Study  
10 resulted in early containment failure.

11 What you really mean is 17 percent of the  
12 361 successful realizations had that behavior.

13 Out of 600 realizations, there were 239  
14 that did not run to completion, which is 40 percent.  
15 40, 4-0, percent did not run to completion when you  
16 tried to force this.

17 It's curious, and I went back and I did  
18 the numbers, that in the baseline study, 40 percent of  
19 the runs in the area that had a large early open  
20 fraction did not run to completion. Same percentage.

21 So, something about MELCOR in this region  
22 is not very good. 40 percent of the runs are not  
23 running to completion in this particular region.

24 A much higher percentage run to completion  
25 everywhere else.

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1                   MEMBER CORRADINI: But I thought we had  
2 asked that.

3                   CHAIR STETKAR: Yes, and we never got an  
4 answer.

5                   MEMBER BLEY: We talked about it a lot.

6                   CHAIR STETKAR: We never got an answer.

7                   MEMBER BLEY: The way it is is kind of --

8                   CHAIR STETKAR: Yes, that's the way it is.  
9 Yes, we looked at it and it doesn't finish. Now --

10                  MEMBER CORRADINI: But I thought -- if I  
11 just want to interrupt you, John -- I thought you guys  
12 promised, I thought, that you were going to go back  
13 and try to unravel the reasons for failure in that  
14 area?

15                  CHAIR STETKAR: That's why I brought it up  
16 now, because I don't think they're planning to discuss  
17 it.

18                  The reason I bring it up now is that in  
19 the results from this Focused Safety Study, they were  
20 reflected back through the overall insights and  
21 conclusions.

22                  There is an inference that the same 17  
23 percent early containment failure and the same  
24 conditional consequences apply for that 40 percent of  
25 the runs that did not finish.

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1                   And I do not know why that must be true. I  
2                   have no evidence --

3                   MEMBER BLEY:   Or at least one wonders --

4                   CHAIR STETKAR:   I don't know if it is  
5                   true.

6                   MEMBER BLEY:   -- if there's something  
7                   going on where there could be a lot more of them.

8                   CHAIR STETKAR:   I would have been really  
9                   happy if like 95 percent of these runs ran to  
10                  completion and you saw that same fraction, but they  
11                  didn't.

12                  MEMBER BALLINGER:   To turn it around, if  
13                  you have 40 percent, I think I made this comment  
14                  earlier.

15                  If you have 40 percent that don't run to  
16                  completion, what's to say that the numbers that did  
17                  run to completion are actually good numbers?

18                  I mean, if there's something fundamentally  
19                  going on here, the fact that you've got runs that went  
20                  to completion and you get numbers kind of makes you  
21                  feel good, but what if there's something fundamentally  
22                  wrong?

23                  So, that's why I think we ask that you  
24                  folks go back and find out exactly why the runs that  
25                  didn't go to completion, what caused them to do that?

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1                   Was it some convergence issue? Or whether  
2                   it's some flat-out mistake in a model or something.  
3                   Because it does reflect back on these numbers.

4                   MS. GHOSH: So, I'm going to just note  
5                   something that I --

6                   MEMBER BALLINGER: Remember, I'm  
7                   metallurgist so...

8                   MS. GHOSH: Yes, I'm not going to give a  
9                   satisfactory answer, but one of the primary  
10                  motivations to do this Focus Study, to do a bunch more  
11                  realizations in this area was that we knew from the  
12                  overall UA that we had 20-some, I think, realizations  
13                  that we had tried to sample in this area.

14                  And we had a 30-some percentage failure  
15                  rate, which is much higher than the overall UA, which  
16                  is pretty small.

17                  So, we knew that there was something going  
18                  on in this sample space, that we were getting higher  
19                  incompletion rates.

20                  So, that was one of the major motivations  
21                  to do this study, is just to explore the response  
22                  surface and the smaller area much more.

23                  So, we have 361 additional points in this  
24                  area, so we have more information but it doesn't  
25                  answer the second part of your question.

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1                   MEMBER BLEY:    But you didn't put any  
2                   diagnostics in the code or anything to see where it  
3                   was failing, what was going on?

4                   MS. GHOSH:    So, I'll let Casey, and if  
5                   Hosseini wants to speak, speak next. We did have our  
6                   Code Guides.

7                   We look at the reason for the failure in a  
8                   bunch of these cases, and in many of them, it was  
9                   frustrating.

10                  I think we had documented some, or maybe  
11                  we didn't end up putting it in the Appendix --

12                  CHAIR STETKAR:   It is not documented  
13                  anywhere in the report, I can guarantee that.

14                  MS. GHOSH:    Okay, so that's probably  
15                  something we could add because at least we know what  
16                  the error meant. We know what the error message was,  
17                  and in some cases it's easily explainable.

18                  I think some cases, things are just  
19                  happening too fast, the time steps are too small and  
20                  you get hung up.

21                  But in a bunch of cases, it was this  
22                  executive abort signal detected, which is really  
23                  frustrating, because it's very hard to untangle.

24                  But let me turn it over --

25                  MEMBER BALLINGER: I'll say the same thing

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1 as I did last time, and that is sometimes, exploring  
2 why these things didn't go to completion provides you  
3 with what I would call surprise, which actually means  
4 something.

5 And so I may be a metallurgist, but if a  
6 student comes to me with results from a model he's  
7 written -- he or she, excuse me, has written -- and  
8 says that 40 percent of the time, the thing didn't  
9 converge, then I would reject the results out of hand.

10 I would say there's no reason for me to  
11 believe that the ones that did run to completion were  
12 not fortuitous.

13 MEMBER CORRADINI: So, you guys don't have  
14 to try to explain more. My interpretation of what  
15 you're saying is you don't know, even though you tried  
16 to look.

17 So, if there is a documentation of however  
18 many it is and the failure message, it would be, to me  
19 -- and this is not a criticism because these are  
20 highly non-linear calculations that go off the  
21 reservation, potentially more easily, and the fact  
22 that you had the small percentage of the bigger  
23 population is a good thing.

24 But I do think you've got to do some sort  
25 of postmortem as to why.

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1                   MEMBER BLEY: I'd like to hear what Casey  
2 has got to say.

3                   MEMBER BALLINGER: He's a thermo-  
4 hydrologist guy so he gets away with more.

5                   MR. WAGNER: Casey Wagner, Dycoda.  
6 There's a couple of things that I have to point out.

7                   This was already done and it used the same  
8 code as the last calculations.

9                   So, whatever problems we were running into  
10 on the last set of calculations, we were going to run  
11 into it on this set of calculations.

12                  MEMBER BALLINGER: See, I rest my case  
13 then.

14                  MR. WAGNER: Well, more calculations were  
15 done there.

16                  It went to a small time step and  
17 eventually, if you have enough time steps that are  
18 very small, it would give up and say that it was not  
19 able to converge. And so that was the stoppage.

20                  The convergence criteria is there, I don't  
21 know if this will satisfy you, to assure that you do  
22 get convergence, and if you don't have convergence, it  
23 keeps on cutting the time step, trying to get there.

24                  If it doesn't get there, those  
25 calculations are stopped, and we are considered

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1 failed.

2 The other ones, presumably, did satisfy  
3 that convergence criteria, and so we do accept them as  
4 successful and reasonable calculations.

5 MEMBER BLEY: It just seems there's no --  
6 since you don't know quite what's going on, I don't  
7 see any basis for assuming that the same percentage of  
8 containment failures are in this group that died as in  
9 the other calcs.

10 There might be something that's happening  
11 on the way to containment failure that's blowing up  
12 the code.

13 MEMBER MARCH-LEUBA: Casey, can I ask you  
14 a couple of questions?

15 You mentioned you're using the same code.  
16 Do you mean the same version of the code, or the same  
17 number?

18 MR. WAGNER: It is the exact same version.

19 MEMBER MARCH-LEUBA: And all these  
20 variables didn't happen on initialization? It  
21 happened in the middle.

22 It did not happen during initialization,  
23 it happened in the middle of the transfer?

24 That typically happens when one of the  
25 nodes goes into other reservations that we mentioned

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1 before. Another's supposed to have water, it doesn't.

2 A little one goes through somewhere, and  
3 that happens all the time in other codes. But if it's  
4 water, somebody dies.

5 CHAIR STETKAR: When you say all the time,  
6 it's, to me, knowing nothing about the codes, it's  
7 just curious that in the baseline study, at least  
8 according to what I understand from the report, they  
9 only had 40 chances to get into this regime.

10 And out of those 40 chances, 17 didn't  
11 run. Here, they forced it to get 600 chances to get  
12 into this regime, and the same fraction of times  
13 didn't run.

14 MEMBER MARCH-LEUBA: You give these codes  
15 too much credit.

16 CHAIR STETKAR: But, okay, you folks are  
17 familiar with it, but we are in fact relying on this  
18 code to draw conclusions and insights about kind of a  
19 fundamental behavior of this machine.

20 MEMBER MARCH-LEUBA: The experience of  
21 people that run this code will tell you that they run  
22 10 runs when it crashes for every run when it  
23 survives. And you converge on the model and you fix  
24 everything.

25 CHAIR STETKAR: But that wasn't the case.

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1 In more of the well-behaved regime of this whole  
2 study, they got something, I don't know, Casey, 90  
3 percent success rate or better?

4 MEMBER MARCH-LEUBA: Eventually.

5 CHAIR STETKAR: No, not eventually.

6 MEMBER MARCH-LEUBA: No, when you're  
7 trying to develop the input there, you're trying to  
8 describe your plant, you try once.

9 You run it, it crashes. Then you fix it.  
10 You run it, it crashes. And eventually, you fix it --

11 MEMBER BLEY: We kind of get that, but  
12 what John's talking about is there's this whole space  
13 they did calculations, 90 percent of the time, the  
14 code runs great.

15 There's this little vulnerable area for  
16 early containment failure. When they run in that  
17 regime, 40 percent of the time it crashes.

18 So, there's something in there that's  
19 causing trouble.

20 MEMBER MARCH-LEUBA: My point that I  
21 obviously didn't do correctly is that's worrisome  
22 because it happens in the middle of the run.  
23 Something is happening.

24 MR. WAGNER: Yes, I can explain what's  
25 happening to get it to make sense to you.

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1           For those cases where the valve sticks  
2           open, we're moving, we're generating more hydrogen,  
3           we're going into early containment failures, we're  
4           getting more core damage.

5           And then the accumulator dumps, and so  
6           we're dumping an accumulator into a much more degraded  
7           core than the cases that are high-pressure, that we  
8           get the hotleg failure, and the core's relatively  
9           intact, and it quenches it pretty quickly.

10          And then we move onto a boil-off severe  
11          accident. This is much more challenging because the  
12          core has formed a debris bed and then we did a hotleg  
13          failure, or it seeps into the accumulator dump.

14          MEMBER CORRADINI: So, let's just backup.  
15          So, I don't do this anymore because I probably  
16          couldn't do it right. I couldn't even get the model  
17          to run at times.

18          So, if I were to do a detective job on  
19          this, the first question I ask is of the 40 percent  
20          that failed, did they all fail at approximately the  
21          same time in terms of event sequence?

22          You are hinting that the event of an  
23          accumulator, essentially, hotleg creep rupture, and  
24          then an accumulator dump, is a common time-to-receive  
25          failure.

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1 Is that the case?

2 CHAIR STETKAR: This is a step up in valve  
3 but I just think --

4 MR. WAGNER: Yes, we also get the hotleg  
5 failure, even if the primary system pressure has come  
6 down.

7 The one thing that I don't think Trey  
8 shared with you is that we did forensics because we  
9 had so many more samples here on our uncertain  
10 parameters.

11 And was there in space in them where we  
12 didn't have representative successful samples?

13 And Trey did a very thorough job of going  
14 through all the different parameters, and they're  
15 interspersed. They're like this, failures and  
16 successes. And so there wasn't a common theme there.

17 On our sample parameters, we were missing  
18 a space.

19 We unfortunately got the 40 percent, which  
20 is very high, but the interspersed end of  
21 representation of what we were trying to look at for  
22 uncertain parameters was very good.

23 And we judged that as success in a lot  
24 more cases.

25 MEMBER CORRADINI: Okay, I get your point.

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1 But what I'm asking, from the standpoint  
2 of just rudimentary failure times, is there an event  
3 that MELCOR records that at, or right after, that  
4 event, everything goes to hell in a handbasket  
5 regardless of the uncertain parameters or the variable  
6 parameters.

7 MR. ESMAILI: This is Hossein Esmaili, can  
8 I just say something? I think we don't know right now  
9 what caused this error.

10 We can going back and look at it, and when  
11 Larry was here on April 18, we went through the whole  
12 thing. We said that this is our quench model, this is  
13 how we do this, this is our comparisons with the  
14 experiments, et cetera.

15 When you apply those models to  
16 sophisticated whole-plan models, you can run into  
17 whether it's on the core side or whether it's the  
18 input model side.

19 We cannot answer this until we go to the  
20 actual source code to try to find out what caused this  
21 problem. But in most cases, we can resolve it.

22 It was not important, I guess as the panel  
23 here discussed. It was not important because we had  
24 an overall high success rate, and most of calculations  
25 that we did was over 99 percent success rate.

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1                   It's just that we got into this issue  
2 here. And we are going to find out exactly what  
3 happened in these calculations, and maybe we can let  
4 you know later.

5                   Right now, I don't think we can tell you  
6 with certainty what happened in these calculations.  
7 It's often one thing, one thing in the code, that once  
8 you get over it, the calculations would go forward.

9                   But I don't know until I talk to my  
10 colleagues about it.

11                  MEMBER REMPE: And so your diagnostics  
12 don't tell you it's in --

13                  MR. ESMAILI: No.

14                  MEMBER REMPE: It doesn't tell you which  
15 nodes? It doesn't give you any clues? It just --

16                  MR. ESMAILI: It gives you some idea but  
17 it doesn't tell you everything about it.

18                  So, you really have to go run the code in  
19 a de-bug mode, find out what happened there, and find  
20 out exactly what was going on.

21                  And in some cases, it could be a small  
22 error in how things are done, and --

23                  MEMBER REMPE: And in the diagnostics that  
24 you've had, you've not gone through and the 17 --

25                  MR. ESMAILI: It doesn't --

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1 (Simultaneous Speaking.)

2 MEMBER REMPE: And the 17 or however many  
3 hundred cases, you've not ever tried to say, oh, it's  
4 always in that same place?

5 You've not had the opportunity to --

6 MR. ESMAILI: I don't know if we have done  
7 that. I don't know if we have put in the tracing  
8 model back on to the reference, but we can go back and  
9 look at it more.

10 I'm just saying that we cannot resolve it  
11 here because we don't have the right people, we don't  
12 have them here.

13 MEMBER BALLINGER: So, you're on record  
14 now as saying you're going to run this to ground?

15 CHAIR STETKAR: They said they'd get back  
16 to us. From an academic sense, not that I understand  
17 any of this stuff, I'm really interested to understand  
18 why the code is blowing up.

19 From a bigger picture regarding this study  
20 and its report, the study and its report does not  
21 highlight the conversation we just had.

22 It basically says look, look, look, we did  
23 this Focus Study, which is a really good idea.

24 The results from the -- we focused the  
25 sample space on a regime that we really wanted to

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1 test, that was a) blowing up more frequently in the  
2 baseline study, and b) generally more important for  
3 offsite health consequences, early containment failure  
4 anyway.

5 It has a good chance, but then we observe  
6 the same behavior, that 40 percent of the runs didn't  
7 run to completion. That's mentioned, it's documented,  
8 but it's just sort of mentioned in passing.

9 And the thing that concerns me most from  
10 the perspective of the study is the inference that 17  
11 percent of that 40 percent of the runs that did not  
12 complete would have behaved the same as the 60 percent  
13 that did complete.

14 Ergo, yes, we might pick up two or three  
15 more early containment failures from the runs that  
16 didn't complete.

17 And therefore, our overall study results  
18 and conclusions and insights aren't affected by those  
19 run failures.

20 That latter point is the thing that  
21 bothers me, and drawing that inference, I believe, is  
22 misleading.

23 I think that you should just own up to the  
24 fact that the runs didn't run to completion and you  
25 don't really know what fraction of those incomplete

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1 runs may have gone into early containment failure.

2 You know from the baseline study that it  
3 can't be -- because I've got confidence in the  
4 baseline study sampling -- you know that it can't be  
5 more than I think 17 additional runs in the baseline  
6 study.

7 So, it can't be 200 more samples in the  
8 baseline study that would have gone into an early  
9 containment failure.

10 But you don't really know what fraction of  
11 those additional runs can go to early containment  
12 failure, and I think the overall study should  
13 highlight that.

14 It's just something we don't know right  
15 now.

16 MS. GHOSH: Okay, so I think we understand  
17 the comment. The one other thing I'll point out again  
18 is this Figure 1-4, which is in the Appendix.

19 This was our attempt to, at least from a  
20 statistical standpoint, to look at is there a region  
21 of the inputs that we're putting in?

22 So, that's only just the initial  
23 conditions. It doesn't get to what's happening  
24 midstream at all.

25 But at least, was there a region of even

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1 this focus input space where we were getting excessive  
2 failures.

3 So, the I-4, the one I think that Trey  
4 summarizes, is, once again, the one area where you see  
5 a little bit of a correlation in terms of the  
6 failures.

7 And we already knew this, because we knew  
8 this from the leger studies, that if you have very few  
9 cycles dealing with big, open areas, you continue to  
10 be more likely to have an incompleteness rate.

11 But if you look at the successful  
12 realizations from those Figures which are shown in  
13 red, the blues were the samples that were attempted,  
14 and then the red ones are -- so the blue is the CDF of  
15 what we attempted to do.

16 The red is the cumulative distribution  
17 function of what actually succeeded in completing.

18 You can see that what Casey was saying,  
19 there's very good coverage across the range of the  
20 inputs, and for most of the input and variables, we  
21 get a very good match.

22 But one exception, again, is there's a  
23 little bit -- you can see a little bit of a difference  
24 in the CDFs for the number of cycles, and that's kind  
25 of pushed to success for a higher number of cycles.

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1                   So, you do see that same correlation.

2                   But we, at least from a statistical  
3 standpoint, not having had been able to do the full  
4 forensics on these realizations, from a statistic  
5 standpoint, we felt comfortable to say that we thought  
6 it was likely that in the runs that didn't complete,  
7 you would see the same percentage of runs going into  
8 early containment failure.

9                   So, again, from a purely statistical  
10 standpoint with the input space --

11                  MEMBER MARCH-LEUBA: And that's why I  
12 wanted to get a little time, because I do know a  
13 little bit about this topic.

14                  Based on the comments we receive here, I  
15 see likely unconcerned that the Staff is going to go  
16 into a five-year effort into de-bagging all those 40  
17 percent run.

18                  I'm thinking, using engineering judgment  
19 of the guys that know what's going on, can you look at  
20 the run and it fail, but I see the passage going, this  
21 is going to be okay.

22                  And then I have to look at that one.

23                  CHAIR STETKAR: That would be really good,  
24 wouldn't it?

25                  MEMBER MARCH-LEUBA: Our guys who have

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1 looked at the other 362 can look at one and say, yes,  
2 it crashed, but this isn't going anywhere.

3 Good. Don't go into a five-year effort.

4 CHAIR STETKAR: And, Tina, I'm sorry, but  
5 don't muddy it up with statistics on sampled  
6 parameters. Make it an engineering problem.

7 MEMBER MARCH-LEUBA: In fact, it would be  
8 perfectly good for this exercise. And you know it,  
9 you look at the run and say I'm wasting CPU.

10 CHAIR STETKAR: At 239 runs, 57 of them  
11 had this flavor, 52 of them had this flavor.

12 MEMBER BLEY: That would be much more  
13 convincing than just saying it's got to be the same  
14 percentage.

15 CHAIR STETKAR: Okay, I think we beat that  
16 horse. That's not a dead horse, it's beaten.

17 DR. HATHAWAY: So, I'm going to be doing  
18 the next part. The next Figures present the CDF, so  
19 the hydrogen-generated, because that was sort of that  
20 interest.

21 Really, when I first started out, I was  
22 just kind of interested in what was the early  
23 containment failure potential in this region.

24 So, just looking at the data a little bit  
25 more, we went in and pulled out the mass of hydrogen

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1 generated up to the time of first deflagration, and  
2 the mass of hydrogen reaching the dome up to the time  
3 of the deflagration reaching the dome.

4 Because those tend to be the important  
5 aspects of the -- that tends to be one of the  
6 important insights from the study.

7 So, what this Figure shows, the dots in  
8 blue represent the BOC realizations, the dots in  
9 purple represent the MOC, and the dots in green  
10 represent the EOC.

11 In these Figures, the dots that are  
12 highlighted in red represent the early containment  
13 rupture cases, and what you can see looking at  
14 hydrogen generation, there was slightly more hydrogen  
15 generated in the BOC realizations.

16 But the EOC and MOC realizations overlap  
17 pretty well.

18 But then when you look at the amount  
19 reaching the dome, that was consistent across all the  
20 realizations, and also, what you see is when you have  
21 a larger fraction of hydrogen reaching the dome, those  
22 tended to have a higher fraction of the cases leading  
23 to early containment failure.

24 MEMBER BROWN: Excuse me, for the  
25 uninitiated, what do you mean by early? I looked

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1 here, and you see the hydrogen buildup, is that over a  
2 6-hour, 10-hour, 20, 1 day, period? After?

3 DR. HATHAWAY: No, it's within the first  
4 15 hours of what the simulation.

5 What I meant by early is if you have a  
6 failure due to the hydrogen deflagration, not  
7 overpressurization, which is lead failure.

8 MEMBER BROWN: Okay, so it's about 15, in  
9 the ballpark of 15 hours for the hydrogen, for the  
10 deflagration --

11 DR. HATHAWAY: So, if you looked at the  
12 previous study, the times are presented on the right.  
13 So, six up to ten hours is what was the result.

14 MEMBER BROWN: I couldn't connect the dots  
15 after I listened for 30 minutes or 45 minutes on that  
16 last interchange of why the runs didn't work.

17 So, I lost the ball on this one. So,  
18 thank you, I appreciate it.

19 DR. HATHAWAY: -- the first 15 hours for  
20 this part of the analysis.

21 So, the next thing we kind of looked at is  
22 what is the pressure response in the dome?

23 So, what this Figure shows, the blue dots  
24 represent realizations and the redundant Focus Study.  
25 So, you can see that those have the early valve

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1 failures on that range of 1 to 65.

2 The purple represent the results from the  
3 full UA, and what this demonstrates is in the full UA,  
4 the axis on the right represents the difference  
5 between the peak dome pressure and the sample  
6 fragility.

7 So, what that really shows you is how  
8 close that early burn gets to actually rupturing the  
9 containment due to the hydrogen burn.

10 So, you can see that in the full UA, a lot  
11 of the results don't get within 25 PSI of the sample  
12 fragility, so they had smaller burns initially.

13 But in the Focus UA, you kind of fill out  
14 that region between the -- well, going back, a lot of  
15 the full UA studies have a hotleg failures, what the  
16 initiating event is first. Or what the  
17 depressurization then is.

18 So, when we were de-pressurizing before,  
19 you would kind of fill out that Region between that  
20 hotleg failure and the admission event.

21 And what you also see in the Uncertain  
22 Figure is a lot of the burns were still -- when they  
23 failed containment, it was when the sample fragility  
24 was less than the mode of the distribution.

25 But also, just looking back, if you look

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1 at the distribution, 42 percent of the fragility  
2 distribution is above the mode, but only 13 percent of  
3 the cases gave you a burn large enough to get into  
4 that region of the distribution.

5 So, after we did this, and really, this  
6 was after the last ACRS Meeting, we looked at it and I  
7 tried to look at the consequences analysis.

8 So, what we did is we went back and  
9 grabbed all the cases.

10 Since we truncated these cases to 15  
11 hours, we went back and ran them all from the  
12 beginning and extended the problem 72 hours, to really  
13 be able to look at what the consequences of these  
14 cases are.

15 So, we did this for two sets. We looked  
16 at all the early-containment rupture cases, but we  
17 also looked at a subset of the late-containment  
18 rupture cases.

19 And we randomly selected late-containment  
20 rupture cases but tried to keep the same breakdown as  
21 the time cycle.

22 So, if there were 11 percent in the  
23 sample, try to pick 11 percent of the BOC cases, for  
24 example.

25 So, what this Figure is, you can kind of

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1 see where the BOC realizations clustered around six  
2 hours, but the MOC and the EOC kind of spread apart.

3 Also, these late-containment failures in  
4 the UA, a lot of them were smaller releases.

5 But we kind of looked at this, this came  
6 about very late, that some of these, when you had  
7 valve failures, produced larger late releases.

8 So, that's why we selected a subset of  
9 these late releases.

10 And this is just really showing the  
11 results, the average cesium release for the early-  
12 containment ruptures was 2.2, and the iodine was 6.3.  
13 The late-containment ruptures were 0.004 and 0.021.

14 MEMBER REMPE: So, can you go back to that  
15 slide?

16 I was going to bring this up later, but if  
17 you had done a sensitivity study where you assumed at  
18 the beginning of the cycle you had a higher eutectic  
19 melt relocation temperature, how do you think it would  
20 have affected all these results?

21 I mean, everything always says, okay, the  
22 cesium release fraction's kind of similar if it's all  
23 at the beginning of cycle.

24 And, again, if you do kind of a thought  
25 exercise on how all these things are interrelated in

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1 MELCOR, what would have happened?

2 Because you would have had a longer time  
3 for the fuel to heat up, it would have gone to higher  
4 temperatures, you would have had a lot of more  
5 release.

6 And it would have really kind of thrown  
7 things off kilter, and I was really disappointed that  
8 you didn't do a sensitivity study.

9 I mean, you've got this 2500 plus or minus  
10 83, instead of 200, which is what the Europeans  
11 recommend.

12 And I kind of think that's an important  
13 sensitivity technology, some of the limitations and  
14 uncertainties associated with this plan.

15 And all plans, frankly. But any comments  
16 on that?

17 MR. WAGNER: So, it's a timely comment  
18 because we're getting ready to do Surry and we  
19 struggled with your comment on how do we address it?

20 It makes sense that BOC is going to have a  
21 higher melting temperature, and maybe that's something  
22 we could look at in Surry, certainly at the  
23 sensitivity at a minimum.

24 But I agree with your conclusions but the  
25 releases would probably be a little bit higher at BOC

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1 potentially because --

2 MEMBER REMPE: Hydrogen generation could  
3 be higher. It could really kind of be an outlier  
4 there, that it's not being explored.

5 And so, again, it's kind of like you get  
6 up in the Executive Summary when you come up with  
7 these general insights from these results.

8 I'd really like to see some limitations to  
9 those insights, because of things like that, so that  
10 you don't get yourself over a bind, in this case,  
11 because there's some uncertainties.

12 In the case of the consequential tube  
13 rupture, your scope of your study is bringing you to a  
14 certain conclusion.

15 Whereas, if you consider other ongoing  
16 studies even, there's some knowledge that you guys  
17 have that ought to be acknowledged as a limitation.

18 And so that's why I kind of wanted to  
19 bring it up here because --

20 MR. WAGNER: To your comments there, maybe  
21 our standard deviation about that is too narrow. The  
22 inverse is maybe 200 and we really ought to go back  
23 and rethink that BOC again.

24 MEMBER REMPE: Yes, at this point, I'm not  
25 trying to say do more calculations, although, I would

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1       like to see what that result looks like because of the  
2       way the models have been constructed.

3               But just to acknowledge the limitations  
4       and uncertainties.

5               MEMBER POWERS: I've tried diligently not  
6       to make comments during this, but I can't anymore.

7               Do you really, really honestly think that  
8       melt relocation depends at all on how long the fuel's  
9       been burned up?

10              MR. WAGNER: I'd be looking for Randy at  
11       this moment. I thought so.

12              MEMBER POWERS: Do you have any solid  
13       evidence that the accumulation-efficient products as  
14       the fuel burns up changes the melting point of the  
15       fuel significantly?

16              MR. WAGNER: That's why we weren't able to  
17       address Joy's comment. We said we agreed with the  
18       hypothesis but we didn't know, we didn't have data to  
19       --

20              MEMBER POWERS: Well, there are data in  
21       the literature.

22              There are several people who have tried to  
23       measure the melting point of irradiated fuel, and they  
24       usually come back with results that are not wildly  
25       different from the melting point of unburnt fuel.

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1           The fact of the matter is that in that  
2 particular range for LWR fuel, there's sufficient  
3 uncertainty and variability just by small changes in  
4 straight geometry and whatnot, that it's very hard to  
5 say.

6           But the overall phenomenon of melt  
7 relocation really doesn't depend very much on the  
8 melting point of the fuel. It really has to do with  
9 liquefaction with the clad interacting with the fuel.

10          And it seems to me that if you were to  
11 hypothesize burn-up has an effect, it would be because  
12 of something happening on the inside of the cladding  
13 to give you a larger region of oxide formation there,  
14 that inhibited liquefaction.

15          It would have had nothing really to do  
16 with burn-up, but it had to do with internal oxidation  
17 of the cladding.

18          MEMBER BALLINGER: But that is a function  
19 of the lambda, right?

20          MEMBER POWERS: It can be depending on  
21 what's happening on the inside --

22          MEMBER BALLINGER: So, the film on the  
23 inside of the cladding is going to be a function of  
24 the potential?

25          MEMBER POWERS: It depends on how the fuel

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1 chooses to behave.

2 And in particular, what it seems to depend  
3 most upon is how much of metallic modules you'd get  
4 in.

5 Because the molybdenum acts as a buffer  
6 for the accumulation of oxygen, and the availability  
7 of the oxygen to go oxidize that cladding.

8 So, it depends on a lot of things, but not  
9 which are sensitive enough, since the code works in  
10 nodes that are like this, as opposed to individual  
11 fuel rods, you're averaging over a lot of things here  
12 to get liquefaction.

13 And liquefaction is treated in the code in  
14 a relatively non-mechanistic fashion.

15 So, you do what they've done.

16 It's they take some breadth of that  
17 relocation number based on matching a variety of  
18 experiments, and they say, okay, you match these  
19 experiments and we take some temperature range as a  
20 criterion for relocation.

21 Honing that number down based on some  
22 hypothesis about what's going on strikes me as kind of  
23 futile.

24 MEMBER BALLINGER: They say about the  
25 great tragedy of science, the slaying of a beautiful

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1 hypothesis by an ugly fact.

2 MEMBER REMPE: So, there's also thermal  
3 cracking, there is cracking during the radiation. But  
4 the thing is that --

5 MEMBER POWERS: Joy, what happens --

6 MEMBER REMPE: Let me finish just for a  
7 minute, sir.

8 There's uncertainty with the phenomena but  
9 there's also what's embedded in the code, and because,  
10 again, there's uncertainty in the phenomena, I think  
11 it's a useful exercise to bump that thing up a bit.

12 Because, again, they only had plus or  
13 minus 83 degrees, and I've been reading up a lot of  
14 stuff from France, where they're saying there needs to  
15 be a larger uncertainty.

16 But just to see how it's all connected,  
17 because I would challenge or query that I think that  
18 if you did bump it up, you might see that because of  
19 the way the models are interspersed in that code,  
20 you're going to see some significant differences.

21 MEMBER POWERS: And presumably, if I take  
22 the ranges large enough, I will get some pretty  
23 radical differences. I'm sure of that.

24 MEMBER REMPE: Yes.

25 MEMBER POWERS: That one I'm confident of.

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1                   MEMBER REMPE: And I would like to see the  
2 sensitivity to explore that because they're getting  
3 some very similar things.

4                   And I think it would be worthwhile to  
5 understand if it's realistic if you go a bit higher,  
6 even if your range is up --

7                   MEMBER POWERS: I guess I don't understand  
8 how increasing your understanding improves your --  
9 increasing your uncertainty improves your  
10 understanding.

11                  A little bit of a mystery to me but I'm --

12                  MEMBER REMPE: But, again, they've limited  
13 it to VERCORS for their plus and minus 83, and if you  
14 consider other things like PHEBUS, the French are  
15 saying go to plus or minus 200.

16                  MS. GHOSH: Can I just clarify --

17                  MEMBER POWERS: I think they're centered  
18 around PHEBUS.

19                  MEMBER REMPE: The report indicates that  
20 they've centered a lot on VERCORS.

21                  MS. GHOSH: That's true, but I do want to  
22 clarify --

23                  MEMBER POWERS: VERCORS didn't involve any  
24 relocation at all.

25                  MEMBER REMPE: It's their eutectic melt

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1 temperature, and that's what they based it on.

2 MS. GHOSH: I just want to clarify that 83  
3 is the standard deviation.

4 MEMBER REMPE: Right.

5 MS. GHOSH: So, our bound's actually go up  
6 to 200-plus, up and above. You just have less samples  
7 in that area.

8 MEMBER REMPE: Right. But I think an  
9 uncertainty would be worthwhile to explore.

10 MEMBER POWERS: I don't understand at all  
11 now. If the sigma is 83, then 3 sigma is huge.

12 MEMBER REMPE: I don't think we ever got  
13 up to that Figure. What was the little red dot?

14 Was it 2800 or something, and you never  
15 had any sampling up there at all?

16 MEMBER POWERS: The 3 sigma would...

17 CHAIR STETKAR: But again --

18 MEMBER POWERS: ...violate the --

19 CHAIR STETKAR: Please.

20 MEMBER POWERS: -- annihilate the  
21 molybdenum issue, annihilate everything.

22 CHAIR STETKAR: This is an Uncertainty  
23 Analysis, and if believe the uncertainty distribution,  
24 if you get a small number of samples out in that tail,  
25 you get a small number of samples out in that tail.

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1           As you should, if you believe the  
2           distribution.

3           MEMBER REMPE: But then the conclusions on  
4           the Regression Analysis are that the temperature is  
5           very important, that it affects hydrogen, and  
6           eventually, it becomes pretty important in the follow-  
7           on documentation.

8           And that's why I am emphasizing it.

9           MEMBER POWERS: I guess I'm still at a  
10          loss that you concluded it's important.

11          MEMBER REMPE: But the models are --

12          CHAIR STETKAR: Well, it is important.  
13          Tina, I don't remember your Regression Analysis. I  
14          mean, it showed up in the mix.

15          Was it very important?

16          MS. GHOSH: The eutectic melt temperature  
17          is clearly very important for hydrogen generation.  
18          We've see that in all the studies.

19          It shows up in combination with other  
20          variables for things like cesium release.

21          So, it's got high interaction effects,  
22          again, for obvious reasons, because it has a big role  
23          to play in the hydrogen generation, which then affects  
24          early containment failure, et cetera, et cetera.

25          MEMBER POWERS: Also, I would think that

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1 the analyses of transport wouldn't mediate the  
2 importance of fuel relocation on cesium release to the  
3 containment.

4 Just because cesium escapes from the fuel  
5 does not ipso facto mean that it goes into the  
6 containment.

7 There are a lot of slips towards the cup  
8 in the lip on that, and the uncertainties inherent in  
9 that transport process might work to mitigate the  
10 importance of fuel relocation.

11 Fuel relocation is very important for  
12 hydrogen because you cook things for a long time, and  
13 that does give you high cesium releases from the fuel,  
14 but doesn't necessarily affect the transport process.

15 So, it doesn't lead -- there's not a one-  
16 to-one correspondence between every location, and  
17 cesium release, just because of the transport process.

18 And quite frankly, you're putting a lot of  
19 heat in the fuel and you haven't got heat to put into  
20 the piping system. So, you end up with a cool piping  
21 system which leads to high deposition rates.

22 MR. WAGNER: Our volatiles are pretty  
23 close to 100 percent release.

24 MEMBER POWERS: You can't get --

25 (Simultaneous Speaking.)

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1                   MEMBER POWERS: That's released from the  
2 fuel, but it's not released into the containment.

3                   MR. WAGNER: Right.

4                   So, over most of these cases, we do get  
5 the volatiles out, but maybe I misspoke that our  
6 releases might change a lot.

7                   Our hydrogen could change and that has  
8 dramatic effects, but maybe not so much what gets off  
9 the fuel.

10                  The release coefficients that we have from  
11 the fuel, but most of the volatiles come off.

12                  MEMBER REMPE: I'll have to look where I  
13 saw it, but I think there's a discussion somewhere on  
14 the report that does kind of have a different  
15 perspective.

16                  But the higher relocation temperatures  
17 would increase the releases from the fuels somewhere.  
18 And I'd have to find where it is, but that may be  
19 something to look for.

20                  DR. HATHAWAY: Okay, so I'm just sort of  
21 moving to the Consequence Analysis.

22                  We took all of the source terms that were  
23 run to 72 hours, and we put them in the uncertain  
24 MACCS model of the site to see what the latent cancer  
25 fatality risk for the zero to ten-mile interval.

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1                   And again, as in the full study, these are  
2 conditional on the occurrence of the assumed --

3                   CHAIR STETKAR:   Trey, I want to make sure  
4 I understand both of these tables, but 11 is the one I  
5 want to understand.

6                   These results, to me, mirror the results  
7 in the baseline study, which is encouraging in the  
8 sense that you're showing a bimodal effect on the  
9 conditional risk, the way the dots on the lower left  
10 are clustered.

11                   And the numerical ranges are similar.

12                   The difference is that the first column in  
13 11 that you called really Containment Rupture is a  
14 subset of the scenarios in Figure -- I'll give you the  
15 Figure number -- 6.1 and 6.3 -- so that the right-hand  
16 side of those Figures, the 87 percent that goes to  
17 early containment failure.

18                   The first column in this table is a subset  
19 of them, right?

20                   The second column, the thing that's called  
21 late containment rupture, is a combination of so-  
22 called late containment failures that are also in the  
23 right-hand side of those figures in Chapter 6.

24                   And the small set that never go to  
25 containment failure which is the far left-hand side,

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1 where the risks are really, really small, the other  
2 mode of that bimodal behavior.

3 And therefore, comparing the numbers in  
4 this table to numbers that appear in other sections of  
5 the report is a little bit misleading. I mean, you  
6 really have to kind of look through that stuff.

7 I was surprised that you didn't cast these  
8 results in the same way as the results in Chapter 6,  
9 so you could see that, yes, when we turned up the  
10 microscope in this area, we basically got the same  
11 shape, we got the same fractions in the bimodal, and  
12 roughly the same ranges in the conditional latent  
13 cancer fatality risk, coming through the zero to ten-  
14 mile snapshot here.

15 You can kind of see it from this, but you  
16 really have to, I think you really have to, study it.

17 Have I mischaracterized anything, Tina? I  
18 mean, you're really familiar with all of those curves.

19 MS. GHOSH: I think it's a good comment  
20 and we can supplement the --

21 CHAIR STETKAR: I mean, basically, on the  
22 Figure on the lower left, if I take a horizontal slice  
23 in that Figure at about 1e to the -6, everything above  
24 that horizontal slice, is what's on I'll call it the  
25 right-hand side of the Figures in Chapter 6.

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1 Everything below the horizontal slice is on the  
2 left-hand side of those Figures approximately, right?

3 I just want to make sure that I got it.

4 MS. GHOSH: Yes, I think that's right.  
5 These results are spread out a little bit more.

6 CHAIR STETKAR: Oh, yes, they're going to  
7 be spread out a little bit just because what you did  
8 here. But in the big-picture concept --

9 MS. GHOSH: Yes, I think that's a good  
10 idea. We can add a paragraph to compare back to the -  
11 -

12 CHAIR STETKAR: Because I like what you  
13 did in Chapter 6, by the way.

14 We talked about that bimodal behavior, and  
15 then you split it out to more explicitly show -- and I  
16 really liked that, that kind of -- emphasize some of  
17 the points you were trying to make in the text.

18 And you can draw the same conclusions from  
19 this but it's a lot more difficult. I mean, you have  
20 to really study this. Okay.

21 DR. HATHAWAY: Okay, I probably won't  
22 dwell much on this.

23 The top table just is the sort of  
24 statistics on the total risk where the bottom is sort  
25 of statistics but looking at the emergency-phase

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1 contribution, and the long-term phase and  
2 intermediate-phase contribution individually.

3 So, finally, because we had more of these  
4 early containment ruptures, we were interested in the  
5 early fatality risk.

6 Previously, we only had four realizations  
7 that had early fatality. So, we just looked at these  
8 results. Past four miles, there was zero calculated  
9 early fatality risk.

10 And here are just the statistics, and  
11 again, this is a conditional long-term event  
12 occurring.

13 And what we tried to do, and this sort of  
14 all is dependent on the discussions from earlier, but  
15 we tried to scale these results to consider the full  
16 distribution because everything outside of this  
17 parameter space would be to zero.

18 So, we tried to just scale it out to  
19 consider the entire distribution, and that's what that  
20 second column is.

21 It would be what the risk would  
22 potentially be if you were to essentially add a lot of  
23 cases that had late containment.

24 CHAIR STETKAR: A comment on Chapter I  
25 think it's 6, where these similar tabulations are

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1 shown.

2 It would help a lot of people to provide a  
3 little bit more of a tutorial in that section about  
4 how one can have a mean value that's something on the  
5 order of ten to the minus, I don't know, small number,  
6 eight, or whatever those numbers are, nine.

7 And yet, have precisely zero values for  
8 the median 5th and 95th percentile.

9 The only reason I dwell on that is that  
10 people who use very broad and very skewed  
11 distributions routinely understand that.

12 Not necessarily everyone who reads this  
13 study will have that level of understanding, and a  
14 little bit of a tutorial will help to those folks to  
15 not get the impression that this is simply some sort  
16 of statistical mumbo-jumbo that has no basis in  
17 reality, kind of anchoring them back to say that, yes,  
18 I can get 95 percent of my samples to have precisely  
19 zero, and yet, the mean value can still be non-zero.  
20 And show them why that is.

21 Otherwise, the naysayers will say, well,  
22 obviously, this is just statistics and numbers and  
23 numbers games.

24 So, I think that would help in Chapter 6.  
25 Here also, but here, at least, most of them, the 95th

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1 percentile is above the mean, and that's reassuring to  
2 a lot of people.

3 DR. HATHAWAY: So, that was all I was  
4 going to cover in this.

5 CHAIR STETKAR: We're at a break time  
6 here. No, any more questions, first of all, on  
7 Appendix I? Because we're going to shift gears here  
8 entirely.

9 If not, let's take a break, and I'm going  
10 to try to hold us to ten minutes. I'll probably fail  
11 but try to get back here by 10:20; we'll recess until  
12 then.

13 (Whereupon, the above-entitled matter went  
14 off the record at 10:08 a.m. and resumed at 10:21  
15 a.m.)

16 CHAIR STETKAR: We're back in session. We  
17 are back in session. Trey, Tina, I don't know, it  
18 says Casey. Anybody?

19 MEMBER BLEY: I don't know when to ask the  
20 -- thank you. I don't know when to ask this, but I'm  
21 going to ask it now, as we move into more general  
22 things. Sure.

23 (Laughter.)

24 MEMBER BLEY: But it's kind of the same  
25 cast of characters here and who we meet in the Level 3

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1 PRA work. And over in the Level 3 PRA work, I think  
2 we've learned that some of the things you're doing in  
3 SOARCA aren't making its way over there, because it's  
4 not state of the practice.

5 But something comes up over there, I'm  
6 curious about it, and over there, in our recent review  
7 of the Level 2 PRA, I find a whole section of their  
8 report on model uncertainties that's really pretty  
9 thoroughly laid out, at least the thinking of things  
10 that might not work the way we expect them to work and  
11 ways that they might consider them in the report.

12 I don't find anything quite as thorough, I  
13 mean, you do a tremendous job on the parametric  
14 uncertainties, but a few sensitivity studies that are  
15 kind of picked here and there, but nothing as  
16 systematically thorough, of saying, where could there  
17 be things about the model that aren't right, that I  
18 see in this new part of the Level 3 PRA.

19 Have you thought about that? And probably  
20 the work you've done here led to how that evolved, but  
21 I would sure like to see it here. It seems that part  
22 of the uncertainty analysis that we've always kind of  
23 talked about and never gone very far on over here.

24 MR. FULLER: Yes. So, Dennis,  
25 unfortunately, Don and Hossein, who were, along with

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1       myself --

2                   MEMBER BLEY: They were here all morning.

3                   MR. FULLER: They just walked in and they  
4 missed your whole question.

5                   (Laughter.)

6                   MEMBER BLEY: You want them to handle it,  
7 you don't want to handle it.

8                   MR. FULLER: So, what I will say is this,  
9 the team that worked on that document and that work,  
10 obviously Don Helton is the lead for all of that.

11                  MEMBER BLEY: Right.

12                  MR. FULLER: It's the same team, so you  
13 could say that --

14                  MEMBER BLEY: It kind of seemed that way to  
15 me.

16                  MR. FULLER: Yes. So, the portion of the  
17 SOARCA team that's been thinking about, we kind of  
18 focused our efforts in supporting Don in the Level 3  
19 PRA study for that more systematic thinking. And, of  
20 course, the scope is much broader for the Level 3 PRA.

21                  MEMBER BLEY: It is, but --

22                  MR. FULLER: Yes.

23                  MEMBER BLEY: -- SOARCA makes a claim that,  
24 one, it finally acknowledges that it isn't a risk  
25 assessment and you pick out particular scenarios. But

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1 then you do a thorough consequence analysis and now,  
2 you've added to that a thorough uncertainty analysis.

3 And, in fact, the parametric uncertainties  
4 affect the results substantially, and we see that.  
5 But the potential of the modeling uncertainty is to  
6 overwhelm what we see in the parametric uncertainties  
7 has always been an issue and we've talked about it  
8 occasionally.

9 But this new part of the Level 3 PRA on  
10 model uncertainties and the Level 2 analysis is the  
11 first attempt at being thorough in a qualitative  
12 examination of the things that might affect it.

13 It seems to me that at least some  
14 acknowledgment of that approach and that it hasn't  
15 been done in the SOARCA analysis would add to the  
16 comfort level of people who have been uncomfortable  
17 with SOARCA to this point.

18 MR. FULLER: I think -- thank you for that  
19 comment. I think it's a good comment and we can  
20 certainly add pointers to that work in our executive  
21 summary and the introduction and when we talk about  
22 the scope of our work being limited to the parameter  
23 uncertainty.

24 We can certainly refer to that work as an  
25 example of more thorough, at least qualitative

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1 thinking through of all the modeling uncertainties  
2 that we're not explicitly addressing.

3 MEMBER BLEY: And that's the first step.  
4 Eventually, one would like to be quantitative about  
5 it, but in SOARCA, we haven't even been qualitative  
6 about it, in a thorough way.

7 MR. FULLER: Okay. Yes, thanks for the  
8 comment. And I see Don is at the mic.

9 MR. HELTON: I just want to -- Don Helton,  
10 Office of Nuclear Regulatory Research. I do just want  
11 to point out, though, that that work is non-public and  
12 will remain non-public for, at least the current plan,  
13 well after this document would be finalized. So,  
14 there is --

15 MEMBER BLEY: The engineering thinking --

16 MR. HELTON: -- a challenge there.

17 MEMBER BLEY: -- beyond it has been around  
18 a long time. The application hasn't. And --

19 MR. HELTON: Yes, I mean, it can certainly  
20 --

21 MEMBER BLEY: -- maybe I shouldn't have  
22 mentioned it, because that is not --

23 MR. HELTON: No, I'm not worried about you  
24 mentioning it and it can be described from a  
25 conceptual standpoint as what was done.

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1 MEMBER BLEY: That's what I'm after.

2 MR. HELTON: I'm just reacting to the idea  
3 that it's --

4 MEMBER BLEY: To have a pointer to it.

5 MR. HELTON: -- it can be cross-referenced  
6 --

7 MEMBER BLEY: Yes.

8 MR. HELTON: -- and that just presents some  
9 challenges, that I'm sure we can work through. But --  
10 I don't know.

11 MR. WAGNER: Casey Wagner, Dycoda. So, I'm  
12 going to go through, not all, but we thoroughly went  
13 through the comments from the last meeting and I'm  
14 going to address some of the highlights of the more  
15 important ones and how we addressed them.

16 So, we're on the first slide here. First  
17 one had to do with the fabric seal failure criteria.  
18 And we had a range of different types of comments that  
19 were relatively extensive discussion on that.

20 And they concerned the error itself, a  
21 confusing description of the failure parameter, and  
22 then, there was also some questions about how we were  
23 handling the seal failure error. We tried to address  
24 these by adding new documentation to the next version  
25 of the report.

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1           And in particular, we did a little bit  
2 more work on the impact of the fabric seal on early  
3 containment failure. And added some new text in  
4 there. In particular, the flow through the ice chest  
5 and the other leakage pathways allowed hydrogen to  
6 move around, whether that seal had failed or not.

7           So, there were other mechanisms for, over  
8 the time frames that we were looking at, that hydrogen  
9 could be moving throughout the containment. So,  
10 certainly, if the seal had failed, which with the  
11 error introduced, it failing more early, it flowed a  
12 little bit more thoroughly.

13           But nevertheless, there was other leakage  
14 paths that allowed that to occur. And so, there's  
15 some discussion about that. In particular, the  
16 focused value study had many cases and in all those  
17 calculations, the fabric seal had been corrected.

18           And so, we looked at the response of those  
19 and tried to compare that to the UA calculations and  
20 drew conclusions that the responses were similar on  
21 key metrics.

22           And then, finally, Hossein had presented  
23 last meeting a comparison to the 2016 UA results,  
24 which did have the correct -- well, it had a different  
25 distribution on the fabric seal failure, but it was

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1 not prone to failing early. And that discussion is  
2 also in there.

3 CHAIR STETKAR: Casey, when I read that,  
4 and I -- the discussion of this issue, by the way, is  
5 much, much improved. But I know nothing about the  
6 physics, but I thought that in the current study, when  
7 you looked at the limited cases that you ran for long-  
8 term, that you saw some -- I think a couple of those  
9 kind of transitioned to an early containment failure.

10 So, the question that I had is, how  
11 significant is that in the context of the full study?

12 I mean, what fraction -- if you had the corrected  
13 model in all 600 realizations in the real study, do  
14 you expect a similar number to transition to early  
15 containment failure?

16 Because we're not finding many early  
17 containment failures, so, like two or three can double  
18 the number that we've seen. And I think I understand  
19 why that's happening, but I'm trying to get a sense of  
20 looking at the full spectrum of the baseline study.

21 You only ran a small number of these long-  
22 term or late containment failure scenarios, right? In  
23 the --

24 MR. WAGNER: Yes.

25 CHAIR STETKAR: -- focus study, there's --

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1 MR. WAGNER: Yes.

2 CHAIR STETKAR: -- about 18 or 20 or  
3 something like that, that you ran, to examine it.

4 MR. WAGNER: Right. If you combine that  
5 with the 2016 calculations that had a more robust seal  
6 --

7 CHAIR STETKAR: But a different --

8 MR. WAGNER: Yes, it's --

9 CHAIR STETKAR: The reason why I dislike  
10 this notion of the comparisons is that the uncertainty  
11 difference -- the differences on the uncertainty  
12 distributions make a difference.

13 MR. WAGNER: They do, yes.

14 CHAIR STETKAR: So, you have to kind of  
15 focus in the regime of the 2016 study, where --

16 MR. WAGNER: This was about a -- in the  
17 couple cases I looked at, it was about a two to three  
18 PSI difference if the seal was there during a burn  
19 that was -- the ones that flipped over --

20 CHAIR STETKAR: Before the --

21 MR. WAGNER: -- that were just below the  
22 failure pressure and if the seal was intact, it was  
23 just above.

24 CHAIR STETKAR: Okay.

25 MR. WAGNER: And so, you had to be very

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1 close. So, we judged --

2 CHAIR STETKAR: Yes, but I was going to  
3 say, but there are two. If I ran an infinite number  
4 of samples in the baseline study, such that you had  
5 the full distribution for everything, I'm trying to  
6 pulse what fraction, a guesstimate. Is it one  
7 percent, ten percent --

8 MR. WAGNER: Okay.

9 CHAIR STETKAR: -- half of a percent might  
10 transition?

11 MR. WAGNER: I certainly can't answer --

12 CHAIR STETKAR: Yes, okay.

13 MR. WAGNER: -- the percentage, but this  
14 plot might be kind of useful. So, we're looking at --  
15 and unfortunately, the blue ones have the corrected  
16 seal behavior --

17 CHAIR STETKAR: Yes.

18 MR. WAGNER: -- versus the purple. But the  
19 purple ones that are within a couple PSI could have  
20 flipped over. So, I see maybe two there.

21 CHAIR STETKAR: And --

22 MR. WAGNER: I think that --

23 CHAIR STETKAR: But, again, they're -- when  
24 you say within a couple PSI, you're still limited by  
25 the number of samples from both the failure pressure

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1 distribution.

2 And, if you're not hitting many samples,  
3 that could either be fortuitous or -- I mean, you  
4 would expect those samples to be somewhere in the  
5 middle of the distribution, if there's only a small  
6 number of samples, right?

7 MR. FULLER: Yes, so, I guess just --

8 CHAIR STETKAR: The containment failure  
9 probability --

10 MR. FULLER: Right.

11 CHAIR STETKAR: -- distribution is what I'm  
12 talking about.

13 MR. FULLER: Right. So, if we get back to  
14 -- so, the focused study was looking at the range  
15 where you could have an early containment failure.  
16 So, you saw in 80-some percentage, it still went to  
17 the late containment failure versus the early. And  
18 what gives us some confidence -- and all of those have  
19 the fabric seal failure criteria fixed.

20 So, what gives us some confidence is that,  
21 in those realizations, the 360-something, with the  
22 fixed seal pressure, we still saw the same, roughly  
23 the same percentage of those cases where it's  
24 possible, actually going to early containment failure.

25 So, that's what -- that's kind of where we're --

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1 CHAIR STETKAR: That might, yes, that might  
2 be reassuring. I have to think about it that way,  
3 thanks. Thanks.

4 MR. WAGNER: I verbally gave you some  
5 information on late containment failure, because in  
6 the last set of documentation in June, you didn't have  
7 that and so, I documented that.

8 The Committee expressed some confusion on  
9 this parameter in general, because there was a thermal  
10 part and then, there was sampling. And so, that was  
11 rewritten and hopefully, that's much clearer now. And  
12 --

13 CHAIR STETKAR: On the record, it is.

14 MR. WAGNER: Great, great. It was a good  
15 comment and I'm glad we could improve the  
16 documentation. And then, there was also some  
17 questions about the seal failure area related to that  
18 comment, because we have some where it's sort of a  
19 cold mechanical failure and then, some where there's a  
20 thermal presence that's maybe more widespread and  
21 maybe that should have a different failure area.

22 And we hadn't thought about that and that  
23 was -- it was good that it was pointed out. It wasn't  
24 a controlling factor on flow, if you look at the K  
25 over A-squared and you look at the thermal hydraulic

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1 resistance, even the small holes that we were sampling  
2 allowed a pretty robust natural circulation to occur.

3 So, we concurred that that probably was  
4 likely, that there's maybe a wider, larger area that  
5 we should use, but it wouldn't impact the results, was  
6 my engineering judgment.

7 And then, if you look at the seal, it  
8 winds around the nooks and some of it's well-shielded  
9 from thermal radiation effects. And so, depending on  
10 where the fireball was, it -- there certainly is some  
11 uncertainty on what parts would be affected.

12 Next slide. The ice condenser doors, and  
13 we're going to call this AJAR parameter. The AJAR  
14 parameter in context of the next couple of bullets, is  
15 whether we fully opened up the doors to form the  
16 hinges somehow and they stuck open. We satisfied that  
17 criteria.

18 CHAIR STETKAR: Casey, just for the benefit  
19 of everybody else, make sure, these are the lower  
20 condense inlet doors?

21 MR. WAGNER: That's right.

22 CHAIR STETKAR: Okay.

23 MR. WAGNER: Exactly. And that's the only  
24 place we had done the sampling, because we thought  
25 those were by far the most important. And just a

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1 little background, those are modeled with five MELCOR  
2 flow paths, representing, I think it's about 20 doors.

3 They take about 46 pascals to fully open,  
4 so it's not a lot of pressure, but surprisingly, that  
5 took a bit of a pressure pulse in order to open them,  
6 all of them, because they open up such a large flow  
7 area, about ten square meters each. And so, you get  
8 these opening up and they start relieving a lot of  
9 pressure.

10 And the general comment was, we didn't  
11 have much discussion about how they behaved. We had  
12 the sample parameter, so we added discussion about how  
13 the valves or how the doors behaved and FSEM plots and  
14 tried to look at a range of different responses.

15 Where we might have had a hydrogen burn  
16 early, prior, due to the PRT, one that might have been  
17 delayed until hot leg failure. And then, one where  
18 there wasn't even enough hydrogen there, we had hot  
19 leg failure and looked at the response.

20 And the interesting thing that we also  
21 got, Trey was able to dig out a few more diagnostics  
22 out of his study, was that if we had a hot leg  
23 failure, we almost got 100 percent, all five doors  
24 sticking open.

25 So, that pressurization from the hot leg

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1 failure was enough. The pressurization from the PRT  
2 wasn't. And that is just a smaller tank, that's  
3 blowing down.

4 And even though I can imagine that's  
5 pretty violent down there, it was triggering some of  
6 the doors sticking all the way open, but not all of  
7 them. And in general, I call that a partial AJAR,  
8 because it's not all five MELCOR flow paths fully  
9 jammed open.

10 And so, we were able to get some really  
11 interesting insights, digging into the door behavior a  
12 little bit more. It's all documented in the report.  
13 We talked a bit about ACRS member comment on or it  
14 came up that -- we talk about burn direction, inside  
15 the report.

16 And we have known ignition sources and you  
17 said, we know the geometry, we know where they're  
18 located, does it make sense that we are randomly  
19 sampling the direction? That made maybe more sense  
20 when we had the random sampling, a couple studies ago.

21 And I'm going to try and make a  
22 distinction to you that, although we know the location  
23 of those ignition sources, they're coming from the hot  
24 leg or the PRT or from the ex-vessel debris, the  
25 distinction I want to make is where the ignition

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1 actually takes place may be a little ways away from  
2 there and elsewhere inside the compartment, because of  
3 the hot plume has to come out and it's got to mix with  
4 some oxygen.

5 It's coming out as just pure hydrogen and  
6 steam and that's not combustible until it mixes and  
7 maybe ends up in different locations. And so, there  
8 are -- or it's aerosols and hot things coming out of  
9 the ex-vessel debris. And so, we were -- we  
10 recognized the point that you were trying to make, but  
11 we felt like there is still uncertainty where ignition  
12 takes place.

13 And then, we kind of go one step further,  
14 recognizing the comment that you had is that, let me  
15 just read that last line, identifies the flame  
16 directions as it propagates within the compartments as  
17 surrogates for uncertainties in the ignition location.

18 So --

19 MEMBER CORRADINI: So, I interpret that to  
20 mean you didn't change anything?

21 MR. WAGNER: We didn't change the words  
22 that we used. The upward, horizontal, and downward is  
23 pervasive through the document. And we tried to give  
24 some motivation that there's some uncertainty on where  
25 it was located.

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1 CHAIR STETKAR: They -- as I read it, you  
2 changed nothing in the model --

3 MEMBER CORRADINI: Right.

4 CHAIR STETKAR: -- you added some words in  
5 the text to --

6 MEMBER CORRADINI: Justify what you're  
7 doing.

8 CHAIR STETKAR: -- impart this notion of  
9 perhaps a more randomization of the ignition location,  
10 despite the fact that you had three nominal point  
11 sources.

12 MR. WAGNER: We --

13 CHAIR STETKAR: Is that -- that's what I  
14 kind of hear you saying this morning, that --

15 MR. WAGNER: Yes, the --

16 MEMBER CORRADINI: I --

17 MR. WAGNER: -- that --

18 MEMBER CORRADINI: I'm sorry.

19 MR. WAGNER: Go ahead.

20 MEMBER CORRADINI: No, you finish, I'm  
21 sorry.

22 MR. WAGNER: We understood, we could --  
23 that was, I think, Mike's comment at the time. We  
24 know where these things are, shouldn't we -- but  
25 that's where the hot gas leaves from. And then, it

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1 isn't ignited yet, it's -- you have to have adequate  
2 oxygen, adequate hydrogen, and you have to have that  
3 mixing and the source, the high temperature, in order  
4 for it to ignite. And so --

5 MEMBER CORRADINI: But -- okay. So, I'm  
6 not going to -- I mean, I don't think this is -- well,  
7 I don't know if this is a big effect, it may not be a  
8 big effect.

9 But in my simple mind, if I know where  
10 it's coming out and I know the geometry, and we're  
11 talking about a specific reactor, then I'm going to  
12 essentially entrain the constituents so that I could  
13 estimate when I'm going to get the right concentration  
14 and, therefore, decide whether it's up, down, or  
15 sideways, versus letting it be just a casting.

16 So, that's kind of the source of my --  
17 right? If I'm dumping it out from hot gas to the hot  
18 leg, then I know how it's going to, not know, but I  
19 can, from an engineering judgment standpoint, decide  
20 how it's going to mix.

21 I'm -- I seem to remember, my memory is  
22 not so good, I seem to remember, I was just very  
23 confused about the directionality issue. And it just  
24 seems to add confusion, particularly when you know  
25 where it's coming.

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1                   So, I'll ask it a different way. Did you  
2 do a side calculation to confirm that it didn't make a  
3 big effect or was nothing done calculational, you just  
4 re-explained it? Re-rationalized it, excuse my  
5 English.

6                   MR. WAGNER: It was the later.

7                   MEMBER CORRADINI: Okay.

8                   MR. WAGNER: It's coming out at sonic  
9 speeds, it's not combustible, what's leading --

10                  MEMBER CORRADINI: Well, I mean, there's an  
11 old study -- so, I only remember things that are old.  
12       There was a study about 35 years ago from Spalding,  
13 which has a very set of simple experiments of a gas  
14 jet, whether it's a light gas or a heavy gas, he does  
15 everything.

16                  And he basically does a very beautiful way  
17 of showing how far down the pathway, how the  
18 concentrations mixed with something, and you can use  
19 Spalding's study as a way to estimate, if I have the  
20 hot debris coming up PRT, it's so many L over Ds and,  
21 by God, that's where it's going to go and it's going  
22 to propagate in that direction and then, we're done.

23                  MR. WAGNER: Yes.

24                  MEMBER CORRADINI: Versus doing it  
25 stochastically. That's kind of what was going through

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1 my mind.

2 MR. WAGNER: Yes. Our dominate source is  
3 the hot leg failure, which we have a lot of  
4 uncertainty on --

5 MEMBER CORRADINI: Where it's going to  
6 happen.

7 MR. WAGNER: -- the working -- and the PRT,  
8 I think that probably makes more sense on. But most  
9 of our ignitions came from the hot leg. And then, the  
10 cavity is a little bit different animal, because it's  
11 hot debris --

12 MEMBER CORRADINI: I think --

13 MR. WAGNER: -- it's kind of closed up --

14 MEMBER CORRADINI: -- the reason I focused  
15 on this is, I have to admit, I still don't understand  
16 the logic of the directionality. Maybe other people  
17 do.

18 CHAIR STETKAR: I thought it got it when we  
19 had a uniformly distributed set of random ignition  
20 sources.

21 MEMBER CORRADINI: Because then they --

22 CHAIR STETKAR: Because they could --

23 MEMBER CORRADINI: -- can go anywhere in  
24 the volume.

25 CHAIR STETKAR: -- go anywhere in the

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1 volume.

2 MEMBER CORRADINI: But when I know where it  
3 is in the volume, it seems to me, I've narrowed my  
4 possibilities. That's, in my --

5 CHAIR STETKAR: I think the truth is,  
6 there's still uncertainty, but it, in my opinion, it's  
7 much more constrained. It ought to be much more  
8 constrained in the current model. But what you said  
9 earlier, does the difference -- would it make a  
10 difference? I can't, I certainly can't answer that  
11 question, I have no idea. I have absolutely no idea.

12 MEMBER CORRADINI: I mean, I know you have  
13 -- sorry, my green light's on. I know you have  
14 limited resources and the uncertainty study is fairly  
15 complex, but I guess a side calculation, just to  
16 verify that directionality doesn't make a big  
17 difference once I have the known location of the  
18 source, would be an interesting way to kill this guy  
19 off. And I see we have a helper.

20 MR. ESMAILI: Let me -- well, I don't know.

21 CHAIR STETKAR: Hossein? Identify yourself  
22 first.

23 MR. ESMAILI: Let me --

24 CHAIR STETKAR: Hossein? We don't know  
25 you.

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1 MR. ESMAILI: Oh, okay. Hossein Esmaili --

2 CHAIR STETKAR: Thank you.

3 MR. ESMAILI: -- Office of Nuclear  
4 Regulatory Research. So, I hope I'm not going to  
5 confuse you further. That's why we wrote down here,  
6 the location of ignition within the compartment. So,  
7 in other words, this is tied to the flammability  
8 limit.

9 So, we have this control volume, and you  
10 can shake your head if I'm going in the right  
11 direction or not, so, we have this control volume,  
12 right? Hot gases are coming from one source, right?  
13 I don't know whether my flame -- the way we are  
14 modeling it, we are modeling it as a flame, right?

15 Propagating either, within this control  
16 volume, not going to other control volume, whether  
17 it's going to go down, going sideways, or going  
18 upwards, right? So, this is one way of capturing  
19 where that flame is going to propagate from and  
20 whether I have satisfied my flammability criteria.

21 Typically, what we do is that, by default,  
22 in medical, for example, we say, if in a control  
23 volume, if you have more than ten percent hydrogen and  
24 other flammabilities are satisfied, then you have  
25 ignition. Or if the ignitor is available, it's seven

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1 percent.

2 Here, we don't know, because we don't know  
3 how this gas, as they are coming out of this hot leg  
4 or as they are going upwards, they are mixing within  
5 that control volume, so I don't know exactly where  
6 that flame front is propagating from.

7 So, this is not only the location of the  
8 ignition sources, but it's tied to how I am doing the  
9 flammability limit within that control volume. This  
10 is not propagating from this control volume to that  
11 control volume. That one, we know already.

12 MEMBER CORRADINI: Okay. So, within the  
13 volume, we're speaking?

14 MR. ESMAILI: Within the volume, we're  
15 speaking. So, as Casey said, this gases are coming up  
16 right at the location where the hot leg is or where  
17 the PRT is, that does not -- that may not satisfy the  
18 flammability limit, because he says that it is mostly  
19 hydrogen and steam. It has to mix with this volume.

20 And we are working within a control volume  
21 approach, right? So, what we really do is that, we  
22 are, in the control volume, we are trying to model a  
23 flame that propagates in that control volume and for  
24 that, we are just changing the ten percent to four  
25 percent, six percent, nine percent, because we don't

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1 know where it occurs. Did I --

2 MR. WAGNER: Yes. It originally went back  
3 to the Kumar data and if you ignite at ten percent, it  
4 can go downward. If you ignite at seven percent, it  
5 can go sideways and upward. And if you ignite at four  
6 percent, it only -- you're the expert, you can --

7 (Laughter.)

8 MEMBER POWERS: I simply relate an example  
9 I have actually used in a class I taught, where having  
10 explained how well we know these ignition directions  
11 and whatnot. That at 12 percent, you get kind of a  
12 uniform expansion of a flame. At nine percent, it has  
13 a tendency to go up. At seven percent, it has a  
14 profound tendency to go up.

15 And then, I show an example of a seven  
16 percent ignition and it does exactly as I said, the  
17 flame propagates upwards. Everybody watches and  
18 amazed that I'm so accurate in my prognostications.  
19 And promptly, the flame comes down. And it's because  
20 the gas gets heated up and pressurized.

21 Directionality of flame once it's ignited  
22 is an extremely complicated thing to model and doing  
23 it in a lump node code, where you've got all kinds of  
24 structures actually there, that are vacuous in the  
25 code, it seems to me to be braver than I am at these

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1 things, especially when you're talking about  
2 relatively lean flames.

3 It -- directionality is easy and  
4 reasonably concentrated, where reasonably concentrated  
5 is like ten to 11 percent. Once you get down to lean,  
6 around seven, it's going to depend on things other  
7 than just the concentration of the hydrogen in there,  
8 everything else is going to make a difference, too.

9 MR. ESMAILI: This is Hossein Esmaili,  
10 again, from Office of Research. One thing we want to  
11 make clear is that, when we say within the  
12 compartment, we don't mean every compartment that we  
13 model.

14 This one, we only imposed this in the  
15 lower compartment region, correct, Casey? Because  
16 that is where the location of the hot leg is. So,  
17 this only means that we do this uncertainty in the  
18 lower compartment, this control. So, the other  
19 compartments are still allowed to propagate. So, yes,  
20 this was another --

21 MR. WAGNER: Yes. That's a good point to  
22 be made. After we ignite it, in some ways, you could  
23 look at this as surveying a range of ignition  
24 strengths and that first place that it ignites. And  
25 then, it will propagate according to the default

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1 criteria, which uses Kumar also. I understand your  
2 point, Mike.

3 MR. FULLER: Okay. So, we'll move on to  
4 the next one. I don't know about you all, but after  
5 the last few years of struggling with the safety valve  
6 modeling, every time I see those words together,  
7 safety valve, I have this sense of dissatisfaction  
8 deep inside my core.

9 But we took your comments from the last  
10 Subcommittee meeting and we tried to address them as  
11 best we could. Oh, you missed my -- dissatisfaction  
12 deep in my core, every time I see those words  
13 together, safety valves.

14 (Laughter.)

15 MR. FULLER: But we're trying, we keep  
16 trying.

17 CHAIR STETKAR: You're very trying.

18 MEMBER POWERS: You're an obsessive-  
19 compulsive, that's all there is to it.

20 MR. FULLER: You're right, it takes a  
21 certain amount of OCD to keep going and soldiering on.  
22 We keep trying.

23 (Laughter.)

24 MEMBER POWERS: This is a psychosis that  
25 can be treated.

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1 CHAIR STETKAR: Tina?

2 MR. FULLER: Yes?

3 CHAIR STETKAR: In all seriousness --

4 MR. FULLER: Yes.

5 CHAIR STETKAR: -- I'm really disappointed.

6 I mean, I'm really, really disappointed. I asked, in  
7 June, a simple question. In June, we said, well, we  
8 had this data -- I'm sorry, I'm not even going to call  
9 it data anymore. We had these numbers from NUREG/CR-  
10 7037.

11 MR. FULLER: Yes.

12 CHAIR STETKAR: Those numbers are 15  
13 failures in a total of 769 demands. That's all it's  
14 in. Then, you said, well, okay, NUREG/CR-7037 only  
15 goes up through September of 2007, so, gee, we went  
16 back to see what more recent experience is.

17 So, we looked at experience from October  
18 of 2007 through March 2016 and, lo and behold, we come  
19 up now with 16 failures, one more failure, in a total  
20 of -- I have to look up my numbers here, so that  
21 they're on the record. I can't find them and I'm not  
22 going to waste my time. A total of 75 more demands,  
23 which you've subdivided into initial demands and  
24 subsequent demands.

25 So, my question in June was, tell me how

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1 you estimated the additional 75 demands and where the  
2 additional failure came from, because that, at least,  
3 was done by people who are still living today and  
4 perhaps have a memory, and probably documented what  
5 they did, so that we could understand, at least from  
6 that snapshot, the thought process.

7 That does not at all come through in the  
8 current report. In the current report, all it says  
9 is, we needed to use engineering judgment and, yes,  
10 there's still a lot of uncertainty on what the failure  
11 rate should be. That's all it says. That's all it  
12 says.

13 So, the report does not answer any of my  
14 questions. So, I'm hoping that some physical body  
15 sitting in this room can answer my questions.

16 MR. FULLER: Yes.

17 CHAIR STETKAR: Because if you can't, I'm  
18 willing to say that the entire study is flawed. This  
19 is a big issue, you make assertions in the report  
20 that, oh, yes, well, things could slide to the left,  
21 things could slide to the right, but you see the same  
22 thermohydraulic behavior whether a valve fails to  
23 open.

24 That's great if you're doing a conceptual  
25 study. It's not good if you're drawing insights and

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1 conclusions about the behavior of the Sequoyah plant.

2 MR. FULLER: Okay. So, what we did add to  
3 the report was a summary paragraph. I realize, again,  
4 it's not satisfying, because a lot of engineering  
5 judgment does have to go in from the people who are  
6 reading these reports and capturing both the demands  
7 and the failures in the database.

8 So, we tried our best. We did talk to the  
9 people who actually do this, the coding of the  
10 operating experience, to figure out what they -- how  
11 they decide. So, everything is reliant on licensee  
12 reporting.

13 CHAIR STETKAR: I --

14 MR. FULLER: So, they have a requirement to  
15 report failures of the codes they see. They certainly  
16 don't have to report all the demands.

17 But typically, the operating events, these  
18 are post-scrum events, you can try to guess how many  
19 demands were placed on the safety valves, because you  
20 do have at least information that the scum event  
21 happened and then, you can read the description of  
22 what happened.

23 Sometimes, there's information about  
24 system pressures, sometimes there isn't. The level of  
25 information just varies a lot from LER report to LER

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1 report.

2 So, in terms of the numerator, at least we  
3 have more confidence that, because of the reporting  
4 requirement, that we know how many failure events  
5 happened for the safety valves. For the denominator,  
6 the number of demands, we don't have a definitive  
7 answer.

8 And I think what we said in the report is  
9 that we may be undercounting the demands, because we  
10 have to use some judgment on --

11 CHAIR STETKAR: But --

12 MR. FULLER: -- when those valves were  
13 demanded and how many.

14 CHAIR STETKAR: Let me read verbatim what's  
15 in the report, so it's on the record. Many LERs  
16 describing the plant response to scram report the  
17 operation of SVs, but a significant portion of the  
18 LERs just use phrases like, all systems operated as  
19 expected. Hence, for the number of demands, expert  
20 judgment must be used to interpret information  
21 provided in the LERs and may be undercounted.

22 My assertion is that you may have  
23 substantially over counted the number of demands,  
24 because it's very, very surprising to me that between  
25 October of 2007 and March of 2016, we had a number of

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1        scrams that resulted in 75 demands to open main steam  
2        safety valves and/or pressurizer safety valves, but I  
3        would be really surprised if we opened any of them.

4                So, my assertion is that you may have  
5        substantially undercounted the denominator, making the  
6        whole failure rate substantially optimistic. And if  
7        the same process was used in NUREG/CR-7037, the  
8        numbers from that report may be substantially  
9        optimistic, the failure rate.

10               So, what I was trying to -- what I was  
11        hoping to achieve, and apparently will fail, is to get  
12        someone who actually did the work from 2007 to 2016 to  
13        tell us what criteria were used when you examine the  
14        operating experience to say, this event I judge today  
15        to result in a demand to open the main steam safety  
16        valves at Plant X and I assumed that n number of  
17        safety valves were demanded to open.

18               I'm not hearing that answer. And without  
19        that answer, I have absolutely no confidence in the  
20        failure rates that are used. And I firmly believe  
21        that they're optimistic. I can be convinced  
22        otherwise, but I need to be convinced otherwise by  
23        somebody who tells me what they did.

24               MR. FULLER: Yes, okay. So, I apologize.  
25        As I said, I summarized the input we got from the team

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1 in that one paragraph we inserted, but maybe we can  
2 arrange a side conversation with the folks --

3 CHAIR STETKAR: No, no, we don't do things  
4 --

5 MR. FULLER: -- who actually --

6 CHAIR STETKAR: -- in side conversations,  
7 this is a -- the Subcommittee has raised this --

8 MEMBER BLEY: At least, not technical  
9 information.

10 MR. FULLER: Right, okay.

11 CHAIR STETKAR: Not technical information.

12 MR. FULLER: So, maybe what we can do is  
13 try to set aside some time at the full Committee  
14 meeting to --

15 CHAIR STETKAR: Well, we have to decide on  
16 --

17 MR. FULLER: Okay.

18 CHAIR STETKAR: -- the problem with the  
19 full Committee meeting is that we have pretty good  
20 representation of Committee Members here and have had  
21 --

22 MR. FULLER: Yes.

23 CHAIR STETKAR: -- in previous meetings.  
24 But I don't think that we've had the full complement  
25 of the full Committee. And the Members who haven't

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1 attended the Subcommittee meetings need to get briefed  
2 on the whole scope of this study.

3 MR. FULLER: Yes.

4 CHAIR STETKAR: And even those of us who  
5 have attended the Subcommittee meetings have to have a  
6 better feel for how you're presenting the full study  
7 to the full Committee.

8 MEMBER BLEY: Other than an informal  
9 communication, which we can't do, if you wrote  
10 something up and sent it to us, that we could look at  
11 ahead of time.

12 MR. FULLER: Oh, okay, I see.

13 CHAIR STETKAR: Yes, if you want to write a  
14 little report --

15 MR. FULLER: I see --

16 CHAIR STETKAR: -- we can do that.

17 MR. FULLER: -- and then put it --

18 CHAIR STETKAR: But you --

19 MEMBER BLEY: A memo.

20 CHAIR STETKAR: A memo.

21 MR. FULLER: -- put it in the public  
22 record, yes. Okay. Actually, that's a good --

23 CHAIR STETKAR: And that might be a way, if  
24 we can get it -- the full Committee meeting is in less  
25 than two weeks.

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1 MR. FULLER: Yes. Okay, yes. So, yes.

2 MEMBER SUNSERI: While you --

3 CHAIR STETKAR: But we can't do it  
4 informally.

5 MEMBER SUNSERI: While you --

6 MR. FULLER: Okay.

7 MEMBER SUNSERI: While you're thinking  
8 about that question, the question I had in association  
9 with this is, does the failure analysis include  
10 testing? I mean, you test these safety valves every  
11 refueling outage --

12 MR. FULLER: Yes. So, we had -- yes. We  
13 had previously talked about that quite a bit. We  
14 discovered through talking to the folks who actually  
15 conduct the testing that the testing setup doesn't  
16 quite test the reclosing probability, which is what we  
17 care about.

18 The testing requirements are focused on  
19 relieving pressure under design-basis overpressure  
20 accidents. So, they test very well the ability of  
21 that valve to open when you demand it to open, but  
22 they don't really test it under the conditions that  
23 we're looking for, repeatedly passing hot steam and so  
24 on. So, there is a --

25 MEMBER SUNSERI: Okay, so you don't

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1 consider a valve that may be in an as-found test  
2 condition low on its setting to be a valve that would  
3 be open during an accident?

4 MR. FULLER: So, yes. So, the setpoint  
5 drift is a separate issue and you're right that we  
6 don't worry so much about the setpoint drifts that are  
7 typically found during testing.

8 It's true that a valve may open at a  
9 slightly lower pressure than it's supposed to, but in  
10 the grand scheme of things, we had looked a bit about  
11 the effect of that in the -- through sensitivity  
12 studies in the Peach Bottom study, which of course is  
13 a different plant and we were looking for different  
14 things.

15 But the setpoint drift issue is not as  
16 important as all the other things that are going on in  
17 the integrated analysis.

18 MEMBER SUNSERI: Okay, thank you.

19 MR. FULLER: And so, yes. So, we are not  
20 using the testing data, because if you look at the  
21 distributions are very different from the operating  
22 experience data. And we did kind of talk to the  
23 testers, we figured out that it's not applicable.  
24 That's why there's so much focus on just using the  
25 operating experience data, which is from actual scram

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1 events.

2 CHAIR STETKAR: Tina, if you -- the other  
3 thing that we brought up back in June is that, and I  
4 don't want to get into details of the uncertainty  
5 distribution, but you -- we've revised the uncertainty  
6 distribution for the open fraction, I forgot the  
7 parameter value, but given the valve sticks open, how  
8 big is the area that it sticks open, that was revised  
9 from 2016 to current time.

10 That distribution says that there is a 30  
11 percent probability, for example, that a valve remains  
12 open more than 90 percent. And that -- the shape of  
13 the distribution seems intuitive, the distribution and  
14 the discussion of the distribution in the report is  
15 quite good.

16 It says that most likely it's just going  
17 to weep, it's going to stick open just a little bit.  
18 There's a non-zero, in this case 30 percent, chance  
19 that it could stick open big. And then, there's kind  
20 of a small probability that it could stick open  
21 somewhere in-between, and that equal probability was  
22 distributed over those open area fractions.

23 That all sounds really good, if indeed we  
24 have information about the numerator, because people  
25 report these things in LERs --

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1 MR. FULLER: Right.

2 CHAIR STETKAR: -- and we have something on  
3 the order of 15 or 16 failure events, 30 percent of  
4 those would be something on the order of four, five,  
5 six events where we would expect to see a valve stuck  
6 open pretty big.

7 So, we would also ask the question, is the  
8 operating experience, even in the numerator, the  
9 things that you have more confidence in, because you  
10 can go read those things, does that operating  
11 experience support the uncertainty distribution for  
12 the open fraction?

13 MR. FULLER: Yes.

14 CHAIR STETKAR: And you said, yes, we're  
15 going to go back and look at that.

16 MR. FULLER: Yes. So, that's what my  
17 second bullet is about. We did go back and reread all  
18 of the LERs for those events and we actually had a  
19 valve subject matter expert also review both the LERs,  
20 as well as we had additional information from a  
21 proprietary database, which we can't get into the  
22 details of that in the study, but we explained in the  
23 report that we have access to this and we looked at  
24 it, but we can't explicitly refer to the information  
25 from that.

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1                   Unfortunately, in relooking at all of  
2                   that, there was nothing new that we could tease out to  
3                   kind of add additional details in the report that  
4                   would be worthwhile. We continued to rationalize, I  
5                   guess, the distributions that we had come up with.  
6                   And for the open area fraction, it's even more  
7                   frustrating because some of the reports had no  
8                   information on it.

9                   But, however, I will say for that large  
10                  open area fraction, there were a handful of events, I  
11                  can't remember if it was four or five, I want to say  
12                  on the order of four, that were due to latent  
13                  conditions, assembling errors, maintenance errors  
14                  where the valve was left in the position that, when it  
15                  was open, the internals got completely misaligned,  
16                  something fell out of place, and it was basically  
17                  stuck open with a pretty large area.

18                  So, the mechanisms for the failing with  
19                  the large open area versus the weeping area are kind  
20                  of different. And what we saw in some of these events  
21                  was, when there was a maintenance or assembly error,  
22                  sometimes it got stuck open with a very large area and  
23                  couldn't be recovered, even by lowering the pressure.

24                  So, we had data, again, hard to quantify  
25                  very specifically what percentage should fall in these

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1 different bins, but we did have data to support these  
2 two ends of the distribution.

3 MEMBER BLEY: You give, in a couple places,  
4 I think, a description of qualitatively the kind of  
5 people you talked to and how you tried to go at this  
6 and the data you looked at. I didn't see anything  
7 real clear on how you picked the 90 percent and the 30  
8 percent.

9 I have a question about the design of the  
10 valve. I think the design of the valve stem is such  
11 that if you're 30 percent open on this kind of valve,  
12 but I'm not sure of this, that you get something like  
13 30 percent mass flow.

14 I don't know if that's true. How did you  
15 translate valve open fraction into mass flow rate for  
16 your calculations?

17 CHAIR STETKAR: That's a MELCOR question,  
18 right?

19 MEMBER BLEY: Well, I --

20 MR. FULLER: It's a --

21 MEMBER BLEY: -- don't know if it's an  
22 input to MELCOR or if it's something done inside the  
23 code. I don't know if that aligns with how these  
24 particular valves are designed for flow rate versus  
25 percent open.

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1 MR. FULLER: Yes.

2 CHAIR STETKAR: And in particular, take  
3 that very, very unlikely thing in the center, where  
4 it's stuck open 37 percent.

5 MEMBER BLEY: That could be a whole lot --

6 CHAIR STETKAR: That's --

7 MEMBER BLEY: That could be almost full  
8 flow or it could be fairly low flow, depending on  
9 exactly how that valve --

10 MEMBER MARCH-LEUBA: If it's high pressure  
11 --

12 MEMBER BLEY: -- seeping surface is  
13 designed.

14 MEMBER MARCH-LEUBA: If it's high pressure,  
15 it's likely to choke flow and be linear with area.  
16 And at this pressures, I would say it's choked flow,  
17 right?

18 MR. WAGNER: That's a true statement.  
19 Sometimes, you get what you're getting to, you get  
20 stem position versus flow area. And so, it will  
21 change and it can be nonlinear.

22 MEMBER BLEY: Well, no, actually, this  
23 isn't one, but if you have a gate valve and it opens,  
24 it only has to get a little bit open before you get  
25 nearly full flow through it.

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1           If you have a carefully designed throttle  
2 valve, then the flow rate, ignoring the point you just  
3 brought up, can be proportional or some other  
4 relationship to the position of the valve stem. So,  
5 there's a lot of detail here and I don't know if the  
6 detail has been worked into the model, that's kind of  
7 what I'm asking.

8           MR. WAGNER: No, we have a simple linear  
9 representation of that.

10          MEMBER BLEY: Okay. Which would be sort of  
11 appropriate, if it's a good throttle valve, if that's  
12 the design.

13          MR. WAGNER: Yes, it --

14          MEMBER BLEY: I don't know that relief  
15 valves are designed to do that. They're designed to  
16 pop open and then, pop shut.

17          MR. WAGNER: Yes. Well, we're --

18          MEMBER BLEY: So, 30 percent open might be  
19 damned near full flow, I don't know.

20          MR. WAGNER: We don't have many samples in  
21 the middle there, we're kind of bimodal distribution  
22 of weeping or full --

23          MEMBER BLEY: Well, you got a --

24          CHAIR STETKAR: But, again, to answer  
25 Dennis's question, that's why --

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1                   MEMBER BLEY: Something near ten percent  
2 chance of 30 percent open.

3                   CHAIR STETKAR: Yes. Well, but --

4                   MEMBER BALLINGER: So, you're satisfied  
5 that 30 percent is the right number? I mean, that's  
6 an awful lot of really bad screw-ups in calibrating  
7 those valves, because those valves have to be --  
8 they're tested quite frequently. It just seems like  
9 30 percent of them --

10                  CHAIR STETKAR: No, this is 30 -- given the  
11 fact that it's stuck open --

12                  MEMBER BALLINGER: Oh, okay.

13                  CHAIR STETKAR: -- what is the fraction of  
14 the area that it's stuck open at?

15                  MEMBER BALLINGER: Okay.

16                  MR. FULLER: So, I think --

17                  CHAIR STETKAR: It -- what I'm -- my  
18 initial question was, how likely is it that it sticks  
19 open? And that number, right now, is on the first  
20 demand, 2.65 times ten to the minus two, I think,  
21 based on 16 failures in -- I've forgotten the -- I  
22 don't have the table in front of me here, but --

23                  MEMBER BALLINGER: Okay.

24                  CHAIR STETKAR: -- 16 failures in some  
25 couple hundred demands, 600 demands or something like

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1       that.

2               MR. FULLER: So, I think the one -- the  
3       reason we gave that ten to 30 percent a little bit  
4       more weight than the 30 to 90 percent is, again, we're  
5       trying to squeeze as much as we can out of a very  
6       small data set.

7               And in one of the events, we were able to  
8       calculate, they had enough information that we could  
9       calculate that there was 20 percent flow area that had  
10      opened up. So, that kind of said, well, so it does  
11      happen, maybe -- so, that was our -- we had that one  
12      data point that --

13              MEMBER BLEY: Just an overview.

14              MR. FULLER: Yes.

15              MEMBER BLEY: What you've done is a lot  
16      more physically pleasing than 2016 was, which wasn't  
17      at all physically pleasing. So, in general, the idea  
18      makes sense. I don't know how far to push this. I  
19      didn't find much to give me, in what's written, to  
20      give me confidence that where you ended up made a lot  
21      of sense either. But it's at least in the right  
22      direction, I would think.

23              CHAIR STETKAR: I think that, I mean, we've  
24      talked about this a few times, you're clear on our  
25      sort of concerns. My personal thought is that this

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1 issue, for the purposes of this particular study,  
2 ought to be met head-on.

3 Acknowledge the fact that perhaps you do  
4 not have good justification for that failure rate or  
5 perhaps even the specific probabilities that's shown  
6 for the uncertainty distribution, although the shape  
7 of the uncertainty distribution is -- makes a lot of  
8 engineering sense.

9 And that indeed will have implications on  
10 the pedigree of, again, I'll call them numbers, I will  
11 not call them data, I refuse to do that if nobody can  
12 tell me where it came from, on the numbers in  
13 NUREG/CR-7037.

14 And I personally would have absolutely no  
15 problem calling into question the fact that they are  
16 suspect and that they have not been corroborated as  
17 part of this effort. That doesn't say that the  
18 overall study is fatally flawed, it just says, use my  
19 data, get my results, and you used this data and you  
20 got your results.

21 Going forward -- and we raised this  
22 question back, I looked back through my notes, in the  
23 Surry study about the valve failure rate. And at that  
24 point, we said, well, it wasn't all that very much  
25 important, so get over it, it's from 7037.

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1           Anything you do from here on out in the  
2           future, ought to, in my personal opinion, recreate a  
3           defensible failure rate for those valves. Even if you  
4           have to go back and start with a piece of paper that  
5           looks like a blank piece of paper and create your new  
6           failure rate, because it has to be justified somehow.

7           MR. FULLER: So, I think we will beef up  
8           the discussion in the report. What I did try to say  
9           in the executive summary and the conclusions was that,  
10          we recognize that what you assume for the safety valve  
11          modeling is very critical to the outcomes and that  
12          there's still considerable uncertainty in our state of  
13          knowledge.

14          And I think that's an accurate statement.  
15          I mean, even if you --

16          CHAIR STETKAR: It is, Tina, but it -- if  
17          I'm a reader of the executive summary, I get these  
18          words uncertainty thrown in and I get confused,  
19          because what you're talking about is, we have no  
20          confidence, I'll be blunt, we have no confidence in  
21          the numbers that come out of that NUREG.

22          We have uncertainty distributions about  
23          those numbers that we use and that we talk a lot  
24          about, because we do this parametric uncertainty  
25          analysis and we went back and revisited the open area

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1 fraction and we have an uncertainty distribution.

2 It gets muddled to a reader of the  
3 executive summary, because all you say is, yes,  
4 there's uncertainty about what the failure rate should  
5 be, in the executive summary. And I say, yes, you  
6 have an uncertainty distribution about the failure  
7 rate as a parameter in your model.

8 So, all you're doing, to me, as kind of a  
9 dispassionate reader of the executive summary, all  
10 you're doing is reinforcing the fact that you looked  
11 at uncertainty and that parameter. That's the way I  
12 came across, reading the executive summary --

13 MR. FULLER: Okay.

14 CHAIR STETKAR: -- rather than saying,  
15 look, we used the failure rate from this source, which  
16 is the best failure rate that we had at the time. We  
17 updated it with additional operating experience, but  
18 we still have questions about what the number is.

19 And that a takeaway from the study is  
20 somebody really needs to go back and reexamine the  
21 technical bases and operational history for not only  
22 the failure rate, but given a failure, what the  
23 relative fraction of the stuck-open area is.

24 MR. FULLER: Yes, okay. Yes. I --

25 CHAIR STETKAR: That's kind of what -- in

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1 the sense of a lessons learned. It isn't -- I'm  
2 coming across as kind of condemning the study, and I  
3 would condemn the study if it says, these are the data  
4 that we are going to hang our hat on, as far as  
5 drawing insights and conclusions about risks.

6 MR. FULLER: Okay. So, I think we are  
7 taking your comments again, we'll try to do a better  
8 job of framing the discussion. The only other thing I  
9 can offer is that, we've had pretty wide review of  
10 this at this point, because of all the questions.

11 We've presented the work at an ASME Pump  
12 and Valve Symposium, we've talked to more valve  
13 subject matter experts. Nobody has looked at the  
14 approach and said, you're doing this totally wrong,  
15 there's something a lot better out there. So, we  
16 haven't -- I understand your point.

17 Maybe we have to reframe how we present  
18 the work a little bit better, given that there is less  
19 confidence in maybe one of the key parameters here.  
20 So, again, as I said, every time I see the words  
21 safety valve on the paper, I have a deep sense of  
22 dissatisfaction.

23 CHAIR STETKAR: No, it's -- but honestly --

24 MR. FULLER: It's just kind of where we  
25 are.

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1 CHAIR STETKAR: Having collected a ton of  
2 data in a previous life, it is absolutely true that  
3 there, in many cases, must -- in all cases,  
4 engineering judgment is involved, because in some  
5 cases, you can't even divine whether something was a  
6 failure or not.

7 So, there's even engineering judgment in  
8 how you throw the numerator into a box for the  
9 numerator. And very often, very often, there's more  
10 engineering judgment in calculating the denominator.

11 That being said, a responsible data  
12 analyst will document the judgment that was used to  
13 calculate the denominator. Today, I used the  
14 following criteria, based on my knowledge, for these  
15 types of events, will result in a safety valve demand.  
16 So, that's the type of event.

17 And then, if the event occurs at Plant X,  
18 this is the number of safety valves at Plant X that I  
19 included. Now, why is the second part important?  
20 Well, if you know something about the plants, for  
21 example, Plant X might have five safety valves, Plant  
22 Y might have three, typically not all of the safety  
23 valves will be demanded.

24 So, out of a population of five, you might  
25 get one or two. So, if I, today, assumed that all

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1 five were demanded at Plant X every time I achieved  
2 these criteria, I'm probably being very, very  
3 optimistic in the denominator.

4 But it's incumbent on me as a data analyst  
5 to document that engineering basis for that  
6 denominator. And if I don't do that, nobody should  
7 have any confidence in the numbers that I put forth, I  
8 have failed as a data analyst. I'm not a valve  
9 expert, I'm not somebody who attends a conference, I'm  
10 somebody who analyzes experience.

11 And I may have uncertainty about that  
12 denominator, there might be plus or minus a factor of  
13 two or three on that, which is fine, I can handle  
14 that. Okay?

15 MR. FULLER: Okay.

16 CHAIR STETKAR: We've beat that one up  
17 enough --

18 MR. FULLER: Yes.

19 CHAIR STETKAR: -- we do have to be  
20 cognizant of the time here.

21 MR. FULLER: The final bullet on that slide  
22 was just to note that we did add the discussion for  
23 why we didn't include the failure-to-open failure mode  
24 and hopefully that was convincing. We showed that  
25 there is a couple orders of magnitude less

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1 probability.

2 CHAIR STETKAR: I'll only make a statement  
3 that I have about a page and a half written up on  
4 that. I agree with you that the failure-to-open curve  
5 that you show in the report will lie below the  
6 failure-to-close curve.

7 I believe that the margin is considerably  
8 less than is shown there, because even the day --  
9 sorry, I almost used that word again, let the record  
10 show I said day, not data -- even the numbers in  
11 NUREG/CR-7037 for the failure-to-open failure mode  
12 give you a higher curve than what you show.

13 And it's not clear at all to me how you  
14 accounted for common-cause failures. Because I -- the  
15 curve, I backed out a, if you want to call it an alpha  
16 factor, or a beta gamma factor combined, for all three  
17 valves of something on the order of couple times ten  
18 to the minus five.

19 And if I look at NUREG, the latest version  
20 of whatever the NUREG for common-cause failure  
21 parameters for safety valves, this is a -- for that  
22 combination of three spring-loaded safety valves  
23 failing to open, I get a couple of orders of magnitude  
24 higher than that.

25 I get kind of two or three or four, I've

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1 got the numbers here, but it's not worth whining about  
2 them right now, higher than that, so that if I apply  
3 the individual failure rate from NUREG/CR-7037 and the  
4 composite common-cause failure fraction from this  
5 other NUREG, I get a couple of orders of magnitude on  
6 the failure-to-open on the first demand, if you will.

7 MR. FULLER: Okay. No, that's a fair  
8 point.

9 CHAIR STETKAR: And that's -- again, the  
10 mark, it's still below --

11 MR. FULLER: Yes.

12 CHAIR STETKAR: -- and I think,  
13 qualitatively, you can still draw that conclusion.

14 MR. FULLER: Yes.

15 CHAIR STETKAR: But the curves that are  
16 plotted, they're --

17 MR. FULLER: No, that's --

18 CHAIR STETKAR: -- a little snarky.

19 MR. FULLER: That's a fair point, I think  
20 we have to discuss the common-cause aspect. So, we'll  
21 do that.

22 CHAIR STETKAR: The only reason I hang up  
23 on this is, I have absolute -- what happens, Casey  
24 would know this, what happens if none of them open at  
25 time -- on the first demand? Things get a lot more

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1 interesting, don't they?

2 MR. WAGNER: Yes.

3 CHAIR STETKAR: Okay.

4 MR. FULLER: Yes, so we haven't modeled  
5 that lower probability scenario. We did --

6 CHAIR STETKAR: Right.

7 MR. FULLER: -- do a sensitivity in Surry,  
8 but --

9 CHAIR STETKAR: Yes.

10 MR. FULLER: -- we haven't done that  
11 sensitivity here.

12 CHAIR STETKAR: Yes.

13 MR. FULLER: And you're right, it's a  
14 completely different --

15 CHAIR STETKAR: It's things -- so, for the  
16 purpose of this study, I think it's clear that you  
17 haven't modeled it. I think the rationale for why  
18 you've not modeled it is -- can be punched up a little  
19 bit.

20 MR. FULLER: Okay.

21 CHAIR STETKAR: Especially because somebody  
22 like me is going to go pull those numbers out and do  
23 that calculation. Okay.

24 MR. WAGNER: Do you have any guidance on  
25 time? We have about two slides left.

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1 CHAIR STETKAR: We're going to try to get  
2 through as quickly as we can here. I'm going to make  
3 an executive decision just because --

4 SPEAKER: Control yourself.

5 CHAIR STETKAR: I cannot do that. I've  
6 tried in the past.

7 If we have to run a little bit long, we'll  
8 run a little bit long, but not much. So, let's try to  
9 get through these and I'll try to be good.

10 MR. WAGNER: The next area that we  
11 addressed is time in cycle sampling. And we had a  
12 lively discussion on that one, too.

13 We have a two-part approach to addressing  
14 the concerns that were brought up. The first part is  
15 we improved the discussion of the distribution between  
16 BOC, MOC and EOC in the current documentation. No  
17 changes were made, but we improved the documentation,  
18 the justification why we went into the three areas.

19 The second approach is we took that to  
20 heart and for the Surry UA we're going to do a much  
21 more continuous approach of using many more ORIGEN  
22 results across the full cycle.

23 CHAIR STETKAR: I saw that. I still, you  
24 know, it is what it is. The discussion is much  
25 improved. I understand the rationale here.

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1 I still don't know why you picked 200 days  
2 and then said there must be 50 percent of the  
3 probabilities, you know, equally distributed on either  
4 side of that 200.

5 Why you didn't pick 200 and whatever the  
6 midpoint is, why you didn't pick 275 days, say, you  
7 know, 250 percent, but it is now explained.

8 Somebody can read through there and say,  
9 okay, I might take issue about your selection, but I  
10 understand the rationale that you used.

11 MR. WAGNER: To briefly go over the  
12 rationale, more ORIGEN work was done to develop the  
13 rationale. We looked at -- we had three points when  
14 we presented last time.

15 We did about 10 or 15 more ORIGEN  
16 calculations to kind of put those points in context  
17 and give us some insights on the buildup of the short-  
18 lived radionuclides.

19 And so, the -- try to get justification  
20 for the BOC space is for that buildup to the secular  
21 equilibrium of iodine-131, that was our surrogate for  
22 short-lived, and how the decay heat changes over that  
23 60 days.

24 And then the EOC, the justification on  
25 that you can -- we had more data points on the Cesium-

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1 137. And so, that was a definition of why we put an  
2 EOC boundary there.

3 And then the sampling looked -- the  
4 particular value that was used, looked at load decay  
5 heat. So --

6 CHAIR STETKAR: No, the story hangs  
7 together much, much better.

8 MR. WAGNER: Next slide.

9 And a question was on the stability --  
10 statistical stability analysis conducted for the  
11 figures of merit. That was performed and that was  
12 added to Appendix A.

13 We recognized the possible impact of  
14 eutectic melt temperature on burnup. We didn't change  
15 anything, but we have some --

16 MEMBER POWERS: Since there is no eutectic  
17 in the system, I really wonder what that is. There's  
18 a monotectic.

19 MR. WAGNER: We use eutectic as our  
20 conglomerate melt and sort of dissociation temperature  
21 for the field.

22 MEMBER BALLINGER: In that case, eutectic  
23 should be put in quotes?

24 MR. WAGNER: Oh, sure. Yeah. Yeah.

25 MEMBER BALLINGER: Okay.

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1                   MEMBER REMPE: Just to follow up on the  
2 earlier discussion very briefly, I'm looking at a  
3 paper from IRSN and Karlsruhe, Comparison of Core  
4 Degradation Phenomena for Various Experiments.

5                   There is a quote in there that clearly  
6 it's referring to some PHEBUS data and it has  
7 "irradiated fuel is dissolved more quickly than  
8 unirradiated fuel." It cites the PHEBUS-FP tests.

9                   And in that whole paragraph they're  
10 comparing differences between irradiated fuel and  
11 temperatures versus unirradiated fuel. And so,  
12 again, it might be a good place to start looking for  
13 data.

14                  MR. WAGNER: Yeah, took some notes on  
15 that. Thank you.

16                  There was some added discussion on our  
17 approach for failed computer runs. It is already  
18 noted that we --

19                  CHAIR STETKAR: Yes, there was. We've  
20 discussed that. Next bullet.

21                  MR. WAGNER: I wanted to go on. There was  
22 some discussion of ice bed response during seismic  
23 event. Improved vessel failure discussion to address  
24 the cited issues.

25                  MEMBER REMPE: So, again, a nitpick, but

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1 it -- the text there needs -- first of all, what is  
2 "gross failure"? It's better than variable failure,  
3 but you have the word "gross failure."

4 To me, that implies it unzipped and the  
5 whole head fell off. I don't think that's what you  
6 assumed. You assumed a limited area, specific area,  
7 right? And so, find some nicer words that are more  
8 representative of what was done.

9 Also, there's another place where it used  
10 to talk about the drain line and John harangued you to  
11 get rid of that. And now it has something about that  
12 -- about penetration -- instrument failures or other  
13 failures. And you have in quotes, "instrument  
14 failures."

15 And so, look at the words there and just  
16 fix it, because it's -- you're having "instrument"  
17 both times and it's just --

18 MR. WAGNER: Oh, I see. Okay.

19 MEMBER REMPE: It's an editing thing. But  
20 I look for those things, because we have had some  
21 comments about it.

22 MR. WAGNER: Yeah. Yeah. The Committee  
23 pointed out that there was some confusing discussion  
24 on the long-term station blackout on specific  
25 generators versus symmetric and asymmetric responses.

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1 And I tried to rewrite that to address that.

2 CHAIR STETKAR: That reads -- there's  
3 still obviously a numbering difference, but it's okay  
4 now.

5 MR. WAGNER: Great.

6 CHAIR STETKAR: As far as I'm concerned,  
7 it states what's done.

8 MR. WAGNER: Okay. Great.

9 MEMBER REMPE: Could I go back to the very  
10 beginning since it has the phrase "steam generator,"  
11 or the acronym there, about our discussion earlier  
12 about the limited scope and not considering  
13 consequential steam generator tube rupture.

14 And you did consider countercurrent flows,  
15 so I bet your MELCOR runs actually have temperatures  
16 of the hot leg and temperatures of the tubes in it.

17 And so, again, my earlier point where I  
18 was slapped down because I was saying, can you use  
19 some insights based on other evaluations you've done  
20 so that up front you -- you're basically looking at  
21 different pump seal leakage rates and you're making  
22 comments about releases into the containment and  
23 things like that.

24 I bet you could even get those insights  
25 that are plant-specific based on the runs you have on

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1 -- and infer that the temperatures of this tube versus  
2 the temperature of the hot legs, you might be able to  
3 come up with a conclusion about what would have been  
4 more likely or not, even.

5 And it would be plant-specific; right?

6 MR. WAGNER: Uh-huh. Yeah. I've noticed  
7 that when I've implemented the natural circulation  
8 modeling, three loop versus four loop. There are some  
9 differences.

10 MEMBER REMPE: Okay. Thank you.

11 MR. WAGNER: Oh, we looked at RCP leakage  
12 as an ignition source, the gases that might be coming  
13 out of the RCP and added a discussion.

14 CHAIR STETKAR: That's an interesting  
15 discussion. And that's all I'm going to say. That's  
16 an interesting discussion.

17 I have some questions about that, but we  
18 don't have enough time for it right now. There were a  
19 couple of curiosities that I --

20 MR. WAGNER: Okay.

21 CHAIR STETKAR: But it's an interesting  
22 discussion.

23 MR. WAGNER: The very last slide is just  
24 to point out that we added two things that we talked  
25 to you about. Hossein's discussion from last meeting

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1 got into the report, and then Trey's focused  
2 pressurizer safety valve study is now fully documented  
3 in the report.

4 On to MACCS.

5 MR. BIXLER: Okay. On the -- there were  
6 several comments also in the MACCS, the consequence  
7 analysis portion of the work from last time.

8 And I think I picked the more major things  
9 here and tried to respond to those and explain what we  
10 have done to address them.

11 The first thing here is a question on  
12 emergency response and triggering by -- in our case,  
13 we had some emergency response triggered by SAE siren.

14 And there was a question, what is that? Does that  
15 really happen? Is that what TEMA would do?

16 And so, we went back and looked at that.  
17 And I think we offered at the time of the last  
18 meeting, that we would take a more careful look at  
19 that.

20 And what we found, we found a couple of  
21 things. One is that there's a documentation by FEMA  
22 in 2004, of an exercise for the Sequoyah Nuclear Power  
23 Plant that shows pretty clearly a time line of events.

24 And one of the earlier things on the time  
25 line is the SAE declaration. And then following that

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1 is a first siren.

2 And it notes there that that would trigger  
3 school relocation, that buses would be -- bus drivers  
4 would be notified to deploy, et cetera. A little bit  
5 more is included on the first SAE -- or the SAE  
6 message -- the EAS messaging.

7 And then following that, at a later time  
8 is the GE declaration. And then following that is --  
9 it clearly specifies a second siren and a second EAS  
10 message.

11 So, that definitely corroborates what we  
12 were modeling the way we had modeled schools and some  
13 of the other cohorts that were also related to that.

14 MEMBER SKILLMAN: Nate.

15 MR. BIXLER: Yeah.

16 MEMBER SKILLMAN: This is Dick Skillman.

17 MR. BIXLER: Yeah.

18 MEMBER SKILLMAN: I asked that question.

19 MR. BIXLER: Yeah.

20 MEMBER SKILLMAN: And I asked that  
21 question, because the gentleman from -- when  
22 challenged, the gentleman from TVA said, "Yes, we  
23 really do move the children at a site versus a  
24 general," which is where, at least in my experience,  
25 the bulk of the evacuations occur.

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1 MR. BIXLER: Uh-huh.

2 MEMBER SKILLMAN: And this has  
3 specifically to do with Cohort 2.

4 MR. BIXLER: Yes.

5 MEMBER SKILLMAN: And this is actually 20  
6 percent of the population --

7 MR. BIXLER: Yes.

8 MEMBER SKILLMAN: -- of the area.

9 MR. BIXLER: Yeah.

10 MEMBER SKILLMAN: But what's interesting,  
11 and I'm going to go back to what either John or Dennis  
12 said, the study is a specific study for this site.  
13 And the study for this site is tied very closely to  
14 TEMA, to how Tennessee Emergency Management and TVA  
15 have agreed in their emergency plan.

16 Because what they do is at an alert, they  
17 dispatch the buses. So, the buses are staged before  
18 the site occurs, if the timing is --

19 MR. BIXLER: Right.

20 MEMBER SKILLMAN: So, from that  
21 perspective, one must be aware that this is not, for  
22 instance, applicable to McGuire, Catawba, TMI, Oyster  
23 Creek --

24 MR. BIXLER: Okay.

25 MEMBER SKILLMAN: -- pick your plant.

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1 MR. BIXLER: Yeah. Okay.

2 MEMBER SKILLMAN: Because this is, at  
3 least in my experience, unusual that an alert --  
4 actually, the control room calls the school.

5 MR. BIXLER: Uh-huh.

6 MEMBER SKILLMAN: That's what the  
7 gentleman from TVA said.

8 MR. BIXLER: Okay.

9 MEMBER SKILLMAN: So, I mean, the analysis  
10 is what it is if that agreement is as stated. I have  
11 no reason to believe it's not --

12 MR. BIXLER: Right.

13 MEMBER SKILLMAN: -- but one must be clear  
14 in one's own mind to recognize this is different.

15 MR. BIXLER: Okay. Yeah, and we -- I  
16 don't think we tried to draw any conclusions for other  
17 plants, just for this one.

18 MEMBER SKILLMAN: But this is 20 percent  
19 of the population.

20 MR. BIXLER: That's right.

21 MEMBER SKILLMAN: So, this is not an  
22 inconsequential --

23 MR. BIXLER: Yeah.

24 MEMBER SKILLMAN: -- uniqueness here.

25 MR. BIXLER: Yeah.

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1 MEMBER SKILLMAN: This is important.

2 MR. BIXLER: Yeah. Okay.

3 MEMBER SKILLMAN: Thank you.

4 MR. BIXLER; And I think I can probably  
5 conclude with that. One additional thing I'd like to  
6 say, though, is that even for this case where we --  
7 and we believe faithfully triggered the beginning of  
8 the emergency response by SAE, it's still fairly late.

9 It doesn't happen early on the overall  
10 time line, because we assume that there'd be quite a  
11 bit of delay for the buses to be able to get to the  
12 schools.

13 And so, it didn't end up being a  
14 particularly early evacuation of the school kids, it  
15 was just triggered earlier. It started the chain of  
16 events earlier, but it still took a while to  
17 accomplish by our time line.

18 MEMBER SKILLMAN: And one probably should  
19 recognize that there could be hours or minutes between  
20 the site and the general.

21 MR. BIXLER: Yeah. Yeah.

22 MEMBER SKILLMAN: And so, that's really  
23 the important piece here. When you tell the children  
24 "Go" at a site, they may be in the next county by the  
25 time their parents are told to leave.

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1                   So, there are some practical implications  
2 associated with this assumption.

3                   MR. BIXLER: Yeah.

4                   MEMBER SKILLMAN: Thank you.

5                   MEMBER BLEY: Nate.

6                   MR. BIXLER: Yeah.

7                   MEMBER BLEY: There was one thing I think  
8 we talked about the last time, and I wonder if you  
9 folks thought more about it.

10                  You do have an assumption that bridges  
11 within the ten miles are unusable --

12                  MR. BIXLER: Right.

13                  MEMBER BLEY: -- and you shoulder people  
14 until you find a route out for them, but I think we  
15 asked if -- what about the people who don't wait for  
16 that and who jump out on the roads and then find  
17 themselves cut off?

18                  I know that area kind of well and there's  
19 a lot of bridges in a lot of place nearby there.

20                  MR. BIXLER: Yeah.

21                  MEMBER BLEY: Do you think about people  
22 who get stranded for a fair amount of time because  
23 they can't find their way back out again when they  
24 keep running into dead bridges?

25                  MR. BIXLER: We did --

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1                   MEMBER BLEY: Did you leave a fraction of  
2 those who get caught outside rather than sitting  
3 inside?

4                   MR. BIXLER: I think we ended up doubling  
5 the amount of evacuation time to account for the fact  
6 that people might reach dead ends and then have to  
7 retrace their steps and try something else.

8                   MEMBER BLEY: Okay.

9                   MR. BIXLER: So, we did try to account for  
10 that in our evacuation time line, hopefully, in a  
11 reasonable way.

12                  MEMBER BLEY: Okay. Yeah, I guess that  
13 makes sense.

14                  MR. BIXLER: Yeah.

15                  MEMBER BLEY: Thank you.

16                  MR. BIXLER: Okay. I think -- next slide.

17                  Okay. There's also a question about how  
18 MACCS treats deposition under humid conditions, which  
19 I imagine you're likely to get in the Tennessee Valley  
20 area there. And that was a good question.

21                  And at the time, we responded that that  
22 would have an impact -- in principal, it could have an  
23 impact, at least, if you have hygroscopic aerosols  
24 being released that are not fully saturated with  
25 water. They could grow to a greater size, deposit

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1 faster, et cetera.

2 That's something we don't specifically  
3 treat in MACCS at this point. There's no accounting  
4 for relative humidity in the area when you're doing a  
5 release.

6 But what we ended up doing in response to  
7 that, was to do a bounding estimate of how much  
8 difference that could make on the deposition velocity  
9 of the aerosols.

10 And I think that's reasonably well-  
11 documented now in the new version of the document, but  
12 what we ended up finding is that it wouldn't even be a  
13 factor of 2 in deposition velocity.

14 And our uncertainty range covered a range  
15 of ten plus or minus the square root of three -- or  
16 square root of ten, roughly a factor of 3 up and down.

17 So, I think we covered that uncertainty  
18 already in our uncertainty range, but it is -- it's  
19 something that we thought was worth adding some  
20 additional description/discussion in the document.  
21 So, we went ahead and did that.

22 Okay. Next slide. And last comment -- or  
23 set of comments was on the presentation of some of the  
24 risks that were in the -- with the earlier version of  
25 the document, both EF, early fatality, and LCF risks.

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1                   So, I basically agree that at the time  
2                   that we met last time in June, that we would go back  
3                   and reconsider that and add to the discussion. And  
4                   so, we've done that now.

5                   There's a specific discussion on the  
6                   bimodal nature of the LCF risk and what that stems  
7                   from and we reduced the amount of presentation on EF  
8                   risk.

9                   Basically, there used to be a table and a  
10                  figure there that we eliminated and now there's just a  
11                  minimal amount of discussion saying that it only  
12                  occurs in a few of the realizations that we had.

13                  And even there it's trivial overall that  
14                  there's almost no chance of an early fatality. So,  
15                  those are the things we did to address the comments  
16                  from last time.

17                  CHAIR STETKAR: I commented earlier on the  
18                  early fatality. There's still a tabulation in there  
19                  that shows the mean value and zeroes for all the other  
20                  percentiles.

21                  I think -- again, I think a tutorial will  
22                  help.

23                  MR. BIXLER: That might be in the  
24                  appendix, are you thinking, or --

25                  CHAIR STETKAR: I don't -- no, there's one

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1 in the appendix, but there's -- the one in the  
2 appendix has mean values and 95th percentiles, as Trey  
3 showed --

4 MR. BIXLER: Right.

5 CHAIR STETKAR: -- for four of the five  
6 distances that indeed are higher than the mean value,  
7 which is reassuring to a lot of people.

8 There is a table in the main body of the  
9 report and I, you know, if you want me to --

10 MR. BIXLER: In Chapter 6?

11 CHAIR STETKAR: I don't remember whether  
12 it's Chapter 6.

13 MR. BIXLER: Okay.

14 CHAIR STETKAR: It probably is. I think  
15 that does show non-zero mean values and zero values  
16 for the median, fifth and 95th percentiles.

17 MR. BIXLER: I think the intention was to  
18 take that table out.

19 CHAIR STETKAR: Well, it's still in there  
20 and it -- you can argue one way or the other about  
21 whether it's useful. It might be useful.

22 If it's in there, as I said earlier, I  
23 think that it would be very useful to have a bit of a  
24 tutorial for folks --

25 MR. BIXLER: Okay.

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1 CHAIR STETKAR: -- about how that type of  
2 behavior makes sense --

3 MR. BIXLER: Right.

4 CHAIR STETKAR: -- because most people  
5 don't get it. And most people -- what I've found is  
6 many people do not support the notion of quantitative  
7 uncertainty analysis and are too easy to dismiss it as  
8 simply an abstract mathematical, statistical,  
9 nonphysical exercise that you push a button at the end  
10 of a study and something comes out.

11 So, I think that table is actually useful.  
12 It shows that the numbers are small --

13 MR. BIXLER: Okay.

14 CHAIR STETKAR: -- but it needs a bit of  
15 discussion.

16 Now, regarding the bimodal nature of the  
17 distribution, in the executive summary, the notion of  
18 a bimodal distribution is introduced. You show the  
19 cumulative curves. You still have this notion that  
20 risk decreases as a function of distance from the  
21 site, which is not entirely true.

22 The discussion in Chapter 6 is much, much  
23 better. You essentially - now, remember an executive  
24 summary has to be written not for people who did the  
25 work. It has to be written for people who want to

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1 understand what you did and what you're trying to  
2 convey with the results so that when you say a bimodal  
3 distribution, most people won't understand what the  
4 heck that is even from the shape of the cumulative.  
5 They just won't.

6 If you say, well, if we turn up the  
7 microscope on this funny-looking thing and show what's  
8 shown in Chapter 6, and then say, well, look, for the  
9 80 percent -- 80, whatever the heck it is, seven  
10 percent of the time when we get an early containment  
11 failure; A, it's 87 percent of the time and here's  
12 what the risk -- conditional risk profile looks at for  
13 that 87 percent. And, look, this one's from the site,  
14 doesn't make any difference.

15 But the other 13 percent when you  
16 basically don't get a containment failure and have a  
17 very small, protracted release, the risk from that is  
18 really, really, really small. And in that case,  
19 distance from the site makes a big difference.

20 MR. BIXLER: Right.

21 CHAIR STETKAR: And I think telling that  
22 story that way in the executive summary, to most  
23 people who read it, is a lot more beneficial than just  
24 the words that are in there and the figures, because  
25 people won't get those figures.

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1 MR. BIXLER: Okay.

2 CHAIR STETKAR: And the same way as  
3 publishing the results as a range from something on  
4 the order of ten to the minus ninth to something on  
5 the order of ten to the minus three is misleading  
6 without that corroborating story.

7 MR. BIXLER: Okay.

8 CHAIR STETKAR: Especially in the  
9 executive summary.

10 MR. BIXLER: Okay. All right. We'll take  
11 that comment to heart and go back and reword that a  
12 little better.

13 CHAIR STETKAR: Because it's really -- I  
14 think to a lot of people it's unexpected. That shape  
15 is unexpected and the fact that that for in this  
16 particular site, in this particular study, distance  
17 from the site for the vast majority of the things that  
18 you're looking at doesn't make any difference is also  
19 counterintuitive to a lot of people.

20 MR. BIXLER: Okay.

21 MS. SANTIAGO: So, that brings us back to  
22 talking perhaps about the topics that we should focus  
23 on for the November 2nd full committee presentation.

24 MS. GHOSH: Yeah. We didn't have any  
25 slides on this, because basically we're soliciting

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1 your input on what we should prepare and focus on.

2 CHAIR STETKAR: Well, in my opinion, I  
3 think recognize that there are some members of the  
4 Committee who I believe have not heard any of this  
5 story.

6 I've tried to go back and see who attended  
7 what meetings, but let's go on the presumption that  
8 there are at least one or more members of the  
9 Committee who have heard nothing of this.

10 That being said, I think that you need to  
11 provide an overview of the objectives of the study.  
12 The fact that it was tailored, in a sense, to examine  
13 hydrogen issues focusing primarily on early  
14 containment failure, I would not dwell too much on the  
15 long-term station blackout despite the fact that it's  
16 part of the study.

17 I think you don't have enough time to draw  
18 that distinction. I would keep focused on the short-  
19 term station blackout exclusively and said that's the  
20 -- that's where we did all of our analysis, that's  
21 where the integrated uncertainty analysis was done and  
22 we just don't have enough time to kind of talk about  
23 the others -- the other part of it.

24 I would show the -- certainly show the  
25 results and explain the results, the bimodal effect of

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1 the results, you know, where they're coming from so  
2 that other members can understand, you know,  
3 essentially the sources of risk and the kind of  
4 phenomena that are contributing to them.

5 And then certainly, you know, in my  
6 opinion, and I'll ask for other help here, I would  
7 grapple -- I would grasp the demon by the horns and  
8 say, you know, what are some of the lessons that we've  
9 learned from doing this study?

10 I think one of the lessons that we learned  
11 is that the -- paying careful attention to the  
12 uncertainties as you do the study rather than as an  
13 afterthought is; A, essential, and; B, can have a  
14 measurable effect on the results.

15 You may want to show a couple of examples  
16 of that in things like the open area fraction and the  
17 fabric seal type of things, but only as an  
18 illustration.

19 You don't want to get bogged down in 90  
20 minutes in a full committee discussion with people who  
21 don't understand how the machine works and don't  
22 understand the study in terms of detail.

23 So, I'm not sure, you know, think about  
24 that, but I think part of the message is that the  
25 uncertainty analysis is not an afterthought and it's

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1 important that it's not an afterthought.

2 I would -- this is -- address the issues  
3 that we have discussed, the non-completion of MELCOR,  
4 the concerns about the pedigree of the numbers for the  
5 valve failure rate and, you know, you've already  
6 established the fact that that's an important  
7 parameter in the study. And perhaps one or two other  
8 issues, you know, that we've discussed.

9 I think that -- here's one area, and think  
10 about this, again, it's -- you're going to have to put  
11 together a lot of material in a 90-minute  
12 presentation.

13 A lot of the really elegant stuff in this  
14 study, both in terms of the modeling and how the  
15 sampling algorithms are done, is really, really neat  
16 stuff.

17 And all of the stuff that you did on  
18 regression analyses to kind of ferret out important  
19 contributors and how they may vary, are really, really  
20 interesting.

21 I don't know how you jam that into 90  
22 minutes or even whether you try. And that's where I'm  
23 looking for -- oh, it's a lot of really neat stuff,  
24 but I'm not sure whether it's worth trying to get at.

25 MEMBER BLEY: Well, what do you want from

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1 the ACRS? I think that's what you ought to focus on.

2 And anything that you really like, but isn't related  
3 to what you want from the Committee, you ought to put  
4 aside.

5 For example, you've done a lot of work  
6 recently on this focus safety valve study. I would  
7 put most of that aside.

8 On something that John talked about, I  
9 might go a little further, because when -- I like most  
10 of the things you talked about, John, but I think you  
11 ought to really narrow it down to the things that will  
12 -- what did you learn, what's good?

13 Now, the one thing I hoped you learned was  
14 when we started going with you through the uncertainty  
15 analysis and said, gee, everything is pointing to this  
16 open fraction of a safety valve, all the important  
17 stuff was sitting there that led you to go back and  
18 say, "Did we really do that right," and reevaluate it,  
19 I think that's an important story to tell.

20 Great details about what you actually did,  
21 I don't think, is that important, but that you learned  
22 from the uncertainty analysis that some part of your  
23 modeling was a lot more important than you probably  
24 figured it would be when you started.

25 I might be wrong about that, but that

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1 would be my guess. So, that would be the one thing I  
2 would focus on a little.

3 MEMBER SKILLMAN: I'd like to offer a  
4 comment, if I could. The major take-away for me is  
5 the uniqueness of the applicability of this study to  
6 this plant.

7 John said it very well a couple hours ago.  
8 One should not paint all ice containments with this  
9 result.

10 McGuire and Catawba or Watts Bar, because  
11 of their site and because of their emergency plan,  
12 might have a very different outcome.

13 And so, in the abstract and in your --  
14 what will become your executive summary, I think it's  
15 very important to communicate the unique applicability  
16 of this specific study for this specific plant.

17 That doesn't take away from the potential  
18 use of some of the results, but the final conclusions  
19 are unique and the users should be advised don't be so  
20 hasty just to apply this anywhere.

21 And if that caveat isn't in the Peach and  
22 the Surry analyses, it probably ought to be because  
23 these are very highly-specific, complicated analyses.

24 It's a unique piece of -- it's a huge piece of work,  
25 excellent piece of work, but it's unique.

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1 CHAIR STETKAR: Any other suggestions as  
2 far as the full committee presentation from our  
3 members?

4 MEMBER MARCH-LEUBA: Yes. For my benefit,  
5 I would like to hear something about why we're doing  
6 this and -- let me rephrase the question in a more  
7 final way.

8 Have you guys worked ourselves out of a  
9 job? the moment you write the report, we can fire you  
10 because we're never going to use this again. Or what  
11 are we going to use -- what benefit does the Agency  
12 gain from this exercise? How are we going to apply  
13 it?

14 Is it going to apply to licensing? Tell  
15 me why we did this.

16 CHAIR STETKAR: Okay. Be careful about  
17 that, because you haven't been here for the last  
18 decade. The --

19 MEMBER MARCH-LEUBA: More reason to tell  
20 me why we did this.

21 CHAIR STETKAR: Okay.

22 MEMBER CORRADINI: But I think Jose's  
23 point is fair. Ten years ago, or thereabouts, this  
24 was done for a particular reason. But now that you've  
25 done it, how do you use it going forward? I think

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1       that's what Jose is asking.

2                   MEMBER BROWN: I would -- can I -- since  
3 I'm uninitiated and I've been here for nine years and  
4 I've sat in on several of these meetings, but not all  
5 --

6                   MEMBER BLEY: Started the year before you  
7 joined us.

8                   MEMBER BROWN: I know.

9                   MEMBER BLEY: You're no longer  
10 uninitiated.

11                   MEMBER BROWN: Well, after the first  
12 couple of meetings, I decided I would be more  
13 selective in the meetings that I attended.

14                   (Laughter.)

15                   MEMBER BROWN: I phrase that very  
16 succinctly. And I agree with Jose in that I think  
17 it's important since this is kind of the end product,  
18 to say why we did this and what are the conclusions we  
19 should gather from this in terms of how we use the  
20 results.

21                   The ones I've sat in on hydrogen  
22 deflagration and stuff like that, how does it apply to  
23 the safety posture of the plants? How can it be  
24 generally applied, if at all, to plants other than the  
25 ice, you know, this specific plant?

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1           Because, otherwise, if you go through a  
2 bunch of stuff where you show graphs and lots of ten  
3 to the minus seventh, eighth and ninth, it's just --  
4 it's a sleeper. You're going to fall asleep.

5           You'd really like -- at least I would, you  
6 really want to know what conclusions do we draw out of  
7 this in terms of is this a big, big problem, safety  
8 posture, because it's just going to spread all over  
9 the place, or did we get -- were we able to come look  
10 at the results and say, look, yeah, this happens, but  
11 here's the general configuration or the impact at the  
12 site or the general areas, because that's -- it's the  
13 safety posture that counts, not the fun and games of  
14 playing with titivating models.

15           That's my personal opinion in terms of  
16 what ought to come out of the final presentation at  
17 the end. That's all I have, John.

18           CHAIR STETKAR: And something to keep in  
19 mind kind of along these lines of why did you do it,  
20 what are you going to do with it, etc.

21           The executive summary does touch on the  
22 fact that some of this, a good fraction of it, is  
23 developing methods, models and tools that can be used  
24 throughout the Agency in many other applications. So,  
25 it isn't just it, the study, and developing expertise

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1 within house on those.

2 And I think that the full committee --

3 MEMBER MARCH-LEUBA: We need to answer the  
4 question now.

5 CHAIR STETKAR: No, but, I mean, I wanted  
6 to kind of alert them that it isn't just it, this  
7 thing.

8 MS. SANTIAGO: Right. We've talked about  
9 that.

10 CHAIR STETKAR: Yeah.

11 MS. SANTIAGO: And it's a good point.

12 CHAIR STETKAR: Anything else on stuff for  
13 the full committee presentation? You have a  
14 challenge, clearly.

15 If not, I will ask if there are any  
16 members of the public in the room who would like to  
17 make comments. Please come up to the microphone and  
18 do so.

19 And not seeing a stampede, I'll ask if  
20 there are any members of the public on the bridge line  
21 who would like to make a comment. Please do so.

22 The bridge line should be open. Please  
23 identify yourself and make a comment.

24 (Pause.)

25 CHAIR STETKAR: That's a good indication

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1 the bridge line is open. So, not hearing anyone, if  
2 there's anyone out there, again, please make a  
3 comment. Okay. We'll get that reclosed again.

4 As we always do in a subcommittee meeting,  
5 I'll go around the table and ask for final comments by  
6 each of the members.

7 Ron.

8 MEMBER BALLINGER: Well, I think we've  
9 pretty much beat the dead horse in understanding what  
10 went wrong with the computer runs and things like  
11 that. So, that would be my only comment.

12 CHAIR STETKAR: Matt.

13 MEMBER SUNSERI: I have no other comments.  
14 Thank you.

15 CHAIR STETKAR: Dick.

16 MEMBER SKILLMAN: No further comments.  
17 Thank you.

18 CHAIR STETKAR: Dana.

19 MEMBER POWERS: I have an organizational  
20 conflict of interest here, so I don't make comments.

21 CHAIR STETKAR: I got to remember that.

22 MEMBER POWERS: I don't believe in  
23 eutectics and the uranium-zirconium oxygen system  
24 based on a huge number of experiments.

25 MEMBER CORRADINI: I just thank the staff.

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1 I do think, though, I guess my only emphasis would be  
2 I would treat the other four or five members that  
3 aren't here as your first shot at the intelligent  
4 public.

5 So, cast it in that regard for them,  
6 because you'll get "why" questions and what-do-you-  
7 use-it-for questions from some of the other members.  
8 And I think that's kind of how I would at least try to  
9 -- at least customize the beginning of your couple of  
10 hours in front of us in full committee.

11 Other than that, I appreciate all that  
12 you're trying to do to educate us for those that  
13 forget what you've done in the past since it has been  
14 a few years.

15 CHAIR STETKAR: Dennis.

16 MEMBER BLEY: Nothing more to add.  
17 Thanks.

18 CHAIR STETKAR: Jose.

19 MEMBER MARCH-LEUBA: Nothing.

20 CHAIR STETKAR: Charlie.

21 MEMBER BROWN: Nothing more.

22 CHAIR STETKAR: Joy.

23 MEMBER REMPE: I also want to thank you  
24 for your presentations and your efforts. I guess the  
25 only point I'd like to emphasize is as you finalize

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1 the executive summary, please consider caveats where  
2 needed when you have conclusions and statements.

3 And I think I've tried to emphasize a  
4 couple of examples today. Thank you.

5 CHAIR STETKAR: Now, as part of a -- let  
6 me also say thanks. Thanks for all of the work that  
7 you did between May or June or whenever and now. A  
8 tremendous amount of stuff has been done.

9 I think the report benefits from it. I  
10 think the understanding benefits from it. Although we  
11 probably won't discuss it, I like Appendix I. I think  
12 it's a confidence builder. And thanks for all of the  
13 work.

14 I was going to say -- oh, the ACRS will  
15 write a letter on this. The ACRS letter will be  
16 written against the material we have and today. So,  
17 there will be no update to the executive summary to  
18 effect an ACRS letter or anything.

19 If you want to send us a little side  
20 report to bolster confidence in the numbers for the  
21 valves, that's fine, but we're not going to entertain  
22 -- we can't because of our scheduling. So, we're  
23 going to write a report on what we have and today.

24 I would ask, and I don't know how we're  
25 going to do this given our other constraints, I really

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1 want some input from the individual members on what  
2 might go into a draft of our letter. And let's  
3 discuss that offline.

4 With that, the meeting is adjourned.

5 (Whereupon, the above-entitled matter went  
6 off the record at 12:07 p.m.)

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# **State-of-the-Art Reactor Consequence Analyses (SOARCA) Project: Sequoyah Integrated Deterministic and Uncertainty Analyses**

ACRS Subcommittee Briefing  
October 18, 2017

Patricia A Santiago, Chief  
Accident Analysis Branch  
Division of Systems Analysis  
NRC Office of Nuclear Regulatory Research

# Schedule

- ACRS Full Committee on SOARCA Sequoyah Analyses – November 2, 2017
- Transmit SOARCA Sequoyah NUREG/CR report to the Commission and NRC publications – November 30, 2017
- Updating SOARCA Surry Uncertainty Analysis – ongoing – June 29, 2018

- MELCOR and severe accident progression: Kyle Ross, Jeff Cardoni, Chris Faucett, Troy Haskin, Randy Gauntt (SNL); Casey Wagner (dycoda); Hossein Esmaili, Trey Hathaway, Allen Notafrancesco, Salman Haq, Ed Fuller (NRC)
- MeIMACCS: Nathan Bixler, Doug Osborn\*\* (SNL); Trey Hathaway (NRC)
- MACCS, consequence analysis and emergency response: Nathan Bixler, Matthew Dennis, Joe Jones, Doug Osborn\*\*, Fotini Walton (SNL); Trey Hathaway, Jonathan Barr, Keith Compton, Todd Smith, Edward Roach (NRC);
- UA methodology: Dusty Brooks, Matthew Denman (SNL); Tina Ghosh\*\*, Trey Hathaway (NRC)
- Accident scenario development: Selim Sancaktar, Jose Pires (NRC)

**\*\*Co-leads**

# Outline

- Focused pressurizer safety valve study
  - New Appendix I in draft report
- Updates in response to ACRS members' comments from June 6, 2017 subcommittee meeting
- Discussion of topics for presentation to full committee



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# **Focused Pressurizer Safety Valve Study**

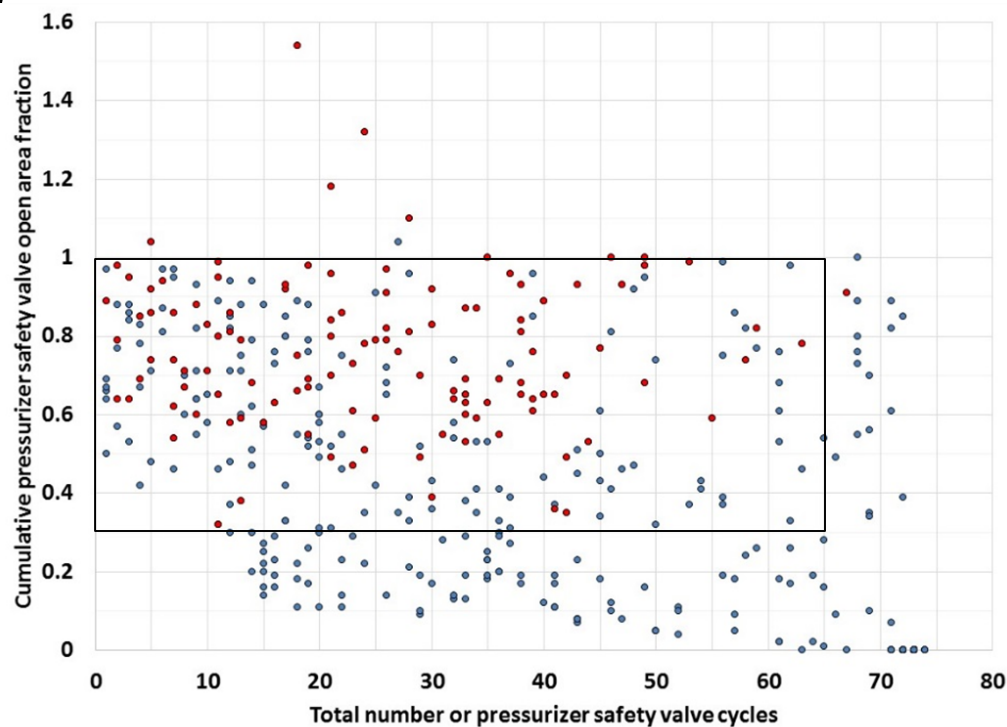
Trey Hathaway

Accident Analysis Branch

NRC Office of Nuclear Regulatory Research

# Focused Safety Valve Study

- Updated Sequoyah model run with sampled safety valve cycles less than 65 (13% of distribution) and open area fraction greater than 0.3 (40% of distribution)
- Most parameter distributions identical to UA
  - Safety valve distribution constructed from sampled values of UA and sampled on range of 1 to 65
  - Open area fraction distribution sampled with lower bound of 0.3
- Calculation initially limited to 15 hours
  - All early failures were less than 1 hr
- Identical model to UA
  - Sampled fabric seal failure pressure input corrected



**Figure I-1 Cumulative pressurizer safety valve open area fraction versus total number of safety valve cycles, where early containment failures are shown in red\*\***



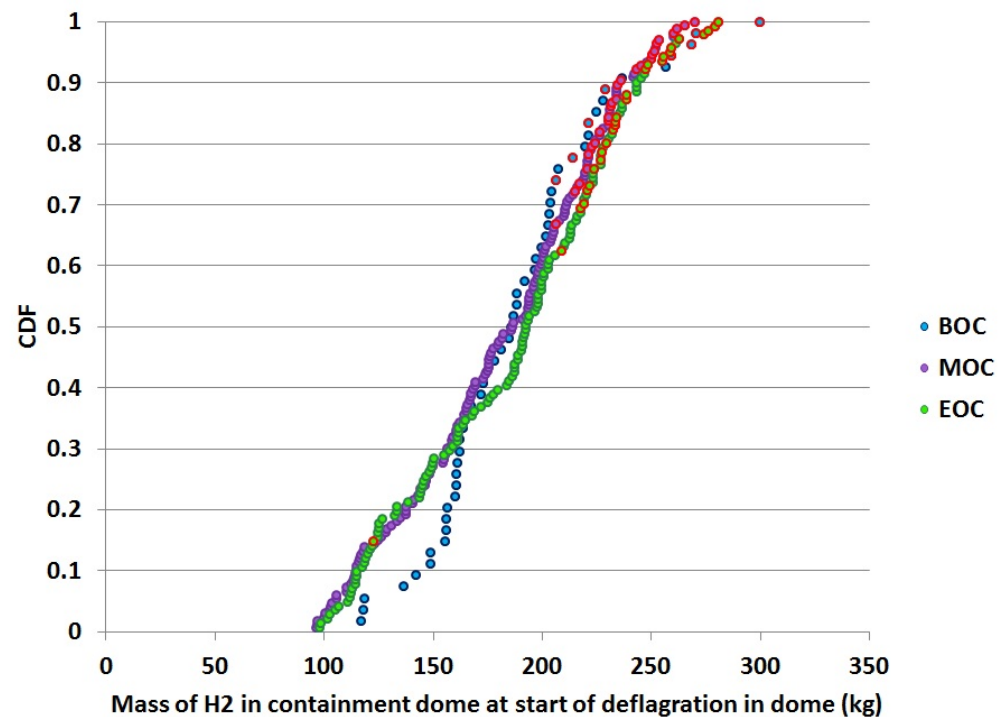
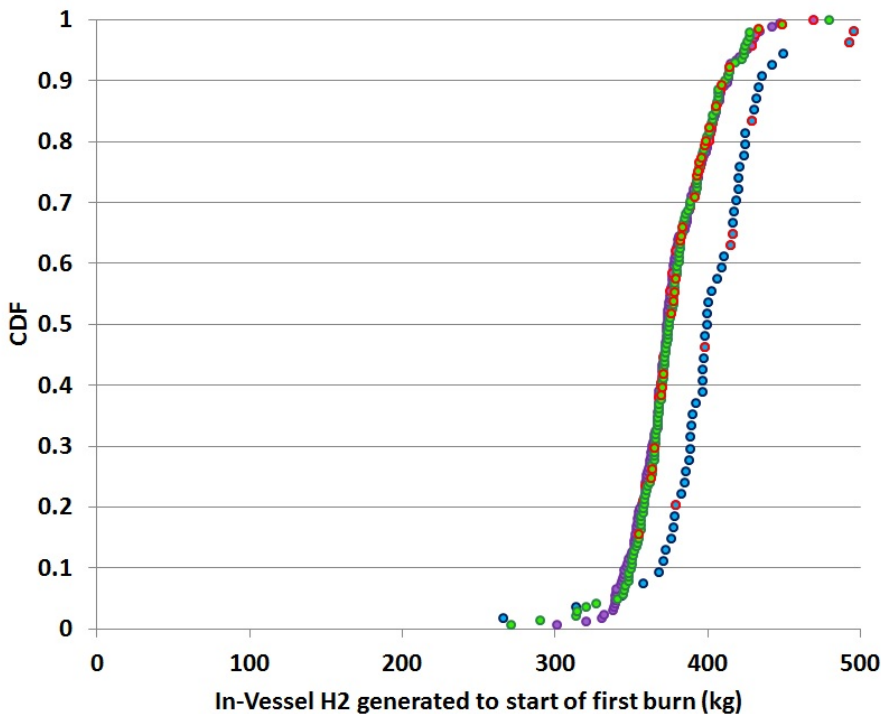
# Early Containment Failure

- Approximately 17% of the realizations in focused study resulted in early containment failure
  - BOC: ~15%
  - MOC: ~16%
  - EOC: ~19%

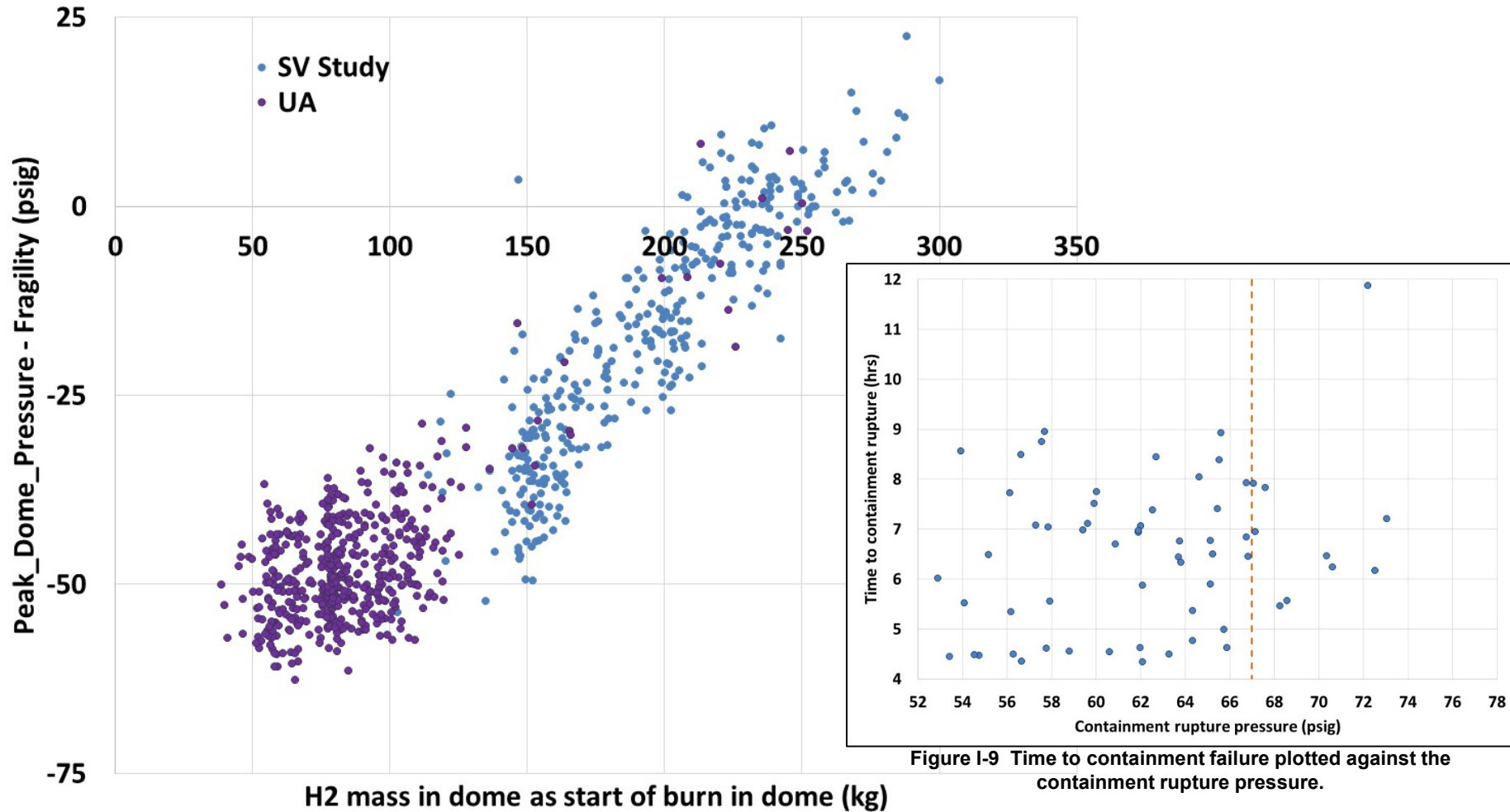
**Table I-1 Statistics on time (hours) of early containment rupture for BOC, MOC, and EOC realizations.**

	BOC	MOC	EOC
<b>Mean</b>	<b>6.0</b>	<b>6.6</b>	<b>6.6</b>
<b>Median</b>	<b>6.0</b>	<b>6.9</b>	<b>6.8</b>
<b>5<sup>th</sup>-Percentile</b>	<b>5.5</b>	<b>4.3</b>	<b>4.5</b>
<b>95<sup>th</sup>-Percentile</b>	<b>6.3</b>	<b>10.8</b>	<b>8.8</b>

# In-vessel Hydrogen Generation and Transport to Dome Up to First Deflagration

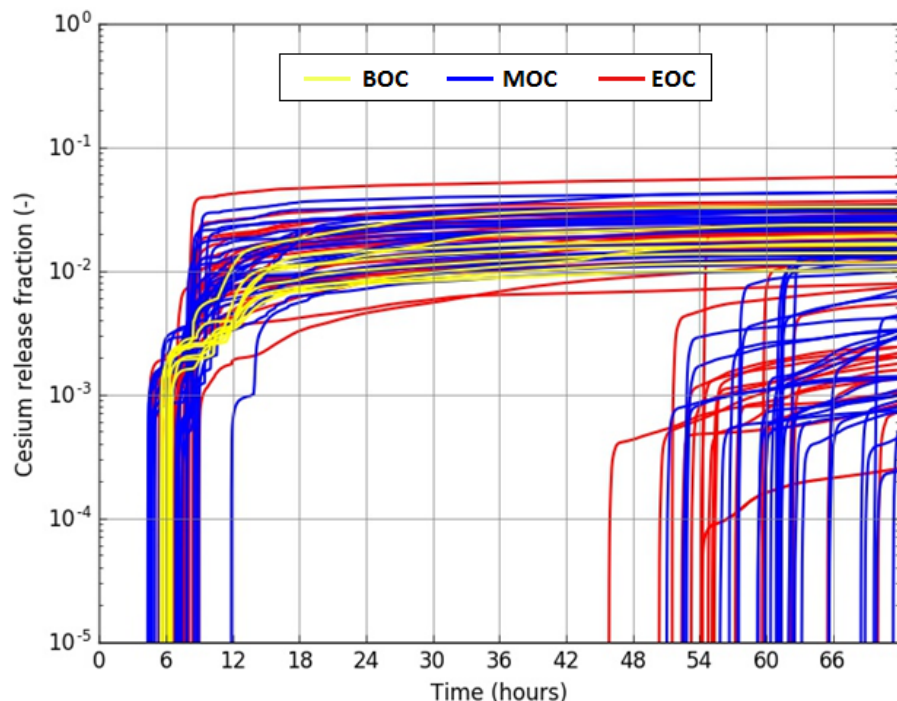


# Hydrogen Deflagration Peak Pressure

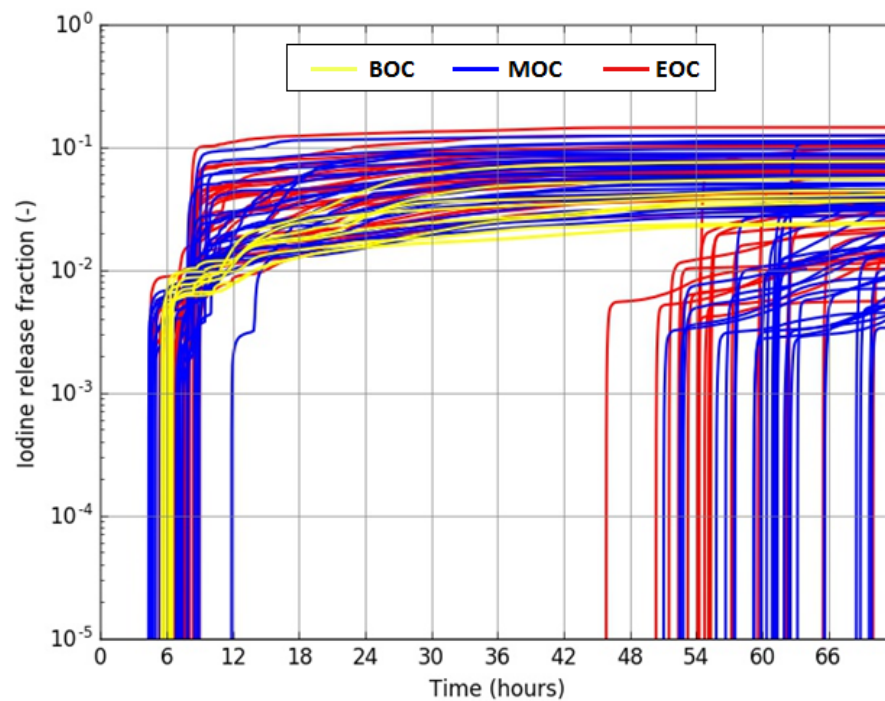


**Figure I-13** Difference between peak containment pressure and sampled containment fragility plotted against maximum hydrogen reaching the dome around the time of burn initiation in the dome.

# Cesium and Iodine Release Fraction



**Figure I-14** Cesium release fraction versus time.



**Figure I-15** Iodine release fraction versus time.

**Table I-10** Statistics on Cesium and Iodine release fraction at 72 hours for the early and late containment rupture realizations.

	Early Containment Rupture		Late Containment Rupture	
	Cs release	I release	Cs release	I release
<b>Mean</b>	<b>0.022</b>	<b>0.063</b>	<b>0.004</b>	<b>0.021</b>
<b>Median</b>	<b>0.022</b>	<b>0.06</b>	<b>0.002</b>	<b>0.014</b>
<b>5<sup>th</sup> Percentile</b>	<b>0.01</b>	<b>0.028</b>	<b>0.0003</b>	<b>0.004</b>
<b>95<sup>th</sup> Percentile</b>	<b>0.042</b>	<b>0.122</b>	<b>0.015</b>	<b>0.084</b>

# Latent Cancer Fatality Risk

## Statistics on Total Risk

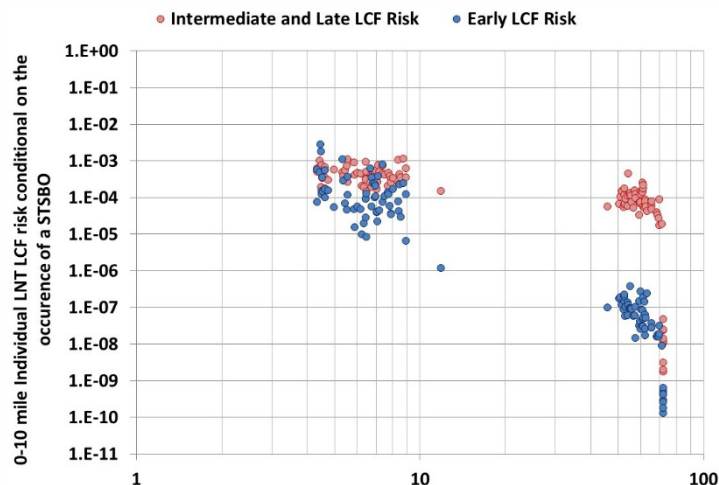
**Table I-11** Statistics for the 0-10 mile individual LCF risk assuming LNT and conditional on the occurrence of a STSBO.

	Early Containment Rupture	Late Containment Rupture
<b>Mean</b>	7.0E-04	8.3E-05
<b>Median</b>	5.8E-04	6.7E-05
<b>5<sup>th</sup> Percentile</b>	2.1E-04	3.2E-09
<b>95<sup>th</sup> Percentile</b>	1.5E-03	2.2E-04

## Statistics on Emergency and Intermediate/Long-Term Risk

**Table I-12** Statistics for the emergency phase, and intermediate and long-term phase contributions to the 0-10 mile individual LCF risk assuming LNT and conditional on the occurrence of a STSBO.

	Early Containment Rupture		Late Containment Rupture	
	Emergency	Intermediate and Long-Term	Emergency	Intermediate and Long-Term
<b>Mean</b>	2.4E-04	4.6E-04	7.6E-08	8.3E-05
<b>Median</b>	1.1E-04	4.2E-04	5.3E-08	6.7E-05
<b>5<sup>th</sup> Percentile</b>	8.5E-06	1.7E-04	2.5E-10	3.0E-09
<b>95<sup>th</sup> Percentile</b>	1.0E-03	1.0E-03	2.4E-07	2.2E-04



**Figure I-18** 0-10 mile Individual LNT LCF risk conditional on the occurrence of a STSBO as a function of containment rupture time.

# Early Fatality Risk

**Table I-14. Statistics for mean, individual, early fatality risk conditional on the occurrence of a STSBO and on an early containment failure (within 15 hr of accident initiation). Tabulated statistics are means over weather variability and express epistemic uncertainties in the MELCOR and MACCS input parameters.**

	0-1.0 mi	0-1.3 mi	0-2.0 mi	0-3.0 mi	0-4.0 mi
<b>Mean</b>	<b>2.6E-06</b>	<b>1.7E-06</b>	<b>1.1E-06</b>	<b>3.8E-07</b>	<b>2.2E-07</b>
<b>Median</b>	<b>1.9E-12</b>	-	-	-	-
<b>5<sup>th</sup>-Percentile</b>	-	-	-	-	-
<b>95<sup>th</sup>-Percentile</b>	<b>2.0E-05</b>	<b>1.3E-05</b>	<b>6.8E-06</b>	<b>2.0E-06</b>	-

**Table I-15. Statistics for mean, individual, early fatality risk conditional on the occurrence of a STSBO. Tabulated statistics are means over weather variability and express epistemic uncertainties in the MELCOR and MACCS input parameters.**

	0-1.0 mi	0-1.3 mi	0-2.0 mi	0-3.0 mi	0-4.0 mi
<b>Mean</b>	<b>2.3E-08</b>	<b>1.5E-08</b>	<b>9.7E-09</b>	<b>3.4E-09</b>	<b>2.0E-09</b>
<b>Median</b>	-	-	-	-	-
<b>5<sup>th</sup>-Percentile</b>	-	-	-	-	-
<b>95<sup>th</sup>-Percentile</b>	-	-	-	-	-



# **Updates in Response to ACRS Members' MELCOR Comments**

Casey Wagner, dycoda, LLC

Tina Ghosh, Accident Analysis Branch, NRC Office of Nuclear  
Regulatory Research



# Fabric Seal Failure Criteria

- ACRS member comments concerned identified error, confusing description of the failure parameter, and seal failure area
- New documentation added on the impact on early containment
  - Flow through the ice chest and other leakage pathways allow hydrogen transport to the dome prior to the first burn
  - Focused valve study includes fabric seal correction
  - Comparisons to draft 2016 UA results show continuous behavior
- New documentation added on impact on late containment failure
  - Intact seal failed following the first hydrogen burn in the dome



# Fabric Seal Failure Criteria

- Fabric seal parameter description was re-written to clarify UA parameter sampling versus the deterministic thermal-mechanical failure criteria
  - Sampled UA parameter is for the cold failure differential pressure
  - Deterministic non-sampled failure criteria for elevated temperature conditions
- ACRS member questioned whether seal failure area is different for mechanical over-pressure versus due to elevated temperature
  - Range of failure areas allowed robust natural circulation
  - Failure area was not important parameter in regression results

# Ice Condenser Doors

- Sampled AJAR parameter controls lower ice chest door open area after fully opening
  - Five separate flow paths (Only 46 Pa required to fully open the doors)
  - AJAR flow paths are large and not the controlling flow resistance when <5 flow paths are open
- New UA discussion illustrating range of door behaviors
- Analysis from the focused SV study and UA shows all 5 MELCOR flow paths usually satisfy AJAR criteria when there is a hot leg failure
  - Partial (<5 flow paths) or no AJAR is the usual response when there is no hot leg failure

# Hydrogen Ignition and Burn Direction

- Known ignition sources
  - Hot gases from the hot leg and the PRT
  - Ex-vessel debris
- Location of the ignition within the compartment has uncertainty
  - May not be near the hot leg, PRT, or ex-vessel debris
  - Dependent on local gas concentrations, mixing, and strength of the ignition source, etc.
- New discussion identifies flame directions as it propagates within the compartment as surrogates for uncertainties in the ignition location

# Safety Valves

- Added discussion of how the number of demands (denominator) is calculated in NUREG/CR-7037 operating experience data
- Revisited publicly available information from Licensee Event Reports on the main steam safety valve failure-to-close events, and SME's summary of these events, but did not add anything further to the report
- Added discussion on rationale for not including failure-to-open SV failure mode

# Time in Cycle Sampling

- Two-part approach
  1. Improved the discussion of the distribution between BOC, MOC, and EOC in the Sequoyah documentation
  2. New Surry UA uses more continuous sampling of inventory & decay heat throughout the fuel cycle
- New Sequoyah discussion includes
  - New ORIGEN work to characterize selected Sequoyah values within the continuum of the fuel cycle
  - BOC sample space defined with consideration of decay heat build-up and development of secular equilibrium inventory of I-131
    - BOC investigates low decay heat response
  - EOC sample space is developed with consideration of long-lived Cs-137 inventory
    - EOC investigates high decay heat response and near maximum Cs-137 inventory

# Other Additions

- Statistical stability analysis conducted for figures of merit and documentation added in Appendix A
- Recognized possible impact of eutectic melt temperature on burnup but also inadequate data to quantify
- Added discussion on approach for failed computer calculations
- Added discussion of ice bed response during seismic event
- Improved vessel failure discussion to address cited issues
- LTSBO discussion improved to address limitations on asymmetric SG response
- Added discussion/plots on RCP leakage as an ignition source

# Other Additions

- Comparison of new UA results with draft 2016 results with different valve failure distributions
  - Presented last ACRS meeting
- Focused pressurizer SV study results



# **Updates in Response to ACRS Members' MACCS Comments**

Nathan Bixler, Sandia National Laboratories





# Emergency Response Timing

- Question – Is emergency response normally triggered by GE?
- Response – Verified that emergency response modeling is faithful to TEMA planning
- Resolution
  - Final Exercise Report Sequoyah Nuclear Power Plant (FEMA, 2004) timeline lists sequentially
    - SAE declaration
    - First siren, first EAS message, “School relocation, notification for buses, stay tuned”
    - GE declaration
    - Second siren, second EAS message
  - Notes from conversation with TEMA state that “upon SAE, schools are evacuated to paired schools outside EPZ”
  - Discussion added to final document

# Humidity

- Question – How does MACCS treat deposition under humid conditions?
- Response – authors indicated that humid conditions could cause hygroscopic aerosols to grow and deposit faster, but MACCS does not treat this mechanism
- Resolution
  - Performed bounding estimate to show that deposition velocity of hygroscopic aerosols could increase by less than a factor of 2 and this is within the uncertainty range
  - Expanded discussion in section on uncertainty of deposition velocity

# Presentation of Risks

- Comment – Improve presentation of EF and LCF risks
- Response – Added discussion of bimodal nature of LCF risk, minimal dependence of risk on distance, and reconsider discussion of EF risk
- Resolution
  - Discussion of LCF risk was expanded to address comments
  - Figure and table showing EF risk was eliminated

# **DISCUSSION OF TOPICS FOR FULL COMMITTEE PRESENTATION**

# References

- SECY-12-0092, “State-of-the-Art Reactor Consequence Analyses – Recommendation for Limited Additional Analysis” (July 2012)
- NUREG-1935, State-of-the-Art Reactor Consequence Analyses (SOARCA) Report (November 2012)
- NUREG/CR-7110, Vol. 1, SOARCA Project Peach Bottom Integrated Analysis, Rev. 1, (May 2013)
- NUREG/CR-7110, Vol. 2, SOARCA Project Surry Integrated Analysis, Rev. 1 (August 2013)
- NUREG/CR-7008, MELCOR Best Practices as Applied in the SOARCA Project (August 2014)
- NUREG/CR-7009, MACCS Best Practices as Applied in the SOARCA Project (August 2014)
- NUREG/CR-7155, SOARCA Project Uncertainty Analysis of the Unmitigated Long-Term Station Blackout of the Peach Bottom Atomic Power Station (May 2016)
- NUREG/BR-0359, Modeling Potential Reactor Accident Consequences, Rev. 1 (December 2012, update in progress)

# Acronyms & Abbreviations

AC	Alternating Current	MSIV	Main Steam Isolation Valve
BOC	Beginning of Cycle	NTTF	Fukushima Near-Term Task Force
CCDF	Complementary Cumulative Distribution Function	PDF	Probability Density Function
CCI	Core Concrete Interactions	PGA	Peak Ground Acceleration
CDF	Core Damage Frequency	PRA	Probabilistic Risk Assessment
CST	Condensate Storage Tank	PRT	Pressurizer Relief Tank
DC	Direct Current	PZR	Pressurizer
EOC	End of Cycle	RCP	Reactor Coolant Pump
EPZ	Emergency Planning Zone	RCS	Reactor Coolant System
EF	Early Fatality	RLZ	Realization
GE	General Emergency	RPV	Reactor Pressure Vessel
HL	Hot Leg	RtePM	Real Time Evacuation Planning Model
FLEX	Diverse and Flexible Coping Strategies	SBO	Station Blackout
FTC	Failure to Close	SG	Steam Generator
FTO	Failure to Open	SAE	Site Area Emergency
LCF	Latent Cancer Fatality	SIP	Shelter in Place
LNT	Linear No Threshold	SME	Subject Matter Expert
LTSBO	Long-Term Station Blackout	SNL	Sandia National Laboratories
MACCS	MELCOR Accident Consequence Code System	SOARCA	State-of-the-Art Reactor Consequence Analysis
MCR	Main Control Room	STSBO	Short-Term Station Blackout
MELCOR	Not an acronym - accident progression code	SV	Safety Valve
MeIMACCS	MELCOR to MACCS Source Term Converter	TDAFW	Turbine Driven Auxiliary Feedwater System
MOC	Middle of Cycle	TVA	Tennessee Valley Authority
		UA	Uncertainty Analysis