Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: ACRS Reliability and PRA Subcommittee

Docket Number: N/A

Location: Rockville, Maryland

Date: April 4, 2018

Work Order No.: NRC-3626 Pages 1-255

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RELIABILITY AND PRA SUBCOMMITTEE

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WEDNESDAY

APRIL 4, 2018

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 1:00 p.m., John Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

VESNA B. DIMITRIJEVIC, Member

WALTER L. KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

JOY L. REMPE, Member

MATTHEW SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

CHRISTIANA LUI

ALSO PRESENT:

PAUL AMICO, Jensen Hughes

SUSAN COOPER, RES

KAYDEE GUNTER, Jensen Hughes*

J. S. HYSLOP, NRR

JEFF JULIUS, Jensen Hughes

ASHLEY LINDEMAN, EPRI

SEAN PETERS, RES

MARY PRESLEY, EPRI

MARK SALLEY, RES

*Present via telephone

T-A-B-L-E O-F C-O-N-T-E-N-T-S

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

2 1:00 p.m.

3 CHAIR STETKAR: The meeting will now come

4 to order. This is a meeting of the Reliability and PRA

5 Subcommittee, the Advisory Committee on Reactor

6 Safeguards.

7 I'm John Stetkar, Chairman of the

8 Subcommittee Meeting. ACRS members in attendance are

9 Ron Ballinger, Dennis Bley, Harold Ray. I believe

10 we'll be joined by Dana Powers and Matt Sunseri, Jose

11 March-Leuba, Walt Kirchner will join us, Joy Rempe, and

12 Vesna Dimitrijevic. Christiana Lui of the ACRS staff

13 is a designated federal official for this meeting.

14 The subcommittee will hear presentations

15 on the Joint NRC EPRI project on main control room

16 abandonment, human reliability analysis in fire

17 probabilistic risk assessments, in particular, the

18 draft quantification guidance.

19 The subcommittee will gather information,

20 analyze relevant issues and facts, and formulate

21 proposed positions and actions, as appropriate for

22 deliberation by the full committee.

23 The ACRS was established by statute, and

24 is governed by the Federal Advisory Committee Act.

25 This means that the committee can only speak through

its published letter reports. We hold meetings to gather information to support our deliberations.

Interested parties who wish to provide comments can contact our office requesting time, after the meeting announcement is published in the Federal Register.

That said, we also set aside some time for spur-of-the-moment comments from members of the public attending or listening to our meetings. Written comments are also welcome.

The ACRS section of the USNRC public website provides our charter, bylaws, letter reports, and full transcripts of all open full committee and subcommittee meetings, including slides presented at these meetings.

The rules for participation in today's meeting were previously announced in the Federal Register. We've received no written comments or request for time to make oral statements from members of the public regarding today's meeting.

We have a bridge line established for interested members of the public to listen in. To preclude interruption of the meeting, the phone bridge line will be placed in the listening mode during the presentations and the committee discussions. We'll

un-mute the bridge line at a designated time to afford the public an opportunity to make a statement or provide comments.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, we request that our participants in this meeting use the microphones located throughout the meeting room when addressing the subcommittee.

Speakers should first identify themselves, and speak with sufficient clarity and volume, so that they may be readily heard. Please make sure that the green light on the microphone in front of you is on when you're speaking, and turn it off when it's -- when you're not. Helps our transcript.

At this time please check all of your cellphones, any other beeping devices, annoying electronic equipment, and so forth, and turn them off. Otherwise, we will smash them.

We will now proceed with the meeting, and I call upon Mark Henry Salley of the NRC staff to begin. Mark.

MR. SALLEY: Thank you, and good afternoon. I'm Mark Henry Salley. I'm the Branch Chief of Fire and External Hazards and the Office of

1 Research. I have Sean Peters with me. He's the Branch
2 Chief for Human Factors and Reliability Analysis.
3 I'm going to give you a little opening for
4 this today, and this is another NRC EPRI project that's
5 worked under the joint MOU. I think it's important
6 when we start out, that a number of successes we've had
7 working together with EPRI, in fire PRA, fire modeling,
8 post-fire safe shutdown circuit analysis, and in fire
9 HRAs, you're going to hear today.
10 So, there's a string of things. We work
11 together for a common goal, and we can pull our
12 resources, as you'll see today, and we can come out with
13 a high-quality product.
14 You're going to be hearing from Dr. Susan
15 Cooper from the Office of Research, as well as Ashley
16 Lindeman and Mary Presley from EPRI.
17 But before I turn it over to them, I just
18 wanted to give a little background here to kind of set
19 the stage for this. In 2005, again, the first big
20 project we worked with EPRI in the fire area, was
21 NUREG/CR-6850. 6850 had a little bit of HRA -- just
22 a bit, I believe, in task 12 -- and there was clearly
23 identified a need to do more detailed HRA in the
24 risk-inform performance-based environment.
25 So, we got together, we put a joint team

1 together. In June 2009, if you remember, they came to
2 the subcommittee and presented the work they had done
3 to-date. In December of that year we put a Federal
4 Register notice out with the draft report. We received
5 public comment on it.
6 We came back in April and September of
7 2011, and presented to you. And then we finally
8 published the report -- NUREG-1921, which is also
9 EPRI-1023001, in July of 2012.
10 So, that was a huge step forward for fire
11 HRA to use in the PRA applications. The one thing with
12 that report where it kind of stops short with the area,
13 and that was main control room abandonment. That
14 wasn't included in that first version of 1921.
15 And it's interesting, if you look at
16 deterministic regulations if you recall, which for the
17 plans that are the, as we call, Appendix R plans,
18 Section 3G and 3L talk about dedicated and alternative
19 shutdown, which is your main control and abandonment,
20 we needed something for the risk-informed
21 performance-based, and also we haven't looked at that
22 topic, if you think about it, since 1981.
23 So this was an area that clearly a lot of
24 work could be done. So, we got the group back together
25 to look at this, and -- check my dates here -- on

1 May 4th of 2016 we presented to the group, and August
2 2017 we published Supplement 1 to NUREG-1921. That's
3 also EPRI 3002009215.
4 And that, of course, is the qual- -- excuse
5 me, the qualitative HRA approach for main control room
6 abandonment.
7 So, the next piece to come up is what you're
8 going to hear about today. And this is the
9 quantitative piece. Before I turn it over, there's one
10 other area I'd like to point out in fire HRA, where we've
11 done quite a bit of work, that some of you may be
12 familiar with, and that's new reg 2180, which is the
13 incipient fire detection.
14 And as we got into that project, we looked
15 at it, we saw that HRA was a key element into doing the
16 incipient fire detection.
17 So, without further ado, I'd like to turn
18 it over to the group here, and get started.
19 CHAIR STETKAR: Green light on, talk,
20 green light off, don't.
21 DR. COOPER: All right, thank you, Mark.
22 Susan Cooper, Office of Research. I'm going to go
23 ahead and kick things off here with the presentation,
24 which, as Mark said, focuses on main control room
25 abandonment, and more particularly, we're going to

spend most of our time on the most recent report -- draft report on quantitative guidance for HRA main control room abandonment scenarios.

So, for today, in general, we're going to provide an update to the overall project and, as I said, we're going to want to focus on the second product of the research for main control room abandonment.

This particular work is based on -- built on the original fire HRA guidelines, which Mark mentioned, which is NUREG-1921, that established the basic process of how to do fire HRA.

And then, again, as Mark mentioned, NUREG-1921 supplement 1, which is the qualitative HRA guidance for main control room abandonment scenarios, was published in August of 2017.

So, those two were the basis for the next product on main control room abandonment. As with those other products, the quantification guidance is built on the experience of the authors, as well as other experts or expertise that we accessed with respect to developing NUREG-1921, performing NFPA 805 submittals, reviewing NFPA-805 submittals, so on and so forth.

This is the last piece of the research that we planned for main control room abandonment, and that

1 is the quantification guidance.

2 So, the agenda for today is to do a little

3 bit of a review of the project's history and background,

4 including introducing the project team. Because

5 supplement 1, which is on the qualitative analysis, did

6 undergo some changes after we presented to the

7 subcommittee back in May of 2016, we wanted to talk a

8 little bit about what those updates were, responses to

9 comments here from the ACRS.

10 In addition, we had a peer review and peer

11 review comments to respond to, as well. So we will

12 spend a little bit of time talking about those updates.

13 And then, as I mentioned, we like to spend

14 most of our time talking about supplement 2, the new

15 product, which you have in draft form, which is the

16 quantitative guidance for HRA for main control room

17 abandonment scenarios.

18 We're going to give a bit of an overview

19 of how we went about this project, and what guidances

20 we provide. In particular, we divide up, and we'll

21 talk a little bit more about this, divide up the

22 scenarios into what happens before abandonment occurs,

23 what happens during the decision to abandon the control

24 room, specifically on loss of con- -- for

25 loss-of-control scenarios. And then also, what

1 happens once you left the control room and you're now
2 implementing your safe shutdown strategy.
3 Then, we're going to wrap up with a quick
4 mention of our status future work and any closing
5 remarks. So, that's the agenda we propose for today.
6 Now --
7 MEMBER BLEY: Susan?
8 DR. COOPER: Yes.
9 MEMBER BLEY: Let me just make a little
10 minor, minor point here. I hope you folks have noticed
11 that you haven't been consistent through this report
12 in defining your phases 1, 2 and 3. There are quite
13 a few places where you say, phase 1 ends at the decision
14 to abandon the control room, which is old speak, I
15 think.
16 DR. COOPER: Okay. We will look for that,
17 but that is true. You're right.
18 MEMBER BLEY: There's at least two or
19 three --
20 DR. COOPER: That does need to be --
21 MEMBER BLEY: -- places that you'll
22 catch.
23 DR. COOPER: Okay. Okay, good. Thank
24 you. That is definitely an error that will need to be
25 corrected. Thank you.

1 Okay, project history and background.
2 So, for -- specifically for the main control room
3 abandonment project, the fire events, the objective is
4 to provide HRA guidance specifically for those types
5 of scenarios where the fire conditions have been -- you
6 know, have created the instance where you have to leave
7 the control room -- the operation has to leave the
8 control room.
9 And there are two different cases that are
10 considered. There's what's called the loss of
11 habitability -- or LOH -- and that's where it's -- the
12 conditions in the control room are not such that people
13 can stay there safely.
14 So, that's one case. And the other one,
15 which is going to be of more interest for today, is going
16 to be loss of control, with the acronym of LOC. And
17 we'll talk a little bit more about those later.
18 We identified in NUREG-1921 when it was
19 published, that we needed to do more work in main
20 control room abandonment, that we had only gone so far
21 in that -- with that guidance.
22 And part of the reason why we have left it
23 until now is that it is a pretty complex topic with a
24 lot of plant-specific differences, a pretty wide range
25 of capabilities for the remote shutdown panel, which

1 also has an associated impact on the procedures and the
2 strategy that you have for shutting down, so that does
3 make it more difficult to develop generic guidance for
4 those -- some of those reasons.
5 So, this is the project team specifically
6 for supplement 1. You see on the NRC side Tammie
7 Rivera and I are on the team. Stacey Hendrickson could
8 not make it today, but she's is on one of the bridge
9 lines that Chris has set up, so I think it's separate
10 from the public line, so if we want to talk to her, we
11 can talk to her. John Wreathall is not available
12 today.
13 And then, on the upper side, both Mary
14 Presley and Ashley Lindeman are here today with me, and
15 Paul Amigo and Jeff Julius are there in the audience,
16 and Kaydee Gunter is also, I think, on the line with
17 Stacey, and Erin's not made it with us.
18 So, this is the same team we had for
19 supplement 1, with the exception of Nick Melly of NRC
20 is not on the team for supplement 2, which is more
21 HRA-related. He provided -- there is a stronger PRA
22 element to supplement 1, and they needed his support
23 there.
24 He's going to be a peer reviewer for
25 supplement 2. All right.

1 MEMBER BLEY: Mr. Stetkar. We did not
2 write a letter on supplement 1, did we?
3 CHAIR STETKAR: We did not.
4 MEMBER BLEY: Are we planning to write a
5 letter on the whole thing, now?
6 CHAIR STETKAR: I think that's something
7 that we should discuss after this.
8 MEMBER BLEY: Okay. They haven't asked
9 for it.
10 CHAIR STETKAR: They haven't asked for it.
11 MEMBER BLEY: Okay.
12 DR. COOPER: Okay. We're now going to
13 discuss some of the updates to supplement 1, the
14 qualitative analysis, and Ashley's going to take over
15 on that.
16 MS. LINDEMAN: Okay. So, we were here
17 about two years ago in May of 2016, when we presented
18 our first draft of supplement 1. And since then, we've
19 done a lot of work. We took the comments from the
20 meeting here and addressed them, that we could. There
21 was other comments that we took that had a longer time
22 frame to resolve.
23 But, we went with a slightly revised
24 version in peer review in the summer of 2016. So, I
25 asked the peer reviewers to review for technical items,

1 and if it meets the needs of the intended users.
2 The peer review comprised a variety of
3 stakeholders, PRA practitioners from both the industry
4 and the NRC, HRA analysts, likewise from the industry
5 and the NRC. And then we also reached out to some
6 cognitive and behavioral science analysts.
7 So, we also got a lot of feedback from the
8 peer review, which, you know, we incorporated into our
9 final draft. So, EPRI published the report in August
10 of 2017, and as I understand that the NRC version of
11 the report is currently in publications.
12 There's been a -- several changes since
13 the version that you guys last formally received in May.
14 Various edits and clarifications from both the ACRS
15 comments and the peer review comments, so didn't want
16 to go through those kind of one-by-one, but wanted to
17 acknowledge that there were several places where we
18 found clarification wasn't good.
19 We also felt that we needed some way to walk
20 through the process. In NUREG-1921 there's a good
21 framework of the HRA process, and we felt since
22 supplement 1 used basis from 1921, we also felt it was
23 necessary to walk through and guide the analysts on what
24 pieces are relevant from 1921, and what pieces of the
25 HRA process are enhanced in supplement 1 in that

1 guidance.

2 We did add a dual unit timeline example in

3 section 7, which is the timing and timelines. I have

4 a picture of that and we'll go over some of the important

5 tidbits and links between actions and communications.

6 There was a --

7 MEMBER RAY: By dual unit you mean a dual

8 unit control room?

9 MS. LINDEMAN: Yes.

10 MEMBER RAY: Okay.

11 DR. COOPER: Dual unit shutdown.

12 MS. LINDEMAN: Yes.

13 DR. COOPER: But --

14 MEMBER RAY: Okay, there's so few dual

15 unit control rooms, that's why I asked. There's only

16 one that I know of, so I assume you're not talking about

17 that. Or both units are controlled from the same

18 control room.

19 DR. COOPER: Susan Cooper. Yes, it is for

20 a shared space control room.

21 MEMBER RAY: Okay.

22 DR. COOPER: So, it could be two separate

23 control boards within a shared space.

24 MEMBER RAY: Yeah.

25 DR. COOPER: There are other ones.

1 MEMBER RAY: All right.
2 DR. COOPER: There are other ones.
3 MEMBER RAY: Right. Well --
4 MR. HYSLOP: On the west coast.
5 MEMBER RAY: I wasn't sure. As I said, I
6 just wanted to ask what dual unit, whether it meant two
7 units side by side, or --
8 MR. HYSLOP: This is J.S. Hyslop. Yeah,
9 from data 5, you know, just because they're not shared
10 from the same space doesn't mean that you don't have
11 a dual unit shutdown. There's some places that don't
12 have alternate shutdown boards and they just have
13 different panels and things like that, and so you have
14 multiple shutdowns going on at the same time. That's
15 possible.
16 MEMBER RAY: Yeah, absolutely. And I was
17 trying to distinguish between that and the shared
18 control room space.
19 MS. LINDEMAN: All right. One of the
20 other comments that we received from the ACRS was
21 addressing the variability and the capability of the
22 remote shutdown panel design. So yeah, there's a new
23 section that looked at a BWR and a PWR and the type of
24 function and capability and instrumentation in the RSDP
25 design, recognizing that each panel, each plant, is

1 weak.

2 CHAIR STETKAR: Be careful, by the way,
3 Ashley, and folks up front. You've received no
4 comments from the ACRS on supplement 1.

5 MS. LINDEMAN: Oh, I'm sorry.

6 CHAIR STETKAR: You've received comments
7 from individual members in a subcommittee meeting.
8 So, be careful, because we're on public record. The
9 ACRS has not made any recommendations formally on
10 supplement 1.

11 MS. LINDEMAN: Thank you for clarifying
12 that. Additionally, since the draft in 2016, we
13 continue development on appendix B, which is command
14 and control, so that was more sought out and more
15 developed at the time of publication.

16 We also added appendix Delta, which was
17 insights from operator interviews conducted both by the
18 NRC and the industry.

19 Supplement 1 also introduced three phases
20 of main control room abandonment, and I'll briefly
21 discuss each phase. We have phase 1, which is
22 associated with actions taken prior to the decision to
23 abandon.

24 So, in this scenario we're very early on,
25 and actions are directed, as usual, from the main

1 control using the EOPs. That's probably the last time
2 we're really going to spend on phase 1, as the
3 supplement 2 really focuses on the quantification
4 differences for phase 2 and phase 3.
5 Phase 2 is the decision to abandon, and
6 there's a little bit different terminology, depending
7 on if the habitability criteria are met, so you're on
8 a loss of habitability situation, or a loss-of-control
9 situation.
10 And phase 2 is really important for the
11 loss-of-control scenarios where there's time to make
12 the decision, the cues come in and they're developing
13 into a situation where the plant may not be controlled.
14 How we've defined the loss-of-control
15 situations is, it's not something like the multiple
16 scurrilous operations less than in fire PRA, where
17 there's a set of equipment involved in a flow diversion
18 or other -- a loss-of-control situation is
19 plant-specific, and it requires an iterative process
20 between the plant operations and the fire PRA and the
21 fire HRA team.
22 So -- so usually the PRA team would come
23 and define conditions that may require abandonment, and
24 they would discuss with the operators to see times or
25 conditions where fires can develop and needs would

1 exist.

2 So, this is a good example of the iterative

3 feedback between training and procedures.

4 CHAIR STETKAR: And actually, it's

5 presented in the guidance that way, that the PRA people

6 know everything about the scenario and they present it

7 to the operators and ask them, will you leave.

8 That's not the way the real world works.

9 The operators are faced with deteriorating conditions

10 in the control room. They will decide to leave or not.

11 The PRA has to deal with that decision. So, the PRA

12 people should never say, here is the scenario, will you

13 abandon the control room or not, from the scenario

14 perspective of the PRA. Because the PRA is a piece of

15 paper.

16 The operators should be faced with a

17 scenario of, here are the indications that you have,

18 here are the effects of the fire, including

19 non-safety-related stuff, including secondary stuff,

20 including coordinations with whatever's going on with

21 the fire brigade. And then ask the operators, under

22 these conditions when do you think you would leave?

23 When do you think you would leave. Not, will you leave?

24 If they say, never, that's good. If they

25 say, well, we don't think, you know, these conditions

1 are tenable, we would leave, then the PRA has to deal
2 with that, and that's a fundamental problem with the
3 way it's presented in supplement 1, because it's always
4 the PRA analyst presents a PRA scenario to the
5 operators, and asks them, what would you do during this
6 PRA scenario? Not, what would you do during a fire.
7 I just make that comment. It's too late
8 for us to have any impact on supplement 1. We might
9 be able to pull that into supplement 2 somehow.
10 DR. COOPER: Susan Cooper, and I'll let
11 Mary talk, too. We'll take a look at that again, but
12 I -- in the -- I think it's section 4 of supplement 1
13 that specifically addresses the decision to abandon,
14 although there's some discussion in section 3, which
15 is the PRA modeling part. But there are two principle
16 criteria for being able to credit loss-of-control
17 scenarios that we talk about.
18 And one is, that there is explicit
19 procedural guidance that obviously has to have been
20 developed not just from the PRA, but operations has to
21 have agreed to, and they made some decisions.
22 The other one is based on interviews, you
23 get a consensus opinion from the set of operators. And
24 we have even questions -- guidance questions -- on how
25 to interview.

1 And at least it was not my intention -- nor
2 did I think it said that, but we'll look -- we'll
3 certainly look and make a correction if needed -- but
4 the idea was not to feed or lead the operators, per se.
5 It was -- because otherwise you're not
6 going to get the answer you want. You're not going to
7 say, well this is happening, aren't you going to leave,
8 then?
9 No, we don't do that. We try to understand
10 what kinds of situations they think. What's -- and it
11 might be system-based, it might be equipment-based.
12 It depends on plants. So, you're right, if it comes
13 across that way, we should fix it, but that was not what
14 we intended.
15 CHAIR STETKAR: Take a look at the
16 guidance for the operator interviews. My personal
17 opinion is they're very leading. They stress the
18 importance of the PRA expert stressing the importance
19 of the PRA scenario to the operators, so that the
20 operators know it's really important that they know
21 when to leave. Because this is the PRA scenario.
22 DR. COOPER: Okay.
23 CHAIR STETKAR: So, be careful.
24 MS. PRESLEY: Was that last -- sorry, this
25 is Mary Presley. Was that last comment with respect

1 to supplement 1 or supplement 2?

2 CHAIR STETKAR: Supplement 1, because the

3 guidance for the interviews is in supplement 1.

4 MS. PRESLEY: Okay, because there are some

5 specific things, and I think that's an area we've timed

6 for some improvement in supplement 2. So, it

7 wouldn't -- when you look at --

8 CHAIR STETKAR: I'm trying to keep

9 separate --

10 MS. PRESLEY: When we look at phase 2, if

11 you think we still are using that language, please let

12 us know, because I think -- hopefully, we'll have fixed

13 that.

14 CHAIR STETKAR: I quite honestly -- we'll

15 get to supplement 2. I didn't see it as much in

16 supplement 2, because supplement 2, you focus more on

17 quantifying human performance within the context of PRA

18 scenarios.

19 I saw it more in supplement 1, and in

20 particular, in the guidance for the interviews, where

21 I felt that they were too focused on a set of predefined

22 PRA scenarios in asking the operators their response

23 within the context of that PRA scenario.

24 You know, you've had a fire that's disabled

25 all feedwater, and you may or may not have control from

1 the main control room over the pressurizer PORVs.
2 Would you leave?
3 You know, it's not as blatant as that, but
4 that type of notion, rather than saying -- there's a
5 whole bunch of alarms. Half of the control room is
6 black. At what point do you lose confidence in your
7 indications, and decide to leave.
8 Regardless of whether or not you have main
9 feedwater, or can control the PORVs, because that might
10 not be the thing that prompts them to leave, you know.
11 We have to get back away from this specific PRA event
12 cut-set mentality and --
13 DR. COOPER: Okay.
14 CHAIR STETKAR: So, look at that guidance
15 for the interviews.
16 DR. COOPER: Okay. Yeah, and -- Susan
17 Cooper here. Yeah, the team members that are here
18 today, we had some discussion this morning about moving
19 forward with supplement 2 and what improvements we
20 would do next.
21 And we are examining possibilities of
22 providing a roadmap that -- even better than it does
23 now, shows where 1921 guidances is overarching.
24 Supplement 1 is good enough, supplement 2 has done a
25 better job, and whatever.

1 So, this feedback is very helpful. So,
2 thank you. We'll do what we can with it.
3 MEMBER SUNSERI: So, I'm just getting
4 involved and I haven't looked at all the previous stuff.
5 So, let me just ask for my confirmation here. We're
6 talking about situations not solely associated with
7 habitability of the control room, but situations where
8 it may not be the best decision to operate the plant
9 from the main control room. Is that right?
10 MS. LINDEMAN: That is correct, yeah.
11 DR. COOPER: That is correct.
12 CHAIR STETKAR: These, in principle,
13 could be fires that do not occur inside the main control
14 room itself. Could be out in some instrument and
15 control paneled room that disables, you know -- I'll
16 use the technical term, snarky. Makes all of your
17 displays look kind of snarky.
18 MEMBER SUNSERI: Yeah. No, I get this
19 spurious in -- stuff like that. Yeah, I get it.
20 CHAIR STETKAR: Open circuit's hot, you
21 know.
22 MEMBER SUNSERI: I just was wanting to
23 make sure I understood.
24 CHAIR STETKAR: Or it could be a fire in
25 the control room itself.

1 MEMBER SUNSERI: You could be having those
2 symptoms before you even know there's a fire.
3 MS. LINDEMAN: Yeah, okay. All right,
4 and then the final phase that we'll talk about in the
5 main control room abandonment scenario is phase 3, and
6 those are the actions once command and control and left
7 the main control room.
8 So, this is a graphic of -- not to scale
9 of the three time phases of main control room
10 abandonment. Just as I presented earlier, we have
11 phase 1, which is the period before abandonment,
12 phase 2, which is the time period for making that
13 decision to abandon the control room, and then phase 3,
14 which is the time period factor.
15 CHAIR STETKAR: Ashley, leave that up for
16 a moment. I was going to wait until we got to here
17 because I think this is my only opportunity to whine.
18 We had some discussion two years ago about why does the
19 quantification and qualitative analysis in
20 supplement 1, for the decision to abandon the control
21 room, the things that occur during that phase 2 block
22 there, why does that apply to loss-of-control
23 scenarios? Why does it not apply to loss of
24 habitability?
25 In supplement 1 you've added additional

1 rationale for loss of habitability and why it is
2 absolutely certain that they will absolutely leave, and
3 that you only need to know, do they leave too late.
4 I'm concerned about their leaving too
5 early. I'm concerned -- and why is that important?
6 It's important because it shifts that vertical line
7 between phase 1 and phase 2 to the left.
8 And maybe they don't have enough time to
9 accomplish the stuff in the main control room, that
10 you're taking credit for them doing in the main control
11 room, and that when they abandon, they find out they
12 can't do it as well remotely.
13 They either don't have the amount of
14 indications, they have to rely more on distributed
15 local people doing things, and that can be important.
16 So, for example, if I have a fire in the
17 main control room, you say, well, according to our
18 criteria, the great gods of PRA and people who wrote
19 NUREG-CR6850, say, when I get to a certain visibility
20 or I get to a certain heat-release rate, or something
21 in your plant-specific procedures, I am told to leave.
22 And I do that, because otherwise I'm going to die.
23 Well, I don't necessarily know that, and
24 I don't necessarily trust procedures when I think I
25 might die. And furthermore, if I have a fire in the

1 main control room and my fire brigade is running around
2 with fire extinguishers, or whatever they're doing,
3 bumping into and distracting me, maybe I decide that
4 I really would like to leave. Long before it gets to
5 hot or too smoky.
6 You talk about people putting on Scott
7 Air-Paks, you know, and staying in there until things
8 get so that they can't see. I was toying with the
9 notion, if you've never worn a Scott Air-Pak and tried
10 to communicate, understandably at all you'd understand
11 that people cannot do that. They're meant to make it
12 so that you don't die before you get out of where you
13 are.
14 So, why this artificial distinction about
15 loss of habitability requires no cognitive decisions.
16 There's only an uncertainty about, do they stay too
17 long, versus loss of control, where you do say, there
18 can be a much broader variability in the decision time,
19 because there might not be those specific criteria on
20 when do you discuss your indications enough to decide
21 to leave. To me, there's no fundamental difference.
22 DR. COOPER: Susan Cooper, and I'm going
23 to start answering the question, and I may defer to my
24 colleagues up here, or maybe throw a lifeline there to
25 the audience.

1 So, the first part that I'm going to
2 identify, and that is, why not do something more
3 detailed for loss of habitability than, you know,
4 something similar to what we do for loss of control.
5 And I'm going to -- but the first answer,
6 which probably is not going to fly, and that is that
7 HRA is doing what the PRA needs, and they haven't asked
8 us to do that. They don't think it's important enough
9 that we dig into those details.
10 If they do different calculations to look
11 at whether or not there makes a difference, it's not
12 going to make a difference.
13 The second part is, that at least for the
14 plants we have now, the control rooms we have now, the
15 remote shutdown panels we have right now, the
16 abandonment strategies we have, the reluctance to leave
17 the control room is maybe even more of a concern than
18 we might have thought.
19 I mean, I think everyone who's done
20 anything with fire and has talked to operators, you've
21 heard something like, well I'm not going to leave until
22 my feet are on fire, or something like that.
23 And I've heard stories like that, and I've
24 heard people tell me that they're -- you know, about
25 their reluctance. But we did look into that as part

1 of the development of the quantification guidance for
2 supplement 2, and the result from the experts that we
3 got was that that is the driving factor.
4 And it has to do with the familiarity and
5 the capability -- well mostly the familiarity of the
6 control room, and being there, and not wanting to go
7 someplace else. That is the driver. Now -- so I mean,
8 that's kind of the basis.
9 Now, if you had a chance to take a look at
10 supplement 1, we did go back and add some material into
11 the section on the decision to abandon related to
12 habitability. And in particular, we went back and
13 tried to explain some things that apparently haven't
14 been documented elsewhere, and Nick Melly was -- and
15 I think Tammie Rivera also was more instrumental in
16 writing up the section, trying to better fill in the
17 blanks on what was in 6850 about the criteria for
18 habitability, and how that links back to actual human
19 subjects, and what you would be experiencing physically
20 if those habits, you know, those kinds of conditions
21 exist in the control room.
22 And, you know, some of the author team has
23 also compared that with other environmental factors,
24 like, you know, trying to control equipment and local
25 plant stations where the panels were hot to the touch

1 and, you know, what are those temperature limits, and
2 stuff like that.
3 And so, you know, we did go back and look
4 carefully at that, and we recognize that it's not a
5 sharp cut in time.
6 CHAIR STETKAR: I hope you read the
7 transcript, and read your words as an outsider.
8 Because you're talking about this as a dispassionate
9 fire modeler might talk about it. You're not talking
10 about it in the context of a fire in the control room.
11 And I'm not talking about something that
12 you spit on and it goes out. It's obviously a
13 meaningful fire. It's generating smoke. It might be
14 generating a lot of heat. It may have a combination
15 of environmental conditions with smoke, and effects on
16 my instrumentation.
17 And there are people who are going to be
18 trying to put the darn thing out. And that is not me,
19 as an operator, because if it is me, then I'm violating
20 some other PRA rule that says I can't do this. Or some
21 procedure rule that says I can't do this, despite the
22 fact that I might want to do it.
23 I'm certainly being distracted, and at
24 some point my cumulative distraction leads me to decide
25 maybe it's better that I do leave. Let them put the

1 darn fire out.

2 Maybe I can come back if there's enough.

3 But maybe I don't trust that other stuff well

4 enough -- perfectly, let's say -- and I decide

5 to -- see, I don't see philosophically why this big

6 focus on loss of control, and total ignorance of loss

7 of habitability. It's conditions that the operators

8 are faced with.

9 DR. COOPER: So, the other piece is

10 operational experience.

11 CHAIR STETKAR: We've had a lot of fires

12 where people have decided not to leave the control room

13 until --

14 DR. COOPER: We haven't had any fires

15 where we'd have left the control room.

16 CHAIR STETKAR: Yeah. Okay, and that's

17 my whole point. Or we're pushed to leave the control

18 room.

19 DR. COOPER: Well, there

20 were -- internationally there may have been one where

21 they left the control room. But there certainly have

22 been fires in the US where they have not left the control

23 room, and we've spent some time looking them.

24 Browns Ferry -- as a matter of fact, Mark

25 Sallie dug up or found an info video interviewing some

of the Browns Ferry operators in some of the conditions that they were experiencing -- hot panels, plastic falling -- you know, popping out of the instruments, and stuff like that.

So, we don't have a lot of operational experience, but the operational experience we have also shows that they're not going to leave, even if it is -- even if the conditions are not optimal. Now, I know we do have examples of people putting on -- you know, using the Scott Air-Paks and staying in the control room.

We've also had a few interviews that said that they were going to do that.

CHAIR STETKAR: No no no. I don't care what they say they're going to do. I'm interested -- you say you have experience that people have done that? I'd be really interested to hear -- to read about that, because I'm not aware of people that have done that.

DR. COOPER: They did in Browns Ferry.

CHAIR STETKAR: Browns Ferry was 30 -- god, I can't -- 33 years ago. I'm sorry, 40 years, 75, 43 years ago.

MEMBER BLEY: Now, I've talked to lots of people -- a number of people in control rooms who say,

1 no problem with the Scott Air-Paks. I haven't talked
2 to anybody who's actually had to try to do that. We
3 don't do -- I'll be Charlie today -- what's done in the
4 Navy We don't put people out in fires anymore. At
5 least not many plants.
6 Some years ago some good send their people
7 to firefighting school and have to do this stuff.
8 These days, not so much.
9 CHAIR STETKAR: Is that right?
10 MEMBER BLEY: Yeah, that's right. At
11 least the ones I've talked to. And so, most of them
12 have never been in that hot, smoky environment with
13 breathing apparatus on and trying to see. They just
14 kind of been told it's okay. But if there is real
15 experience there that's documented, it'd be real
16 interesting to see it.
17 MS. PRESLEY: So, I just -- I think one
18 other maybe already obvious point is that HRA, we only
19 have so much resolution we can go into. We can
20 postulate how the operators might behave, and we can
21 interview them and what they think they're going to
22 behave, and we can look at the sparse operating
23 experience and try to extrapolate, but we recognize
24 this is something that has uncertainty.
25 And we talk about the uncertainties

1 associated it and how you have to look at that. But
2 for the other -- there are other consequential
3 decisions that we've seen in operating experience,
4 where operators have kind of delayed it as long as
5 possible.
6 So, this is a model, and it's the best we
7 can go forward at this time with the experience and
8 information we have. I think it's the best --
9 CHAIR STETKAR: We'll talk more about
10 uncertainty later. I mean, you can just get one shot
11 --
12 MEMBER BLEY: I'd like to turn John's
13 question around a little bit then, and ask you about
14 your interviews. Did you find plants -- and I assume
15 you talked with trainers as well as operators, and where
16 folks are essentially trained to believe they're never
17 going to have to abandon the control room. I was
18 looking at your discussion of reluctance, so that's
19 fine.
20 Is there a belief out there that this
21 never -- it's not a real scenario, we're never going
22 to have to do this? Do plans actually go through the
23 drill and move the control out to the distributed or
24 local control areas?
25 DR. COOPER: Susan Cooper. All

1 plant -- all interviews that we've done -- and I think
2 that includes the rest of the team, including those out
3 in the audience -- have indicated that they practice
4 at -- train on certain aspects of abandonment.
5 Usually, doesn't in- -- almost always never includes
6 the actual decision.
7 But it does include all the moving parts
8 once they've left. So, that's -- and that's
9 Appendix R. So, they've been doing that for some time.
10 Since I'm at the NRC, I'm not doing the actual work.
11 I may need to throw this to either what EPRI or some
12 of our consultants in the audience.
13 But I -- for another project I do know that
14 that particular plant, they had their own fire training
15 facility onsite, which included the capability of
16 producing fairly large fires.
17 All of the field operators there were
18 trained on fire brigade, and they were moving toward
19 getting more of their licensed operators also trained
20 in fire brigade, even some people in management.
21 So, that familiarity was there. That
22 having been said, the capability of the remote shutdown
23 panel was such that I think they didn't really imagine
24 needing to leave, because they could transfer control
25 of individual pieces to their remote shutdown panel,

and just basically have another local panel that's taking some of the load of control without actually -- because for us abandonment means command and control, all operations leave the control room, not that some pieces of it have been farmed out elsewhere.

So, in that particular case the way -- and there are other plants that probably have that sort of capability, where they can, you know, select specific systems and trainings and equipment, and, you know, selectively move the control from the control room to their remote shutdown panel. And then they don't have to leave.

MEMBER BLEY: At the bottom line, I think, from John's point of flipping this around, the habitability, it just really doesn't sound like anybody's thought real hard about the habitability issue.

MR. SALLEY: Hey Susan, if I could just jump in --

MEMBER BLEY: Yeah.

MR. SALLEY: -- for a second on the habitability, and let's take our trip back in time to Browns Ferry. If you go back to the Browns Ferry fire, '75, and you look at the habitability, of course nobody wanted to leave the control room then, and they did a

1 lot of heroic actions to not do that.

2 They breached a lot of barriers and opened

3 fire doors so that they can move the smoke. They went

4 as far as taking the plant air system and bringing in

5 air lines and chucking them open to literally blow smoke

6 out of the main control room.

7 So, they clearly weren't going to leave

8 the, you know, leave the main control room. That's

9 pretty much their safe zone. That's what they're

10 trained to do.

11 After Browns Ferry, we also made some

12 design changes. A lot of plants have smoke purge. So,

13 we can now align the HVAC and we can do a purge so that

14 they can, you know, stay there longer. Breathing

15 apparatuses -- the Scott Air-Paks -- was brought up.

16 Some plants even brought in line masks

17 where they have, you know, air cylinders that are

18 compressed and you open your line mask, and you have

19 an unlimited amount of time.

20 So, I think there is a lot to do that. The

21 key, I think, in the decision point -- and when I was

22 reviewing this with Susan, was when that SOS makes that

23 decision to throw the transfer switch. Because one he

24 throws that transfer switch, enters those procedures,

25 then he's locking himself into, this is how I'm going

1 to do shutdown now.

2 So, even though they may leave some people

3 in the main control room to monitor things and assist

4 them to do work, once they make that procedural jump,

5 they start that process, then they start into their hot

6 shutdown. So, that's kind of the key there.

7 DR. COOPER: Yeah, I guess -- this is

8 Susan here -- just to add to that, not all, but many

9 of the plants' safe shutdown strategies also are a

10 single path to success.

11 So, not only are you giving up all of the

12 indications and other capability you have in the

13 control room, but now you're on, you know -- there's

14 only one train of equipment that you can rely on for

15 shutdown, and if anything goes wrong, you know, you

16 don't have -- at least not procedurally

17 identified -- options to do other things.

18 So, that can also be considered a

19 deterrent, you know, so far as, you know, what I have

20 in the control room. What are my options in the control

21 room, versus when I leave? And I go to a different set

22 of procedures and different capabilities of equipment.

23 CHAIR STETKAR: I think we need to be a bit

24 cognizant of the time. But I did want to dwell on this

25 a little bit, because we won't have a chance in the

1 supplement 2 discussion.

2 Mary mentioned this is our model and this

3 is what we've had today. There's another way of

4 formulating the model. You mentioned uncertainties.

5 We'll talk more about uncertainties in supplement 2,

6 or I will.

7 One could develop an uncertainty

8 distribution, and I don't care whether it's loss of

9 control or loss of habitability, or some amalgam of the

10 two, that says there's some probability that they will

11 leave at time key 1. There's some probability that

12 they'll leave at time key 2, and there's some

13 probability that they'll leave at time key 3.

14 That's pretty simple. I didn't try to get

15 any more sophisticated than that. They don't have to

16 be precise probabilities. Each of those

17 keys -- key 1, key 2, key 3 -- has implications about

18 what you can accomplish in what you're calling phase 1,

19 and what you can accomplish in what you're calling

20 phase 3.

21 So, they have implications on your

22 quantification of human error probabilities, that will

23 eventually feed into the PRA.

24 Now, key 3 is too late for phase 3. That

25 makes the quantification in phase 3 pretty darn easy.

1 If key 1 is too early for phase 1, maybe you don't get
2 a chance to do some of the stuff that you're
3 already -- you're taking credit for them doing very,
4 very reliably in phase 1.
5 I'm not talking -- but that's a different
6 type of model than you've established. It's a
7 different modeling thing. I'm curious why your
8 experts didn't propose that model. That -- why you've
9 latched onto this particular type of model.
10 DR. COOPER: There isn't any interview
11 that I can recall -- I'll ask Mary and Ashley to
12 remember too -- I don't remember anyone bring up the
13 notion of leaving too early.
14 MS. LINDEMAN: I have one comment loss of
15 habitability.
16 CHAIR STETKAR: Is that because you only
17 asked them what's the latest you might leave under these
18 conditions?
19 DR. COOPER: No.
20 MS. PRESLEY: The bias towards reluctance
21 was so strong that there was no -- I mean, we tried to
22 ask the question in many different ways, and -- Paul
23 Amico from Jensen Hughes
24 CHAIR STETKAR: Paul, we don't know who
25 you are, so make sure you identify yourself.

1 MR. AMICO: I'm Paul Amico from Jensen
2 Hughes. So, there's no question that this is a
3 simplification. Okay, I mean, you know -- and as are
4 many things are in PRAs are simplifications. We don't
5 do T-1, T-2, T-3 for different options for feed and
6 bleed, for example.
7 We always say, well what is the least
8 amount of time you have available for it to get to feed
9 and bleed, and that's the way we do it.
10 In this particular case, the least amount
11 of time is, the longer they wait in the control room
12 for a habitability situation, that's the least amount
13 of time to accomplish everything else in phase 3. So,
14 that tends to maximize that part of the probability.
15 As to leaving too early, I guess we're a
16 little bit conservative in that too, in that we actually
17 give very, very little credit -- we don't say, we'll
18 they can stay for 16 minutes, so they do 16 minutes worth
19 of stuff.
20 Generally, we only give them credit for
21 those first few actions, like trip the reactor, trip
22 the turbine, those things. And then we say, well if
23 this turns into an abandonment scenario, basically we
24 assume they've got to do everything in the abandonment
25 shutdown process.

1 We really don't give them credit for the
2 fact that before they left the control room, maybe they
3 started this pump, or maybe they did this thing. We
4 still say they have to do that, as part of the execution.
5 So, it's a simplification which I would
6 say, you know, tends to be on the conservative side.
7 We minimize the amount of time they have to execute
8 phase 3, and we also give very little credit for doing
9 things in the control room before they have to abandon.
10 And that's really the simplification.
11 CHAIR STETKAR: Thank you. We'll talk
12 more about phase 1 when we get into supplement 2.
13 MEMBER BLEY: Let me just ask something to
14 make sure I understand the model. Just back up one
15 slide, please. Phase 1 here is described as the
16 associate -- time associated with actions taken before
17 the decision to abandon. Now go to the next one.
18 Actually, the decision to -- it depends on
19 what you mean by the words. The decision to abandon
20 is right at the end of phase 2. But I think what you're
21 saying is, at the end of phase 1, you've decided
22 to -- at least your words say, see if you are to abandon.
23 DR. COOPER: So -- Susan Cooper here.
24 Not exactly that. It's actually -- I think the way we
25 described it is, if you were to know when all the cues

1 were available and occurring -- you know,
2 existing -- indications of any kind, environmental
3 conditions, or whatever -- the point at which that
4 information is available in some way, that means that's
5 the cue for abandonment.
6 So, what that end of phase 1 is really the
7 cue for abandonment, which is, in fact, probably a
8 collection of cues, and they accumulate over time. So,
9 figuring out exactly where that is, is a little bit
10 tricky.
11 So -- but that's really the end of phase 1,
12 is when the so-called cue for abandonment occurs. But
13 it's a lot fuzzier than a cue.
14 CHAIR STETKAR: The difference, when I
15 think of loss of habitability -- and at least the way
16 I read the guidance -- is that the cue to abandon the
17 loss of habitability is when you meet those magic
18 criteria for visibility or heat, temperature, things
19 like that.
20 And those things are calculated by fire
21 models. And it might take quite a while for those
22 things to develop. But it said in the guidance that
23 once they make that decision, the time -- from that
24 condition until they make the decision -- is minuscule,
25 so that phase 2 -- the time in phase 2 for loss of

1 habitability -- is essentially zero.

2 You get the cue, you decide to leave,

3 you're definitely going to leave when you get the cue,

4 and you're not going to leave before you get the cue,

5 and until those conditions are met, people are sitting

6 in the control room doing, happily, everything that

7 they would normally do, and it might be 30 minutes.

8 And I will tell you that if I was using the

9 guidance as it's written, I would do that in my PRA,

10 because that's what the guidance tells me to do.

11 MEMBER BLEY: And I read it differently in

12 different places.

13 CHAIR STETKAR: Okay.

14 MEMBER BLEY: The words didn't seem

15 consistent as I went through, on what these things

16 actually mean, and how you --

17 CHAIR STETKAR: But it seemed pretty clear

18 that the loss of habitability cue is determined by fire

19 modeling, either smoke density or temperature, and that

20 once you meet those crit- -- or whatever -- there might

21 be different plant-specific criteria -- but once you

22 meet those criteria for fire modeling, there's not a

23 degrading condition where there's vagueness. It's,

24 people decide to leave and they leave. And before

25 that, they decided not to leave --

1 MEMBER BLEY: But only if those things are
2 codified in the procedure for telling them --
3 CHAIR STETKAR: That's true. They have
4 to be - yeah.
5 DR. COOPER: Susan Cooper. With respect
6 to habitability, the criteria that are calculated doing
7 the fire modeling end up being pretty severe. So,
8 you're right, it's not -- it's actually an accumulation
9 of effect. They may actually make the decision before
10 they reach the actual criteria as we calculate.
11 CHAIR STETKAR: Yes.
12 DR. COOPER: Because, for example, for the
13 visibility criteria, as I recall, that criteria said
14 that you cannot see this far. In other words, if the
15 indications are rubbing the panel here, you cannot see
16 those indications, because the visibility is just not
17 there.
18 So, if they needed to read that and they
19 thought this was getting to be a problem, they
20 probably -- depending on how the scenario evolved and
21 where the smoke was, and stuff like that -- they may
22 leave earlier than what the calculation would say.
23 So, the calculation is a simplification
24 for the longest time they would stay in the control
25 room, which, at least as far as phase 2, gives them the

1 least amount of time to implement their shutdown
2 strategy.
3 So, as Paul said, it's a simplification.
4 You know, we could -- there are other things we could
5 do, but that's -- there are tradeoffs.
6 CHAIR STETKAR: But I -- you know, my --
7 MEMBER KIRCHNER: Can you go to the next
8 slide, Susan? So, you don't put some kind of
9 distribution on each of these vertical lines. My
10 thought would be -- maybe it's a variant of what you
11 were saying earlier --
12 CHAIR STETKAR: Yeah.
13 MEMBER KIRCHNER: -- that they aren't
14 going to be that precise. Even if they are calculated
15 precisely -- at 38 minutes, for example, or whatever
16 those lines are -- the reality is, even in your case
17 of visibility, it might be billowing smoke in one corner
18 of the room, and the other half of the room is fine.
19 So, they're not going to go until the whole control room
20 is filled with smoke, or whatever the scenario is.
21 So, isn't there some distribution that
22 should be put on these to look at the sensitivity or
23 uncertainty, and propagate that in execution of what
24 is then subsequently analyzed? I don't understand.
25 MS. LINDEMAN: So, for loss of habitabil-

ity -- right? T equals zero is the start of the fire. And fire -- and analyzing it, we have a distribution of heat release rates based on, you know, certain cabinet type.

And when you run your calcs for loss of habitability, you'll discretize that distribution, so you may fires of 50 kilowatts, 100 kilowatts, 200, etc. And as a result, there are different times when the habitability criteria are met, you know, on maybe the order of eight to nine minutes anywhere, to roughly 30, depending on the fire growth.

So, in that aspect there is a range of times for loss of habitability, and I'm not sure if we did a good job of explaining that before.

MEMBER KIRCHNER: I presume the same would obtain for a loss of control.

MS. LINDEMAN: So, we'll talk about loss of control timing -- so, if we go to the slide -- I don't want to go to the slide before because I don't want to go backwards. But that --

CHAIR STETKAR: You don't want to.

MS. LINDEMAN: That figure is a construct to help analysts think about the response in phases. And the way we use the timing information is maybe the more important point. And when you see how we use the

1 timing information in phase 2 and 3, and 1, maybe this
2 will be little bit more clear.
3 Because I think we're getting caught up on
4 lines on a diagram which are constructs, not
5 hard -- they weren't meant to be hard lines, and we'll
6 see there's some squish, and this is actually an item
7 that we have to describe more of what that squish is
8 used for.
9 DR. COOPER: Mary's exactly right. This
10 is Susan. The important of the phases, though -- the
11 time phases -- is that we treat them differently in HRA,
12 and the way we develop the quantification guidance, the
13 kinds of qualitative analysis you need to do, what
14 actions operators are taking and where, what procedures
15 we're using, those are all different.
16 And that's why the different phases are
17 important to us. So -- but they are constructs not
18 necessarily measurable in all places.
19 MEMBER SUNSERI: So, I was going to ask
20 another question. I mean, you know, I hear talk about
21 loss of control and habitability and all that stuff.
22 But I think from an operator -- from being a former,
23 you know, operator in one of these plants, it always
24 seemed to me like it wasn't a matter of that, but it's
25 a matter of, is this a fast-moving issue, or a

1 slow-moving issue. Right?

2 And so, it all comes down to the cues, not

3 times. Right? So, an operator on a fast-moving

4 thing, maybe all they can do is tell the guy that's at

5 the board, trip the reactor, we're leaving. And that's

6 the initial step of the shutdown process, or the

7 transfer process.

8 The other situation may be if the

9 slow-moving thing, the shift supervisor says, hey look,

10 we're losing this thing. We're going to have to go in

11 a few minutes. I want you to do these three things,

12 which is in accordance with my shutdown guidance.

13 Right?

14 When we leave I want the reactor tripped,

15 I want the auxiliary feedwater pump started, whatever

16 it is, you know? And then, you know -- but once again,

17 it's not so much time-driven. It's cue-driven.

18 MS. LINDEMAN: Mm hmm. Okay.

19 MEMBER SUNSERI: And, you know, it

20 shouldn't be, you know, when the visibility is down to

21 whatever the lumens, it's going to be when you can't

22 see the controls anymore, or whatever the thing is.

23 Right?

24 DR. COOPER: You're right. It's very

25 context-specific. And so, there are variations of

1 main control room abandonment scenarios, including,
2 you know, what's happening, and why is it happening that
3 way. So, yes.
4 MEMBER SUNSERI: And, by the way, I
5 wouldn't ever recommend this as like an ongoing thing,
6 but I've been involved in the startup of a couple of
7 plants, and one of the things that we had to demonstrate
8 was that you could trip the reactor and establish a
9 cooldown rate from outside the control room, and it
10 wasn't as scary as we thought it would -- I mean, the
11 operators -- it wasn't as anxious of a -- now granted,
12 there was a control situation, a lot of oversight, and
13 all that kind of stuff. But, you know, having walked
14 through that --- but, I mean, you know, with the modern
15 instrumentation of the plants and the shutdown transfer
16 panels and the remote shutdown, it's a quite doable
17 thing.
18 MS. LINDEMAN: Okay. All right, well, I
19 guess due to time we'll just kind of skip to the next
20 slide, which is the timeline for doing it is at the end
21 of May. And I realize that this graphic is really
22 difficult to see, and, you know, even the point of
23 showing this isn't to demonstrate that you can
24 construct a timeline that includes all the actions for
25 two units.

1 What I'd like to highlight is, you know,
2 one of the outcomes of supplement 1, which was having
3 a narrative and a picture for the analysts to identify
4 all of the actions, but also all of the critical
5 communications and staffing locations, and, you know,
6 we believe that's, you know, one of the most powerful
7 outcomes of supplement 1 is giving this tool to the
8 analysts, not only for feasibility, but, you know, the
9 entire scenario.
10 DR. COOPER: Susan Cooper here. If you
11 can't read the graphics, the blue lines are where
12 communications are occurring between operators, and
13 would indicate, you know, probably some kind of
14 coordination that's required.
15 So, that's one of the keys of this kind of
16 timeline. It doesn't have to be dual unit, but to show
17 that. But this is just trying to show all the activity,
18 and try to get a handle around what all's going on, which
19 could be important for staffing considerations also.
20 MS. LINDEMAN: Time, sequence, actions.
21 I think with that we'll all kick it back over to -- well,
22 we're currently under development, which is
23 supplement 2, which is the quantification guidance.
24 DR. COOPER: Susan Cooper. I'm going to
25 give you an overview of supplement 2 first. And then

1 we'll get into some of the details.

2 So, supplement 2 has been developed to be

3 a companion document to both NUREG-1921, which is the

4 overall fire HRA guidance, and then, supplement 1 to

5 1921, which provides a qualitative analysis guidance

6 for main control room abandonment scenarios.

7 The high-level approach that we used,

8 although we -- you know, we developed a construct of

9 the different phases, at least for the purpose -- the

10 focus of quantification, we looked mostly at phase 2,

11 which is the decision to abandon, and that's

12 specifically for loss of control.

13 And then, phase 3, which is implementation

14 of the main control room abandonment safe shutdown

15 strategy.

16 We used supplement 1 to try to identify key

17 issues that should be represented in quantification for

18 both of these phases. We used these consensus list of

19 issues, and compared them to existing methods, to see

20 how well existing methods could be used to represent

21 what we thought was important for main control room

22 abandonment.

23 As a result of those comparisons, the

24 author has developed some strawman approaches for

25 quantification. And then, what we did with -- and it

1 was a little bit different between the two phases. In
2 phase 2, which is the decision to abandon, the team
3 developed some candidate decision trees to be used for
4 quantification for command and control issues.
5 Specifically, for shutdown after leaving the control
6 room, we just had that list of key issues.
7 And then, we brought in some experts and
8 had a panel to discuss those issues, and confirm or
9 modify the strawman approaches. And then we used that
10 input to complete the quantification approaches for
11 both phase 2 and phase 3.
12 I want to talk a little bit about the expert
13 panel. There were a number of things that we wanted
14 to do. We wanted to keep a balance between the NRC and
15 the industry, so far as number of people on the panel.
16 So, we had two people from the NRC and two people
17 actually from the author team.
18 In both cases, we wanted to make certain
19 that the experts had knowledge of operations and
20 training, fire-related experience, but specifically,
21 related to main control room abandonment.
22 So, we wanted people that had experience
23 with either developing the fire models, doing the HRA,
24 or, from the operations side, had an understanding of
25 what those kinds of operations involved.

1 So, that -- those were the guiding
2 principles for the experts. The other thing is, we
3 wanted to -- down the line we talked about the fact we
4 wanted to make certain that the experts had a wide range
5 of understanding, not just for one or two specific
6 plants, because we were developing a method that was
7 going to be generic. So, we wanted to make sure it
8 wasn't just, you know, I just know this one plant. So,
9 that was important also.
10 So, the experts we had -- from the NRC side
11 we have Harry Barrett, formerly of NRR, and he was an
12 NFPA-805 reviewer. He's since retired. We got him
13 just before he left.
14 And then, also, we had Jim Kellum from NRO,
15 who has decades of experience as operations trainer,
16 so he represents lots of plants. And then, from the
17 EPRI side, industry side, we had two of our
18 authors -- Jeff Julius and Erin Collins, both with
19 Jensen Hughes, which, between the two of them,
20 represented a lot of plant and plant analyses.
21 We used the experts differently between
22 phase 2 and phase 3. For phase 2 we started off by
23 confirming, or focusing, whether or not we got the key
24 issues right. That should be represented in
25 quantification.

1 After that we had the experts take a look
2 at the strawman decision trees. As a result of that
3 they made some modifications and prioritizations. And
4 then, we went ahead and did an actual HEP development,
5 starting with worst-case scenarios, best-case
6 scenarios, intermediate, and so on and so forth.
7 For phase 3, which was the impact of
8 command and control on the implementation of safe
9 shutdown strategies. We didn't use the experts to
10 develop HEPs for a quantification tool. We simply used
11 them to confirm or prune our key issues list, and then
12 to identify priorities and associated context for what
13 we wanted to include in our guidance. So, that's how
14 we used the experts in the two different phases.
15 MEMBER KIRCHNER: May I ask you a
16 question? Did you then kind of take a representative
17 plant of different types and just run through it to see
18 if this is what the experts decide this is what the
19 operators might do?
20 DR. COOPER: We did not -- this is Susan
21 Cooper -- we did not have specific example scenarios
22 to go through in doing these developments. But the
23 discussions naturally led to plant-specific examples
24 that were brought into the discussion.
25 But the end results were not based on a

1 plant-specific input, you know. It was -- and the
2 answers were consensus answers. So even if one expert
3 brought in, you know, I have this information that I
4 know about this plant, and then another expert will
5 offer something else, and then all of those opinions
6 were brought together into a consensus, so far as, you
7 know, in the case of phase 2 -- the decision to
8 abandon -- there were consensus HEPs that were
9 developed.
10 And then, for phase 3 there was just a
11 consensus that across the board these are the things
12 that we think would be most important, you know,
13 generically.
14 So, the end result is generic. The actual
15 discussions in getting to that answer might have
16 brought in some plant-specific information.
17 So, how to use supplement 2, the purpose,
18 of course, for supplement 2 is to provide that
19 quantification guidance that's beyond the scope of
20 NUREG-1921, which does provide quantification guidance
21 for other fire scenarios.
22 For the most part, although there's some
23 types of operator actions and human failure events that
24 we identify in supplement 2 where 1921 guidance is
25 sufficient, and in the case of supplement 1, there are

1 places where we repeated that guidance because we
2 thought it was important, there's some cases where
3 supplement 2 expanded on concepts that were started in
4 supplement 1, and so there may be some redefinition.
5 Command and control is definitely one of those
6 instances.
7 And, at least in the draft that you have,
8 we've tried to indicate where 1921 certainly in those
9 cases, if that's the guidance you need to use, we've
10 indicated that. And we've tried to also indicate where
11 you need to go back and look at supplement 1.
12 We've already mentioned that we're
13 considering trying to provide some additional help to
14 the analysts on how to sort those things out, and of
15 course welcome your comments on how we can continue to
16 improve that. Next slide.
17 So, that's the end of the overview. And
18 then, we're going to go into, specifically, discussion
19 and decision.
20 CHAIR STETKAR: Let me intercept you here.
21 DR. COOPER: Okay.
22 CHAIR STETKAR: Because you're going to
23 skip phase 1 and I'm not. The guidance in supplement 2
24 for phase 1 is, I'll call it thin. Let me quote a
25 couple of passages.

1 During phase 1 operator actions are
2 directed from the main control room. Similar to other
3 fire scenarios, these actions are not necessarily
4 unique to main control room abandonments, since the
5 cognition and execution for these actions are very
6 similar, if not identical, to fire scenarios where the
7 fire is not inside the main control room, or even
8 internal events PRA actions following a reactor trip.
9 Section 2.2 says, up until the point of the
10 decision to abandon, the operating crew is responding
11 to the fire from the main control room, so the guidance
12 in NUREG-1921 is applicable and sufficient to evaluate
13 and quantify phase 1 actions.
14 I look at 1921 -- 1921 says, ah, main
15 control room abandonment is a different issue, and
16 that's why we're having this meeting today. 1921
17 focuses an awful lot on distributed actions being
18 guided from the main control room with people running
19 around in the plant doing things.
20 It doesn't talk much about fires inside the
21 main control room. Inside the main control room.
22 Which brings me back now to my loss of habitability.
23 How is it that I can use the guidance in 1921, or
24 guidance for HRA, for internal events, to quantify my
25 actions inside the main control room, when, as Walt

1 said, over in the corner there's smoke billowing out.
2 Now, it hasn't got -- I can still see
3 things. And, oh, by the way, the fire brigade is
4 pushing me out of the way because they want to get to
5 the corner, and the only way is through me.
6 So, how is the guidance for quantifying
7 fires outside of the main control room, I can almost
8 say, that the guidance in 1921 applies because as long
9 as I'm not being distracted by people trying to put out
10 the fire, if one of those people who might be me.
11 Or, potentially in fear for my own
12 survivability, I can say, well, it doesn't make too much
13 difference if the fire is out in a cable-spreading room,
14 or out in some other location, because I'm just reacting
15 to whatever indications are coming in, which 1921 does
16 a fairly decent job.
17 I was hoping, during phase 1, that you
18 would say, well, for fires inside the main control room,
19 you have to think about much different things. But you
20 don't say that. You say that I just use standard,
21 everyday human reliability analysis until I have to
22 abandon, and everybody knows that the abandonment thing
23 is the most important stuff.
24 So, can you address that? Why does this
25 phase 1 not need separate guidance to alert people to

the fact -- especially for fires inside the main control room -- that that is a different beast than anything else that has been addressed in the guidance to-date?

DR. COOPER: So, especially with you reading things directly, we need to make a correction that it's not up until decision to abandon --

CHAIR STETKAR: That's what it says, though. If I'm going to --

DR. COOPER: We need to correct that.

CHAIR STETKAR: -- read the guidance --

DR. COOPER: We need to correct that. So, I would say that it's shorter than it should be. I will agree that we need to add something there. I would say that for fires in the control room, that 1921 probably can still address that, because we do address environmental factors and their influence on operator performance. However --

MEMBER BLEY: That's typically --

DR. COOPER: -- it doesn't -- it's typically outside the control room.

MEMBER BLEY: It's typically outside the control. I wanted to be --

DR. COOPER: It's typically outside the control room. So --

1 MEMBER BLEY: But in their behalf, it does
2 identify the things that it does to you. It's just not
3 in the control room. Which is important. I'm not
4 disagreeing.
5 DR. COOPER: Yes.
6 CHAIR STETKAR: Typically, the
7 environmental factors, though, are presented in terms
8 of accessibility, you know, stay times, and things like
9 that, which can, in principle, be extended to the main
10 control room, but --
11 DR. COOPER: There -- yeah, there's some
12 other influences. But yes. Yeah. So, I think you're
13 correct. We should add some more guidance there. We
14 need to clean up the way we discuss the construct of
15 the time phases is tripping us up there.
16 But definitely, we need to add some words
17 so that 1921, which, as you say, usually the
18 environmental factors is coming in on plant locations
19 at -- local plant locations.
20 MR. AMICO: Yeah. And --
21 CHAIR STETKAR: Paul, you have to -- every
22 time you have to identify yourself.
23 MR. AMICO: I know. I'll get to that.
24 This is Paul Amico from Jensen Hughes again, because
25 I can't sit down and keep quiet. So, we have been using

1921 for -- keep in mind the wording may be a little wrong, but the point being that the actions in phase 1 are up until the point where you have the cues, where now you might consider abandoning.

Up until that point, the situation is the same. Whether it eventually becomes an abandonment scenario or not, you're operating only from the EOPs and the fire response procedures.

Now, when I say we use 1921, 1921 instructs you to address the context under which the operators are performing. And we do look at what kind of fire's occurring in the control room, how big it is -- because we do do the analysis, even for non-abandonment scenarios about what's happening -- and we make adjustments to the PSFs in the existing models.

So, for the HCRORE model, we would say, okay, their fighting the fire in the control room. That's a distraction. We're going to add four minutes to time delay. Or, we're going to add three minutes to the cognition time, because these other things are occurring.

So, we actually do quantify those aspects of the actions in the control room. We may add to execution time because somebody -- because there's a big fire and there's a big commotion.

1 So, we do actually consider that the stress
2 of the operators in performing the actions on the
3 control panels will be higher. And so, we'll address
4 the THERP stress factors.
5 So, all that really is addressed by 1921,
6 and we do, in fact, use different adjustments to the
7 things that happen in the control room -- if there's
8 a fire in the control room, versus if the fire is
9 someplace else and they're performing the same actions.
10 I think that's the context we're talking
11 about. And we do try to base that on actual operator
12 interviews, to the extent that that's something that
13 is reasonable to do.
14 So, that's, I think, the context that
15 they're trying to lay here is, 1921 covers the things
16 you do in the control room when there's a fire in the
17 control room, up until the point you reach the cues,
18 where you may want to abandon. That's phase 1.
19 MS. PRESLEY: We could probably stand to
20 make that a little more explicit in our guidance.
21 CHAIR STETKAR: That's -- you know, I did
22 a quick search of 1921, and it's -- to my mind it's not
23 as clean as Paul makes it sound, because it -- 1921
24 focuses mostly on main control room abandonment, and
25 it -- I can read it to make it sound that way, but since

we're now development guidance explicitly for these scenarios, some of which are fires in the control room, some of which are not fires in the control room, but all affect the integrated performance of people in the control room, or decisions to leave.

See, quite honestly, I'd feel more comfortable about this notion of loss of habitability -- have to be careful here because I don't feel comfortable about it at all -- but if there was enough guidance to say that the evaluation of team performance in the main control room for fires that occur in the main control room, has to be really, really, really careful to account for the environment, the stress, everything that Paul just mentioned --

MEMBER BLEY: I think you're at a spot --

CHAIR STETKAR: I'd feel more comfortable.

MEMBER BLEY: -- where the developers in the method know exactly how to use it and the place they want to use it, but a third party coming to the guidance and trying to do an analysis based on the guidance, may be confused.

CHAIR STETKAR: If I -- I tend to read it --

MEMBER BLEY: Or take the wrong turn.

1 CHAIR STETKAR: I tend to read it as that
2 third party. I would pick up this guidance, quite
3 honestly, as a human reliability analysis
4 practitioner, if you will, and say, well, okay, if one
5 of the actions -- if I have enough time in phase 1, is
6 to try to start an auxiliary feedwater, and if I can't
7 do that, try to start main feedwater. If I can't do
8 that, try to depressurize and start condensating.
9 If I can't do that, try to initiate feed
10 and bleed, and maybe I got 27 minutes to be able to do
11 that, and I've got 27 minutes because the smoke density
12 doesn't get up to whatever it's supposed to be until
13 36 minutes.
14 Well, I have procedures, I have training,
15 I've done this oodles of time for my internal events
16 at power risk assessment. I'll just use that human
17 error probability, because you say I can.
18 MEMBER BLEY: And that's -- honestly,
19 that's what I would do.
20 MS. PRESLEY: We can make that link more
21 explicit. But I think also the integrated timeline is
22 an important piece, because it shows who's where, doing
23 what. And if there's a part that's being taken off for
24 the fire brigade and fighting the fire in the control
25 room, that would be reflected, and we would take that

1 into account in the analysis.

2 CHAIR STETKAR: That's not -- I'm worried

3 about -- I'm not part of the fire brigade. I'm worried

4 about the fire brigade people pushing me out of the way

5 because the only way to the corner is through me, and

6 me having to battle with them, because I have to look

7 at these indicators here.

8 So, it's not depleting my resources for the

9 fire brigade. That's -- take a separate fire

10 department, you know. They're still going to want to

11 disrupt me to put the fire out, not to mention

12 whatever's going on with the fire, itself.

13 MR. JULIUS: Jeff Julius from Jensen

14 Hughes. The pieces missing in that discussion is,

15 looking at the overall -- all the phases, because a lot

16 of times the procedures in phase 2, or once you've made

17 that decision, you go and you turn off the feedwater,

18 you turn off everything you do.

19 And so you pick it up, and so you give

20 people -- fire protection people and people at the

21 plant that don't like the PRA people, because I was

22 telling them, I'm not giving you any credit for this

23 in phase 1 because you were taking quick -- you were

24 following procedure guidance and you're turning these

25 up, and we're only going to model the failure to restart

1 it in phase 3.

2 So, some of those -- you're right. It's

3 probably a case, as Dennis said, that as a developer,

4 we know when we've seen that, but when you look at these

5 in isolation -- you can't look at them in isolation.

6 You have to look at the overall scenario.

7 MS. PRESLEY: So, you didn't even get to

8 phase 2. So, this -- I guess that goes with --

9 MEMBER BLEY: I'm sorry to interrupt you

10 already. Have you let anybody else try to use this?

11 MS. PRESLEY: No.

12 MEMBER BLEY: Not yet.

13 MS. PRESLEY: Not yet. No. Our peer

14 review -- we'll talk about peer review in the next --

15 MEMBER BLEY: Different.

16 MS. PRESLEY: Yeah. Well -- okay, so to

17 echo what Susan had discussed about high-level

18 approach, the high-level approach is the same. We kind

19 of took -- looked top-down and bottom-up. We

20 developed a list of factors that we thought were

21 important to the quantification for the decision to

22 abandon and loss of control. We did that based on the

23 information from the interviews that the analysts have

24 done and that we had -- the team had done with the NRC

25 folks, as well as our understanding of the kinds of

1 literature.

2 So, we've pulled all of that together, and

3 for each factor, we tried to kind of understand the

4 range of what we've seen and what might be seen. So,

5 we kind of about what's the best-case, what's the

6 worst-case, and what are some of the intermediate cases

7 we've seen.

8 And then we looked at a set of HRA methods,

9 and we looked at failure modes and mechanisms, and those

10 methods, to see if there was anything related to either

11 issues or failure modes that we need to add our list,

12 or anything that we could use kind of -- I would say

13 off-the-shelf -- without a ton of modification.

14 So, we found that there's one that we

15 thought maybe we could use, and we started playing with

16 it, trying to adapt that, and found really it was

17 stretching the method too much, and ended up developing

18 our own decision trees based on the factors that the

19 team thought were important through the reviews and the

20 issues list development.

21 And then we took that strawman to our

22 experts and got some more feedback, and that ended up

23 consolidating our three trees into one tree, and

24 getting some ATP values to quantify the tree with.

25 So, that was the overall process, and I'll

1 go through a little bit more detail on each step.
2 So, the first -- when I said we had our
3 issues tabled, this is one of three slides, and I'll
4 go through this fairly quickly. The first issue that
5 we came up with was procedure content. Whether or not
6 there was an explicit definition of what the criteria
7 were for abandonment.
8 We saw quite a variation from, if there's
9 a fire in this area, the supervisor should consider
10 abandoning. So, that was kind of our worst-case. It
11 was very open-ended. And the best-case would be, these
12 are the systems you should look at. If they're not
13 functional, then abandon.
14 So, we saw quite a range. We didn't see
15 anything super explicit, which would have been our
16 best-case. So, most of them fell under the
17 intermediate or worst-case, where they provided some
18 indication of what location is important, or when the
19 fire is identified and confirmed, or whether or not your
20 emergency procedures are working the way they should
21 be.
22 So, that was the first -- our first thought
23 was, the procedure was very important. We'll see what
24 the experts had to say, but we had parsed it into three
25 layers.

1 Then, we looked at time available, and
2 across the set of analyses, we saw that the time
3 available was typically 30 minutes or less from what
4 we've seen. So, we parsed that up into best/worst/
5 intermediate case.
6 And then, when we looked across the
7 training spectrum, the worst-case was only classroom
8 training at the minimum level -- I think once every two
9 years or something -- you might have some classroom
10 training on the criteria to abandon.
11 The best-case is realistic training in a
12 simulator. Maybe it's integrated with the actual use
13 of the shutdown panels, that -- I'm not sure we've seen
14 any instances of that. So the best-case in this case
15 is quite a high bar that's not really seen in the
16 industry.
17 The intermediate cases where you have
18 detailed classroom training which talks through the
19 criteria. Maybe we'll talk about, you know, what
20 exactly are the criteria? How do you know you've met
21 them? You might have some simulator training where
22 they actually simulate the conditions, and you have to
23 figure out you've abandon- -- you have to abandon.
24 So, there's a range on training, and the
25 best-case we don't really see. So, cues and

1 indications was another issue that we thought was
2 really important.
3 So, the procedure tells us when we need to
4 abandon. The cues and indications tell us how do we
5 know that that criteria's been met? There's a ton
6 happening. We don't know exactly, necessarily, what
7 exactly the operators are going to see, because we only
8 trace some cables -- the ones that are important in the
9 PRA.
10 And some fires may be fast-growing, some
11 may be slow-growing, and this was -- the cue and
12 indication is really not one like triple little HRA,
13 where you have a parameter or a couple of parameters
14 that you're looking at that's trending, and you see the
15 parameter, it matches the level, you go do an action.
16 This is not that. This is a unfolding
17 scenario that's getting progressively worse. And so,
18 the cues and indications, being able to interpret what
19 you're seeing against your criteria, was one important
20 aspect. And we're going to talk about that a little
21 more when we talk about the timeline for phase 2, and
22 how you build that.
23 We talked about reluctance, and initially
24 our thought was that reluctance was highly tied to the
25 capability of the remote shutdown panel, and the

1 comfort and familiarity with the main control room, and
2 just this inability -- like, it's a bad day, we don't
3 think we'll ever actually abandon.
4 And we saw, through some of the operator
5 interviews, that there was -- there's kind of a -- it's
6 hard to get operators to see some of these PRA
7 scenarios, that they were so Appendix R-minded that it
8 was really beyond some of their imaginations to get to
9 this scenario.
10 Now, AB&C is what we thought -- or our
11 initial thoughts -- the capability of the remote
12 shutdown panel for phase 2 turned out, through our
13 expert opinions, to be one of those areas where they
14 didn't think it was necessarily that important, so
15 we'll talk about why that is and what happens to that
16 information, in a couple of slides. But that was our
17 first cut, was based on those three factors. Next.
18 Staffing and Communication. So, this has
19 to do with how much backup you have in helping make that
20 decision. Best-case is you have the STA or other crew
21 that are monitoring actively the criteria to abandon,
22 and helping you watch that, so you have -- ready to make
23 that decision once you get to that point. The
24 worst-case is, if Justin's your supervisor, everyone's
25 tacked out doing other things, and he needs to make that

1 decision with little input.

2 And then, finally, transfer the procedure

3 with that main control room abandonment criteria. So,

4 you need to get to the main control room abandonment

5 procedure to abandon. It wasn't always clear in the

6 scenarios that we had, that there was an explicit

7 procedural path that gets you there.

8 And some of our operator interviews found

9 that there were situations where that was true, and we

10 thought that was pretty important to bring up. Again,

11 with our expert opinion, we found that was actually not

12 necessarily a driving factor for this HEP, and so I'll

13 talk about that a little bit when we talk about how we

14 end up pruning some of the trees.

15 MEMBER REMPE: Again, this isn't my field,

16 but when I was reading your report on page 34, you talk

17 about a situation where the staff needs -- there are

18 certain staff members -- like the shift technical

19 advisor -- needs to be in the control room to make the

20 decision to abandon. And there's a certain time that

21 they have to be there after the start of the event.

22 And if this person isn't there, you can't

23 make that decision to abandon. And is this a situation

24 that ought to be cleaned up if you found this to occur

25 at a plant? Am I misreading your report?

1 MS. PRESLEY: So, some clarification is,
2 the shift technical advisor might support that
3 decision. So, in order to credit his support of it,
4 he will never be making the decision.
5 MEMBER REMPE: But he needs to be there for
6 them to go forward?
7 MS. PRESLEY: No, he doesn't need to be
8 there. He's not required.
9 MEMBER REMPE: It says, required to
10 support the decision. He has to be there if --
11 MS. PRESLEY: That's poor wording.
12 MEMBER REMPE: Okay. Well, again, I
13 don't know --
14 MS. PRESLEY: Yes, thank you.
15 MEMBER REMPE: -- a lot about that.
16 That's why I said that to start.
17 PARTICIPANT: What section was that?
18 MS. PRESLEY: Page 34.
19 MEMBER REMPE: You know, again, I'm just
20 like going, well if that's the case, this reminds me
21 of other things we've heard of where critical folks
22 aren't there to make a decision, and -- so never mind
23 I guess is the answer to my question.
24 MS. PRESLEY: Well, thank you for pointing
25 out that --

1 MEMBER REMPE: Yes, thank you for clearing
2 that up --
3 MS. PRESLEY: -- poor wording.
4 MEMBER REMPE: -- bad choice.
5 DR. COOPER: Not what we meant.
6 CHAIR STETKAR: Some shift supervisors
7 would say it would be a good thing if the shift technical
8 advisor was out, you know, cleaning the ice off the
9 windshields.
10 MS. PRESLEY: Next slide? Okay, so --
11 CHAIR STETKAR: That would be Zion.
12 MS. PRESLEY: We're not naming it in here.
13 So, our beautiful timing fire growth picture, which you
14 guys probably cannot read the text on, which is okay
15 at the moment, because I'll walk you through it,
16 but -- so the point is, is that the timing is not as
17 clear cut as the typical read-the-parameter,
18 take-an-action, that the definition of T -- we have
19 T-delay and T-cog is our typical timing nomenclature.
20 And T-delay is the time to get the cue, and
21 T-cog is the cognition time. So, between the time you
22 get the cue and the time you make the decision, and so
23 that's like phase 1 and phase 2.
24 So, that is not a clean line, and it's
25 highly linked with your procedure and your training.

It's -- and your cues and indications. Those three things are intractable from each other. So, you have to understand how the procedures work and how the operators are trained, and what the expectations are, versus the progressions scenario.

So, we came -- we actually -- I have a printout -- so we came up with a half-dozen of these fire growth scenarios. But basically, it walks through -- you have -- the fire starts at reactor trip, then you have your immediate memorized actions complete.

And then you have that fire that happens. You might have had an alarm. So then, you have an -- you've acknowledged the alarm. You know that there's -- you've gotten a fire alarm, you're going to go send someone to go --

MEMBER KIRCHNER: Do you always assume reactor trip with the fire starting?

DR. COOPER: It won't be modeling it with PRA if you --

MEMBER KIRCHNER: Mm hmm.

DR. COOPER: It won't be modeled in the PRA if there's no reactor trip. So, the fires we care about will have a reactor trip.

CHAIR STETKAR: In your opinion, it would

1 not be modeled in the PRA if there's no reactor trip.
2 PRAs do model fire scenarios that do not result in a
3 reactor trip, but disable, for example, necessary
4 cooling water systems.
5 MEMBER KIRCHNER: Right. And then the
6 reactor trip --
7 CHAIR STETKAR: I have done that said
8 PRAs, so I can say PRAs do that. Perhaps none that you
9 ever did.
10 MEMBER KIRCHNER: And then the reactor
11 trip may come well after the fire.
12 CHAIR STETKAR: Right. That's right.
13 And that's why it's important. But it is important
14 that the start of their scenario -- it's one of the
15 things I look for -- is the initiation of the fire. And
16 indeed, the reactor trip can occur sometime after that.
17 Whether it's caused by the fire, whether
18 it's coincident, whether it's somebody manually trips
19 the reactor, that begins a certain type of transient.
20 But the fire can cause a tran- -- can cause a disruption
21 of cooling without tripping the reactor.
22 MEMBER KIRCHNER: Yeah.
23 CHAIR STETKAR: And that -- that is --
24 MEMBER KIRCHNER: So, my question is, are
25 all the scenarios you look at reactor-trip-coincident

1 with the fire alarm? Or is this just an example?
2 DR. COOPER: I want to defer that
3 question.
4 MS. PRESLEY: I would say --
5 MEMBER KIRCHNER: I mean, the more likely
6 thing is that you would have a fire somewhere in the
7 plant, and it would take sometime either to recognize
8 you had a problem, or to do grade equipment, or to get
9 to reactor trip. But I wouldn't see them coincident.
10 MS. LINDEMAN: Yes, that's correct. A
11 common simplification is the fire starts at T equals
12 zero, and there's also a reactor trip at T equals zero.
13 I believe in supplement 1, we acknowledged that that
14 simplification may not be appropriate in all instances,
15 and, you know, it's dependent on a lot of things.
16 Right?
17 The fire can happen like a transient, and
18 that's not associated with a piece of equipment, so it
19 can take time for that fire to grow and develop. Or
20 you can have a fire on the right location and a reactor
21 trip --
22 MEMBER KIRCHNER: So, let's go back to
23 Browns Ferry. When did they discover the fire, and
24 when was the reactor tripped?
25 MS. LINDEMAN: I would say the fire was

1 detected rather quickly, based on my recollection.

2 MR. SALLEY: Browns Ferry -- so it was a

3 manual trip on Unit 1. After they had the fire and they

4 fought it for quite a while. So, there was an amount

5 of time, and the key on Browns Ferry was they, at that

6 point, knew they lost all their cooling systems. So,

7 they were pretty much done.

8 Now, the interesting thing is Unit 2,

9 because Unit 2 was a sympathetic trip. There's -- you

10 know, it was sympathy that they were going to lose it

11 too, so they tripped that manually.

12 CHAIR STETKAR: But the point is that the

13 fire damaged -- the effects of the fire damage begin

14 at time T zero when the fire occurs. The reactor trip

15 is simply some of that that occurs. It could happen

16 at zero, it could happen, you know, 17.3 minutes after.

17 That doesn't necessarily start the PRA

18 scenario. The PRA scenario starts when you get some

19 damage to equipment that can affect the nuclear power

20 plant. Cooling the core in particular.

21 MS. PRESLEY: So, that point is

22 not -- this timeline's a simplification. So --

23 CHAIR STETKAR: But see, in supplement 1,

24 indeed, that's one of the things I looked at. And

25 supplement 1, perhaps, is not belabored as much as we

1 just belabored it. But it is -- that distinction is
2 made in supplement 1, that the reactor trip doesn't
3 necessarily need --
4 MEMBER KIRCHNER: Yeah.
5 CHAIR STETKAR: -- to have gotten
6 started --
7 MEMBER KIRCHNER: Because coincident was
8 your fire start.
9 CHAIR STETKAR: T zero starts the fire.
10 MR. AMICO: Paul Amico from Jensen Hughes
11 again. Yeah, but again, is it -- it's more like a
12 typical PRA assumption that we -- that we don't -- we
13 look at everything. For example, all the failures that
14 occurred due to the fire, we assume they happen
15 immediately, as was brought up.
16 It's similar to when we look at a failure
17 to run, for a pump. It could really occur any time.
18 And if it occurs anytime, it could change the amount
19 of time you have left to do some action. So, we don't
20 get into that. A failure to run, we assume it happens
21 at T zero, whether it does or not.
22 And so, the thing here is, we're talking
23 about is that in the PRA assumption, we bring everything
24 back to happening simultaneously, so that you get the
25 worst effect -- the least amount of time, the least

1 amount of heat removed from the plant.

2 If you say everything happens at T zero,

3 I've got the most latent heat, I've got the most decay

4 heat, I've lost all my equipment at that time. And

5 that's not unique to the abandonment scenario.

6 That's not unique to buyers. That's

7 pretty much the way we do all of our PRAs.

8 CHAIR STETKAR: Okay, that's -- and

9 again, you're speaking of the way you do all of your

10 PRAs. I've done PRAs that do look at the timing of fire

11 damage.

12 MR. AMICO: And indeed PRAs do look at the

13 timing of fire damage. It's called fire growth

14 detection, fire ignition detection, growth and

15 suppression, so that you get a sequence of extending

16 damage, depending on how long the fire exists, and where

17 it is.

18 And indeed it's not unique to fires. For

19 example, if I look at losses of offsite power and

20 station blackouts, I parse my models -- and I'm saying

21 now, I, rather than we, as the royal

22 everyone-does-it-this-way -- I parse my model in terms

23 of, what's the likelihood that I recover offsite power

24 within X minutes? And if I do, I have certain

25 opportunities.

1 Why minutes? I have different
2 opportunities -- zed minutes -- I have three
3 opportunities, and maybe, you know, one more. So, this
4 course distinction of times is not what everyone does.
5 I mean, it's not what everyone does on
6 these time-sensitive things, to always presume
7 everything is worse happening at T zero. That's a
8 holdover from LOCA analyses. It's not necessarily the
9 best thing to do for fires.
10 MS. PRESLEY: And because it shows on this
11 view graph, that doesn't mean that we are requiring --
12 CHAIR STETKAR: No.
13 MS. PRESLEY: So, I want to clarify. So,
14 for this example, we're not requiring that. We
15 acknowledge it as a typical simplification. But we're
16 not requiring it. But this --
17 MEMBER KIRCHNER: What I was objecting to,
18 I guess, is making Rx trip coincident with fire starts,
19 or fire alarm. The fire might go on for quite a while
20 before you realize you have a problem. And then, much
21 later in the scenario, you trip the reactor, manually
22 or automatically.
23 And then, you may have a heck of a lot less
24 time to do other actions to mitigate the problem. So,
25 I'm just -- maybe this is misleading me and this is not

1 the way you actually do the analyses, but putting Rx
2 trip coincident with the fire alarm seems magical.
3 DR. COOPER: Susan Cooper. I agree. I
4 agree.
5 MEMBER KIRCHNER: Magical, in fact.
6 DR. COOPER: I'm not sure that's the point
7 that she wanted to make with this graph. And I
8 guess -- but I agree with you. Probably at sometime
9 after the fire is acknowledged and the local operator
10 has been found out what -- after he made his
11 investigation and calls back to the control room and
12 they make an assessment as to where that fire is now
13 located, and now they'll have some guidance about
14 whether or not they're going to have a reactor trip.
15 So, I think there's -- and we'll fix this.
16 I don't think this graph is actually in the report.
17 CHAIR STETKAR: That is not.
18 DR. COOPER: Yeah, it's not in the report
19 yet. It's something we're trying to use to help
20 explain some things. So, the feedback you've given
21 here to help will help us decide whether we want to use
22 it or not.
23 But the point is that we're trying to
24 illustrate that we understand that there is a
25 progression of things. And this is -- and she's got,

1 I think she said, 12. So, we do have multiple cuts.
2 It's not just one picture.
3 CHAIR STETKAR: When you think of these
4 things, I always -- you know, we -- we get trapped in
5 this too, so I can say we. We tend to get pigeonholed
6 into things. This, for some reason, seems to be the
7 guidance for quantifying main control room abandonment
8 for fires that happen only during full power operation.
9 Now, I think -- the fire doesn't know
10 what's going on. The people in the control room live
11 in the control room 24/7. So, think about shutdown
12 conditions. There's no reactor trip. Reactor trip is
13 shut down. On the other hand, the fire has
14 all -- causes some damage that results in a trajectory
15 of the plant, and results in responses of the people.
16 Now, if the plant happens to be operating
17 at power, one of the things that the fire might do is
18 trip the reactor. One of the things that the people
19 might do is trip the reactor.
20 But that's irrelevant to guidance for how
21 to think about this in the sense of a PRA. Fire damage
22 begins at zero.
23 DR. COOPER: We have not develop guidance
24 for shutdown fire.
25 CHAIR STETKAR: But no. My point is that

1 shutdown fire is no different -- the fire doesn't know
2 and the people don't know.
3 DR. COOPER: So --
4 CHAIR STETKAR: So, why do we have to
5 pigeonhole the guidance for, you know --
6 MS. PRESLEY: The point of this is to say
7 that timing is not as clear cut as in -- and I think
8 we've all -- we've just furthered the demonstration
9 that this is true. So, even with my simplified
10 version, which is not clear cut, it could be even more
11 less clear cut.
12 So, at some point you're going to have a
13 fire. At some point you're going to have an alarm.
14 Somewhere you're going to have a reactor trip. Then
15 you do your immediate memorized actions. When you get
16 your alarm, you send someone to confirm it locally.
17 That person eventually will come back and
18 report with, you know, what's going on and where the
19 fire is, and confirm that you have a fire. Then, you're
20 going to start seeing at some point instrumentation
21 failure.
22 And then, at some point you're going to
23 decide that that instrumentation failure is
24 significant enough that your major systems and
25 instrumentation has been impacted.

1 And then, you're going to get to the point
2 where, yes, I think I've lost control. I need to
3 abandon. So, that's -- so, the order of those things
4 happening, and how compressed or elongated they are,
5 depends on the fire modeling piece and what scenario
6 you're modeling.
7 But you can't just look at, you know, this
8 cue says I need to look at these three pieces of
9 equipment. When does my modelings of these three
10 pieces of equipment are gone?
11 You have to look at the totality of the
12 picture. So, thank you for proving my point for me.
13 MS. LINDEMAN: We'll get a better picture
14 --
15 MS. PRESLEY: Yeah. And there's, you
16 know -- like I mentioned, this is one snapshot of one
17 kind of progression we looked at. We looked at a
18 half-dozen of these, and it depends on what your cue
19 says.
20 So, if your cue says consider abandoning
21 after a fire in the cable spreading room after local
22 confirmation, then in this particular graph, local
23 confirmation comes before you have major systems
24 identified.
25 Well, are they really doing to do that? Or

are they going to wait a little bit? Are they going -- you have to start asking questions about training.

Are you trained to confirm any particular equipment? Or do you take this verbatim? So, the procedure progression and the fire growth progression need to be matched up so you understand what's happening.

That was kind of the point of this graph. So, if you want to go to the next one.

MEMBER BLEY: But before you -- before you --

CHAIR STETKAR: I'm sorry. I'm sorry I was away for a little while.

PARTICIPANT: I have one comment.

CHAIR STETKAR: Hold on. Jazz, let him --

PARTICIPANT: Oh, I'm sorry.

CHAIR STETKAR: -- finish talking, please.

MEMBER BLEY: It's hard to hear back there. If you want to keep something like this, you know, the words here make sense. The discussion makes sense. But I'd really urge you, if you're going to keep something like this, that you keep at least a couple,

1 to say, there's a couple of different ways this could
2 happen.
3 There are lots more. But showing one kind
4 of anchors in somebody's head that, yeah, the first
5 thing that ever happens is that the reactor gets
6 tripped. And then we start watching the fire. And
7 they happen in this order, and that's not -- your point
8 was they don't.
9 MS. LINDEMAN: And I think what's in the
10 report is actually just a bullet list of the things that
11 you consider.
12 CHAIR STETKAR: In supplement 1 -- I'm
13 staring at it right now -- in chapter 7 of
14 supplement 1, there is a discussion about this relative
15 timing, and it's clear that zero is when the fire
16 starts, and things happen after that.
17 In the latter part of section 7, it says,
18 PRAs often simplify this by assuming the reactor trip
19 occurs at zero, but the construct in supplement 1
20 actually does distinguish between the -- JS.
21 MR. HYSLOP: Yeah, this is JS. I guess
22 I'm not sure I need to say what I was going to say since
23 you just did, but often, yeah, the trip is assumed at
24 T equals zero, often. And some of the reasons
25 sometimes is just we haven't traced all the cables, so

1 we're not sure what will happen.

2 But there is a fire growth modeling that

3 occurs, and if you wanted to take advantage of that and

4 say you didn't damage in the target sets, I guess you

5 could delay it.

6 CHAIR STETKAR: Any more discussion on

7 step one, because if there's not, I'm going to call for

8 a break, because we're going to shift gears here to talk

9 more in terms of models and methods, and that sort of

10 stuff, and we need a break. So, let's take a break and

11 return at 3:15.

12 (Whereupon the above-entitled matter went

13 off the record at 2:56 p.m., and resumed at 3:16 p.m.)

14 CHAIR STETKAR: We're back in session.

15 MS. PRESLEY: Okay. So, Step 2 which we

16 did in parallel with the issues list, actually a little

17 bit of an iterative process, but we listed several HRA

18 quantification approaches to see what was out there,

19 what might be used, and what we might be able to pull

20 from. And the ones on the screen are the ones we looked

21 at.

22 The cause-based decision method and

23 decision tree method, HCR/ORE, which is a time

24 reliability method.

25 We looked at IDHEAS At-Power.

1 We also looked at -- we're familiar with
2 IDHEAS G and we looked at the cognitive literature stuff
3 underlying it. So while that wasn't one of the
4 quantification methods we looked at specifically, we
5 did look at the failure mechanism there.
6 We looked at SPAR-H.
7 We looked at NARA and CREAM.
8 So if you want to go the next.
9 MEMBER BLEY: NARA's still not public;
10 right? Except for a couple papers?
11 DR. COOPER: Susan Cooper. Yes, that's
12 correct.
13 And we did, we'll see later that we did use
14 NARA. And that was from one of the papers. Among the
15 authors on the team we do have access to the non-public
16 version and can make internal comparison. So, it's
17 good.
18 MS. PRESLEY: So, our initial, so after
19 we'd looked at this set of methods we thought maybe we
20 could adapt the cause-based deficiencies. At the high
21 level, the failure modes, the operator, information
22 interface and the operator procedure interface,
23 failure modes seem to be potentially applicable.
24 So we started there and we went through the
25 review process. And we went tree by tree and we asked

1 is the failure mode of the tree still applicable? We
2 looked at each branch point and kind of performance
3 shaping factor associated with the tree and we said,
4 Are those the right ones for the failure mode? Are they
5 still applicable? And are there dominant failure
6 modes or mechanisms missing from the set of trees, from
7 the set of CBDT trees that we should, we should be
8 accounting for?
9 And as we went through we found that at the
10 failure mode level it was pretty applicable. But once
11 we started going through we were stretching the method
12 more than maybe it was intended to. We were
13 reinterpreting things.
14 For example, four of the trees talk about
15 the operator procedure interface. But what procedure
16 step are you really talking about? We found we were
17 convoluting the transfer to get to the abandonment
18 procedure and then the actual decision to abandon cue.
19 We were conflating the two as we went through the
20 case-based decision trees.
21 We saw some, or there were binary decisions
22 where we thought more gradation might be warranted.
23 And some of the trees just required more
24 reinterpretation than we were willing to make.
25 So we said, okay, we'll pull what we can

1 from it and what we think is important, but we're really
2 not going to go with the existing method and try to just
3 adopt that wholesale.
4 So we ended up with three new decision
5 trees:
6 Failure to transfer to the main control
7 abandonment procedure;
8 Failure to understand the criteria have
9 been met;
10 And then, so, if we get to the criteria then
11 we have to understand the criteria have been met. And
12 then once you understand the criteria have been met,
13 you have to actually make the decision.
14 So the last one is reluctance of delay in
15 making the decision.
16 MEMBER BLEY: In the report itself isn't
17 there just one?
18 MS. PRESLEY: In the report there is one.
19 So this is what we went into from the discussion.
20 So, so that formed the discussion that the
21 skeleton of what we discussed with the -- if you want
22 to go to the next slide.
23 MEMBER SUNSERI: Wouldn't the reluctance
24 to delay just be a subset of one of the other ones?
25 MS. PRESLEY: Well, that's what the

1 experts told us. So, so yeah.

2 We, we thought it might be a separate

3 factor after we looked at it, but it turns out that

4 reluctance is primary driving factor from the expert

5 elicitation is that reluctance is key. And it

6 underlies everything. So it will always be there. So

7 it's built into the base HEP.

8 There wasn't a separate branch point

9 called out reluctance, or there weren't levels of

10 reluctance based on the quality of the remote shutdown

11 panel because an operator doesn't know that plant X has

12 a great remote shutdown panel, but theirs is really

13 crumby. They just know that they have a remote

14 shutdown panel and it's not the control room.

15 So they, they might not -- they would not

16 necessarily have more or less reluctance than another

17 operator at a more or less capable plant.

18 So, so one of the, one of the key points

19 was that reluctance needs to be built into a base HEP,

20 and we don't need to look at factors around that.

21 We also learned that timing, which we

22 thought would be important, was going to be a key

23 differentiator.

24 And then the other piece was we thought

25 procedures were really important: how you get to the

1 procedure and the quality of the procedure. And there
2 was a lot of discussion about the process the operators
3 go through of integrating information to always be
4 looking ahead at what's coming, and that they would have
5 an idea of what the criteria are based on their
6 training.
7 And so there are prudent actions that all
8 operators they need to understand as part of their
9 fundamental training. And if they get -- start seeing
10 indications of spurious operations, they're going to
11 start thinking about the abandonment criteria.
12 And so that was more important more of a
13 dominant factor than just the procedures themselves.
14 So, so that was also, from an offsetting perspective,
15 built into the base HEP. And it actually goes with
16 training as well. So we pulled out training as one of
17 the branch points in the final, in the final tree.
18 MEMBER BLEY: Let me ask a kind of broad
19 question about that.
20 Let's say 20, 30, 40 years ago we would
21 argue the same things about the emergency operating
22 procedures, the LOCAs and all that kind of stuff. And
23 we did.
24 And then we saw more and more. And some
25 utilities ran tests of their old experienced operators

1 who produced relevant, newer procedures. And pretty
2 soon everybody was coming on board. But they have a
3 better chance to do well with more elaborate
4 procedures.
5 But that only came after a lot of
6 exercising the procedures and getting used to them. We
7 don't exercise these procedures very much. I don't
8 know how much people even look at them when they're not
9 in the midst of it. And most of them are never in the
10 midst of it.
11 And do you have a sense for whether that's
12 what's going on here, or is it just there's something
13 about this that doesn't lend itself to writing a linear
14 procedure that will be helpful to you?
15 MS. PRESLEY: So, in the process of doing
16 the HRA some of our team members have found that there
17 was great potential to improve the procedures. There
18 were extra actions in there that people, well, while
19 you're there we're going to do it, but it would
20 challenge the time, the feasibility from the timing
21 perspective.
22 So there was definitely a lot of refinement
23 possible. But from a cognitive perspective I think we
24 don't understand the exact progression that is here and
25 exactly what the operators will be seeing. And that

1 was talked about a lot. So, having some high level
2 criteria and training the, training that could be a
3 little more agile is important where, where we just
4 don't know how the scenario might unfold.
5 One of the things the experts did talk
6 about was management philosophy and whether or not the
7 operators are trained to think at the higher level and
8 encouraged to do that. So, I think, I think in this
9 particular scenario we can't be so prescriptive because
10 we just don't know what it's going to look like. And
11 I don't know if --
12 DR. COOPER: Yeah. Susan Cooper. I'll
13 just add to that.
14 There seems, despite the fact that we had
15 experience among the author team with making changes
16 to procedures, getting certain utilities to buy into
17 changing the procedures to have more explicit criteria
18 for the decision to abandon the loss of control, when
19 we got the expert panel together there seemed to be some
20 pushback on making, you know, funneling analysts to
21 saying that's the solution to this problem as opposed
22 to looking more at the experience of the operators and
23 not getting sort of fenced in into particular criteria.
24 Exactly where that's coming from is hard
25 to say. But certainly we don't have any experience to

1 show us which is the right way at this point. I don't
2 think we've run across any plant that is doing training
3 on the decision to abandon, except in the classroom.
4 MEMBER BLEY: Thank you.
5 MS. PRESLEY: There is one that was
6 brought up during the -- there was one plant that was
7 brought up during our elicitation that they were doing
8 it. But even in that case they said, you know, we do
9 the classrooms training and then we go into the
10 simulator to do it. So they're sort of seeded to think
11 abandonment already. So maybe it's not realistic.
12 MEMBER KIRCHNER: How often is the remote
13 shutdown panel tested, "tested" at a typical plant?
14 Once a week, once a month, once a shutdown, once a
15 refueling?
16 MS. PRESLEY: What do you mean by
17 "tested," like trained on? Or even observed and
18 checked.
19 MEMBER BLEY: To make sure the switches
20 work and that kind of stuff?
21 MEMBER KIRCHNER: Everything, yeah.
22 MR. AMICO: This is Paul Amico again from
23 Jensen.
24 So, the question is like to actually
25 operate things? Because they don't --

1 MEMBER KIRCHNER: Well, or check that it's
2 operating.
3 MR. AMICO: Yeah. I mean, they don't
4 actually go through and start pumps and things like that
5 using that panel.
6 MEMBER KIRCHNER: No. But I mean at least
7 inspect it.
8 MR. AMICO: Right.
9 MEMBER KIRCHNER: Ensure that it's --
10 MR. AMICO: It will vary from plant to
11 plant. Jeff, I don't know if you have the -- you know,
12 at least during the refueling outage they would check,
13 they would energize it to check the meters come on and
14 everything like that. But every plant would do it
15 differently.
16 DR. COOPER: Susan Cooper. There are
17 some plants that have their remote shutdown panels
18 energized all the time.
19 MR. AMICO: That's true.
20 MEMBER KIRCHNER: That's what I would
21 expect. That's why I was asking.
22 DR. COOPER: But they still have to
23 transfer control from the control room to the remote
24 shutdown panel. I don't know when that testing is
25 done. I seem to remember that Paul or one of our other,

1 other authors in the audience, has run across that that
2 may not happen so often.
3 MEMBER SUNSERI: So I don't, I mean I may
4 be mixing up, and I'm sure I am mixing up some things
5 here, but I'll ask for some clarification. It seemed
6 to me like I recall during triennial fire inspections
7 every three years a reg guy goes out to the plant,
8 inspects. And they walk the operators through a lot
9 of these fire scenarios and actually time them to make
10 sure that the timed responses are within the regulatory
11 or the analyzed limits.
12 It would seem to me that that exercise or
13 that piece exercises some elements of what you're
14 talking about up here. So I guess I'm surprised that
15 operators then are reluctant, because they do get a
16 chance periodically to walk through these procedures
17 and become more comfortable with them.
18 Can you comment?
19 DR. COOPER: Susan Cooper. So, so the
20 part where they've left the control room and they're
21 taking actions, either at the remote shutdown panel or
22 at local plant stations, yes, it has been and is being
23 exercised quite a lot. You could say it's familiar in
24 a certain sense.
25 The parts that aren't exercised are things

1 like the decision to abandon the control room. What
2 we've heard I think almost universally is the way that
3 they train abandonment scenarios starting in the
4 simulator is that the trainers for the operators will
5 say you have an abandonment scenario, show me what
6 you're going to do next. Which really is about
7 exercising all of the steps that are needed to be taken
8 in the control room before you can leave.
9 Like what actions do you have to take to
10 transfer control; what other pieces of equipment you
11 might need to operate if you haven't tripped; or
12 whatever, those kinds of things that will be exercised
13 but not the decision.
14 The other piece that's not exercised,
15 which we're going to talk about after Phase II, and that
16 is what's happening at the remote shutdown panel with
17 the supervisor who is trying to keep track of all the
18 things that are going on either at the remote shutdown
19 panel and the variety of local plant stations out at
20 the plant. You know, his, his communication with them,
21 the way he keeps track of going to the procedure and
22 so forth, that also -- you know, there have been some
23 plants that have said they've done that, but that's
24 rare.
25 So that piece also is not trained often.

1 MS. PRESLEY: Okay. And so the last piece
2 is that we just wanted to point out, because this came
3 up in the expert elicitation and the bounds of it, our
4 estimation was based on current U.S. fleet. We did
5 include performance working factors that may be like
6 training, above what the current fleet is doing, to show
7 that there are potentials for improvement. But we
8 didn't look at what new designs were. They might have
9 a second main control room which has, you know,
10 virtually the same capabilities.
11 So that wasn't in the scope of the what
12 we're looking at.
13 So, Step 6. Our drumroll please.
14 Our final tree that we came out with with
15 the -- and consolidating the three trees into one. And
16 as I mentioned, the reluctance, you don't see a branch
17 for that. That was baked into the base HEPs, which is
18 why they all start fairly high. And the way to -- I'll
19 talk across the branches.
20 The first was abandonment logic explicit
21 in the procedures. So is there some indication of what
22 the criteria are?
23 MEMBER BLEY: Do you mind if I interrupt
24 you just a second.
25 MS. PRESLEY: Yes?

1 MEMBER BLEY: For the other members, if
2 you haven't looked at decision trees and HRA methods,
3 don't get confused. They are not like event trees.
4 They're really just a truth table of conditions. And
5 when you analyze your plant, you know what the
6 conditions are. You come into this tree and say for
7 this scenario, under these conditions it's a certain
8 place here. It's just saying, yeah, I do have the
9 criteria document in the procedure. It's only
10 classroom training and it's not -- if you work your way
11 through this tree you come in with your conditions,
12 match it up, and read the number off the end.
13 I'm sorry. Just this confuses people.
14 MS. PRESLEY: Thank you very much. Yeah,
15 thank you very much for that background.
16 So the first question that we ask then is,
17 is the abandonment logic explicit in the procedures?
18 Now, we mentioned that it's not as much of
19 a driver as we initially thought, but it's still an
20 important driver. And instead of three gradations,
21 which we originally had, we pared it down to one. And
22 is it really purely judgment-based or is there some
23 criteria that are documented in the procedure that the
24 operators can refer to and monitor?
25 So you can go up or down based on your

1 answer to that question.

2 The second question asks for simulator or

3 talk-through training specifically on the decision to

4 abandon. So everyone kind of gets the training on the

5 abandonment procedure but have they actually simulated

6 what they're going to see and how they're going to think

7 about the decision and how they're going to make that

8 decision?

9 So, while this is not standard practice,

10 this is one area that people could improve. So the

11 question is, is it classroom only or do they go that

12 one step above where they actually do talk-throughs or,

13 again, a simulator run?

14 And so then the third question has to do

15 with training and understanding of the scenario. So,

16 do they have an awareness of the urgency? And this gets

17 to different, different scenarios progress at

18 different rates.

19 So how much time you have is important, but

20 it's equally important to know if the operators

21 understand how quickly they need to make the decision.

22 So this, this gets --

23 MEMBER BLEY: Sorry to interrupt again.

24 MS. PRESLEY: Yes?

25 MEMBER BLEY: When I read something

1 earlier in these where it said is this time Phase III.
2 Well, this is the time from when they decide to abandon
3 until the PRA shows when they wouldn't be able to get
4 everything done. That's not something in an
5 operator's head.
6 MS. PRESLEY: No. Yeah, so that is the
7 operator will not know if they have 5 minutes, 25
8 minutes. But they would know, they would understand
9 if it's a fast progressing or slow progressing fire.
10 They would be able to tell you what are the types of
11 things they might check in different scenarios before
12 they would make the decision.
13 So the kinds of questions that you should
14 be asking it's do you know you have 5 minutes, or how
15 much time do you think you have? It would be questions
16 like, okay, what would you check before you made the
17 decision? Or how would you make the decision?
18 And then you can start getting an idea of
19 how much time they think they have and what they would
20 do. And that would give you an understanding of
21 whether or not they have an awareness of the urgency.
22 MEMBER BLEY: Question. I haven't looked
23 at these procedures in quite a few years so I don't know
24 what they look like now. Do they give hints of the
25 urgency and time available to carry out all this stuff

1 to the operators?

2 MS. PRESLEY: I don't believe they do.

3 But Paul can.

4 MR. AMICO: Okay. Paul Amico again from

5 Jensen Hughes.

6 So, it really varies a lot from plant to

7 plant. Unlike EOPs, these fire abandonment procedures

8 are completely different. There's no Westinghouse

9 approach, or CE approach to an abandonment procedure.

10 So it varies greatly.

11 Some of them are changing. As a result of

12 the fire PRAs and 805 -- and then J.S. can talk to this

13 also because he's familiar -- the plants are realizing

14 that they do need to make improvements. So you are

15 seeing some cases now where it's sneaking into the

16 procedure that you need to make this decision within

17 25 minutes, or some range. So it varies greatly,

18 Dennis.

19 It's just but we're starting to see

20 improvements in that, also improvements in the

21 training. So, so it's one of the benefits.

22 MEMBER BLEY: It's like I remember but

23 it's getting better.

24 MR. AMICO: Yeah. Yeah. It used to -- I

25 mean, some of these procedures were so simple, like when

1 the shift manager feels that they can no longer control
2 the plant from the control room, consider abandonment.
3 MEMBER BLEY: That's it.
4 MR. AMICO: And, you know, and it's
5 getting better because the PRAs are starting to say
6 these are the things that you are likely to see. And
7 they're putting that in as the cues to consider. And
8 they're giving some indication of the urgency.
9 MEMBER BLEY: That's good. Okay, thanks.
10 But it's still varies.
11 MS. PRESLEY: Yes. So sometimes you have
12 time-critical actions linked with fires in different
13 locations, but it's definitely all over the map still.
14 And then so after --
15 MEMBER BLEY: One more thing. Is the
16 staff doing anything about that to encourage that these
17 become more consistent and useful to the operator?
18 MR. HYSLOP: Well, I was just going to --
19 MEMBER BLEY: You've got to say who you are
20 again. I'm sorry.
21 MR. HYSLOP: J.S. Hyslop. We are seeing
22 in our, you know, we had an application meeting with
23 the licensee and we didn't encourage it because, you
24 know, we were at a certain stage of analysis and stuff
25 like that. But they came in and said we're going to

1 re-do our analysis. So this is one of the better 805
2 main control analyses that was done.
3 I said, Why are you doing that? You did
4 one of the betters.
5 He said, We're updating our procedures to
6 be more specific on the criteria for abandonment.
7 And so I don't know, I don't think, I don't
8 think the staff is encouraging it at this point, but
9 we're hearing it happen.
10 MEMBER BLEY: Do you have any hints as to
11 whether INPO's pressuring this work or not?
12 MR. HYSLOP: I don't.
13 MEMBER BLEY: Okay.
14 MS. PRESLEY: So then the last, the last
15 thing it asks about is how much, how much time to you
16 have available to make that decision. And the way we
17 calculate time available is we look at how long it takes
18 to actually be successful in the Phase III action and
19 see what the leftover time is. And that's your time
20 margin to make a decision. So, basically, that's how
21 much you can delay before the downstream actions won't
22 be effective anymore, so.
23 DR. COOPER: If I can just add. The point
24 is, as Matthew was saying, the actions taken to shut
25 down the plant after you've left the control room are

1 practiced. You can get times for those. And you can
2 also talk about you'd need a little extra time for
3 recovery, or you certainly factor in travel time. So
4 you can, you can estimate all those times based on
5 actual demonstrations.
6 And then you can total up all those times,
7 using the integrated time lines to account for overlaps
8 and so forth, and then you can get an estimated time
9 for implementation of the safe shutdown strategy. You
10 might want to give yourself a little bit of a margin.
11 But the point is you have an overall system window that
12 you've calculated for your thermal hydraulics on when
13 you reach core damage.
14 So you subtract off what you think you need
15 for implementing all those act -- executing all those
16 actions for shutdown, and also subtracting off when you
17 got the cue, and then you've got something left over
18 for your decision. That's, so it's a calculated thing.
19 Since it's not trained in the control room, it's not
20 like we can go out and collect data on it or anything
21 like that.
22 MS. PRESLEY: And next slide.
23 MEMBER SUNSERI: Well, I had one question
24 on that slide before you leave it.
25 Does it -- my mind can't go through the

1 permutations as quickly as you start it -- but does it
2 make a difference on what order you ask these questions?
3 It seems like if you brought the awareness question up
4 earlier it might change the outcome.
5 You know, because if you are unaware that
6 you're in an urgent situation and you're using your
7 judgment, not procedures, to drive the outcome, you
8 might get in a different place than you would if -- see
9 what I'm saying?
10 MS. PRESLEY: Yes. So I should probably
11 describe how the numbers came to be.
12 So, the numbers came to be we did, we asked
13 the experts to give us estimates for the worst case,
14 which is judgment-based cue, only classroom training,
15 and no awareness of urgency, and for 5 minutes and 25
16 minutes. And then they gave us the best case
17 probabilities.
18 And then what we asked them to do was a
19 parallel comparison between each branch point pairs.
20 So they actually went scenario by scenario and said we
21 think this scenario is better or worse than that
22 scenario.
23 So in that case it doesn't matter whether
24 you said it first or not. They thought about the
25 scenario as a whole when they compared it against.

MEMBER SUNSERI: Okay, so I think I see. It doesn't matter if you ask the three questions in any order, you still get through the branches and you still get through the --

MS. PRESLEY: Yeah.

MEMBER SUNSERI: I get it.

MS. PRESLEY: Yeah.

MEMBER BLEY: Your concept might be right.

MEMBER SUNSERI: Yes.

MEMBER BLEY: But this is simply a truth table.

MEMBER SUNSERI: Yes.

MEMBER BLEY: And so if both of them are in one direction it's under that condition of both being one way or both being the other. It's not a scenario in the sense of when we think of something happening over time.

CHAIR STETKAR: I guess -- don't switch it yet. Leave it on the screen.

I very much appreciated the discussions in Supplement 1 and Supplement 2 about how complex all of this is and all the variability and how some plants are better and some plants are worse. And we've heard a lot about that today. What I was really surprised about was that your experts, considering all of that,

1 have assessed that there's between an 80 percent and
2 98 percent success rate of always doing this successful
3 with enough time left.
4 To me that seems really darned good, given
5 all of the stuff we've heard about variability, about
6 reluctance. This says the worst it can be is they'll
7 be 80 percent successful in leaving with enough time
8 left to do everything they need to do in Phase III.
9 That's the worst it could be, an 80 percent success
10 rate.
11 A lot of students in school would be really
12 happy after a lot of studies to have an 80 percent
13 success rate. So I'm really curious how your experts
14 came up with this very, very highly likely success, with
15 no uncertainty by the way, because Appendix A where you
16 discuss the expert elicitation specifically says that
17 you didn't look for uncertainty in the expert
18 elicitation process.
19 MS. PRESLEY: So I'm going to caveat that
20 with it's 80 percent given we've met the feasibility
21 criteria.
22 CHAIR STETKAR: Sure. Obviously, yes.
23 MS. PRESLEY: So you've already met a
24 fairly high bar to get into that. Right? You've
25 weeded out your students that didn't study.

1 CHAIR STETKAR: This is a plant where it's
2 left up to the supervisor. If you think it's a good
3 idea, get the heck out of the control room. That you've
4 talked about it in a classroom. And the people aren't
5 aware of the urgency that I need to get out of here,
6 and I, by the way, I have to make that decision within
7 5 minutes, and I'm still 80 percent successful. Eighty
8 percent successful.
9 DR. COOPER: Susan Cooper. Feasibility
10 also requires even if there's judgment in making the
11 decision only, the procedure only has judgment as a
12 criteria, there needs to have been interviews of the
13 operators and a consensus opinion on what constitutes
14 a loss of control where they would leave the control
15 room that has to have been obtained.
16 So there is another piece to that bar. So
17 that's an important piece of the feasibility.
18 So it's not like they have no notion of what
19 it is that would represent or be defined as loss of
20 control.
21 CHAIR STETKAR: Right.
22 DR. COOPER: So there is another little
23 bit more there.
24 CHAIR STETKAR: And in your interviews you
25 make it very clear that loss of control is they have

1 to know that if the core is going to melt they're going
2 to leave. That's the way you've characterized it, is
3 that loss of control is the plant is on a trajectory
4 that you cannot prevent the core from melting from
5 inside the control room. Look in your guidance.
6 And, of course, if I'm an operator I'm
7 going to say, Well obviously if I know the core is going
8 to melt I'm going to leave.
9 DR. COOPER: Susan Cooper. If it doesn't
10 say it, it should say this because what the operators
11 believe and what we've discussed in detail is that they
12 need to tell us what those conditions are. Not that
13 we tell them that this is it. They have to tell us what
14 those conditions are.
15 And then and it has to be a consensus answer
16 from more than one operator. So it's not like we tell
17 them this is what the situation is, are you going to
18 leave? It's what are the conditions that you think
19 define loss of control? And that has to be a consensus
20 answer.
21 MEMBER KIRCHNER: Susan, one thing on this
22 chart. Is T available for decision? It's a
23 calculated quantity?
24 DR. COOPER: Yes.
25 MEMBER KIRCHNER: From a PRA or whatever?

1 DR. COOPER: No. It's calcul -- well, it
2 has a number of different inputs. The first and most
3 important input is going to be some kind of thermal
4 hydraulic calculation associated with the scenario
5 that says when core damage would be reached if you
6 haven't been successful with the shutdown strategy.
7 Other pieces of it are going to be, for
8 example, I mentioned you're going to, for each of the
9 actions that are required for shutting down the reactor
10 after you've left the control room there have been
11 demonstrations on those actions and you can collect
12 times on those. And that was discussed even in 1921.
13 We have some more I think in Supplement 1.
14 So those, those pieces so you can measure
15 out how much time you need for, for Phase III, and you
16 can add in some time for some communications and so on
17 and so forth. And then you need to also subtract off
18 some time to when you think the cue is going to come
19 in.
20 But that's, so that calculated -- that's
21 a calculated time with a number of different timing
22 inputs. But it's a back calculation from all of those
23 different things.
24 MEMBER KIRCHNER: Yeah, I understand
25 that. I'm just going through this logic and thinking

1 I'm the operator, I don't know whether I'm going to have
2 5 minutes, 5 to 25 minutes, or 25 minutes.
3 DR. COOPER: No, you don't. You don't.
4 It's an HRA calculated to make a distinction between
5 if you have 5 minutes to make the decision, we're making
6 a distinction saying that that's going to be more
7 difficult, or we think it's going to be less likely that
8 they can --
9 MEMBER KIRCHNER: I agree with the notion
10 that if you have more time to make a decision the human
11 error probability of the first order should go down.
12 DR. COOPER: That's what it's, that's what
13 it's supposed to say, yes. That's what I would expect.
14 MEMBER KIRCHNER: But I don't know that as
15 the operator, as this fire commenced --
16 DR. COOPER: No, you don't.
17 MEMBER KIRCHNER: -- and I'm starting to
18 make this decision.
19 DR. COOPER: You don't.
20 MS. PRESLEY: So the part that you know,
21 so everything on this side is things the operator would
22 know. So you would, you would have, either you would
23 or you wouldn't have an awareness of the urgency. You
24 would either understand it as progressing quickly.
25 MEMBER KIRCHNER: Well, I'm going to tell

1 you as an operator, former operator, if I'm thinking
2 about abandonment, this is urgent.
3 MS. PRESLEY: Yes.
4 MEMBER KIRCHNER: So the answer is yes,
5 I'm already under the gun. I feel the pressure. We
6 need to make a decision.
7 MS. PRESLEY: So all of this is just saying
8 if we have more margin we may be more successful. So
9 this has nothing to do with whether or not the operators
10 understand how much time they have. It's just purely
11 how much margin do you have.
12 CHAIR STETKAR: And if you have -- again,
13 I'm personally very skeptical of these numbers that
14 they've got here.
15 MEMBER KIRCHNER: I am.
16 CHAIR STETKAR: Because if you have more
17 margin, yeah, you get the difference between 80 percent
18 success rate and 98 percent success rate. Both of
19 those to me are very, very successful.
20 Now, if it was a difference between 1
21 percent success rate and 98 percent success rate I'd
22 say, yeah, maybe you thought about the problem a little
23 bit. But I don't think your experts thought about the
24 problem, quite honestly. That is my personal opinion.
25 DR. COOPER: Well, so the -- I mean, I

1 don't know if it's helpful.

2 CHAIR STETKAR: Because, because I can't

3 read anything in your appendix that tells me what your

4 experts thought about or what their uncertainties were

5 or how they, how they did their evaluations.

6 DR. COOPER: Okay.

7 CHAIR STETKAR: It simply reports their

8 results as point estimates.

9 DR. COOPER: So are you asking for the

10 answer or are you asking us to put the answer in the

11 report?

12 CHAIR STETKAR: I would really like to see

13 -- I mean, if you have the answer that would be great.

14 But I'd certainly like to see it for the benefit of

15 people who use this guidance.

16 DR. COOPER: Sure.

17 CHAIR STETKAR: Because if users look at

18 the rationale that your expert team used and said, Well,

19 gee, maybe -- I'm not sure that anyone would but I'll

20 leave the field open -- I'll look at that rationale.

21 I'm not sure that that really applies for my plant. And

22 maybe, maybe I want to do things a little bit

23 differently. Maybe I want to -- I'll use this

24 conceptual framework but let's skew things differently

25 for my plant.

1 Now, I can't do that unless I understand
2 what rationale your experts used and if they did have
3 uncertainties, if there are ranges. I mean, if this
4 is a consensus opinion and two people said it's 1.0 and
5 another person said that it's, you know, .007.
6 MS. PRESLEY: It ranged from .1 to .3, so,
7 for the .2 or the, yeah, the 2 to the minus 5. A very
8 tight range.
9 CHAIR STETKAR: But those are, those again
10 are single point estimates. They aren't --
11 MS. PRESLEY: We only got single point
12 estimated.
13 CHAIR STETKAR: The .3 person I don't know
14 whether there was -- what the range was or what.
15 MS. PRESLEY: Okay.
16 CHAIR STETKAR: It seems awfully for --
17 again, I'll come back without trying to be as
18 antagonistic, if I read all of the words that you have
19 in both Supplement 1 and Supplement 2 about the
20 uncertainty -- and now I'm not talking quantitative
21 uncertainty, I'm talking about the variability from
22 plant to plant, the degrees of sophistication of the
23 training, of the guidance, of the experience of the
24 people, of the fact that, you know, when you say do they
25 experience time pressure? Well, Walt might say, well,

1 I always will feel that it's urgent for me to get out.
2 Other people might say, well, no. Hey,
3 wait a minute, you know, I think that we should really
4 take our time here and think through this because
5 getting out is a really bad thing.
6 Those are two different opinions. But,
7 but again, within the context of this, that only gives
8 you a differentiation between 80 percent successful and
9 98 percent successful.
10 MS. PRESLEY: So we can look and see what
11 other rationale we can pull for it. Susan?
12 DR. COOPER: Yes, Susan here.
13 There is quite a lot more we could document
14 on the process that we used with the experts. We spent
15 a day with the experts. That might seem like a short
16 period of time actually, but everyone that was -- served
17 the role as an expert had already been either part of
18 this project or aware of the issues. We didn't have
19 that, you know, week of exchanging information, reading
20 material, and so on and so forth. So we, we had an
21 educated group of experts.
22 But, nevertheless, we spent a whole day
23 doing all of this. And we did use a formal process of
24 getting each of the experts view, having them discuss
25 what went behind their numbers, and so on and so forth.

1 How much of that to document has been a question. We
2 don't want to document all of it because it would be
3 -- probably we don't need to document all of it.
4 But more needs to be documented. I guess
5 I'm interested that maybe if you could clarify what
6 specifically you think you would like to hear about.
7 I guess you want to hear about what the expert, what
8 kinds of scenarios or contexts they were thinking about
9 when they were coming up with this. Is that what you're
10 asking about?
11 CHAIR STETKAR: I'd be happy to have seen
12 an expert's elaboration of uncertainty. I, I for these
13 conditions today believe that the worst it could be is
14 1.0 for the following reason; and the best it could be
15 is .07 for the following reason; and my best estimate
16 is, I don't know, .23 for the following reasons. None
17 of that rationale is there. So I can't look at the
18 reasons for why you say the range of your experts was
19 .1 to .3.
20 DR. COOPER: So, Susan again. So just I
21 want to clarify this.
22 CHAIR STETKAR: Because it doesn't strike
23 me as a valid -- I mean, we've done expert elicitations.
24 DR. COOPER: Yeah.
25 CHAIR STETKAR: In many cases you ask,

1 well, for these conditions at least I'd behave
2 differently. How bad do you think it could be, and why?
3 How good do you think it could be, and why? And now,
4 within that range give me your best estimate.
5 But get them thinking about the ranges
6 first rather than just focusing in on a single number.
7 Because people who are very, you said, very
8 knowledgeable, experienced, they know the process,
9 they know everything, tend to focus on very narrow
10 values, and may not have carefully thought about those
11 sources of uncertainty. And that can be dangerous,
12 especially because people are just going to pick these
13 numbers up and use them as the intent of the guidance.
14 DR. COOPER: I'm going to go ahead and let
15 Jeff.
16 MR. JULIUS: Thanks, Susan. This is Jeff
17 Julius of Jensen Hughes. And I was one of the ones that
18 was on that expert panel.
19 So, you're right, when we talked about
20 those we spent the day going over the different aspects.
21 We were pushed and looked at the different ranges of
22 the worst case and the best case, and then coming up
23 with our point estimate. And, yes, the description we
24 could add some text and explanation of the rationale.
25 Part of that is the recognition, or what

1 I was looking at this, was the action is feasible? It
2 was a fairly high bar with some conservatisms that are
3 in there. But the approach is not only just to use this
4 number, but in Section 5.3 it says use a sensitivity,
5 or set it to 1 and see what the results are. Because
6 there is a lot of complexity and variability in this.
7 And also stretch it the other way.
8 I understand what you're saying. And
9 those reporting, you're right, doesn't give you a good
10 basis for using a multiplier of 2X or 5X on these numbers
11 if you wanted to skew it. And we can improve that.
12 But there was the consideration in the
13 discussion on the pushing the ranges of the conditions.
14 And that most of the time the numbers that are showing
15 up here in this final decision tree were given that it
16 is feasible, and differentiating between a .3 or a .5
17 is, you know, is a difficult decision to make.
18 MEMBER BLEY: Jeff, since we've got one of
19 these people here I'm going to ask you a couple
20 questions.
21 First a comment. I kind of agree with
22 John, when you read the two documents and all the
23 caveats are in there about how bad this could be, I'm
24 surprised that you didn't think these are kind of
25 optimistic given all of those words. That's number

one.

Number two is we've separated the habitability and loss of control. But if you're really about to lose control, habitability has probably gone to hell as well. And did you think about the habitability conditions that might be going on in the control room as you approach this point where you think, ah, for control purposes I've got to get the heck out of here? Was that really part of the thinking? Did you guys discuss that as you went through this?

MR. JULIUS: This is Jeff Julius, Jensen Hughes.

So the second question first. So the comment first. The thinking on the loss of control was more for the cable spreading room or instrument room fires where you're not seeing the environmental impacts. And --

MEMBER BLEY: If you're lucky.

MR. JULIUS: In general. And that the --

MEMBER BLEY: There's a guy over here might say something.

Where is that cable spreading room physically?

MR. JULIUS: Some are above, some are below the control room.

1 CHAIR STETKAR: Assuming it's below --
2 MR. JULIUS: Yeah.
3 CHAIR STETKAR: -- it may or may not have
4 shared ventilation systems. There might be a hole in
5 the floor.
6 MEMBER BLEY: It's something to think
7 about. But anyway, keep going.
8 MR. JULIUS: That's right. And that's
9 right, the fire is in the main control, there are in
10 the panels that are causing loss of control, you do get
11 a combination of the smoke and the system impact.
12 MEMBER BLEY: Were you thinking about that
13 when you made these estimates?
14 MR. JULIUS: Generally goes with
15 afterthought. It wasn't one of the primary.
16 MEMBER BLEY: Yeah. That's kind of what
17 John was talking about.
18 CHAIR STETKAR: What I was talking about
19 in terms of the rationale that it's clear that from what
20 we just heard that at least one of the experts for loss
21 of control had a particular fire location and a
22 particular set of effects on the personnel in the main
23 control room. Those effects not involving
24 habitability concerns at all, simply what's available
25 in front of them and how much confidence they have on

1 those displays and indications.
2 Could be different for that fire in the
3 main control room that never got to the loss of
4 habitability criteria, whatever those are. But still
5 resulted in enough snarky -- I'll use that term again
6 -- indications and controls that they decide I can't
7 control it or I've lost confidence and have to leave.
8 But that would again be compounded by the
9 habitability, local environment conditions.
10 DR. COOPER: Susan Cooper. Yeah, I've
11 talked with some of the research staff on fire
12 protection about scenarios that could be considered by
13 habitability and loss of control scenarios. The
14 answer I got, which is a simplification, is that
15 probably loss of control criteria would be used first
16 before habitability criteria.
17 However, you raise an interesting point,
18 good point, that some of that habitability stuff could
19 be happening while they're seeing some strange
20 instrumentation. So that's, that an important --
21 that's a good point.
22 I want to get back to the main question
23 about the expert elicitation. I, since I did not have
24 any preconceived ideas about the numbers, nor did I lead
25 them in numbers, I did go through the ATHEANA User's

1 Guide has some guidance on expert elicitation for
2 quantification I used that guidance, including the
3 controls, if you will, on probabilities.
4 And had some discussion with the experts
5 before we got into the quantification part about what
6 those numbers meant, including the case of the one
7 person who wasn't an HRA person or had any experience,
8 I talked with them about, you know, numbers of crews
9 going through simulators and how that might be related
10 to numbers.
11 So I -- and we did talk about a number of
12 different things. I guess getting back to the point
13 about, you know, how Supplement 1 sounds compared to
14 Supplement 2, I think the same kind of thing sort of
15 ended up happening for Phase III from my perspective.
16 Because I've been hearing about command and control and
17 how all these different things are going on, and they
18 never practiced it, and they've got all these phone
19 calls coming in, and they have no administrative
20 controls about who can open up the door and start
21 bothering you.
22 But then when it came right down to, well,
23 what's important about this, sort of like, Uh-huh, I
24 know, I think there -- the notion that probably with
25 their basic training and so forth that they're going

1 to get through this despite having any demonstrations.
2 So it did seem to me that when we got down
3 to talking with experts, people who as far as I know
4 would probably be the best or have the best knowledge
5 available in the industry about what might happen
6 because no one's seen this in a simulator, very few
7 people have actually done any kind of demonstrations,
8 integrated demonstrations after they left the control
9 room, when it got right down to it, as far as they could
10 imagine it didn't seem to be as big of a problem as,
11 you know, when you're just sort of asking them for some,
12 you know, like complaints about the process, it didn't
13 end up, you know, when it came down to it that they
14 thought that seemed to be that important.
15 It was a little bit of a surprise to me to
16 be honest, because I was, you know, especially like I
17 said with the command and controls, like, well geez,
18 you know, we don't know what kind of procedures they
19 have. They probably haven't practiced. They've only
20 got one phone or one radio and they've got everyone else
21 calling them. And, you know, it's going to be kind of
22 a nightmare.
23 But when you got right down to it it was
24 sort of like, well, so what's important about that?
25 Not that much.

1 So I don't really know how to -- you know,
2 what kinds of messages to take away from that. I think
3 one message for me is that even with the people I would
4 have expected to have the best understanding of this
5 context, that we don't understand very much about this
6 context still. And we probably need to get more
7 information.
8 It would be nice if people, you know, even
9 just motivated by some of the things here that we've
10 written down, that they would start looking at, you
11 know, looking at doing some training, at least having
12 some talk-throughs or whatever, doing some integrated
13 training, you know, once they get to the remote shutdown
14 panel, that sort of thing. And actually, actually sort
15 of see where -- kick the tires and find out where the
16 problems are.
17 Right now we've just had some kind of a lot
18 of people that have been in certain situations with
19 anecdotal comments and concerns. But when it comes to
20 informing error probability there seems to be kind of
21 a more optimistic view than I would have expected.
22 MEMBER BLEY: I guess I'm thinking this
23 thing -- and John's brought it up a few times -- if
24 somehow when people are thinking about this they know
25 they're worried about core melt, and they focus in my

1 mind would I stay here if I think we could get core
2 damage? I think that makes it real easy.
3 In a real control room with a fire going
4 on, and I'm still driving the plant okay, I'm probably
5 not thinking I'm going to be in a core damage situation
6 pretty soon.
7 DR. COOPER: Yeah. We did --
8 MEMBER BLEY: I don't know if you were able
9 to keep the right mindset on these people. Of course,
10 we weren't there to see that.
11 I'm sorry. I cut off Matt.
12 DR. COOPER: Yes.
13 MEMBER SUNSERI: All I was going to say is,
14 well, may be off key, so but anyway I've heard several
15 times now that the plants don't practice this. And
16 that's not my experience. I mean, my experience is the
17 plants have remote shutdown simulator panels near their
18 simulators that they practice it periodically. I've
19 seen situations where smoke generators are brought into
20 the simulator to --
21 MEMBER KIRCHNER: Don't they do this when
22 they do a FLEX deployment?
23 MEMBER SUNSERI: Well, I don't know about
24 that. But maybe there's aspects of this whole scenario
25 that aren't being exercised. But certainly I think

1 that operators do the transition, that they practice
2 making the decision to go to the remote shutdown. That
3 they practice stopping the control. And they do it on
4 their simulators.
5 MEMBER BLEY: I think your experience is
6 more to the unique side from what I've heard about in
7 plants.
8 MEMBER SUNSERI: Well, maybe. But I mean
9 I can think of at least three plants --
10 MEMBER BLEY: I mean there's an awful lot
11 of plants not only don't have a simulator for the remote
12 shutdown panel, they don't even have a remote shutdown
13 panel. How many plants have just distributed stuff,
14 they go out and operate? Twenty or 30?
15 MEMBER SUNSERI: Good question.
16 MEMBER BLEY: I'm hoping Mark will have an
17 answer. I know you used to look at this stuff a lot.
18 MR. SALLEY: I'd almost go to J.S. for
19 that. I mean, yeah, a lot of the plants don't --
20 MEMBER BLEY: I'm sorry, I forgot J.S.
21 MR. SALLEY: Yeah. When 81-12 went in a
22 lot of them had load control spaces, is what they called
23 it.
24 MEMBER BLEY: Yeah.
25 MR. SALLEY: So they were doing that at all

1 multiple places in the plant. For some they put --
2 MEMBER BLEY: Yeah. Local control
3 stations and just using those as a remote shutdown.
4 MR. SALLEY: So 20 or 30 we could
5 guesstimate, J.S., unless you've got a better number.
6 MR. HYSLOP: J.S. Hyslop. There are a lot
7 of -- I don't have a number. I just know we've seen
8 cases where it's distributed. We've seen cases where
9 they've better panels. I'm not sure how many true
10 simulator remote shutdown panels, right, but I haven't
11 seen a lot of those but I know they're out there.
12 I don't have a number so I can't tell you.
13 MEMBER BLEY: It's a mix.
14 MEMBER SUNSERI: Well, I'll take that.
15 So I had another question and maybe this would be a good
16 time to ask it.
17 I've seen some human, or I'm familiar with
18 some human performance studies that show intelligent
19 beings that would have all the right information
20 available to them don't always make better decisions
21 when they have an unlimited amount of time. In other
22 words, having a time limit actually improves their
23 decision making because they don't end up second
24 guessing themselves and making the wrong decisions
25 later.

1 But that, your data doesn't seem to
2 indicate that. It seems like given more time they also
3 make a better decision.
4 CHAIR STETKAR: This isn't data. This
5 isn't data.
6 MEMBER SUNSERI: Well, analysis or
7 whatever it is.
8 CHAIR STETKAR: And remember, let me read
9 something. We have to be aware of time here because
10 we need to talk about Phase III and things. But my
11 concern about having the experts and the whole group
12 colored too much about preconceived notions of what
13 this is from not an operator's perspective, from a human
14 reliability analysis widens perspective, is in
15 Supplement 1.
16 It explicitly says "loss of control
17 scenarios are those that will lead directly to core
18 damage if the operators remain in the main control room,
19 i.e., in the absence of operator actions taken
20 following abandonment. For each loss of control
21 scenario, or group of scenarios that share the same
22 characteristics, that would lead to core damage in the
23 absence of abandonment actions the HRA analyst will
24 need to conduct operator interviews to determine if the
25 abandonment procedures and equipment cover these

1 situations, and also whether the operators would
2 interpret the conditions as a loss of control."
3 Well, if you ask me if the core's going to
4 melt do I have loss of control? Well, hell yes.
5 Will I leave the control room? Well, hell
6 yes.
7 And if your experts know that these are
8 scenarios where the core is going to melt, if they don't
9 decide to leave the control room within 5 minutes, that
10 knowledge will color their evaluations, the same way
11 that the knowledge is not inside the control room, it's
12 in some place outside the control room.
13 DR. COOPER: So what I'm hearing you say
14 -- and because we're not saying that to the operators.
15 This is guidance to the analysts so they understand that
16 they're not to look all over the place for scenarios
17 to model those loss of control scenarios. They can be
18 informed by the PRA and other modeling as to these are
19 the ones that we're concerned about. We'd like to take
20 credit for them in the PRA. And HRA analysts figure
21 out whether or not we can take credit for them in PRA.
22 We're not going to the operators and saying
23 if you don't do this you're going to melt, the core's
24 going to melt, are you going to leave or not? We didn't
25 run the elicitation that way.

1 The, you know, I guess, I guess what
2 probably is needed is to be more clear about how we talk
3 with the experts or operators versus what we're giving
4 guidance to HRA analysts. The HRA analyst needs to be
5 informed about this so they can have their, their
6 analysis focus and they can make sure that they're
7 focusing on the right things to support the PRA. But
8 that's not how you interact with the operators. You're
9 absolutely right.
10 So I'm not really sure what, what the
11 answer would be, but probably some beefed-up guidance
12 on how you interact with the operators and so forth.
13 But to be real honest, except for the fact
14 that you need to find out from the operators what they
15 think are the set of conditions that they feel would
16 be loss of control, what they define as loss of control,
17 you know, I mean that has to happen. And I think we're
18 pretty clear about the fact that the operators guide
19 that definition. If that definition doesn't match up
20 with the PR -- what the PRA says you don't get the
21 credit. That's bottom line.
22 So, anyway, and we didn't do the expert
23 elicitation that way either. I'll ask Jeff, one of the
24 experts.
25 MR. JULIUS: Jeff Julius, Jensen Hughes,

1 member from the expert panel.

2 Just to confirm what Susan said, that it

3 wasn't -- we didn't ask leading questions. We were not

4 asked leading questions in terms of conducting the

5 expert panel.

6 And just a clarification of earlier

7 statements. So the comment, when I was thinking about

8 the fire in the cable spreading room I was

9 conservatively not taking credit for the smoke going

10 up in the control room. Because if there was smoke in

11 the control room, that would give some additional

12 indications to the main control room team that, hey,

13 maybe there should be some more urgency here and maybe

14 we should need to make this decision faster.

15 So I think that's a good example, though,

16 where that type of rationale, you know, the report would

17 benefit from having that kind of rationale or

18 additional detail added in Appendix A.

19 MS. PRESLEY: And I just, just to be very

20 clear, and since I have the notes in front of me, the

21 things that were -- so, so we asked for each criteria

22 kind of what are the best, what are the worst?

23 We discussed, because we had a lot more

24 criteria here to begin with even, we ran through some

25 of them. But some of the things that were coming out

1 were operators know that there are only a few fire areas
2 that would lead to abandonment. So they are signaled
3 when they have an alarm in one of their areas. They're
4 starting to think right away about what those criteria
5 are.
6 They're thinking about the procedures are
7 important, but as soon as they're starting to see
8 effects they're going to start wondering about, because
9 they know those areas are critical, they're going to
10 start thinking forward. So that was on the why it's
11 reliable side.
12 On the not reliable side they were thinking
13 things like they brought up several historic events of
14 areas where they were reluctance and delays. They
15 talked about the David-Besse AFW failure where the
16 steam generator level was, you know, they kind of
17 wiggled their way out of it was low, it wasn't at the
18 rock bottom but they knew it wouldn't be at the rock
19 bottom because that's not the way that indicator works.
20 So they bought some time and delayed them.
21 Calvert Cliffs they had the -- they were
22 supposed to do the SI injection but the shift supervisor
23 overrode the procedural direction and delayed that.
24 So they, they did bring up they talked
25 about the Robinson fire and the crew that was assembled

1 and the quality of that crew. And so when they were
2 talking about the HEP they were talking about these
3 sorts of things.
4 So we can put in a little bit of discussion
5 about what we have heard as the background. We didn't
6 specifically say, okay, in the fire's in your control
7 room and you're almost at habitability but not quite,
8 we didn't go quite into that level of detail but we did
9 push the bounds of best and worst. And we only
10 solicited a best estimate number. We didn't ask for
11 5th to 95th percentile because it wasn't, it wasn't that
12 level of expert elicitation.
13 So I just I want to make that clear and we
14 can document that. But the, yeah, the level of
15 resolution you see in there, that's what's in it and
16 that's what's not in it, so.
17 DR. SMITH: Let's, we do have to be a
18 little bit aware of time here. I don't know how
19 flexible people are in running long, but I don't want
20 to get too late.
21 For NRC staff, be aware that these numbers
22 will be interpreted throughout the industry as
23 NRC-approved human error probabilities. These are
24 NRC-approved human error probabilities. Okay, I will
25 just put that -- just be aware of that. It isn't, this

1 isn't -- once this hits the street these are cast in
2 stone.
3 DR. COOPER: Susan Cooper. One thing I
4 want to add is that because we don't have demonstrations
5 of all of these pieces, especially here we're talking
6 about decision core damage, people are practicing this
7 in the control room. We haven't seen it happen.
8 So I think even with the experts I think
9 there's probably some aspects that they understand
10 about sort of conduct of ops that are not usually
11 touched by HRA but get more into, you know, conduct of
12 operations, you know, sort of your basic bible for how
13 the plant does business, which we don't always get to
14 that level of control, if you will, or operations in
15 HRA because we're -- because some of those typically
16 well-practiced simulator exercises aren't the basis
17 for our understanding of how these operators will
18 perform.
19 There may be some additional things that
20 we need to talk about so far as, you know, what the
21 expectations are of the operators, especially going
22 back to the training and their fundamental
23 understanding of how things are going on, you know,
24 what's going on in their plant. So there may be some
25 more pieces that we need to add in that underline this

1 in addition to reluctance.

2 MR. SALLEY: Yes, Susan, if I could for a

3 second.

4 John, I understand exactly what you're

5 saying is you put the number out there and then for lack

6 of anything better the rank and file person who's doing

7 the work is going to see this number. Use this as a

8 reference and go with it.

9 What would you recommend that we do, you

10 or Dennis, your thoughts on this to improve it or to

11 make it better or safer, whatever?

12 CHAIR STETKAR: My initial thoughts -- and

13 again, these are personal, you know, it's a

14 subcommittee meeting so there can be ten different

15 interpretations here -- at least bare minimum the

16 experts' understanding of what they were evaluating and

17 their uncertainties.

18 I'll come back to this notion of

19 uncertainty is if they, you know, this point number

20 really doesn't mean anything to me without

21 understanding what their uncertainties are. And

22 saying that three experts, two of which has .1 and one

23 of which had .3 doesn't tell me anything either because

24 they were all people who -- first of all, they were all

25 people who are very familiar with this process and could

be biased that way. They knew, they knew what they were answering. And other folks might not know that the say way.

So I think some notion of the fact that there may be more uncertainty in these numbers than people are led to believe, especially for this very, very narrow, the worst it can be is 80 percent success rate, and the best, regardless of what you say about feasibility because the guidance for feasibility actually is pretty good, but just given the fact that it's feasible, if you pass that screen, it still sounds -- it might be in my opinion it might be well justified but I can't understand why they are, given the documentation that you have.

Dennis.

MEMBER BLEY: I guess I'd start with John's bare minimum. And when you have that I'd draw some conclusions about it.

Like, if you hear from all of the people who were on your panel that, no, they didn't consider the environment, the degradation, habitability at all as they looked at this. But put a caveat in that, you know, the scenario we've quantified is with the clean atmosphere.

CHAIR STETKAR: Basically for a fire not

in the control room. Now --

MEMBER BLEY: Or with smoke leaking in from somewhere else.

CHAIR STETKAR: Yes.

MEMBER BLEY: No, it's a clean control room.

CHAIR STETKAR: It's a clean control room.

MEMBER BLEY: I don't know what you'll find when you're talking. That might not be the case. Maybe some of them really thought about that. But if you find other things as you go through that that imply it's a more narrow set than you intended, just be up front about that and say, look, we did this. These are guidance but this guidance really only applies to a selected set of conditions. And for other conditions it will be different.

CHAIR STETKAR: The problem is -- and Jeff and Paul perhaps can back this up -- I believe that this issue becomes most important quantitatively for fires inside the main control room. But I could be wrong there. I'm not sure.

Cable spreading rooms aren't the same problem that they used to be because cable fire frequencies in part are much lower than what people used to have. And, yeah, you've got to consider transient

combustibles but you have to consider transients in the main control room also.

I don't know how much you get into fires in instrumentation and control cabinet rooms driving this. But the problem with those rooms is they often have the same shared ventilation system as the main control room. So, as Dennis said, it's pretty important to understand what the experts knew in terms of the conditions when they established these --

MEMBER BLEY: Mark told us something earlier that's a change to me. You know, when I was aboard ship we had ventilation systems. That's the first thing you did if you had a fire was you killed the supply vents and turned the exhaust vents on high.

Most plants, when I looked at them, had no separate controls for inlet and outlet and you couldn't adjust them like that. It was ventilation on/ventilation off. You can either suffer in the smoke or feed the fire with more air.

So if that's changed, and you were saying you now have purge in a lot of the plants, that's a difference. But I don't think we talked about that sort of thing anyway, did we, in the report? I don't remember seeing that.

CHAIR STETKAR: No.

1 MEMBER BLEY: It came up in the
2 discussion.
3 But that's a really important point if in
4 fact most of the plants now have the ability to purge
5 smoke, and especially in the control room, that really
6 would help.
7 MS. LINDEMAN: Ashley Lindeman. For lack
8 of habitability usually you would evaluate two cases:
9 one with no ventilation. And if you had purge mode you
10 would take that into account in your fire model.
11 MEMBER BLEY: Ashley, my problem is
12 habitability and loss of control aren't separate
13 things. We parse them separately to talk about them
14 here and then we haven't done much with one. But often
15 they go together. And when they go together, that's
16 important.
17 CHAIR STETKAR: I do want to leave time for
18 Phase III because I have comments on Phase III analysis.
19 And there's a lot of good discussion I know you want
20 to get to in terms of command and control. So if we
21 can, let's go on to the Phase III guidance.
22 DR. COOPER: Okay. This is Susan Cooper.
23 I'm going to talk about our Phase III HRA quantification
24 guidance. And this is for the implementation of main
25 control room abandonment safe shutdown strategies.

1 Supplement 2, Section 4 provides the
2 guidance on the quantification of all of the HFEs that
3 would be associated with Phase III .
4 CHAIR STETKAR: Susan.
5 DR. COOPER: Yes?
6 CHAIR STETKAR: Before you get started on
7 this, because you're very quickly going to get into the
8 discussion of command and control, which is a pretty
9 interesting discussion, let me ask you a very leading
10 question, but one that I honestly came away being
11 somewhat confused.
12 Does your guidance recommend that an
13 analyst evaluate only implementation errors in Phase
14 III except for conditions where you identify very
15 specific command and control issues? So, for example,
16 if you say there's no command and control issue
17 according to the guidance here, everything in Phase III
18 is that only implementation or does it also include
19 cognition?
20 In other words, when I think of standard
21 typical HRA I have a cognitive part and I have an
22 implementation part and, you know, I parse it up that
23 way.
24 DR. COOPER: So --
25 CHAIR STETKAR: Because I read it in

1 different parts of the guidance, whether it's
2 Supplement 1 seems to lead me to believe that there is
3 absolutely no cognition associated with Phase III, that
4 it's strictly rote: follow a procedure, push this
5 button, eat that banana.
6 In Supplement 2 there seems to be a little
7 bit but it's always associated with this make a decision
8 about whether or not there is a command and control
9 issue. And if there's no command and control issue,
10 if it's literally a rote follow the procedure, then it's
11 strictly implementation. But I will submit that there
12 is never a rote follow the procedure. Somebody is
13 always going to be in control.
14 DR. COOPER: So it's a -- there's a little
15 bit, there's a little bit of discussion about this.
16 What we discovered when we were developing this
17 guidance is that in particular there could be
18 differences between PWRs and BWRs so far as how, how
19 their strategies are laid out. For a particular BWR
20 the shut -- main control room abandonment safe shutdown
21 strategy is one path. There is one set of steps.
22 There's no alternative system written in the procedure
23 --
24 CHAIR STETKAR: Right.
25 DR. COOPER: -- to go do if this doesn't

1 work.

2 So a good portion of our guidance is

3 written for that particular set, that scenario. But

4 it recognizes that there could be other, other

5 strategies that might have decisions between either

6 using different systems, or you might try a system. It

7 doesn't work and you have the option written within the

8 procedure for shutdown, main control room abandonment

9 shutdown, to go to that other system or second system

10 or third system.

11 So there are some plants that have that

12 kind of strategy. But it's very much tied to what the

13 strategy is as documented in their safe shutdown

14 procedure.

15 CHAIR STETKAR: Let me, because I want to

16 get through this, let me just drop this as a suggestion.

17 Take a look at the discussions in both Supplement 1 and

18 Supplement 2 of the guidance of Phase III and be

19 sensitive to whether or not the guidance reinforces the

20 notion that the analyst now should account for

21 cognition.

22 Now, at a particular plant for a particular

23 fire scenario with a particular set of procedures,

24 perhaps consideration of cognition says that it's not

25 a contributor. But only for that particular plant, for

1 that particular fire scenario, with those particular
2 procedures.
3 If you read the guidance, as I did as kind
4 of a skeptic, I'm led to quickly draw the conclusion
5 of the opposite, that in general you don't consider
6 cognition except for very, very specific cases that you
7 identify as particular command and control issue. And
8 I'm not sure that's what your intent was.
9 DR. COOPER: No, it's not.
10 CHAIR STETKAR: Okay.
11 DR. COOPER: And this is one of those
12 places where there is an evolution from Supplement 1
13 to Supplement 2. And it was actually -- I mean, whether
14 or not it was late for all the authors, it was late to
15 getting to the document so far as there being a
16 distinction between how you treat these different types
17 of strategies so far as whether or not there's decision
18 making going on like there would be, say, like in EOPs
19 where you have, you know, alternative and another path
20 to go in your procedures, and other choices with respect
21 to systems and so on and so forth.
22 So that's, that's we do call it out very
23 briefly in Supplement 2 and we say that if that is the
24 kind of strategy we have, if we have, you know, response
25 not -- maybe equivalent of a response not obtained

1 column where you would go to another procedure or
2 another system, then this, the rest of this guidance
3 doesn't apply. So we recognize that.
4 The other thing is that we don't say there
5 is no cognition. But the way we treat it for those
6 strategies where you really only have one path, there's
7 only one set of things to do, we do look at the
8 interactions between operators, especially
9 communications between field operators and a
10 supervisor who might be recording information or then
11 later worrying about coordination, and the time that
12 it takes to do that.
13 CHAIR STETKAR: But that's, and the
14 discussion of time I think is done well there. But what
15 I'm talking about is the standard cognition of
16 identification diagnosis decision making. And
17 despite all the things you say that when people abandon
18 the control room I have a set of procedures that tells
19 me to do this, I'll guarantee you that those procedures
20 are not going to match what's happening in the plant.
21 And some supervisor is going to have to make a decision
22 about how do we adapt what we have to match what's going
23 on in the plant.
24 That may involve creative alternatives.
25 It may involve delays for decision making. It may

1 involve time to go get additional information for
2 people. It's never going to match the presumptions,
3 especially the way the procedures are written now, that
4 you have a certain Appendix R fire that says go do A,
5 B, and C and everything is going to be perfect, because
6 it never will.
7 DR. COOPER: So --
8 CHAIR STETKAR: And that's, I'm not trying
9 to get very specific. I'm trying to step back and say
10 why should the guidance for doing Phase III type human
11 reliability analysis be different from the guidance for
12 doing any other human reliability analysis, except for
13 the fact that there might be more complex things that
14 I'll allow you to get to here in a minute, in terms of
15 coordination of command and control communications
16 that may not apply, certainly do not apply to sitting
17 in the confines of the main control room with a set of
18 emergency operating procedures.
19 DR. COOPER: Well, some of what you're
20 talking about is, again, it's not all doc -- some of
21 the steps, the interim steps we went through are not
22 documented. But we went through all of the pieces of
23 the definition of command and control that we
24 established in Supplement 1, which includes things like
25 situation assessment, and allocating resources, and

1 making decisions and so forth, and looked at each of
2 those to see what their contribution was for the
3 specific set of strategies that I just mentioned where
4 it's a single path through the procedure.
5 And then identified what kinds of failure
6 modes might be coming from each of those pieces. And
7 that's on top of the execution.
8 And the end point that we reached was what
9 I'm going to be presenting so far as the main
10 contributor of really cognition, thinking, decision
11 making, controlling, that sort of thing. I'm not going
12 to -- I mean, I' not going to say that, you know, whoever
13 is at the remote shutdown panel looking at whatever
14 indications they may have there, they're going to be
15 following their procedure, getting information that
16 they can. They're going to be keeping track of what's
17 going on.
18 But based on the set of strategies that we
19 were trying to address here, and we tried to be -- talk
20 about, you know, this is the scope we're looking at --
21 those steps of strategies do not really specify or
22 codify or formalize any of these kinds of deviations.
23 The reality is, of course, I mean, I realize the reality
24 is going to be different but we've made, we've made that
25 boundary. We've talked about some additional things

1 that might happen in the future, you know, so far as
2 other equipment that you might be able to credit if you
3 had time to do that, that sort of thing. But we haven't
4 gone beyond what is specified specifically in the main
5 control room abandonment safe shutdown procedures.
6 If it's not in there now, we're not talking
7 about crediting some other innovative idea that might
8 be a recovery to failed system or a failed piece of
9 equipment. We haven't looked at that, no.
10 There's no procedural link to anything
11 else right now. It's not in the procedure right now.
12 There are efforts looking further, but that's, you
13 know, not -- and we mention that there might be other
14 things that are happening in the future, but that's not
15 in this project.
16 CHAIR STETKAR: I just think it's a
17 regression in 2018 to give human reliability analysts
18 the notion that they ought not to think about cognition
19 as a fundamental part of their analysis, regardless of
20 preconceived notions about how specific the procedures
21 may be for a particular scenario. I believe, or some
22 belief is that they should always think it's cognition.
23 If they think about it and dismiss it for a particular
24 scenario, that it's not an important contributor, fine.
25 They've thought about it and dismissed it, and

1 documented it.

2 If they're surprised, they've thought

3 about it and, gee, they're surprised and they've

4 accounted for it. But the guidance ought to force them

5 to be surprised, not tell them to ignore it unless it

6 slaps them in the face from some other set of criteria.

7 Do you follow me?

8 DR. COOPER: Yeah.

9 CHAIR STETKAR: We've spent too much time

10 over the last decade talking about the importance of

11 cognitive performance and how people really make --

12 people don't make mistakes by pushing wrong buttons,

13 you know. They occasionally push the wrong button but

14 that's not what gets people into trouble.

15 DR. COOPER: I agree. I agree.

16 The difficulty that I have is, again,

17 getting back to the variability on the remote shutdown

18 panels. And now we're not just talking about controls,

19 we're talking about indications. Because that's what

20 is going to drive someone to decide to do something.

21 CHAIR STETKAR: But my point is let the

22 analysts. This is guidance that's supposed to apply

23 to any plant for any fire. So let the analysts struggle

24 with that for their plant and their fire scenario.

25 They have to struggle with their plant, their

capabilities, their operators, their training, whatever their procedures are and how well they fit a particular fire scenario. That's their job.

And if the guidance gets too pigeonholed with some preconceived notion about how all of the procedure, you know, the average of all of the procedures that you've looked at and what you think might be important, I think that's a disservice to guidance for performing human reliability analysis. It's kind of back to the old THERP of you follow the procedure and look up numbers in a table, and by definition that's how people perform.

DR. COOPER: Yeah, that's not, that's not the picture. But the bottom line is, and as we get into the later slides, for implementation of the safe shutdown strategy you are talking principally about single operators in individual locations by themselves at a panel doing something that's been put out on their, on their procedure. It's not a crew per anymore, at least not the same type of structure anymore. That's, so they're --

MEMBER BLEY: They don't, when they're doing that they don't have somebody at some place coordinating all those activities?

DR. COOPER: Well, in principle they do.

1 But there's a lot of variation, there's a lot of
2 variation between plants so far as whether or not there
3 is actual coordination. In some cases -- and we talk
4 about this some I think in Supplement 1 -- one of them,
5 I can't remember -- but the point is that there could
6 -- or maybe I wrote it and we axed it out -- but I mean
7 in some cases, you know, field operators are given
8 individual attachments. They go out. And the only
9 communication they really have with a supervisor is I'm
10 done, I'm going on to the next thing. You know, that's
11 it. There's no coordination.
12 Or if there is coordination it might be
13 between individual operators, field operators if
14 they're, you know, trying to control, you know,
15 singular level and injection or whatever, maybe they're
16 talking together on headsets. We can do that.
17 And then there are some other instances
18 where there is coordination. But the bottom line is
19 it's a lot of the communication is just reporting.
20 Now, when we get into this, we are trying to focus on
21 those places where coordination is needed and to model
22 something there.
23 CHAIR STETKAR: Why don't we go on because
24 --
25 DR. COOPER: Yes.

1 CHAIR STETKAR: -- I'm going to try to
2 finish by about 5:15 to no later than 5:30 certainly.
3 DR. COOPER: Okay.
4 CHAIR STETKAR: But 5:15 or so.
5 DR. COOPER: So, so I guess I'm going to
6 skip to the bottom so we can try to -- of this slide
7 and just say that the principal focus of our research
8 for Phase III was to look at command and control and
9 to try to understand what was important about it for
10 the range of strategies that we were considering and
11 try to identify what needs to be modeled. And
12 sections, there are various sections in Section 4 that
13 talk about. And Appendix B provides some of the
14 background.
15 And there is -- this is one of the most
16 significant areas of additional research that we did
17 in supplement to, you know, expanding on what
18 Supplement 1 had.
19 So I'm just going to very quickly go over
20 this. This is the definition of command and control
21 that we put into Supplement 1. And it's based in a
22 military definition. We haven't found anything
23 better.
24 One of the main take-aways that we have in
25 Supplement 1 in the conclusions is that we still think

1 there's not much out in the literature anywhere about
2 command and control, certainly nothing specific to
3 nuclear power plants.
4 So command and control is maintaining a
5 coherent understanding of the plant state; timely
6 decision making; allocating resources; coordinating
7 actions; managing communications.
8 And why don't we go to the next slide.
9 So for Supplement 2 we expanded on this
10 understanding of command and control. And as I
11 mentioned, we specifically went through each of those
12 aspects of the definition and tried to examine where
13 there might be failure modes or what aspects of it, of
14 those definitions were relevant or not relevant to the
15 main command and control safe shutdown strategies.
16 And then after that we, like the Phase II,
17 we developed a consensus on the likely relevant issues
18 among the author team before we went to the experts.
19 And the principal thing that we got from the experts
20 was to try to confirm the key issues and then try to
21 hone in on what they thought was the most important
22 thing that ought to be represented as a failure of
23 command and control in the implementation of the safe
24 shutdown strategy.
25 And this process is what I had mentioned

before. Until we got down to saying, so what's going to matter? What's going to result in something, something being done incorrectly? This is where we might have seen a little bit of a disconnect between all these concerns about, you know, how command and control hasn't been actually practiced, you know, in an integrated way with all the field operators and so forth, and then coming to actually something that we need to model.

So based on the information we got from the experts we developed a set of screening rules for whether or not you should model something as a, I think we said we can either put it as an additional HEP or failure mode, additional failure mode for an execution action. That comes --

MEMBER BLEY: Is this the same experts as before or different?

DR. COOPER: It is the same experts.

MEMBER BLEY: Okay.

DR. COOPER: And then to develop an HEP we looked at existing HRA methods to try to find some overlap of similar issues. There was no actual overlap but there were some words that sort of seemed to sound the same. And we felt like it was addressing some of the same instances, and so we looked at the range of

1 those values, and then selected, the authors selected
2 a value to use. That's how that process went.
3 So this, I think there's a similar table
4 in --
5 CHAIR STETKAR: I don't think that, just
6 for the record for this meeting, --
7 DR. COOPER: Yes.
8 CHAIR STETKAR: -- you don't publish that
9 value here, do you?
10 DR. COOPER: Sorry, publish what?
11 Publish what?
12 CHAIR STETKAR: In your slides. Oh yeah,
13 you do. I'm sorry, it's on Slide 51. We'll get to it.
14 DR. COOPER: So we have this table was in
15 Supplement 1. Actually, I think this might be a little
16 bit updated by our experts.
17 No, this, I guess this is from Supplement
18 1. We did make some updates from what you had seen.
19 But some of the key things that we wanted to highlight.
20 We found it helpful to think about in control room
21 normal operations first, and how it seemed like command
22 and control was working and what things, what were the
23 things that seemed to be helpful in supporting command
24 and control, and then trying to contrast that with what
25 we understood about main control abandonment

1 operations once you've left, once you've left the
2 control room.
3 And this just kind of highlights some of
4 the key things.
5 When you're in the control room you have
6 kind of centralized cognitive entity that's
7 represented by the team. You are going to have some
8 coordination with some other plant people, including
9 the plant staff, including the fire brigade.
10 Because you have the heads-up board, and
11 everyone's in the control room for backing each other
12 up, you have shared visual cues. And because of the
13 simulator training and so forth you've got
14 well-rehearsed, tested plans. You know, your
15 resources are anticipating available -- we could argue
16 about the limits of need for flexibility in response,
17 but that's in comparison to main control and
18 abandonment.
19 One of the key things is because we have
20 some of these things, this is recognition-primed
21 decision making model is what my psychologists on the
22 team are telling me.
23 Another really key thing is the
24 communications are mostly face-to-face and, you know,
25 voice communications model real time.

1 And because of the protocols for the
2 control room there should be restricted interruptions.
3 I mean, of course there will be phone calls. But you
4 have conduct of operations, or whatever, that limit
5 people coming into the control room. You have to ask
6 permission to get in, and so on and so forth. So
7 there's only so many people that are going to be there.
8 And you probably have some extra help answering the
9 phone.
10 In contrast, when you get to after you've
11 left the control room you are now at the remote shutdown
12 panel and distributed in the field there's the team.
13 The operating crew is distributed through the plant.
14 The supervisor might be alone at the remote shutdown
15 panel. There might be another operator there. And
16 they're going to have to be coordinating with the fire
17 brigade, other plant areas, along with all of those
18 field operators.
19 Each operator, depending on where they're
20 located, is going to have their own view of plant
21 information. Most remote shutdown panels do not have
22 anywhere near the array of information that's in the
23 control room so far as indications. And most of them
24 don't have alarms.
25 And this gets to the point that I think

1 Matthew made earlier, there are parts of Phase III that
2 are frequently practiced, and that's the field operator
3 actions at the local plant stations. What's not so
4 much practiced is the coordination and interaction with
5 that supervisor who has got the procedure and is at the
6 remote shutdown panel and if he needs to be coordinated.
7 That coordination aspect is not frequently practiced
8 because they don't do that integrated training, they
9 do the pieces, not all together.
10 So let's skip ahead.
11 So, communications are mostly going to be
12 radios or phones. Limit to the confirmatory
13 indications, and they may have to send somebody to go
14 find that information. And we don't really have
15 information on how many interruptions are possible, but
16 there's no control on it that we know of.
17 So, the things that we, we had a set of
18 issues to discuss with the experts ahead of time. And
19 this slide and the next slide are the results of those
20 sorts of things. We actually we talked through with
21 the experts on one day and we continued our
22 conversations actually by phone and email to try to get
23 to this list of that kind of issues and concerns based
24 on what they -- their input.
25 So the role of the shift supervisor or

manager, whoever is in charge of command and control, when they leave the control room they still have the same responsibilities but they don't necessarily have the same indications and controls at the remote shutdown panel that they would have in the main control room.

Communications are going to be different and there are going to be time impacts associated with that.

Most likely no alarms, and few indications for the remote shutdown panel, so the ability to closely monitor parameters, you know, is going to be different.

And the way, you know, the information that's there, you know, you might have to pay more attention to monitoring those parameters and so you might be susceptible to distractions.

Coordination might be required, and it's going to be complicated by different operators being in different locations with communication issues.

There's a little more expansion on the next slide, but the real, the real focus when we came down to final discussions on what it is that we should be most concerned with, the experts said we should focus on coordination actions, especially things where they weren't done properly that could result in irreversible

1 damage. This is again getting back to the notion that
2 you have a strategy that has really one train of
3 equipment that you're going to be using for shutdown.
4 That's the design of many of the plant
5 procedures out there. That's what we found.
6 Just a couple things off of this slide so
7 we can try to get through to the end.
8 So while the shift supervisor or shift
9 manager continues to drive the actions that are going
10 to the procedure, for the most part they're not looking
11 at them, they can only monitor some of those actions
12 and record that they're done. But is of importance
13 when they have to coordinate those actions.
14 Allocation of resources, which is one of
15 those definitions of -- one of those aspects of the
16 definition of command and control, that's mostly done
17 by the assignments to the various operators through
18 procedure attachments. That's how the strategy is
19 usually implemented in procedures as there's a master
20 procedure for the supervisor and then individual field
21 operators will have pieces of, you know, or attachments
22 to the overall procedure. But that's their
23 responsibility.
24 Communications are not, typically not
25 face-to-face. And many of those communications may

1 just be reports that things are done.
2 And then it was noted that communications
3 equipment and associated problems could be a concern
4 with those communications.
5 So, in focusing on sequencing failures in
6 particular, the authors went ahead and developed these
7 screening rules on when to model a command and control
8 failure.
9 We had various iterations on these rules
10 before we settled on this set that's shown in these next
11 two slides. But the first few steps mostly were
12 getting us to t hose sequencing failures. And then the
13 later steps have to do, are kind of related to what you
14 might call performance shaping factors, or whatever.
15 One iteration of this was to actually give
16 different HEPs associated with those different
17 performance shaping factors that because we didn't have
18 enough information to know how important some of these
19 factors would be specifically for this context, we
20 decided to go with a single set of screening values.
21 And from my perspective, because no one's
22 modeled these sorts of things before I would use these
23 screening rules to say, you know, I don't want to model
24 this. How can I avoid this? And I'd look at these
25 screening rules and try to think about, you know, can

1 I design some compensatory measures by putting
2 something in my procedures so I can avoid having to
3 worry about this particular failure mode.
4 So, anyway, so the first step is just
5 asking whether or not command and control coordination
6 is required. And if it is, you need to continue with
7 the screening rules. They have to be done in order.
8 The next one is whether or not there are
9 sequencing of operator actions that need to be
10 coordinated. And if so, then we need to continue.
11 One thing actually kind of interesting
12 there was some feedback on because we weren't able to
13 come up with anything else, and that is the notion of
14 the irreversible failure within 15 minutes. We can
15 probably write some more up on that discussion, but the
16 idea was that it had to be a relatively quick failure.
17 You had an hour to discover there was something wrong
18 with your pump. We thought that was probably, probably
19 that would be discovered and something would be done
20 before it was irreversibly damaged, so.
21 CHAIR STETKAR: Like they did at H.B.
22 Robinson in the main control room with all kinds of
23 procedures and people there. They didn't discover it
24 in, it was like 39 minutes, that they had no cooling.
25 DR. COOPER: Yeah.

1 CHAIR STETKAR: Go on. Continue.

2 DR. COOPER: So I may be very interested

3 inputs on how we can develop a different number or what

4 number or range numbers there would be.

5 CHAIR STETKAR: The important thing is --

6 and for the other members here -- remember, whenever

7 it says "screened from consideration" that means

8 cognitive performance in the context of this

9 evaluation is perfect. The HEP is zero. That's the

10 way I would interpret this guidance as a practitioner.

11 DR. COOPER: No. I wouldn't say that.

12 CHAIR STETKAR: Well, tell me how I should

13 interpret it.

14 DR. COOPER: I would say --

15 MEMBER BLEY: It's the implication of

16 that.

17 CHAIR STETKAR: How would I interpret it

18 otherwise? Because it says if I have no command or

19 control, if it's tossed out by any of these criteria,

20 then all I need to worry about is what I call about

21 implementation slips that can be accreted through a

22 THERP type analysis with recovery factors and, you

23 know, all of that neat stuff. That leads to a really

24 low probabilities typically.

25 DR. COOPER: Well, maybe not so low in this

1 sense because we don't allow for recovery of many kinds.
2 And there are other things, too. There are some
3 differences in how we handle that, but.
4 MEMBER SUNSERI: Well, there doesn't
5 appear to be anything, at least from my view, unique
6 about these three things from a command and control
7 outside the control room or this, like an operator stuck
8 inside the control room.
9 CHAIR STETKAR: Or inside the control
10 room.
11 MEMBER SUNSERI: That's what I mean.
12 CHAIR STETKAR: When you say we haven't
13 addressed this --
14 MEMBER SUNSERI: Firing up with the
15 suction valve closed, 15 minutes is plenty of time to
16 ruin that --
17 DR. COOPER: Okay. So you would have a --
18 the notion is that, okay, so if it -- that's the short,
19 15 minutes or less. So I mean, I mean like I said, I
20 am actively soliciting input on that what number should
21 be. And if it was too generic. I mean, you obviously
22 have to find something out about the specific
23 equipment. How long does it take this pump to deadhead
24 if you have no suction. That's information you can
25 come up with. And you can compare that to whatever

1 number this is supposed to be.

2 But the next, the next things, I mean, I

3 mean that's the bottom line is what is the short period

4 of time for them not to notice? And the thing is that

5 we're also then going to ask, you know, what are you

6 doing to monitor this? You have somebody there that's

7 going to notice the pump's vibrating. Do you have

8 indications at the remote shutdown panel or somewhere

9 else that someone's looking at it. So that's the next

10 piece of the detection.

11 So the point is, is there a way you can fail

12 a piece of equipment so that it can't be used anymore?

13 CHAIR STETKAR: I'm sorry. This is

14 guidance, and you just said some words that I don't

15 recall reading anywhere in the guidance. I only read

16 a table that says here are the -- I'm an analyst and

17 I don't want to do anything. I want any excuse for not

18 quantifying anything in the world. That's my world

19 view going in.

20 Anything that I can find here where the

21 Nuclear Regulatory Commission approved guidance tells

22 me I don't have to do anything, by God, I will not do

23 it.

24 So I didn't hear -- read anywhere in the

25 guidance that it says, oh, by the way, you have to as

1 an analyst make sure that you have enough indications
2 at the remote control area so that you can discover the
3 bad thing, and the people are indeed looking at those
4 indications.
5 DR. COOPER: Well, that's the next step.
6 CHAIR STETKAR: And guiding people to do
7 it.
8 DR. COOPER: That's the next step. Maybe
9 they --
10 MEMBER BLEY: That's one piece of it. The
11 other piece, I want to go back to where you said, no,
12 it isn't like concerning with success. Yes, it is. It
13 is. If you're going to screen it, then maybe the least
14 you ought to do is have some not too low chance of
15 failure that gets stuck in instead of that. Because
16 what you're sticking in is zero if you don't include
17 it in the model.
18 CHAIR STETKAR: Well, if they get done, if
19 they still grudgingly keep it, there's still a 95
20 percent chance that you're successful. So you don't
21 have much margin there. You're either 100 percent
22 successful or 95 percent successful; right?
23 MEMBER BLEY: I think this would whittle
24 away at that 95 percent successful if you put in a
25 reasonable screening value. Screening implies

1 you're, well, here it implies you're throwing it away,
2 assuming that's --
3 CHAIR STETKAR: No, and that's, and that
4 --
5 MEMBER BLEY: But if you put in .1 or --
6 CHAIR STETKAR: But if I'm
7 misinterpreting something, if I'm now going to use this
8 guidance, my interpretation of the guidance, reading
9 this stuff, is that if I meet in any one of these steps
10 screened from consideration the, I'll call it the
11 cognitive portion of my Phase III human error
12 probability is precisely zero. And I then am led to
13 guidance that says, yeah, I can go look it up and look
14 at a standard implementation type of error.
15 DR. COOPER: Not standard. Not standard.
16 CHAIR STETKAR: Now, I need to worry about
17 the timing.
18 DR. COOPER: Yes. Not standard. And
19 only for this specific set of guidance that we're
20 talking about. And that's because unless coordination
21 is required going through the supervisor, or it could
22 be just going through operators, unless that
23 coordination is required and it results in something
24 that fails a piece of equipment -- that's what we're
25 looking to add is some kind of failure mode, additional

1 failure mode for a particular piece of equipment that's
2 a key, you know, key piece in the whole sequence of
3 things, that's what we're looking for. So.
4 MEMBER BLEY: I'm going to give you
5 something that will help you here.
6 DR. COOPER: Okay.
7 MEMBER BLEY: It's very different as you
8 go from plant to plant on what they have for a panel
9 or for a distributed system. And in a lot of cases you
10 don't have anywhere near the instrumentation you have
11 in the control room, so it's not clear that you'll
12 always have discharge pressure or that you'll have flow
13 indication. Gee, I got the pump running; maybe that's
14 all you see.
15 So then for your plant you've got to be very
16 careful about this one because unless somebody goes
17 running over near that plant -- pump, you aren't going
18 to know it's clunking away. So it's very plant
19 specific in its implementation.
20 DR. COOPER: Okay.
21 MEMBER BLEY: And I don't remember if you
22 tell us that. I'm sure somewhere you tell us all of
23 this is plant specific, but.
24 DR. COOPER: So, okay, I mean I guess, I
25 mean the key thing on this second one is that if you

1 get the operator actions that need to be coordinated
2 out of sequence, in other words you don't get suction
3 provided to the pump before you start the pump that you
4 can damage the equipment. But maybe if we just leave
5 out the timing piece that's enough.
6 But the point is that we're looking for
7 ways that the coordination can fail. In particular the
8 experts wanted us to focus on sequencing failure. So
9 if we could get things out of sequence, mostly because
10 you've either lost track of what people have done and
11 you get to the point where you want to start a piece
12 of equipment and you've either not kept track of or got
13 confused in some communications and didn't realize that
14 the first piece of this action has been done.
15 So that's what those, that's what those --
16 MEMBER BLEY: I've never seen anybody do
17 the steps and walk through it, if they walk through it.
18 I always had a vision of if we're going to do this stuff,
19 especially if it was distributed, we're going to have
20 radios or headsets on or something. We're going to be
21 saying, Hey, John, go do this. Or, Charlie, go do that.
22 Susan, go over here and do that. Because then when he's
23 done it and I can keep track of it all and make sure
24 he's sequenced right.
25 What you said is maybe not, maybe they all

1 just get sheets of paper and go out. And then those
2 numbers we saw earlier get even more --
3 DR. COOPER: Well, yeah, I mean I guess the
4 thing is that even though the actions might appear in
5 order in the procedure, the order in which you get the
6 communications may not be the same. So the point is
7 that you could be sending out operator A, B, and C to
8 do things and you're going to wait on B to get D done,
9 and they're going to report back differently.
10 So that's the error, the kind of thing that
11 we're worried about. And then the sequencing error is
12 the ultimate problem.
13 CHAIR STETKAR: Let me try something for
14 you to think about. And that is -- and Matt alluded
15 to it -- when I read through these things I don't --
16 I know that there are different issues as a human
17 reliability analyst that I need to be aware of in these
18 types of conditions compared to sitting in the main
19 control room with whatever procedures I have, which is
20 difficult to know.
21 And I, I certainly endorse the notion that
22 the guidance should make analysts painfully aware of
23 that.
24 On the other hand, accounting for those
25 conditions now that I'm painfully aware of it, I don't

1 know why we need such prescriptive screening criteria
2 and prescriptive numerical values to plug in because
3 we don't do that, for example, when I'm in the main
4 control room under strange situations that may not
5 perfectly match a set of procedures. I leave it up to
6 the analyst to evaluate performance-shaping factors,
7 use whatever cognitive reliability model they're going
8 to use and whatever implementation slips and all that
9 kind of stuff.
10 Why do we need to be so prescriptive both
11 in terms of screening criteria and explicit numerical
12 values in this particular guidance? In other words,
13 why doesn't the guidance just simply, given the
14 expertise and the amount of time and effort that people
15 have put into thinking about this, this part of the
16 problem, why doesn't the guidance just simply make it
17 very, very clear, as an analyst you need to be
18 considering these factors in the context of your
19 scenario, in the context of your procedures, in the
20 context of your panels, and in the context of whatever
21 the fire damage is?
22 Because it strikes me that the human
23 reliability analysis, given all of that stuff and the
24 fact that communications might be more difficult than
25 standing in the control room, things might take more

1 time because I need to do Step A clearly before Step
2 B, but I need to do that in the control room.
3 DR. COOPER: So, I guess I think I
4 understand what you're saying. And I think that the
5 thing is that we, maybe we tried to come up with a
6 distillation of what we understood from the experts to
7 try to come up with a simplified approach. And what
8 I think I hear you saying is that we should open it up
9 a little bit and provide the explanation that went
10 behind it so that an individual analyst can try to
11 better match up to their specific thing.
12 CHAIR STETKAR: I'm just a bit
13 uncomfortable about the prescriptiveness of this and
14 its potential for being misused in ways that you hadn't
15 thought about by people who will say, well, this is the
16 NRC-approved -- I followed the NRC-approved guidance
17 and, therefore, it is perfect.
18 You might not have thought about the ways
19 people, creative people can use guidance in very
20 creative ways if they don't want to do something.
21 MEMBER BALLINGER: I think given the
22 variability in all the plants and things like that that
23 you've described, if you're having a very bad hair day
24 in one of these plants they're going to do things that
25 are going to be different. And so being as

1 prescriptive as John is saying you're having, it seems
2 to me that it is too prescriptive. It's just too --
3 DR. COOPER: Yeah, I guess that the
4 intention was not so much to be prescriptive as to be
5 simple. And part of the thinking behind the going for
6 simple is because more so than with the decision to
7 abandon, I think our experts and their ability to
8 imagine something that's never been done was, it was
9 beyond their ability to imagine how things could go
10 differently or badly.
11 In other words it was sort of it was more
12 like so we've come to this point, we could -- I mean
13 there are a number of other things that we conjectured
14 so far as errors of commission and doing this and that.
15 And after we came out of the expert panel we still sort
16 of debated some of those things. And we finally came
17 down to this.
18 And part of it was we didn't feel like there
19 was anything in the literature that could help us. And
20 certainly we were stretching to try to find other HRA
21 methods that we could use to develop any kind of HEP.
22 And I didn't think we could push our experts to give
23 us them. I think they were -- they got to the issues
24 and that was as far as they could go.
25 And they realized that this is, this is,

1 I mean this is no longer in the control room. You know,
2 the point was made, yes, there are some remote shutdown
3 panels in the simulator. But as far as I know, the
4 only, only plant that I've heard that actually has been
5 doing integrated training on safe shutdown after the
6 main control room abandonment is Calvert Cliffs.
7 CHAIR STETKAR: Okay. So if I'm at
8 Calvert Cliffs, maybe, maybe my human error
9 probabilities are much smaller than if I'm at Plant X.
10 But I don't tailor my guidance for how to do human
11 reliability analysis based on those snippets of pieces
12 of information. I tailor my guidance so that if I'm
13 at Calvert Cliffs for a particular fire scenario I come
14 out with a human error probability of, you know, 3.7
15 times 10 to the minus 4.
16 And I'm at Plant X for the same fire
17 scenario I come out with .5.
18 DR. COOPER: Yeah, we, like I said, there
19 was a version of this where we were going to have --
20 I mean more five, five on compensatory measures. That
21 could be procedural, health, or training, or whatever.
22 There was some discussion about having different
23 values.
24 But the problem was that how to make
25 distinctions between, you know, what, you know, how can

1 we make distinctions in the numbers? And what would
2 be the basis for it other than the fact that we just
3 intuitively know they ought to be different?
4 I mean, I guess if you go back to the
5 decision to abandon tree, I know you were hanging on
6 the best case probability.
7 CHAIR STETKAR: No, no.
8 DR. COOPER: But the main thing for me that
9 came out of that was that there was only a factor of
10 10 difference between the best case and the worst case
11 scenario. And to me that meant that they thought the
12 main thing was the reluctance to leave. And anything
13 that could help, like procedures, they didn't think
14 there was much of an impact.
15 And whether that's because they didn't,
16 couldn't imagine how that would work or what, that was
17 the result.
18 CHAIR STETKAR: And again, you say a
19 factor of 10. I say the difference between the 80
20 percent success and 98 percent success, which is a
21 really small difference. It means it's always really
22 successful.
23 MEMBER SUNSERI: Well, I worry about the
24 1 in 5 chance it was not going to be successful. That
25 seems like pretty high failure rate to me.

1 DR. COOPER: Let's just arbitrarily move
2 it. So it was .5 and .4. I mean the point is that there
3 wasn't that much difference between -- or a .5 and --
4 well, anyway.
5 CHAIR STETKAR: Let's see --
6 MEMBER SUNSERI: I want to add one comment
7 though regarding this slide that you have up here which
8 I mean I think the focus of this is on when is your
9 command and control, say you have a failure there or
10 not a failure; right? And my earlier comment, well
11 this looks like, a lot like normal operations is, well,
12 did you think about going back to your criteria?
13 Because when I think about what a command and control
14 failure would look like in a control room abandonment
15 scenario I think about this; right?
16 So if I'm in the control room and I'm
17 dispatching an operator to start a pump he's going to
18 go down, he or she is going to go down there. I'm going
19 to be on the radio with them, or I'm going to be on the
20 telephone with them. And they say, I'm starting the
21 pump. Watch for the flow. I get a report back; right?
22 DR. COOPER: Right.
23 MEMBER SUNSERI: When there's a fire out
24 in the plant and I've left the control room, my radios
25 may not be working, my telephones may not be working,

1 I may not be able to communicate with that person. So
2 that's when it becomes -- so I would put criteria around
3 that to tell me whether or not I lost command and
4 control.
5 So I would look at these five things you
6 have on page 31 and maybe think about what screening
7 criteria would I wrap around those to tell me I had a
8 loss of command versus these human performance issues.
9 DR. COOPER: At least with respect to the
10 communications that's a feasibility criteria. You
11 have to have the communications and the equipment and
12 all those sorts of things. So that that screen has
13 already been met. So you know that you can
14 communicate.
15 There may be some things about the
16 communications that are not optimal. And we discuss
17 that as being part of the command and control.
18 The bottom line is that we're trying to
19 focus on when there is a need for command and control
20 such that it affects one of these actions in the field.
21 Because they're not doing anything at the remote
22 shutdown panel. At least that's not the situation
23 we're looking at. We're looking at a situation where
24 someone's doing something out in the field, and what
25 can we do to make that fail. And it's either -- and

1 we're focusing on, I mean we have looked at delays.
2 That was one thing that we looked at. But that's not
3 where the experts led us to look.
4 So we're looking at things where you can
5 get things reversed such that you could fail something.
6 Because a delay is just simply going to change the
7 timing, which we can reflect directly in the rest of
8 our analysis and in communications.
9 MS. PRESLEY: So it's not so much that
10 these things can't happen in normal operations, but in
11 the normal command and control situation you have
12 certain bounds and you have people working together.
13 So this is, it's a bigger vulnerability when you're out
14 in the field because you have a different command and
15 control sector. So we're looking for things that are
16 especially vulnerability now that your command and
17 control has changed.
18 MEMBER SUNSERI: Right. So I think about
19 this, so you know in your control room you've got your
20 shift manager and your supervisor right there. When
21 you go abandon the control room those two people may
22 not be in the same place.
23 MS. PRESLEY: They probably are not.
24 MEMBER SUNSERI: And your ability to make
25 timely decisions is now changed; right?

1 MS. PRESLEY: Right.

2 MEMBER SUNSERI: That's command and

3 control.

4 MS. PRESLEY: So the things on Slide 31,

5 we basically had to -- so some of those, the timely

6 decision making, and the, like, the feasibility of

7 communications, the communications, the comms

8 equipment being available, those we've already

9 demonstrated through a feasibility assessment.

10 So we're looking at the additional things

11 that can cause -- that are harder to recover from and

12 become more impactful than they are normally because

13 you have that backup, you have that crew working

14 together the way they're used to. So I guess that's

15 how we got to those five criteria. So these are more

16 vulnerable than they would normally be in normal

17 operations because the command and control is not the

18 same level essentially.

19 DR. COOPER: So, for example, in the

20 control room you had a procedure, and if you're talking

21 about putting a pump into place there's probably one

22 step, one step or substeps that are all related to

23 putting that pump into service. And it will be gone

24 through in order, in sequence, read out loud by the

25 shift supervisor with the board operators responding

1 as they do things.

2 Now we don't have that. We have people in

3 the field reporting when things have gotten. And you

4 might have in a particular attachment, you might have

5 a note that says this needs, this is a whole point you

6 need to communicate with someone else. Or you need to

7 know that, you know, Step A has been performed before

8 you do what you're going to be doing.

9 But that usually, that's going to run

10 through the shift supervisor. And he actually has to

11 do the job of making sure that they're done in the

12 correct order. So that's what we were focusing on.

13 And how is it possible that it could be, those steps

14 could be done out of order, or Step A never got

15 performed, and you tried to get that pump started or

16 you tried to start that diesel without having, without

17 having cooling water or something like that.

18 So that's the issue that we're, that's what

19 we're trying to get at, could that possibly occur or

20 how could that occur? And so the kinds of things that

21 we're thinking about, well, you know, we just lost track

22 of all the communications that are going, coming in.

23 Maybe he doesn't have place-keeping aids. He doesn't

24 have a place or a good way to write things down. Too

25 many calls come in at once. And when he gets, when he

1 gets the call from the field operators, wants to start
2 the pump and he wants to know have you started this?
3 Has, you know, operator A started the section head?
4 Can I go ahead and start this thing, start this pump?
5 And the shift supervisor is thinking, well, there is
6 a whole bunch of phone calls that just came in, I've
7 got some scribbles here, I think they got a -- I think
8 you're okay. Go ahead. Using the formal
9 communications.
10 So that's, that's one of the failure modes
11 that we imagined that could happen because of the
12 disconnect between, you know, the beginning of an
13 action and end of an action because they're being
14 performed in the field at different locations, running
15 through the shift supervisor.
16 So that's how it's different is that
17 there's no longer control on the ordering of the steps.
18 Okay, so we -- the first screen is, is there
19 coordination.
20 The second one is are there actions that
21 have to be sequenced, these coordinated actions.
22 The next screen is whether or not you can
23 detect whether or not there's something going on wrong
24 with your equipment.
25 And we give some examples of local

1 indications or, you know, it's possible the shift
2 supervisor might have a procedure step or note to ask
3 somebody the mod for the equipment from another
4 location if it's not the remote shutdown panel.
5 Then the fourth screen is whether or not
6 the shift supervisor is the one that has the
7 responsibility for all the communications. In other
8 words, he's the final point for all the phone calls.
9 He's not -- and then we have some examples of things
10 that would kick you out. Or, you know, if there's
11 nobody else that's helping them make these, fielding
12 these calls.
13 And then I guess the other thing is if there
14 was a specific set of steps that had to be coordinated,
15 you know, it's not like the shift supervisor is just
16 focusing on these steps. You know, he's got a larger
17 set of duties. So he's, he's the focus of all these
18 communications.
19 And then the fifth and final screening step
20 is any kind of compensatory measures that might help
21 the supervisor with coordination and you don't have
22 those. And we give a couple examples. And we're
23 focusing on procedures in these examples.
24 Things that could help that you don't have
25 that would keep you to model this would be if there's

1 like a hold point written into the procedure, or a
2 warning, or a caution, that sort of thing.
3 And then another thing would be good
4 place-keeping aids so that the supervisor can record
5 when support systems are being put into service so that
6 when he gets to those, those interactions with
7 operators that are putting front line systems into
8 place he does know that the supporting systems have
9 already been put into service and they can move ahead
10 with these final steps to get this equipment into
11 service.
12 So this is the set of screens that we put
13 together. Those are the concerns that we put together
14 and that have been informed by all the interactions that
15 we've had with experts in other discussions. And as
16 I indicated before, the simplified approach that we've
17 taken is to go ahead and assign a single value as you
18 come through these screens. And the basis for this
19 value is -- comes from three, four different places.
20 We did a review of various HRA methods or
21 guidance to see if it addressed some of the similar,
22 some of the issues that we thought were important.
23 NUREG--2114 which is the cognitive basis for HRA NUREG
24 has some discussion about workload and multi-tasking.
25 The NUREG for IDHEAS At-Power, NUREG-2199,

has a decision tree that addresses workload that includes consideration of distractions and interruptions.

NARA, the publicly-available paper has a communications generic task type with some error producing conditions that include that include information overload, which we identify in the instructions as a possible failure mode.

And then THERP Table 20-8 also talks about errors in recalling oral communications.

So, using these, these inputs, we looked at each of these methods. And the range of HEPs from these methods went 1E to the minus 2 to .1. And we picked the middle of that arbitrarily. But those are the -- you can see the range is not, not wide. But that's what we got in -- that's where we came out in the end.

MEMBER BLEY: Susan.

DR. COOPER: Yes.

MEMBER BLEY: I'm still a little off center on this stuff. But much of this kind of looks reasonable to me. The screening steps 2 and 3 together just feel a little funny to me.

DR. COOPER: Okay.

MEMBER BLEY: This idea that step 3 is

1 saying, well, you don't protect things right away.
2 You're off trying to do something else. Which kind of
3 seems in conflict with this business of 15 minutes or
4 less.
5 And then 2 is the one bothers me. If in
6 fact you have a condition that would lead to failure
7 in 15 minutes or less, I guess if you don't have that
8 then we're screening from consideration. And that
9 just feels very optimistic to me.
10 CHAIR STETKAR: Everything is perfectly
11 detectable given more than --
12 MEMBER BLEY: From then on.
13 CHAIR STETKAR: -- given more than 15
14 minutes.
15 MEMBER BLEY: And then I get to the next
16 step and, Oh my gosh, I've run off doing other stuff.
17 DR. COOPER: Well, if you took the 15
18 minutes out does that fix the problem?
19 MEMBER BLEY: You've still got to have
20 something that falls through the screening failure rate
21 at a minimum for me.
22 CHAIR STETKAR: Well, the worst it can be
23 is 95 percent success. Again, it's either 100 percent
24 success because it's screened out, or 95 percent
25 success if it's not screened out. So the worst it can

be according to their guidance is 95 percent success, .05 for failure.

DR. COOPER: But the basis for this is the role of command and control in the implementation of the safe shutdown strategy. And in the cases where you don't have to coordinate anything, then there really isn't a role except for the time for the communications. There's no, for the strategies we're looking at there's no deciding to use something else. There's no calls from the supervisor to a field operator to do something else.

They all have their pieces of procedure. They're implementing those. That's it. That's the way the procedures are written right now.

So there isn't -- you know, the shift supervisor doesn't have to allocate resources. He doesn't have to pick up the phone and say, hey you, field operator, go do this. He's not assigning anybody anything. The procedure doesn't, well, the procedure doesn't have the supervisor making any choices so far as going to another procedure, using a different piece of equipment.

MEMBER BLEY: If you go back to number two, if you got rid of the whole phrase after the comma.

DR. COOPER: "Such as"?

1 MEMBER BLEY: Yeah.
2 DR. COOPER: Yeah, that's -- exactly.
3 MEMBER BLEY: Then it says if there is no
4 thing that can fail without some kind of recovery, yeah,
5 then you could go on, I guess.
6 DR. COOPER: Okay. All right.
7 MEMBER BLEY: I'd have to think about that
8 some more. But it just smells a little funny.
9 DR. COOPER: No, I mean it is -- it was,
10 it was a place where I wanted input because I wasn't
11 sure. I didn't -- we had some discussion about it among
12 the team and didn't have any other answers at the time.
13 So we can certainly take that feedback as --
14 MEMBER BLEY: If you don't -- if you can't
15 have an irreversible failure of equipment --
16 DR. COOPER: That's, that's correct.
17 MEMBER BLEY: Fifteen minutes stuff is in
18 interfering with the next --
19 DR. COOPER: Okay. Fair enough.
20 CHAIR STETKAR: Before we get to the -- Is
21 there anything more on these screening and this topic?
22 DR. COOPER: No.
23 CHAIR STETKAR: I want to bring one more
24 thing up that I intentionally left to the end.
25 I really like the notions of the time lines

1 that you have. I think they're really good. It keeps
2 people focused on those times.
3 Feasibility assessment. Why -- and we've
4 had this discussion in the past -- why do you not
5 quantify uncertainties in the time available, in the
6 time required and look at the overlaps and the
7 uncertainties as a contributor to the overall human
8 error probability, which we have in fact already in the
9 guidance for at-power ideas?
10 And there's a notion that at least I
11 personally have been trying to instill in this
12 organization going forward is that are there
13 uncertainties? Yes, there are. If there's a 2
14 percent probability, given the uncertainties, that the
15 time required is longer than the time available,
16 there's a 2 percent probability that I'm not going to
17 make it. For the other 90 percent chance I'm now
18 looking at what fraction of that 98 percent chance do
19 I win and do I not win?
20 And that's sort of a conceptual thing that
21 is not -- you don't talk about uncertainties in the
22 times, and you certainly don't talk about it on that
23 time dilution type thing.
24 DR. COOPER: Unfortunately,
25 uncertainties are overlapped, yeah.

1 CHAIR STETKAR: Well, it is. And that's
2 why I didn't want to start it but I'll just throw that
3 out there. It's on the record. We don't have time for
4 an in-depth discussion. We've had the discussions.
5 Mary can dredge up her notes. But it something that
6 there is -- it's in the IDHEAS methodology, or it has
7 been.
8 And that's a conceptual notion. It's not,
9 it's not focused on these particular scenarios or
10 anything, it just kind of a way of thinking of things.
11 And now you can go on with your path
12 forward.
13 MS. LINDEMAN: Okay. I'm going to give
14 Susan a break. She's done an excellent job thus far
15 explaining all the technical details.
16 So I think our next step and current
17 status. There's a bullet missing, and I just wrote it
18 down it says digest today's presentation and
19 discussion, so.
20 (Laughter.)
21 MS. LINDEMAN: I mean, personally, I think
22 the feedback is valuable and certainly can be, you know,
23 embraced. Having the discussion today, as you alluded
24 to, has anyone tried this out? So, you know, the next
25 step down the road is seeking peer review.

1 And Susan and I have been discussing peer
2 review. So I've solicited a number of volunteers.
3 And I know Susan has done the same. So we'll have a
4 good panel of both NRC expertise and industry and
5 practitioner expertise. So I think next step once we
6 digest this feedback is go to peer review and then go
7 through our publication process.
8 CHAIR STETKAR: You don't have plans I
9 don't see here for a -- I'm assuming -- Well, let me
10 ask you. After you have the peer review of the guidance
11 you will now have Supplement 1 and Supplement 2 and the
12 original 1921. Is there any notion of a pilot
13 application, in particular for the main control room
14 abandonment guidance?
15 DR. COOPER: Susan Cooper. It wasn't our
16 original plans. I think that it's possible, you know.
17 Ashley, and Mary and I need to talk some more about the
18 peer review. Part of our public comment period for
19 1921, which was also part peer review, did -- was
20 actually a pilot of I think it was the Westinghouse
21 Owners' Group. I think they did a pilot. So it might
22 be that some of our industry peer reviewers in
23 particular can take that to be more than just reading
24 the document and providing some feedback, but actually
25 trying to exercise it.

1 The other thing that we have discussed that
2 isn't in Supplement 2 are examples. And I think there
3 are places where some of the discussions we had today
4 could be better understood if there were some examples.
5 Some, you know, some of the things that we've talked
6 about today, and we've had some other discussions
7 internally coming up to this, this briefing today where
8 we thought that that probably would be, especially on
9 the timing discussions and the phases and how you
10 calculate time available for Phase II and stuff like
11 that, having some illustrative examples on that would
12 probably assist that.
13 But the current schedule for publication,
14 as shown here in brief, does not have a specific
15 piloting phase. The original schedule did but we kind
16 of stretched out time to get to this point with this
17 document.
18 And I'd like to add that I think that
19 without this being a joint project with EPRI, I think
20 coming up with any kinds of guidance in this area that
21 is not supported by operational experience, by
22 plant-specific training or demonstration, and little
23 literature, I think it would be very, very difficult
24 to come up with anything.
25 CHAIR STETKAR: As Mark Henry said in the

1 introduction, I think that in these areas that that
2 process, the MOU process benefits both the agency and
3 the industry tremendously because it kept both entities
4 kind of grounded --
5 DR. COOPER: Yes. And I'd like --
6 CHAIR STETKAR: -- in some concept of
7 reality anyway.
8 DR. COOPER: I'd like to, I mean, you know,
9 the, you know, we looked at existing methods in the
10 beginning, but the fact that our industry partners were
11 willing to put CBT aside and start with something new
12 because it technically matched what we thought were
13 concerns, I think is not something that probably would
14 have -- either one of us would independently have felt
15 like we could have done.
16 CHAIR STETKAR: Thank you. Thank you,
17 thank you. Let me take care of a couple of things here.
18 If there's anyone in the room here who'd
19 like to make a comment, come up to the microphone and
20 do so.
21 I'm assuming that there is still some
22 chance that there might be members of the public on the
23 phone line. If there is anyone out there who would like
24 to make a comment, I'm hoping that the system will work,
25 please speak up and identify yourself and make a

1 comment.

2 (No response.)

3 CHAIR STETKAR: I don't hear anything.

4 I hate to do this because the system is

5 supposed to work. But is there anyone out there

6 listening who can just confirm.

7 MR. BROWN: The line's open.

8 CHAIR STETKAR: It is? Okay, thanks,

9 Theron. Thank you.

10 All right, having heard no comment --

11 MS. GUNTER: This is Kaydee Gunter. I've

12 been listening the whole time.

13 CHAIR STETKAR: Okay.

14 MS. GUNTER: I have no additional

15 comments.

16 CHAIR STETKAR: Great. Thank you.

17 Thank you, thank you. This time of the day and the

18 silence on the line made me a bit uneasy.

19 So, no public comments.

20 I'd like to go around the table and get any

21 final comments or observations from the members. Dr.

22 Ballinger, sir.

23 MEMBER BALLINGER: No comments. Great

24 presentation.

25 CHAIR STETKAR: Dennis?

1 MEMBER BLEY: It's been a good discussion.
2 I still have some things to think about. I guess if
3 you're doing revisions of this and you're getting
4 public comments then if we ever want to write a letter
5 it would be after they get these comments I think.
6 But nothing more to question I don't think.
7 CHAIR STETKAR: Matt.
8 MEMBER SUNSERI: It's days like this where
9 I'm glad I sit on this side of the table instead of that
10 side of the table.
11 You guys did a great job of fielding all
12 the questions we asked. And I appreciate all the hard
13 work that goes into this. I know it's a tremendously
14 difficult task trying to figure out how people would
15 act in every situation. So, thank you for your work.
16 CHAIR STETKAR: Jose.
17 MEMBER MARCH-LEUBA: Nothing for me.
18 CHAIR STETKAR: Walt.
19 MEMBER KIRCHNER: No, thank you.
20 CHAIR STETKAR: Joy.
21 MEMBER REMPE: No comments.
22 CHAIR STETKAR: Vesna.
23 MEMBER DIMITRIJEVIC: Well, I was silent.
24 Usually I'm silent when I don't have a question. So
25 I have a comment.

1 This was the second reason because I really
2 didn't have a chance to carefully looking at the report,
3 so that's why I was so withholding on the questions.
4 So I noticed that sometimes in this,
5 because it's such a complex problem, and we really
6 admire what you guys are trying to do as such a complex
7 problems by always so many issues. And sometimes I had
8 the feeling that we were discussing not completely the
9 same thing because it wasn't clear exactly what HEP for
10 Phase II, if it's actually abandonment of the control
11 room in the sense that they decide to do that and they
12 do whatever they have to do, turn this switch or not.
13 And in some case this habitability issue
14 comes ten to decide to leave, but it may be worse for
15 them to perform actions they have to perform. So we
16 are often discussing things on different levels.
17 So this is why I was thinking that we should
18 actually, it will really help if you guys have examples.
19 Now these examples can be coming, obviously doesn't
20 have to be specific plan, you just see the remote
21 shutdown panel or procedure, but it could be some
22 different scenarios because a lot of different
23 scenarios will leave completely different responses.
24 And it seems to me that there is a danger
25 we don't identify, but right now we are in the situation

1 if you have a scenario where we lost any controls, you
2 know, could be component cooling system, could be
3 offset power, could be whatever, any control from main
4 control room, that we have to, you know, make decision
5 to abandon the control, that, it could be for different
6 scenarios, you may see this number. Right now the
7 number is 3 minus 1 in the worst case and 5 minus 2 for
8 CMC, so this is 2.5E minus 1; right? So we have a 25
9 percent status to pay for any scenario which requires
10 to abandon the control room.
11 And if this is how the plants are going to
12 interpret that, then there is certain dangers there,
13 so. You know, so some examples I think may benefit.
14 A couple scenarios go down and see, you know, what's
15 happening. So that's about it.
16 CHAIR STETKAR: Thank you. And I'm not
17 going to say it. Thank you for all the work. And I
18 really appreciate your stamina. I think, I think we
19 had a good discussion.
20 With that, we are adjourned.
21 (Whereupon, at 5:41 p.m., the meeting was
22 adjourned.)
23

Supplement 2, NUREG-1921 Quantitative HRA for Main Control Room Abandonment

Susan E. Cooper (NRC/RES)
Ashley Lindeman & Mary Presley (EPRI)

ACRS PRA Subcommittee Meeting
April 4, 2018
Rockville, MD

A Collaboration of the Electric Power Research Institute (EPRI) & U.S. NRC Office of Nuclear Regulatory Research (RES)

Status of Fire HRA Modeling for Main Control Room Abandonment (MCRA)

- Today's presentation:
  - Provides updated information for joint EPRI/NRC-RES HRA research project
  - Addresses second product of this research which:
    - Builds on previous research products
      - NUREG-1921 / EPRI 1023001, which established guidance for the conduct of fire HRA
      - NUREG-1921, Supplement 1 / EPRI 3002009215, which established guidance for the conduct of qualitative HRA for MCRA
    - Uses the experience developing NUREG-1921 & supporting NFPA 805 submittals
    - Will provide the last piece of the MCRA research, i.e., guidance for the quantification of MCRA HFEs

Today's Agenda

- Review project history and background
  - Project team
- Review of Supplement 1 (Qualitative Analysis)
  - Summary of responses to comments
- Supplement 2 (HRA Quantification Guidance)
  - Overview
  - HRA quantification guidance:
    - Before the fire creates conditions for abandonment (minimal guidance so not discussed today)
    - For the decision to abandon the MCR on loss of control
    - For implementation of MCRA shutdown strategy
- Status and future work
- Closing

Project History and Background

Project History and Background

- Objective of research is to provide HRA guidance for scenarios involving abandonment of main control room due to fire generated conditions
  - Loss of habitability (LOH)
  - Loss of control (LOC)
- Identified as an area of future research in EPRI 1023001 / NUREG-1921
- Complex topic and plant specific considerations
  - Wide range of remote shutdown panel (RSDP) capabilities of and associated procedures
  - Therefore, difficult to develop generic guidance

Project Team

- NRC/RES
  - Susan E. Cooper, NRC
  - Stacey Hendrickson, Sandia National Laboratory
  - John Wreathall, John Wreathall & Co., Inc.
  - Tammie Rivera, NRC
- EPRI
  - Ashley Lindeman, EPRI
  - Mary Presley, EPRI
  - Erin Collins, Jensen Hughes
  - Paul Amico, Jensen Hughes
  - Jeff Julius, Jensen Hughes
  - Kaydee Gunter, Jensen Hughes

Supplement 1 (Qualitative Analysis)

Qualitative Analysis (NUREG-1921 Supplement 1 / EPRI 3002009215)

- Presented to ACRS PRA Subcommittee in May 2016
- Held peer review in Summer 2016
  - Objectives
    - Review for technical items
    - Does it meet needs of intended users?
  - Peer review composition
    - PRA practitioners (industry and NRC),
    - Human reliability analysts (industry and NRC), and
    - Cognitive and behavioral science analysts (consultants)
- EPRI published joint report in August 2017

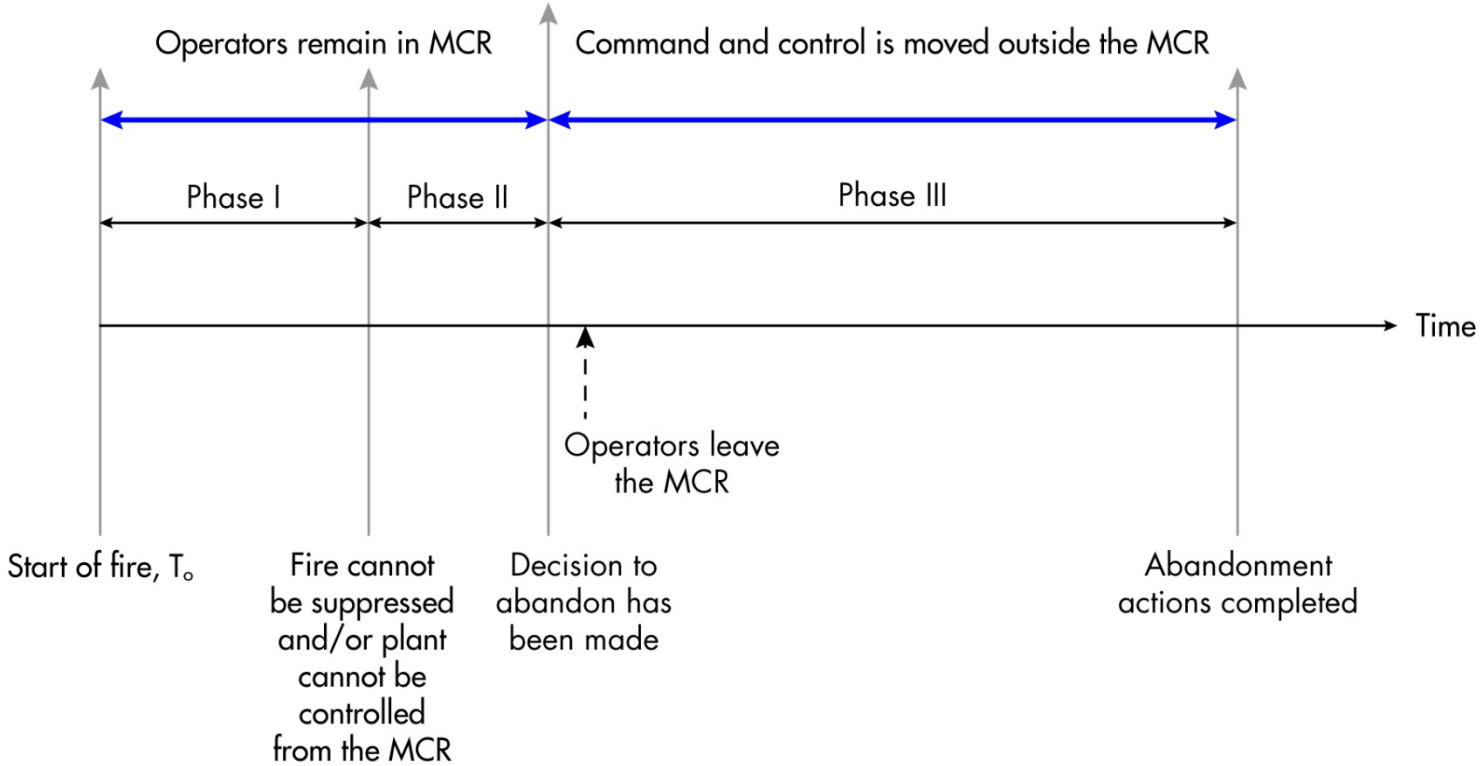
Qualitative Analysis (NUREG-1921 Supplement 1 / EPRI 3002009215)

- Summary of revision since May 2016
  - Edits and clarifications associated with ACRS and peer review comments
  - Added analytical process diagram (Section 2.4.1)
  - Added dual unit timeline example (Section 7.6.3)
  - New section in Appendix A addressing variability in capability of RSDP design (Section A.3)
  - Provided additional development on Appendix B – Command and Control
  - Added Appendix D – insights from operator interviews

Three Phases of MCRA

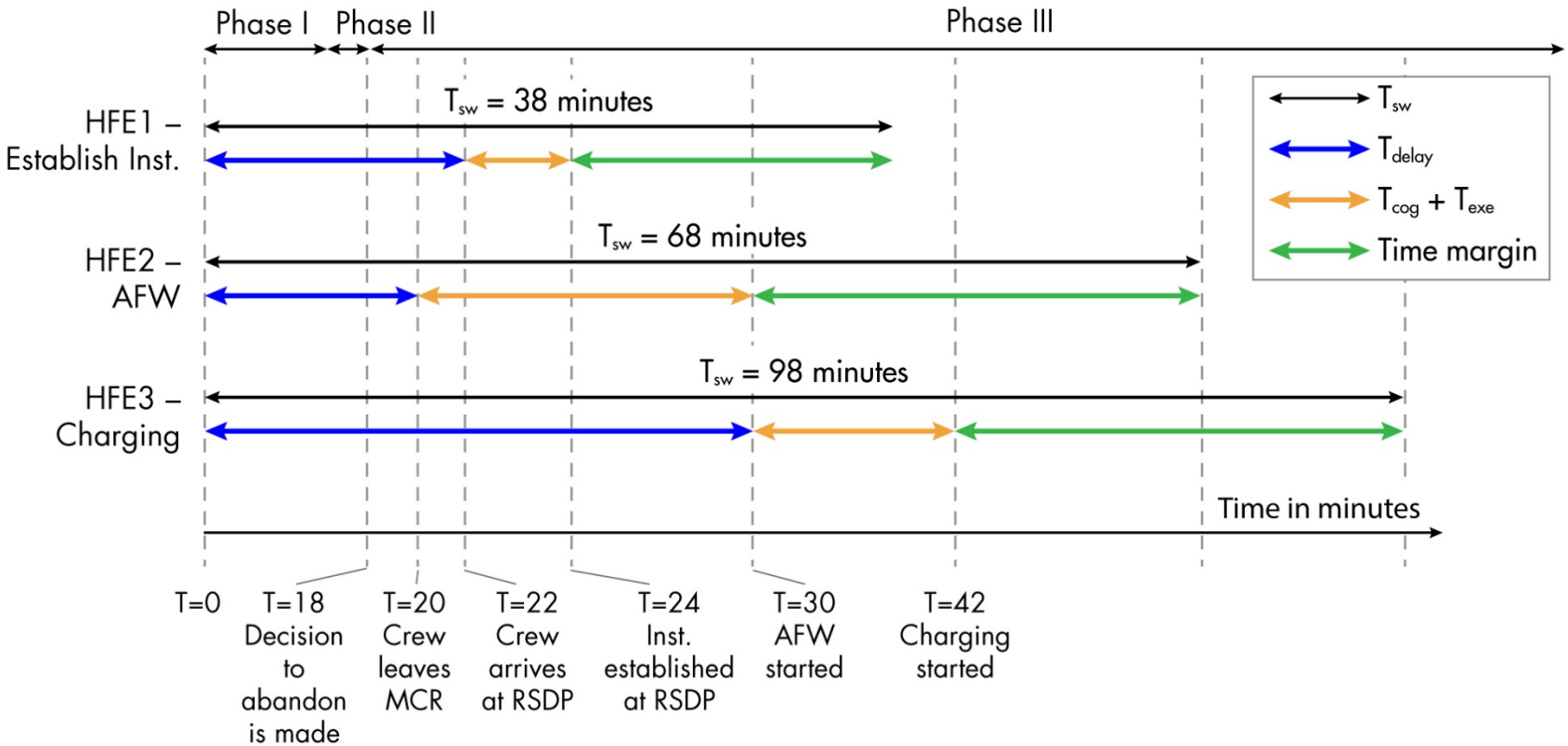
- **Phase I** - associated with actions taken before the decision to abandon
  - Actions directed from MCR using EOPs
- **Phase II** – the decision to abandon is plant-specific and requires agreement between plant operations, fire PRA modeling and fire HRA
  - Typically the HRA/PRA team will need to define conditions which require abandonment and the time at which these conditions will exist. Good example of FPRA feedback to training and/or procedures.
- **Phase III** – models actions after the leaving the MCR, similar to NUREG-1921 ex-MCR actions
  - Also addresses command & control, coordination and communications

Three Time Phases of MCRA

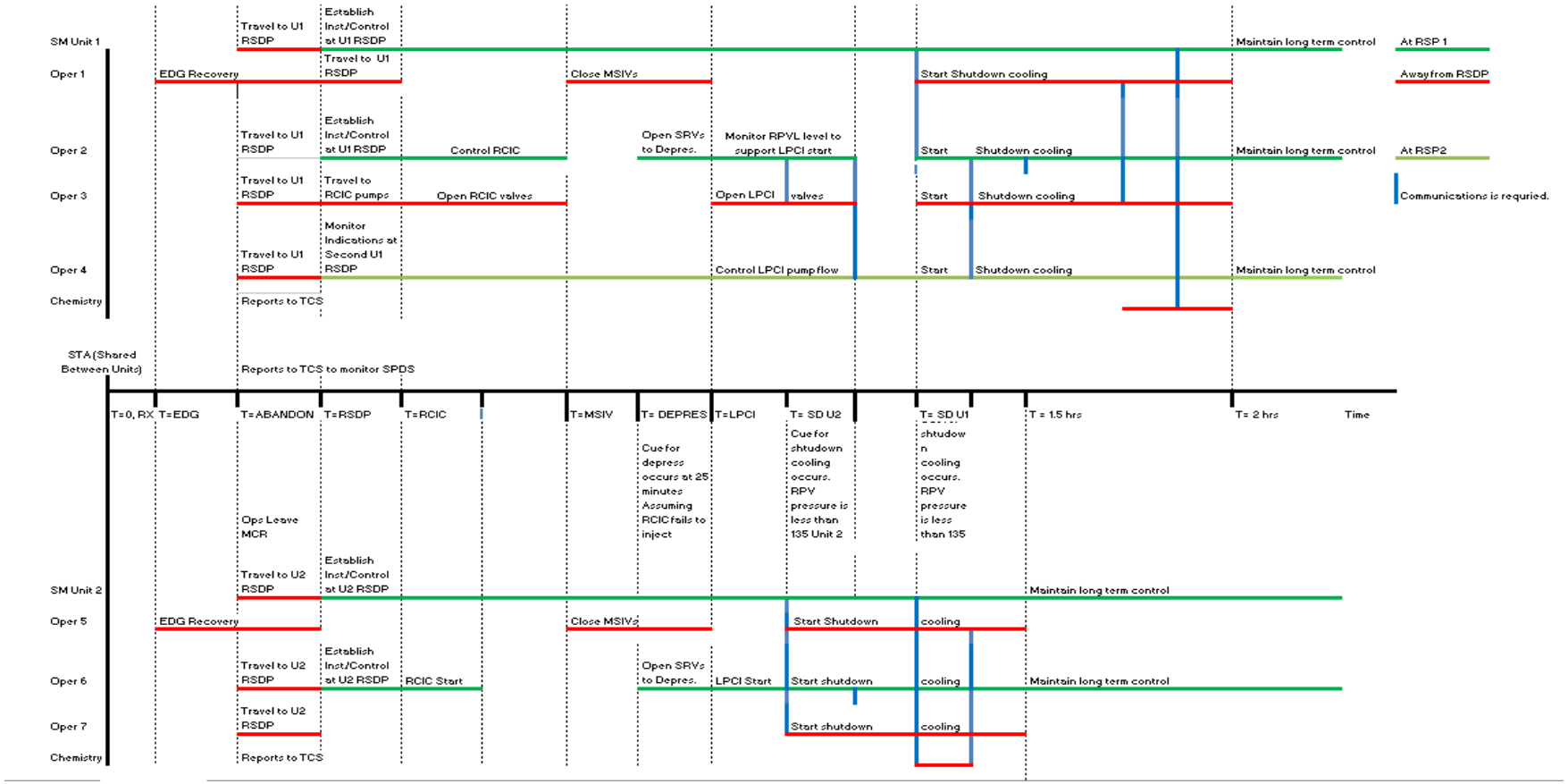


Phase I – Time period before abandonment decision
Phase II – Time period for the decision to abandon
Phase III – Time period after abandon has been made

Example of integrated timeline for multiple HFEs



Example of Timeline For Phase III (Dual Unit Abandonment)



Supplement 2 (HRA Quantification Guidance)

Overview of Supplement 2

- Supplement 2 developed to be a companion document to NUREG-1921 and NUREG-1921, Supplement 1
- High-level development approach
  1. Focused development on Phase II & Phase III
     - Decision to abandon on loss of control (LOC) (Phase II)
     - Implementation of MCRA safe shutdown strategy (Phase III)
  2. Insights from Supplement 1 were used to identify key issues that should be represented in quantification
  3. List of issues were compared to existing HRA methods
  4. Authors developed “strawman” quantification approaches
     - Phase II – developed candidate decision trees
     - Phase III – list of issues only
  5. Expert inputs were used to confirm and/or modify each “strawman” and complete quantification methods

Role and Use of Expert Panel

- Panel composed of:
  - Two NRC staff with knowledge of operations and training, including fire-related expertise
    - Harry Barrett (retired; formerly NRR NFPA-805 reviewer)
    - Jim Kellum (NRO)
  - Two HRA/PRA analysts experienced with plant fire-risk studies
    - Jeff Julius, JENSEN HUGHES
    - Erin Collins, JENSEN HUGHES
- Experts needed to have experience and understanding of a wide range of HRA/PRA and operations issues, especially with respect to MCRA scenarios
  - Experience/understanding across a range of NPPs (not just plant-specific for 1-2 NPPs)
- Experts used differently for Phase II and Phase III
  - Phase II: Confirmed key issues, pruned/modified strawman decision trees using prioritized uses, provided HEPs for “best,” “worst,” & a few immediate-case contexts, pair-wise comparison inputs for other decision tree branches
  - Phase III: Confirmed/pruned key issues, identified main priorities & associated contexts

Overview of Supplement 2 (continued)

- How to use Supplement 2
  - Supplement 2 provides quantification guidance on MCRA scenarios that were beyond the scope of NUREG-1921
  - Certain types of operator actions & human failure events (HFEs) in MCRA scenarios should be addressed with NUREG-1921
  - NUREG-1921, Supplement 1 qualitative analysis guidance
    - Is needed to apply HRA quantification guidance in Supplement 2 (and is repeated, if needed)
    - Introduced, defined, and illustrated (via event analyses) the key concept of “command and control” (C&C)
      - Supplement 2 expands upon this concept

Phase II – Decision to Abandon

Phase II – Decision to Abandon (LOC only)

High Level Approach

- Step 1: Developed list of factors important to the quantification of the decision to abandon
- Step 2: Consideration of existing HRA methods
- Step 3: Adaptation of existing HRA methods against factors important to quantification
- Step 4: Development of new decision trees specific for decision to abandon
- Step 5: Obtained subject matter expert (SME) feedback on decision trees and human error probability (HEP) values
- Step 6: Document findings and provide guidance to analyst

Step 1: Factors important to decision to abandon (team consensus)

Issue	Differentiation Points
Procedure Content	- Best case: Explicit statement of severe conditions (such as extensive MCR instrumentation failure or equipment failure consistent with fire PRA modeling) due to fire that require abandonment - Worst case: SS/SM discretion only - Intermediate case: Procedure provides fire locations that, when identified and confirmed, indicate likelihood of needing to abandon, but still leave it up to SS/SM decision
Time available (versus time required)	- Best case: Long (~20-25 mins) - Worst case: Short (~5 mins) - Intermediate case: Moderate (15 mins)
Training	- Best case: “Realistic” training in simulator - Worst case: Classroom only training at minimum level - Intermediate case: Detailed classroom training coupled with explicit MCRA criteria provided in procedures

Step 1: Factors important to decision to abandon (team consensus) (continued)

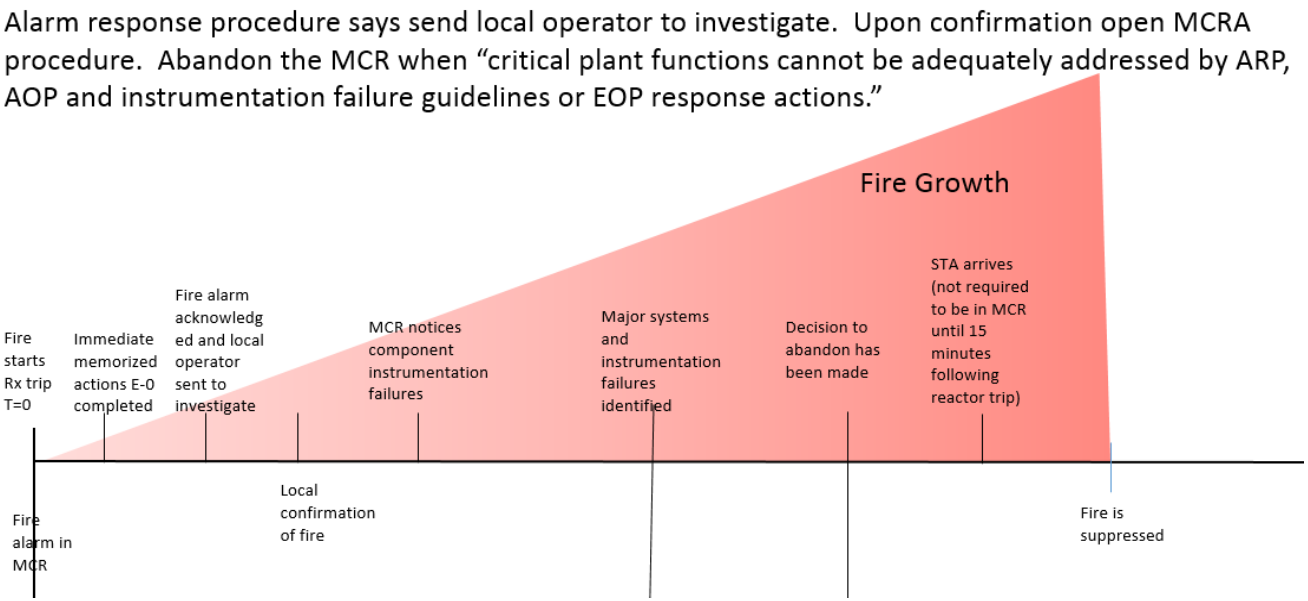
Issue	Differentiation Points
Cues and indications	- Best case: SS/SM has procedural guidance and training on cues that clearly and quickly identify that: (a) fire has been detected in a location relevant to the abandonment criteria, (b) the MCR is no longer reliable as a source of system/component information and control - Worst case: No consistent or coherent way of seeing that LOC is occurring using the displays in the MCR. - Intermediate case: Multiple cues but simulator and classroom training has prepared operators on what to look for and how to make decision
Reluctance	This is related to the: a) capability of the RSDP, b) operator comfort & familiarity with the MCR, c) inability of operators to conceive of such a desperate situation. - Best case: Capable RSDP, explicit MCRA criteria & “realistic” training - Worst case: Very limited capability RSDP, no explicit MCRA criteria, & minimum classroom training - Intermediate case: Most major systems on RSDP, some MCRA criteria; some training

Step 1: Factors important to decision to abandon (team consensus) (continued)

Issue	Differentiation Points
Staffing and Communications	-Best case: SS/SM aided in decision-making by STA or other crew who are monitoring clear abandonment criteria as would be done with Critical Safety Function Trees -Worst case: SS/SM discretion only -Intermediate case: SS/SM receives timely input from ex-MCR operator on severity of fire OR from other in-MCR crew on status of MCR boards and key equipment
Transfer to procedure with MCRA criteria	- Best case: Clear transfer to necessary procedure steps (or STA is assigned to monitor MCRA criteria and MCR indications in order to achieve quick transfer to procedural steps for MCRA) - Worst case: No specific transfer steps. - Intermediate case: Transfer is not distinct.

Step 1: Timing associated with decision to abandon on LOC

- Timing not as "clear cut" as typical internal events actions
  - Time available: left over time (after Phase III)
  - Time required: gradually unfolding cue, highly dependent on procedures/training



Step 2: Existing HRA Quantification Methods

- Considered several HRA quantification approaches:
  - Cause-Based Decision Tree (CBDTM)
  - Human Cognitive Reliability/Operator Reliability Experiment (HCR/ORE)
  - Integrated Human Event Analysis System (IDHEAS) At-Power
  - Standardized Plant Analysis Risk Human Reliability Analysis (SPAR-H)
  - Nuclear Action Reliability Assessment (NARA)
  - Cognitive Reliability and Error Analysis (CREAM)

Step 3: Adaptation of Existing HRA Quantification Methods

- Initial quantification discussion centered around re-interpreting the CBDTM decision trees
- Review asked:
  - Is the failure mode of the tree still applicable?
  - Are there dominant failure modes or mechanisms missing from the set that should be accounted for?
- Review yielded:
  - CBDTs intended for one main cue. For LOC, the “cue” is more vague (fire alarm, verification of fire, and verification of LOC)
  - Both abandonment procedural step and transfer to abandonment were supposed to be covered and this presented some confusion in re-interpretation
  - Decision trees were binary decisions, but the procedure quality range was too large to fit within binary structure

Step 4: – Draft decision trees

- Developed three new decision trees for decision to abandon
  - Failure to transfer to MCRA procedure
  - Failure to understand the MCRA criteria have been met
  - Reluctance / delay
- Decision trees formed the skeleton for discussion with SMEs
  - Failure to transfer to MCRA procedure – removed from consideration by the SMEs who concluded it was not a significant contributor to failure.
  - Failure to understand the MCRA criteria have been met –expanded to address reluctance and timing
  - Reluctance / delay – subsumed into criteria tree

Step 5: Summary of Expert Feedback

- Primary driving factors from expert discussion
  - Reluctance to abandon, key driving factor, across all response
  - Timing (as discussed earlier)
  - General training of crew to integrate information and look forward to "what is coming" (judgment and understanding)
- These considerations are built into the base HEP estimates in the final decision tree
- HEP estimates and key drivers based on current U.S. fleet
  - HRA guidance for MCRA would be substantially different for a new NPP design that uses a substantially different MCRA safe shutdown strategy, including re-constitution of the entire MCR operating crew at essentially a backup MCR

Steps 5 & 6: Final Decision Tree

Abandonment logic explicit in the procedures	Simulator or talk through training on the decision to abandon	Awareness of urgency "time pressure"	HEP when T*avail decision* is less than or equal to 5 minutes	HEP when T*avail decision* is between 5 and 25 minutes	HEP when T*avail decision* is greater than 25 minutes	
Criteria documented in procedure	Talk- through/ simulator observations	Yes	1E-01	6E-02	2E-02	(a)
		No	1E-01	8E-02	3E-02	(b)
	Classroom only	Yes	1E-01	7E-02	3E-02	(c)
		No	1E-01	9E-02	5E-02	(d)
Judgement	Talk-through / simulator observations	Yes	1E-01	9E-02	5E-02	(e)
		No	2E-01	1E-01	8E-02	(f)
	Classroom only	Yes	2E-01	1E-01	6E-02	(g)
		No	2E-01	2E-01	1E-01	(h)

Phase III

Phase III: Implementation of MCRA Safe Shutdown Strategy

- Supplement 2, Section 4 provides guidance on HRA quantification for all HFEs in Phase III
  - Section 4.3 provides process for identifying, modeling, and assigning HEPs to HFEs (including feasibility assessment and analysis of timing)
- Most of Phase III HFEs are associated with execution of MCRA procedure steps at local plant stations
  - NUREG-1921 guidance for quantification should be used with Supplement 2
- Most of the research effort for Supplement 2 focused on when/if additional HFEs (or failure modes for existing HFEs) should be added to represent failures in C&C
  - Section 4.1 and 4.2 summarize concerns with respect to C&C
  - Section 4.3.3.3 addresses C&C failures
  - Appendix B provides additional information regarding C&C research

Phase III: Definition of C&C

- Supplement 1 to NUREG-1921 (qualitative analysis for main control room abandonment [MCRA]) is based on military definitions but is focused on the following as key functions related to C&C at nuclear power plants (NPPs):
  - Maintaining a coherent understanding of the plant state (situational awareness)
  - Timely decision-making
  - Allocating resources as needed
  - Coordination of actions
  - Managing communications between team members such that they are timely and effective

Phase III – High-Level Approach to Address Command & Control Impacts

- Expanded upon Supplement 1 regarding understanding of C&C for implementation of MCRA safe shutdown scenario
- Developed a consensus on likely relevant issues
- Used input from experts to:
  - confirm key issues
  - focus on a specific C&C failure mode and associated context
- Developed a set of screening rules for analyst to identify contexts when a C&C failure should be modeled
- Reviewed existing HRA methods to identify those that addressed issues “similar” to C&C issues
- A human error probability (HEP) was selected from range of HRA methods with similar issues

Supp 1: C&C differences between Normal Operations and MCRA Operations

During in-MCR, Normal Operations (typical plant)	During MCRA Operations (typical plant)
Control room team, acting as a single centralized "cognitive entity" • Coordination with fire brigade and some plant area staff	Control room team distributed in plant areas • Supervisor may be alone at RSDP, but typically also has one RO • Coordination with fire brigade and plant areas
Shared visual cues	Single views of plant information by individuals
Well-rehearsed and tested plans and actions • Resources anticipated & available • Limited need for flexibility in response • Recognition-primed decision-making	MCRA phase III is one of the most frequently exercised fire PRA scenarios, however it is not sure if C&C is exercised. The concern is that C&C portions of the plans and actions occasionally rehearsed, rarely tested (but this is plant dependent). • Some resources anticipated & available but complete range untested • Potential need for flexibility in response
Communications (mostly) face-to-face, voice	Communications mostly audio via radios, phones; so few confirmatory indications such as annunciators & alarms
Restricted interruptions during response period	Unknown potential for interruptions

Phase III: Expert Input on Key Issues/Concerns for C&C

- Because of how the MCRA safe shutdown strategy is implemented, C&C is different for MCRA operations, such as:
  - While the role of shift supervisor (SS) or shift manager (SM) who has the primary responsibility for C&C in main control room (MCR) is the same following MCRA, the capabilities for indications and controls at the remote shutdown panel (RSDP) are different
  - Communications are different, and impacts time required for response
  - Most likely no alarms, and few indications at the RSDP so need to closely monitor parameters and may be more susceptible to distractions
  - Coordination of actions may be required & is complicated by operators being in different locations & any associated communications issues

Focus on C&C failures to coordinate actions, especially irreversible damage

Changes in Role of Supervisor and Communications

- Role of SS/SM in MCRA operations
  - SS/SM continues to drive operations but for most actions cannot directly observe the action
    - Monitors some actions, and coordinates some actions
  - Operators have different roles
  - Allocation of resources mostly done via assignments of various procedure attachments to operator (ROs & field operators)
- Communications are different for MCRA operations
  - Typically NOT face-to-face
  - May be only “reports” that actions are completed
  - Communications equipment & associated problems can be a concern

Phase III: Screening Rules for When to Model a C&C Failure

Screening Step	Description of Screening Step	If 'No'	If 'Yes'
1.	C&C coordination is required for placing equipment into service, e.g., successful pump operation requires adequate suction head from supporting equipment/system.	Screened from consideration	Go to screening step 2.
2.	Failure to properly sequence operator actions for placing equipment into service would result in an irreversible failure of the equipment, such as either condition below leading to SSC failure within 15 minutes or less.	Screened from consideration	Go to screening step 3.
3.	Operators can not immediately detect improper functioning of equipment (in order to immediately shut down equipment), due to, for example, i. A lack of local indications (including a lack of equipment or flow noises that are recognizable from training or experience); or ii. The field operator moving to a different location without checking for proper functioning	Screened from consideration	Go to screening step 4.

Phase III: Screening Rules for When to Model a C&C Failure

Screening Step	Description of Screening Step	If 'No'	If 'Yes'
4.	Supervisor in C&C role has responsibility for all (or the bulk) of communications to/from field operators, e.g., i. No one else is providing significant help to take or make calls to field operators implementing MCRA safe shutdown strategy and call from other plant staff (e.g., fire brigade, health physics), or ii. C&C is NOT solely (or mostly) focused on the communications associated with the equipment of concern and its supporting equipment/systems such as due to lack of help from other staff in taking/making these communications. iii. Communications are "segregated" such that supervisor and multiple field operators whose actions must be coordinated are NOT on a common loop such that all parties hear all communications (e.g., operator controlling cooling water to a pump does not hear the command to start the front-line system pump and therefore cannot alert the supervisor that there is no cooling water in service).	Screened from consideration	Go to screening step 4.

Phase III: Screening Rules for When to Model a C&C Failure

Screening Step	Description of Screening Step	If 'No'	If 'Yes'
5.	There are NO compensatory measures to assist the supervisor with coordination. Example cases where compensatory measures are NOT present are: i. The MCRA procedure does NOT include a written step, or Hold Point, or Warning (Caution) that prerequisite SSC alignment is needed prior to operation. For example, if an MCRA procedure includes a caution about putting in supporting equipment/system into service before putting into service the equipment in question. ii. The MCRA procedure does NOT include place-keeping aids such that the supervisor can record when support systems are in service, allowing the start of front-line systems.	Screened from consideration	Include C&C-related coordination failure.

Phase III: HEP to Assign to C&C Failure

- If screening rules result in “C&C failure should be modeled”, then an HEP of 5E-2 is recommended
- Basis for HEP:
  - Focused on sequencing failures and how they might occur
  - Review of literature for other technologies turned our focus to “distractions” and “interruptions”
    - Focused on “interruptions” as a good description of many types of communications that could compete for supervisor’s attention
  - Search for HRA methods that addressed similar issues:
    - NUREG-2114 considers workload and multi-tasking
    - NUREG-2199 (IDHEAS at-power) has workload decision tree that includes distractions/interruptions
    - NARA has a communications generic task type with error producing conditions such as information overload
    - THERP, Table 20-8 addresses errors in recalling oral communications
  - Range of HEPs from these sources: 1E-2 to 0.1

Status and Future Work

Current Status

- Supplement 2, Quantitative HRA Guidance for MCRA scenarios:
  - Draft report provided to ACRS PRA SC will be starting point for peer review
  - Peer Review:
    - Scheduled to begin April 2018
  - Final publication is planned for end of 2018

Closing

- Remarks from EPRI and NRC/RES management
- Questions?

Supplement 2
Backup Slides

Phase I – Time Period Before Abandonment Decision

- Operator actions directed from MCR, similar to other fire scenario
  - Tripping reactor
  - Starting emergency diesel generator (EDG)
  - Starting a system that failed to auto start

- Quantification guidance:
  - Use NUREG-1921 to evaluate and quantify Phase I actions

ATHEANA expert elicitation process (NUREG-1800) used in expert panel

- Facilitator guided feedback from experts (& controlled bias)
- Experts were already familiar with MCRA context & concept of probabilities
- Important details of contexts were discussed:
  - Decision to abandon on LOC
    - Discussed HRA team's list of key issues
    - Confirmed, clarified, & focused list of issues
    - "Pruned" initial three decision trees => one decision tree with fewer branches
  - Role of C&C after MCRA
    - Discussed HRA team's candidate issues
    - Confirmed & focused issues (e.g., priority of C&C sequencing that results in catastrophic equipment failure)
- Facilitator guided experts through quantification process (decision to abandon only)
  - "Best case," "worst case," & intermediate case for each expert, then consensus reached
  - Pair-wise comparisons used to determine other branch points

Supplement 1
Backup Slides

Qualitative Analysis (NUREG-1921 Supplement 1 / EPRI 3002009215)

- Provides foundational material required to support quantification
- Content:
  - Mindset shift from internal events and fire HRA to MCRA HRA
  - PRA modeling of MCRA scenarios
  - Analysis of the decision to abandon
  - Identification and definition of MCRA HFEs
  - Feasibility assessment for MCRA scenarios
  - Time and timelines for MCRA scenarios
  - Performance shaping factors
  - Recovery/dependency/uncertainty
  - Appendices (Historical events review of MCRA scenarios, Command and control, and Guidance and tips for MCRA information collections)

Qualitative Analysis
ACRS Organizational Comments

- PRA and HRA people should read everything, not just pertinent sections
  - Removed Section 1.2, *Intended Audience,* which encouraged selective reading of material
  - Toned down degree of interface between HRA/PRA throughout
- Add more in Appendix A about capabilities of RSDP
  - Added new Section A.3, *Alternative and Remote Shutdown Panel Variations*

Qualitative Analysis
ACRS Reference Comments

- References to IDHEAS (specifically Appendix B / PSF)
  - Report acknowledges IDHEAS-G in Section 2
  - IDHEAS also referenced in Supplement 2 (both for decision to abandon and command and control)
- Discuss NUREG-2114 influence on PSF / C&C
  - More explicated references in Section 8 (PSF) & Appendix B (C&C)

Qualitative Analysis
ACRS Approach/Scope Comments

- SISBO strategy should be addressed in the report
  - ACRS version: SISBO not addressed
  - Final: Added Section 3.5.6 *Self-Induced Station Blackout (SISBO) and Other Recoverable Pre-Emptive Actions*
- Why is LOH fundamentally different from LOC?
  - Greatly expanded on discussion on LOH (Section 4.1), including revisiting the technical basis
  - Silent on discussion between too early and too late.

Qualitative Analysis
ACRS Timing Comments

- Timing
  - Time = 0
    - Clarified T=0 assumption in Section 2.4.3, *General Assumptions*
  - Recovery actions called out in Phase III as separate items (10 minute recovery artificially constraining timeline)
    - Removed recovery actions in timeline discussion
  - Time uncertainty
    - Time remains source of uncertainty
    - In interviews generally look for a range
    - Use point estimate in development of timeline
    - If key source of uncertainty, should do sensitivity study