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NUCLEAR REGULATORY COMMISSION

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NRC HEAF PHASE II INFORMATION SHARING WORKSHOP

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WEDNESDAY

APRIL 18, 2018

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The NRC HEAF Phase II Information Sharing Workshop met in the 02A14 Classroom of Three White Flint, 11601 Landsdown Street, North Bethesda, Maryland, at 8:44 a.m., Michael Cheok, Deputy Director, NRR, presiding.

STAFF PRESENT

MICHAEL CHEOK, Director, Division of Risk
Analysis, Office of Nuclear Reactor
Regulation

THOMAS AIRD, General Engineer, Division of Risk
Analysis

THOMAS BOYCE, Branch Chief, Regulatory Guidance
and Generic Issues Branch

ROBERT DALEY, Branch Chief, Region III

STANLEY GARDOCKI, Program Manager, Regulatory
Guidance and Generic Issues Branch

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1 NICHOLAS MELLY, Fire Protection Engineer,
2 Office of Nuclear Regulatory Research

3 KENN MILLER, Office of Nuclear Regulatory
4 Research

5 MARK HENRY SALLEY, Branch Chief, Fire and
6 External Hazards Branch

7 DAVID STROUP, Project Manager, Office of
8 Nuclear Regulatory Research

9 GABRIEL TAYLOR, Senior Fire Protection
10 Engineer, Office of Nuclear Regulatory
11 Research

12 MICHAEL WEBER, Director, Office of Nuclear
13 Regulatory Research

14
15 ALSO PRESENT

16 JENS ALKEMPER, FM Global

17 SCOTT BAREHAM, NIST

18 JANA BERGMAN, Curtiss-Wright

19 ROBERT CAVEDO, Exelon

20 FRANK CIELO, KEMA Laboratories

21 MARK EARLEY, NFPA

22 KENNETH FLEISCHER, EPRI

23 DANIEL FUNK, Jenson Hughes

24 FRANCISCO JOGLAR, Jenson Hughes

25 CASEY LEJA, Exelon

1 ASHLEY LINDEMAN, EPRI
2 DAVID LOCHBAUM
3 SHANNON LOVVORN, TVA
4 MATTHEW MERRIMAN, Appendix R Solutions
5 ALICE MUNA
6 FRANCESCO PELLIZZARI, EPM
7 ROD PLETZ, AEP
8 SUJIT PURUSHOTHAMAN, FM Global
9 ANTHONY PUTORTI, NIST
10 ROBERT RHODES, Duke Energy
11 BRENDA SIMRIL, TVA
12 THOMAS SHUDAK, NPPD
13 STEPHEN TURNER, Independent Consultant
14 BAS VERHOEVEN, KEMA Laboratories
15 BETH WETZEL, TVA

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C-O-N-T-E-N-T-S

Opening Remarks	5
Introduction & Meeting Objectives	5
Review of Phase I HEAF Research	19
Generic Issues Process	58
Aluminum HEAF PRE-GI-018	60
Pilot Plants	106
Arc Flash/Blast/HEAF Definition & Bin 16	137
Small Scale Testing at SNL	164
PRA Modeling Implications	191
NFPA Perspective	207
EPRI Perspective	226
Physical Testing & Failure Rates	252
Public Comment	299
Adjourn	301

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

8:44 a.m.

MR. TAYLOR: Okay, we're going to go ahead and get started. For those in the room, just beware that there's some cords for the transcriptions and please be safe as you move about the room. With that, we already went over the logistics and the administrative stuff, so I will go ahead and turn it over to Mark Salley to open up and introduce him.

MR. SALLEY: Opening the meeting up -- thank you all for attending. And Mike Cheok, my division director in Research, is going to open up for us. So, Mike?

MR. CHEOK: Well, thank you and welcome to the Public Workshop on Phase II Testing of High Energy Arcing Faults, or HEAFs. And first of all, thank you for all your patience as we set up and we have some logistics, too, that came up. And as Mark said, I am Mike Cheok and I am the Division Director for the Division of Risk Analysis in the Office of Nuclear Regulatory Research.

So now, HEAFs is an important topic for us. And we would like to better understand the phenomenon and to better characterize the safety significance in nuclear power plants. It is also

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1 very important for us to reach out to you all, to all
2 our stakeholders, to get your input as we move
3 forward to the next phase of HEAF testing. So one of
4 the lessons learned here in our first phase of
5 testing was that we need to get stakeholder input
6 earlier in the process to guide future tests. So
7 your experience and expertise are important to us and
8 we value it as we move forward to Phase II of the
9 testing.

10 In addition to all the participants in
11 this room, which there is a lot of, we have also a
12 number of people on the webinar. I would like to
13 point out that this week in France, their OECD
14 nuclear energy agency's fire modeling program led by
15 the French regulator of IRSN, is also meeting to
16 discuss their current activities. So many members of
17 their program are also members of the International
18 OECD HEAF Program and many of them are on this
19 webinar. So I know it makes for a very long day for
20 those participants, and I want to thank them for
21 taking the time to participate in both meetings.

22 As you will see from the agenda, we have
23 more information to cover over the next two days. We
24 encourage your active participation and your input
25 into each one of these sessions. So, starting with

1 it in mind, this slide shows the desired outcomes
2 from the workshop. First, we hope to develop clear
3 and concise definition of the arc flash and the HEAF
4 phenomenon. We will work with you as experts in the
5 nuclear industry and as well as from the National
6 Fire Protection Agency, NFPA -- NFPA Factory Mutual
7 and KEMA Labs to develop definitions that are
8 consistent with the needs of the nuclear community
9 and with the commercial industry as well.

10 Next, as I have mentioned earlier, there
11 was a lot of discussion about the Phase I testing,
12 which said that on testing -- that the test needed to
13 be more realistic and representative of what was
14 found in nuclear power plants. So our second desired
15 outcome as far as to get your input towards Phase II
16 testing. We will discuss the proposed test
17 parameters and methods and we hope to accomplish --
18 and what we hope to accomplish for Phase II testing.
19 Then we will open up the discussion to your opinion,
20 insights and input. We will include the new and
21 relevant information that's made available to us
22 during this workshop.

23 Finally, I would like to mention that
24 Mike Franovich from the Office of Nuclear Reactor
25 Regulation and I are co-chairs on the panel for the

1 ongoing pre-Generic Issue on aluminum HEAF. The
2 NRC's generic issue process is a phase process where
3 we evaluate the issue is safety significant enough
4 and if there are generic implications to warrant
5 further study or action. We hope to get additional
6 information from this workshop and from subsequent
7 testing to help us inform the resolution of this
8 issue on aluminum HEAFs.

9 So, again, I thank you all for taking the
10 time to support this workshop. I know your schedules
11 are very busy and demanding. So I appreciate the
12 interest and you attendance today. Your insights
13 will help us perform the necessary research needed to
14 better understand and resolve the issue in more than
15 high energy arcing faults. I am confident that the
16 results from this project will be useful for guiding
17 the safety decisions for both the nuclear and
18 commercial industries. Thank you, and I will hand
19 the proceedings over to Mr. Mark Henry Salley who
20 will lead us through the rest of the workshop. Mark?

21 MR. SALLEY: Can Nick and I go back and
22 forth?

23 PARTICIPANT: Let me turn this off so we
24 don't get too much feedback.

25 (Pause.)

1 MR. SALLEY: All right, thank you very
2 much for coming in today. We've got some special
3 guests, Mark Earley from the NFPA is going to be with
4 us at a presentation. We got Bas from Netherlands
5 all the way from -- what? Netherlands? Going to
6 give us a presentation. He runs the KEMA lab over
7 there, which I guess is the mother ship of the one
8 that we work with in Pennsylvania. And also, Ashley
9 -- I see Ashley got a presentation for what EPRI is
10 going to be showing. In addition to that, we've got
11 a lot of NRC folks to talk -- N.J. Taylor, Nick
12 Melly, Stan Gardocki is here, he can talk about our
13 Generic Issue Process. And we've got Kenn Miller
14 back there. He is going to talk about some of the
15 work we're doing with the definitions. So I'd just
16 like to introduce -- if everybody just go around and
17 introduce themselves here to get started. If we could,
18 Gabe?

19 MR. TAYLOR: Gabe Taylor, Officer of
20 Research, NRC.

21 MR. MERRIMAN: Matt Merriman, Appendix R
22 Solutions.

23 MS. BERGMAN: Jana Bergman, Curtiss-
24 Wright.

25 MR. TURNER: Steve Turner, Consultant.

1 MR. BAREHAM: Scott Bareham, from NIST.
2 MR. PUTORTI: Tony Putorti, Fire Research
3 at NIST.
4 MS. WETZEL: Beth Wetzel, TVA.
5 MR. CAVEDO: Rob Cavedo, Exelon.
6 MR. LEJA: Casey Leja, Exelon.
7 MR. RHODES: Bob Rhodes, Duke Energy.
8 MR. JOGLAR: Francisco Joglar, Jenson
9 Hughes.
10 MR. FUNK: Daniel Funk, Jenson Hughes.
11 MR. ALKEMPER: Jens Alkemper, Research,
12 FM Global.
13 MR. PELLIZZARI: Francesco Pellizzari,
14 EPM.
15 MR. PURUSHOTHAMAN: Sujit Purushothaman,
16 Research, FM Global.
17 MR. GONZARIO: Tony Gonzario, NRC Office
18 of the Chairman.
19 MR. DALEY: Bob Daley, NRC, Region III.
20 MR. MILLER: Kenn Miller, Office of
21 Research, Division of Engineering.
22 MS. SIMRIL: Brenda Simril, TVA.
23 MR. LOVVORN: Shannon Lovvorn, TVA.
24 MR. STROUP: David Stroup, NRC Office of
25 Research.

1 MR. GARDOCKI: Stanley Gardocki, Office
2 of Research, Generic Issues Program.

3 MR. MELLY: Nick Melly, Office of
4 Research.

5 MR. SALLEY: Okay, thank you. Oh -- yes.

6 MR. EARLEY: Mark Earley, NFPA.

7 MR. CIELO: Frank Cielo, KEMA
8 Laboratories.

9 MR. VERHOEVEN: Bas Verhoeven, also KEMA
10 Laboratories.

11 MS. LINDEMAN: Ashley Lindeman, EPRI.

12 MR. FLEISCHER: Kenn Fleischer, EPRI.

13 MR. SHUDAK: Tom Shudak, Nebraska Public
14 Power.

15 MR. PLETZ: Rod Pletz, American Electric
16 Power.

17 MR. SALLEY: Okay, and we also are doing
18 this on a webinar. Who do we have on the webinar?

19 (Off-microphone introductions.)

20 MR. MELLY: Thank you. All right, mute
21 the line. We will have a few people joining in
22 occasionally at the webinar, like we mentioned
23 earlier. There are some time differences and some
24 meetings going on in Europe right now. Many of the
25 members for the OECD Program are -- have that

1 conflicting meeting. So they will be joining in
2 occasionally throughout the meeting.

3 MR. SALLEY: So, again, we are doing it
4 with -- live here. Sorry the room is small. We had
5 a little trouble booking it, but I guess it will be
6 -- it will be comfortable. But we are doing this via
7 the webinar. You folks on the webinar, if you would
8 email your information to Tom Aird and he will get
9 that for you there. Also, this meeting is going to
10 be transcribed. We figure there is going to be a lot
11 of discussion, especially tomorrow. So we wanted to
12 make sure that we captured everything. So as we look
13 at the test plan moving forward, we can go back to
14 remember what was said and to get the input. So
15 again, we are going to transcribe this. So when we
16 do get to the discussion piece, if you could
17 introduce yourself before you speak, it would be
18 easier for the court reporter to do the
19 transcription. And again, our end goal is -- we've
20 got a lot of good presentations. And I look at some
21 of the stuff from EPRI and the NFPA, and I am sure
22 the stuff from KEMA is going to be top-notch. So we
23 wanted to capture that. We are looking at doing a
24 NUREG/CP. A NUREG/CP is a conference proceeding. So
25 it would be a standard NUREG with all our

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1 presentations and anything that comes out of this
2 meeting in there. So again, we can capture this and
3 use this moving forward with the HEAF Program. Next
4 slide, Paul?

5 MR. MELLY: And like Mark said, we do
6 have a microphone in the back of the room. It would
7 be beneficial today if anyone -- any -- for any
8 discussion -- so the people on the phone can hear you
9 if you use that microphone when -- while asking any
10 questions today.

11 MR. SALLEY: So, the purpose of this
12 meeting, again, we have a number of things we would
13 like to accomplish. We would like to share with you
14 what we've learned to date. Different people coming
15 into this -- this program at different points, so
16 we'd like to bring everybody up to speed with what
17 we've got, what we've done and where we're at. As
18 Mike said, very important -- as the NRC is a
19 transparent agency, we'd like to solicit your input
20 as we move forward. That's very valuable to us. You
21 guys are the ones who read the plans, doing the work
22 and that information is very valuable as to how to
23 move forward.

24 Again, we want to learn from each other.
25 And we've reached out to people like the NFPA who

1 have done a lot of work in this area. I think we can
2 gain some of that. FM Global is here and I hope we
3 can get some insights and information from you also.
4 Again, we have the meeting going on in Europe at the
5 same time. We look to move forward with our partners
6 as we did in the first phase, which we will talk
7 about in a little bit. And again, the Generic Issue
8 Program -- you know, you guys are familiar with plans
9 with generic letters. Generic Issue is a different
10 thing. We haven't done one in Fire for a while. So
11 it is going to be worth a little time that Tom Boyce
12 and Stan are going to walk us through the process.
13 I know there is -- when we issued the information
14 notice, there was a little bit of apprehension --
15 okay, what comes next? What do we have to do? And
16 again, we put this into the Generic Issue Process,
17 which is a very formalized process the NRC has had
18 since the 1970s and I think it's worth Stan walking
19 you through, so that will explain how this is going
20 to work out in the long term. Next slide?

21 So we broke this presentation down,
22 basically, into two days. We could have done it in
23 a week, there was so much to cover. But we thought
24 two days would be about right. They're going to be
25 long days, so I hope you're all up for that. The

1 first day we wanted to really share a lot of
2 information with you -- wanted to get you up to speed
3 where we're at. The information we've done to date
4 and get a lot of those presentations.

5 The next day -- the second day -- the
6 second day we look for a lot of interaction with you.
7 And that's where we really want to have -- after
8 loading everything up today, you think about it
9 tonight, then tomorrow we have a lot of good
10 discussion as to how are we want to look at that test
11 plan, and how do we want to move forward? So today
12 is going to be a fair amount of getting
13 presentations, getting information down. Second day
14 we'd -- like I said, we would really engage for a lot
15 of discussion.

16 Path forward, again, we've put our test
17 plans out. You've seen them in the Federal Register.
18 We've gotten a number of comments on them. We've
19 also got some small-scale testing we're looking at
20 doing with the lightening research out at Sandia.
21 And that test plan is also out there again. Again,
22 we're soliciting information, comments from you on
23 that so we can get the -- the best product we
24 possibly can. And again, we'll work with our
25 partners over in Europe and Asia in the second phase

1 of OECD Program. But again, we want to -- we want to
2 do this in a methodical manner. So, we'd like to
3 have this well thought out and well planned.

4 We haven't procured our equipment for the
5 second phase of testing too much yet. We've got a
6 little bit from some of our European partners. We
7 haven't drawn and done that. And again, the second
8 day, tomorrow, I hope there are a lot of electrical
9 engineers who can really give us some insights as to
10 what we need to look at for the -- for the biggest
11 bang from our buck as far as doing the testing. We
12 were hoping to get a test off in the fall, that was
13 our target -- it still is. However, with the
14 international agreement, the OECD -- OECD, the NEA
15 and our legal departments, there's some questions on
16 some wording that changes with the international
17 agreements that truthfully -- like everything, our
18 lawyers need to work out before we can move forward.
19 So, right now, our agreement with working with the
20 international group is with the lawyers. So, we
21 would have worked that through the process.

22 Again, at the end of the day, in the long
23 term, what do we want to do? In the nuclear area --
24 you guys are all familiar with those things in
25 depths. Where we use a defense in depth principle,

1 and that's who we like to do things. I don't see the
2 HEAF issue as anything different -- with the elements
3 like we do in Fire Protection and other areas, we
4 always want to do the preventive activities if we
5 can. If we can't prevent it, we want to detect it
6 and mitigate the hazard. And if we can't do that, at
7 the end of the day, we need to start a safe shutdown
8 for the reactor. So again, I see this process as it
9 evolves over time with different parts of the testing
10 feeding into different parts of this, operating
11 experience, et cetera -- as we develop a defense in
12 depth process moving forward.

13 Last line as we get started here is the
14 NRC -- our mission is safety, you know. So there's
15 our statement. And again, it is about protecting the
16 public, the environment. Safety is our business.
17 But I will tell you something else about -- that I've
18 learned doing fire research is fire research is
19 bigger than the NRC, it's bigger than the nuclear
20 community. Things that we learn in fire protection
21 we can reach out and share with our other partners.
22 For example, one of the things Nick and I do with
23 this program is the thing called the Federal Fire
24 Working Group. So all your three- and four-letter
25 agencies belong to that -- NASA, DOE, DoD. And we

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1 get together once or twice a year and we share what's
2 going on in our area. The last two years Nick and I
3 have been sharing what we've been learning about the
4 HEAF with that larger federal community with the idea
5 that these HEAFs are not -- or, these arc flashes are
6 not unique to power plants. Anybody who is using
7 electricity has this same thing. And we see a lot of
8 this in the general industry as Mark Earley is going
9 to share with us later. So again, if we can benefit
10 the greater area and greater good, we are all for
11 that. Again, partnering with those NIST and that --
12 we can get this information out to different areas.

13 So, with that being said, the first thing
14 we'd like to do is a quick review of what we've got.

15 MR. TAYLOR: Yes, while Nick brings that
16 up. One thing I did want to mention, for those on the
17 webinar, if you have questions -- and this is a
18 category three public meeting, so it's kind of a
19 free-for-all. There is no designated time like a
20 category two. But for those on the webinar, if you
21 have a question, there's two ways to bring it up.
22 One, you can text a question into the webinar box and
23 our webinar controller will then bring that question
24 up. Or, two, you can raise your hand. And then the
25 webinar controller will un-mute your line and you can

1 then ask your question that way. For those on the
2 webinar, two ways to bring up questions.

3 MR. SALLEY: Thank you, Gabe. So
4 quickly, moving forward here, we are going to give
5 you a Reader's Digest of what we've done over the
6 last six, eight years and where we're at with -- with
7 this program. A key to this presentation is that
8 this really is -- is the roadmap of where we're at
9 and this is the reference. There is a lot of links
10 in here to different reports. If you want to
11 download them, they're all publicly available on the
12 web. You'll also see a thing -- ML. And when you
13 see that ML, that ML number is the NRC's document
14 control system. We call it ADAMS. And those are the
15 identifiers for the documents to bring it up. So
16 again, you can find us on the NRC's public web page.
17 Any of the ML numbers will be the identifier that
18 will bring that report, that memo or whatever that
19 document is for. So again, the key to this is to do
20 a review for you and it's also the Reader's Digest
21 version of all the references of where we're at.
22 Next one, Nick.

23 So, when we started this, we first looked
24 at getting going for this, we looked at the document
25 NUREG/CR 68-50, this is EPRI 1011989. It was a joint

1 project we had done with EPRI a number of years ago.
2 Francisco is here. He was very intimate with that
3 back in the day when that was written. He can answer
4 a lot of your questions.

5 But again, this was a chance for the
6 industry and the NRC to work together to develop a
7 five PRA method to do a five PRA for a nuclear power
8 plant. So it's a very big document. It's got a lot
9 of different things in it. And it was one of the
10 first times where we really identified the HEAF and
11 said, hey, this is a -- a hazard that you need to
12 look at when you're doing your risk analysis for your
13 power plant. And they had done some work on it. And
14 looking at the enclosures, as we're going to see here
15 in a little bit, that we had postulated two types of
16 failures. You could have the thermal failure where
17 an electrical enclosure caught on fire and caused
18 damage. Or you could have the explosive force of the
19 HEAF. So it was a -- a binary thing.

20 Cutting ahead a little bit, as we've
21 looked at that and we started down that road, we've
22 kind of put it in neutral for a little bit and we
23 stopped because some things that we're going to talk
24 about here in a little bit, that Nick's going to
25 discuss, is that -- and again, this gets to the

1 testing. Not every time we have an electrical
2 failure does it immediately go to a HEAF. There's
3 other things that happen in there and things we're
4 learning from the NFPA where they have arc flashes,
5 arc blasts and HEAF. And we're going to get into a
6 discussion on that.

7 So this is a point where we've learned
8 something going through the process, kind of want to
9 slow it down and stop it for a second and get a
10 little more resolution.

11 Next slide? This is a slide that Kelly
12 Gosing (phonetic) presented at our RIC conference
13 this year. She's from EPRI. And it looked at the
14 hazard that we see in the power plants from the
15 different risk drivers. And you can see in the back,
16 you can call this is a skyscraper -- skyline?

17 MR. MELLY: Skyline, skyscraper chart.

18 MR. SALLEY: Yes, skyline chart -- you'll
19 notice that we see the big risk driver is from the
20 thermal fires in the electrical enclosures. That's
21 the lines in the back. Moving forward a little bit
22 you'll see that, I think, number three on there is
23 the high energy arc faults. So again, as far as the
24 risk in power plants, this is something that's
25 important in a risk-informed environment this is

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1 something we want to look at. This is something we
2 really want to understand. Next slide, Nick.

3 MR. MELLY: Moving forward we kind of
4 wanted to provide the background, history of all the
5 links and things like that that Mark mentioned. And
6 you'll see here that we provide a link to all the
7 documentation that we're going to be discussing
8 throughout the workshop. Starting with NUREG-6850,
9 it provided the methods for doing the Bin 15
10 electrical fires as well as the Bin 16 -- the high
11 energy arcing fires. One of the lessons that we
12 learned is that our -- Bin 15 is fairly broad. It
13 encompasses all electrical enclosures. And for the
14 Bin 16, the high energy arc faults, it's a one size
15 fits all model. So having a very broad BIN for all
16 electrical cabinets, using a one size fits all model
17 proved to be a problem when there's not much that you
18 can do to mitigate the effects of the high energy
19 arcing faults. So one of the things that we're kind
20 of focusing on with a couple of our presentations as
21 well as -- YMPA is here and the discussions that
22 we've been having with them -- is to really define
23 what we mean by the high energy arc faults and
24 separate them into appropriate BINS with the
25 appropriate frequencies that you can use in your

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1 PRAs.

2 One of the other major efforts that we've
3 done recently is the HELEN-FIRE work as well as our
4 RACHELLE-FIRE work. It was a focus on looking at Bin
5 15 and creating realistic heat release rate profiles
6 associated with them so that we could advance the
7 main risk driver that we saw from that skyline chart.
8 A lot of this work was done with EPRI and it has been
9 done as relatively -- a success in advancing the
10 state of knowledge. And that focused directly on the
11 thermal fires associated with electrical cabinets and
12 did not take into account the electrical energy
13 associated with the fire itself. It may have started
14 the fire, but it wasn't a prolonged electrical event.

15 This is the second part to that. The
16 HELEN-FIRE report that was on the previous slide was
17 the actual testing program, which was done with NIST,
18 testing over 100 electrical cabinets to evaluate the
19 heat-release rate profiles. And the follow-along was
20 done as an expert panel to create appropriate Bins
21 and do the application of that research. And as we
22 discussed earlier, we are really going to try and
23 focus a lot of our effort on the subdividing Bin 16
24 into the appropriate Bins. As we'll see in our
25 further definition -- or, further presentations, we

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1 are going to be looking at separating the terminology
2 for arc flash, arc blast and the high energy arcing
3 fault. And we want to link that with how we are
4 going to be doing the modeling.

5 So again, we are going to have another
6 presentation from NFPA on their work in this area.
7 A lot of it is primarily focused on personnel
8 protection where we have a little bit different
9 mindset moving into the protection of a plant and
10 plant equipment in PRA models.

11 MR. SALLEY: And keep your -- keep your
12 eye on these slides, this pictures, in the back of
13 your mind because, you know, the picture is worth
14 1,000 words. When Kenn Miller does his talk about
15 these differentiating -- how we are going to
16 differentiate the categories between an arc flash and
17 a HEAF, this will be in -- a lot of this in more
18 detail in Kenn's presentation. So keep these
19 pictures in mind as Nick goes through it.

20 MR. MELLY: Yes, and to kind of explain
21 these pictures at a high level is that, whenever you
22 have the breaker trip or these flash events, a lot of
23 them go into the Bin 15 fires where it may have --
24 you failed circuit protection, or you had a short or
25 a fault in your cabinet, but it doesn't lead to this

1 large damage state that we're seeing. It can just
2 generate a small fire in the cabinet, or no fire at
3 all. Typically, that's going to be in Bin 15.

4 Another category that you can see is that
5 you have this blast -- where you have the pressure
6 effect damaging things in the room. What you're
7 seeing on the screen right here is the event that
8 happened in 2017 at Turkey Point where you don't see
9 that large cabinet damage. There was a pre-phase
10 fault in this cabinet, lasted for approximately half
11 a second, which was a success of their circuit
12 protection -- or, operated as designed. But you
13 still saw that we had -- that there was a breach of
14 the fire door from the over-pressurization in the
15 room. This fire door was located 15 feet away from
16 the cabinet of origin -- so clearly outside the
17 three-foot horizontal distance that's currently in
18 6850, but again, you saw that breach of the door into
19 the 4B switch gear room. So essentially, you -- you
20 had a area breakdown between a 4A and a 4B, which can
21 be a potentially serious problem.

22 Again, another instance of this, you see
23 Brunswick in 2017. You see that severe cabinet
24 deformation from the pressure wave, but you didn't
25 see this large damage effect that's in 6850 upon

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1 exam, and you don't see then, during fire condition.
2 So these are the things we kind of want to focus in
3 on moving forward, how we create the frequency of
4 these events occurring.

5 Some of the more classical examples of
6 what you do see as HEAF is the San Onofre fire in
7 2001. This is a SONGS event. This is essentially
8 what was used to model what's in 6850, Appendix M.
9 This event was well documented and gave the authors
10 of 6850 a good picture of what they were trying to
11 prevent with this damage state. So that's kind of
12 what led to the three-foot, five-foot and the caveats
13 that is in Appendix M of 6850. You see on the right-
14 hand side, this is the damage associated with the
15 Onagawa event in 2011. From the earthquake itself,
16 they had a hanging magnet blast breaker that created
17 -- stads (phonetic) got crossed up from the shaking
18 of the earthquake itself. This plant was the closest
19 to the epicenter, so it did have the highest ground
20 fall acceleration, and you saw that problem. This
21 fire lasted for seven hours because the onsite
22 brigade couldn't get into the room. It damaged seven
23 pieces of equipment and it was a very difficult fire
24 to fight. If Fukushima wasn't occurring, this is
25 probably what would have been in the news headlines.

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1 And again, it's not only the electrical
2 cabinets that we're worried about. It's also the bus
3 ducts. You see these two events from Diablo Canyon
4 and Columbia, where you see the large damage states.
5 There was approximately eight feet of bus ducts and
6 four feet of the bus bars inside the bus duct that
7 were damaged here. And you also see that this kind
8 of brings up the problem of aluminum that we're
9 currently facing and looking at in the generic
10 issuing program. You can see in the Columbia bus
11 duct event, you have that -- everything looks like it
12 is white-washed around the event, and that's because
13 in this event the bus ducts themselves, as well as
14 the enclosure, was made of aluminum. And again, I
15 mentioned four feet of the bus duct conductors and
16 eight feet of the enclosure was vaporized during this
17 event, and it had a lot of people scratching their
18 heads in the root cause analysis.

19 The center picture you see is the Zion
20 bus duct that we tested in 2016 where we vaporized
21 seven inches of the enclosure material and one-and-a-
22 half inches of the conductor. We will see a video of
23 that moving forward that you can kind of keep in your
24 mind -- the energy associated with the release of
25 this amount of material. One of the other important

1 aspects that we're going to really dive into tomorrow
2 during our discussion is the duration that's
3 associated with how we test these events. Electrical
4 protection comes into play -- it's extremely
5 important in the durations of -- a primary driver for
6 how much energy is released during the event. We are
7 trying to base it off operating event history that we
8 actually see in these plants, and this is one piece
9 of information that we want to do better on in the
10 future at collecting how long these events actually
11 last in the plant. Some of the information is a
12 little hard to find on -- in LER information and the
13 condition reports. But it's something we want to do
14 better on and dig deeper into so we can inform the
15 testing program.

16 This is just a sampling of some of the
17 events that constitute the Bin 16 high energy arcing
18 faults. And you can see the duration of these events
19 is longer than you would normally expect if your
20 circuit protection works. Like we talked about at
21 Turkey Point, that was half a second, which is fairly
22 long for a successful operation of a breaker, but we
23 do see these events occurring. We range anywhere
24 from two seconds that we typically see, to the Fort
25 Calhoun, which is a little weird of an event. It was

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1 a low-voltage system that was holding in on an
2 upstream transformer that did last for 42 seconds
3 until operators actually manually terminated the
4 event. And we can look at some pictures of the
5 damage associated with that event moving forward.
6 Again, that was an aluminum event and there's some
7 indication that it may have led to some -- a
8 conductive environment that led to later faulting.

9 MR. SALLEY: So duration is going to be
10 one of the topics, I guess, that we're going to
11 discuss a lot tomorrow. And then we will be looking
12 for a lot of your input. Swinging back to the
13 regulations a little bit on how we -- the NRC
14 regulates the plants -- the safety significance of
15 this, is we have a thing, Appendix A to 10 CFR 50,
16 which is a code of federal regulations. Appendix A
17 is the general design criteria. And there's two of
18 them that apply to this area, GDC 3, of course, is
19 fire protection. And for the fire hazards analysis
20 done by the Fire Protection engineers, one of the key
21 things is that you'd postulate the fires and
22 explosions. I guess the question comes of how
23 rigorous in that FHA were you at postulating
24 explosions from electrical equipment? And it was
25 easy to do the hydrogen and different things in the

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1 plant, but the question comes up, do we consider --
2 consider the heat for the electrical?

3 And the other area, GDC 17, that's for
4 our electrical engineering colleagues. And again,
5 that's the single failure that should prevent these
6 type of events. So again, this is codified in the
7 regulation. And again, it will tie back to the work
8 Stan's doing with the Generic Issue Program.

9 So how do we -- how did we get into this,
10 and you know, what brought this up? And I like to
11 think of this with what we're doing as almost
12 connecting the dots. We belong to the international
13 group we talked about, the OECDNEA. And we work a
14 number of programs internationally sharing safety
15 information. One of the things we look at is the Fire
16 Events Database. And it's a -- it's a fairly
17 inexpensive program. It's a good program for the
18 NRC. The part that I like about it is that we can
19 look at the events that we've had -- the LER,
20 licensed event report fires, which are typically
21 between three and nine a year. We can look at those
22 fires. We can take that to the international
23 community and say, hey, we've had this, this and
24 this. What are you seeing in your plants? Is there
25 something we're doing wrong or unique in the United

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1 States that you've done better in Japan or Korea or
2 Germany or France? Or, are you seeing the same type
3 of events that we are?

4 And when we first brought up the high
5 energy arc faults, it was interesting because all of
6 the sudden, everybody started saying hey, we've had
7 one or two of those. And we all started exchanging
8 information. So we saw it that this wasn't something
9 that was unique to the United States nuclear plants,
10 but we were seeing this worldwide. And then when we
11 started tallying it up and we started seeing that,
12 hey, of all the fires that we're talking about in
13 this group, ten percent of them are HEAFs. Wow, how
14 much do we know about this? Not that much. This is
15 a significant issue. Do you think we ought to do
16 some research to do something with this? And
17 everybody, pretty much, around the table agreed, yes,
18 this is a -- this is a risk driver that we need to
19 think about and we need to do some work on. So this
20 was the genesis for bringing the High Energy Arcing
21 Fault Program and why we went with the international
22 approach in what we saw here.

23 MR. MELLY: And in the most recent
24 database update that we're going to be completing
25 later this year, that number has jumped to 64 out of

1 a -- I believe it -- we're at 475 events. And again,
2 it may be skewed a little bit in this ten percent
3 because everyone reports these events. There's no
4 chance you're missing a high energy arcing fault
5 occurring in your country because they're typically
6 the larger fires that have severe consequences and
7 difficult plant shutdowns associated with these
8 events as we see in our history as well.

9 MR. SALLEY: So we started doing some
10 work in that area and one of the other groups picked
11 it up -- one of the risk groups -- and they started
12 looking at the methods. Okay, so you see these
13 events, how do we postulate this event? How do we do
14 the analysis? And basically you can read the report,
15 but it all comes back to what we had done with
16 Francisco and company and 6850 and the Appendix M.
17 And that seems to be about the state of the art, the
18 best information that's out there. A little
19 additional work the Canadians put into this report,
20 and again, the key here is for you, there's the
21 links, and you can download all this.

22 Again, with our testing we hear realism.
23 You know, everybody wants realism in PRA -- realistic
24 tests, realistic -- so that's kind of where we're
25 going with this. We're not trying to do worst case,

1 conservative tests, but again, something that's
2 realistic that we can get a realistic model, an
3 accurate model and we will be discussing that at some
4 of the later presentations as to -- to what that is
5 going to take.

6 MR. MELLY: Again, we are going to
7 quickly go over these because we are going be
8 touching on them later -- primarily in the discussion
9 phase. But a lot of the comments that we've
10 received on the initial Phase I of testing was that
11 we -- plants do not see these three-phase faults like
12 we are initiating in the program at KEMA using the
13 IEEE standard wire to initiate the faults. We went
14 back and reviewed the LERs and we do see that while
15 the event may occur phase-to-phase, or phase-to-
16 ground initially, that the ones that last for a long
17 period of time quickly progress to a three-phase
18 fault because of the ionization with the cabinet
19 itself.

20 So we do see these three-phase faults
21 occurring in event history, and that's what we're
22 trying to recreate in our test program. Again, the
23 over-pressurization is something we're going to be
24 taking an enhanced look at in the second phase. We
25 did collect pressure information in the first phase

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1 of testing. However, there was little that could be
2 drawn from the pressure information that we collected
3 to extend to how it would affect a enclosed room. So
4 that's something we're going to be looking at moving
5 forward because of the Turkey Point event, as well as
6 some events that we've seen internationally where we
7 have breached fire doors. We did see this in 6850,
8 one of the -- I believe it's Event 3 in Appendix M --
9 did breach a fire door. However, there was -- again,
10 no associated enduring fire with that event, so it
11 wasn't a main area of focus.

12 Mr. SALLEY: So, let's talk about how
13 we're going to do this testing. And in this testing,
14 it's quite interesting -- it fits kind of where we
15 are in our money and research. This isn't something
16 that I can take NFPA 2519 and say I am going to test
17 a firewall or an assembly and we have a well-
18 established standard on how to do that testing -- for
19 fence seals, fire doors, building construction. For
20 looking at things like the HEAF, we have no standard.
21 So we are kind of venturing off in the unknown here.
22 The closest thing that we could find -- a lot of the
23 work that was done by the IEEE and the NFPA was done
24 for personnel safety. And again, the goals are
25 personnel safety versus reactor safety are somewhat

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1 different. And in their test they had to be a little
2 a shorter. Again, they were looking mainly at the
3 things you guys are familiar with -- the PP that the
4 electricians wear when they are servicing the
5 cabinets in the plant. And that's where we've seen
6 all the research. And it's good research. I mean
7 this is a significant hazard. You can see a lot of
8 different numbers out there if you're reading the
9 safety journals where I think there's -- they
10 postulate -- the last journal I looked at, two people
11 a day -- two workers a day in the United States die
12 because of electrocution. So that could be in the
13 plants working, and it also got the guys who are
14 working on the high-tension lines outside.

15 So it's a significant number. It's
16 something that needs research. And that's where the
17 work was done. Of course, with reactor protection,
18 we're looking at something different. We're looking
19 at protecting the plant. We're preserving the
20 diversity and redundant systems. And we have a
21 different problem in the nuclear environment. So we
22 set our tests up a little bit. And again, we're
23 inventing as we go. And we hooked up with our
24 partners in NIST. Tony and Scott are here. They've
25 done a lot of the testing with us as well as the

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1 expertise from the labs like KEMA to help guide us.
2 And a lot of the things we tried didn't work. And we
3 moved along as we went. We also had Sandia work with
4 us a bit.

5 So here was our basic set up that we came
6 in for the first days of testing. You'll notice the
7 piece of equipment is in the center that we're going
8 to fail in the test. We put up racks and we set the
9 racks up specifically at three foot. Why three feet?
10 Because our model in 6850 says that anything within
11 that three-foot window should be damaged. Anything
12 three-foot-one-inch should be safe. So we set our
13 instrument racks with our slug calorimetry on it to
14 get a measurement at three foot.

15 We also did some things that we thought
16 would be observable. For example, you will notice
17 the cable tray that we set above the top. You know,
18 you can equate this to ASTM E-119, how we used the
19 cotton waste on back of the firewall to make sure
20 that we don't get emission during the test. The same
21 thing here. We says, hey, typically we find that the
22 enclosures -- you'll find cable trays above it. What
23 do you say we put some cables above it and see if we
24 get emissions in the cables. That will give us an
25 indicator of the -- of what's coming off the HEAF.

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1 One area that we tried real hard was the
2 collection hood. And this is something, again -- us
3 being fire protection engineers, we fall back to what
4 we know. We like to talk in terms of heat release
5 rate to describe the power of a fire. The way we do
6 that is we put the capture hood up. We capture the
7 energy that comes off and we can go and say how big
8 the fire was in terms of it. So we set a portable
9 hood up and we tried to capture that.

10 Final thing we did was a lot of cameras.
11 And we've got a lot of high-speed videos we tried.
12 We've got some infrared stuff that we're working with
13 NIST to -- we'll have a report coming out shortly
14 this year that shows some of the IR work we'd done.
15 And just the regular camera work. And that tended to
16 be some of the most valuable stuff we saw. So again,
17 it was very much of a learning experience for us as
18 to just how do you do this test? So this is a basic
19 setup you're going to see. We're going to run
20 through a number of videos here, and Nick is going to
21 show you what we learned in the first phase of
22 testing.

23 MR. MELLY: I'm trying to get this set
24 back up because we can hardly hear it. Okay, so let
25 me walk you through this before I do show the video.

1 As Mark did mention, you see the heat-release rate
2 hood that you have there. You're going to notice
3 from the test immediately that this hood is
4 completely overwhelmed by the amount of smoke that's
5 created initially on the event. So, while the hood
6 was valuable in collecting heat release rate
7 information for the enduring fire, the initial blast
8 -- there's just no way that we can create it at a --
9 a non-fully enclosed laboratory that has a much
10 larger hood.

11 There were also some limitations at the
12 KEMA facility of what we can do. Again, this is open
13 air in -- right outside of Philadelphia in a suburb,
14 and there's a Metro line running directly behind the
15 facility. Whenever we tested, coincidentally, the
16 train was always there. We got a lot of calls to the
17 fire department and a lot of shocked people. So this
18 test -- this is test 3, one of the first tests that
19 we ran on a Korean-donated piece of equipment. We
20 initiated the arc in the back of the center cubicle
21 using the three-phase, IEEE guide wire -- it was a
22 10-gauge wire that we used for this test for a low-
23 voltage power standard.

24 This cabinet itself was built very
25 sturdily. The insulate -- it is '70s vintage -- '60s

1 vintage. The insulation material is actually
2 mahogany wood. This thing was battleship grade. So
3 you will see this test was run at 35 kA for eight
4 seconds. This was a low-voltage, 480-volt cabinet.
5 Again, all copper material inside the cabinet. The
6 sound is not coming through quite well. Do we need
7 to do something to get it to come through the room?
8 All right, we'll just role.

9 So you can see it's an impressive looking
10 test. You see the flames and everything shoot out.
11 The arc did hold in for eight seconds, which was a
12 problem for some of the low-voltage cabinets. You
13 see the amount of smoke that's initially created.
14 And you can see the problems that that would case in
15 a switch gear room itself. You're immediately
16 filling the entire volume with smoke. It's very
17 difficult to fight these fires.

18 Again, that is the color of the smoke.
19 It was a dark black smoke with this event. And you
20 will notice the difference when we look at the
21 aluminum. For this event, and other low-voltage
22 cabinets that we saw with copper -- for this specific
23 event we did not breach the cabinet itself, even
24 though the arc was fairly close the exterior barrier.
25 We had no arc through and there was very limited

1 damage. Again, this was early on in the test program
2 when we were thinking this is a good sign, we have a
3 very clear way to differentiate low voltage and
4 medium voltage, potentially, moving forward.

5 Moving on you'll see some of the -- this
6 is a German cabinet. We tested 10 kV, 15 kA, three
7 seconds. This was an oil-filled breakers that were
8 donated. We did have to remove the oil for concerns
9 of the explosion associated with vaporizing the oil
10 itself during the event. Again, copper bus bars and
11 we have the cable tray above this cabinet. And the
12 three seconds was very close to the KEMA limit on
13 what their generator can perform for this type of
14 voltage test. There's some wiggle room. We've been
15 talking with them about what we can do. But again,
16 that three seconds is close to what we can do. So
17 when we talked about the operating experience at the
18 Robinson, eight to eleven seconds at this type of
19 voltage level cannot create that at the KEMA
20 facility.

21 (Pause.)

22 MR. MELLY: Again, this test was one of
23 the medium voltage. You see that immediate fire
24 condition. We immediately ignited everything within
25 the cabinet. The cable tray that was above the

1 cabinet reached full ignition within 30 seconds after
2 the event. So we had a fully involved fire 30
3 seconds after this event.

4 PARTICIPANT: What was in the cable tray?

5 MR. MELLY: I don't know off the top of
6 my head what type of material. I believe that it was
7 -- is Gabe in the room? I think it was thermo-set
8 cable above the cabinet. But I'd need to confirm
9 that.

10 MR. SALLY: Scott, Tony, you guys know?

11 (Simultaneous speaking.)

12 MR. MELLY: PEPVC.

13 MR. SALLEY: It was some new PEPVC.

14 MR. MELLY: So now we are moving on to
15 some of the later testing. This was the cabinet that
16 had aluminum in it. This was tested 480 volts, 40 kA
17 for seven seconds. We initiated the arc in the
18 center of the cabinet -- right about there. And we
19 did see the arc migrate to the more substantial
20 portion where there was more aluminum. Again, our
21 rack is located right here at three feet.

22 (Pause.)

23 MR. MELLY: So I am going to pause it
24 here, and you can see the color of the smoke is
25 completely different than we saw in the other events.

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1 After this event itself, you see -- we saw the entire
2 KEMA facility essentially white-washed. We have some
3 picture of moving forward, but there was a lot of
4 damage to the KEMA facility itself, which we
5 apologized for. But we're learning as we move
6 through this.

7 Again, we did see the arc migration, and
8 after the test itself, we saw that we had vaporized
9 a lot of the equipment on the test stand itself. So
10 all of this material over here was completely white-
11 washed and it was a little bit of a shock for us in
12 the control room. We were not expecting this type of
13 damage. Like I said, for some of the previous 480s,
14 it was even difficult maintaining the arc itself. We
15 would have extinguishment almost immediately and not
16 be able to maintain it for the full seven seconds.
17 We did not see that with this test. Again, aluminum
18 inside the enclosure, pull up some pictures.

19 MR. SHUDAK: I think after that one,
20 Nick, we had to stop, right? Because the -- the
21 facility was completely coated.

22 MR. MELLY: Yes, we -- you will notice
23 that there is not heat release rate hood. In this
24 next test I will show -- because after that test we
25 had to shut down for a week because we couldn't

1 perform any more testing in that test cell because of
2 the damage that was caused from that event and the
3 aluminum coating all of the --

4 MR. SHUDAK: Yes, we had to basically
5 scrub the cell.

6 MR. MELLY: Yes, and for quite a while it
7 was still -- problems. This is the bus duct test
8 that was designed -- bus that could be pulled out.
9 This had copper conductors, but an aluminum enclosure
10 -- which we did not realize before we ran the test as
11 an important factor knowing. We squeezed this in
12 with some of the Japanese test program that occurring
13 at the time. We didn't have the hood. We thought,
14 copper material -- this shouldn't be a big deal for
15 testing for a short duration. We thought we knew
16 what was going to occur for the test. This was
17 again, 4160, 26 kA for three-and-a-half seconds.

18 (Pause.)

19 MR. MELLY: And again, we saw that white
20 smoke. It's difficult to explain the violence of
21 this event. People in the control room were running
22 away from the viewing screen during this event
23 because it was so explosive -- an interesting event.
24 We weren't prepared for that at the time. And that's
25 really -

1 (Simultaneous speaking.)

2 MR. CIELO: DEP showed up an hour later.

3 MR. MELLY: What?

4 MR. CIELO: The Pennsylvania DEP showed
5 up an hour later.

6 MR. MELLY: Yes, they did. There was a
7 lot of smoke involved with this event. So this is
8 kind of what led us to kick off the Generic Issues
9 Program is that we'd -- we've ran two tests. The
10 only two tests that we ran with aluminum during this
11 test series showed the extreme difference from the
12 ones that we ran with copper -- much larger damage
13 zone, much -- there were many more consequences at
14 the facility itself with coating material, damaging
15 cables further away and a major disparity.

16 MR. SALLEY: And again, with the
17 aluminum, that -- that's what we're kind of seeing
18 here. We really have two data points. We did have
19 some aluminum in some of the early tests with -- like
20 tests 4, 5 and 6, which were very well separated
21 buses. And we didn't see that. As a matter of fact,
22 we had trouble trying to hold an arc in. So there's
23 a lot here that we need to learn as to where the
24 hazard exists. So just because something is
25 aluminum, doesn't immediately mean failure. But

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1 based on these two data points, we've seen something
2 here that clearly warrants additional resource --
3 research, excuse me.

4 MR. MELLY: So again, what we saw was
5 that there's potentially much larger zone of
6 influence associated with events with aluminum. Here
7 you can see, of course, the amount that was in the
8 cabinet that was from the two tests. And the top
9 pictures are from the test 23, the low-volt cabinet,
10 and the bottom are the bottom are the bus ducts,
11 higher risk of propagation and potentially the
12 greater likelihood of maintaining the arc at lower
13 voltages. Again, there's a potential new failure
14 mode that's associated with the conducting material
15 release during the event itself. You can see the
16 white-washing effect that I saw -- that I was talking
17 about earlier. The entire facility was coated in
18 this white material. We will be taking efforts to --
19 to analyze that material in future testing. We also
20 have NIST as well as Sandia looking into methods for
21 evaluating products --

22 MR. SALLEY: And again, that's another
23 reason for us to put this into the Generic Issue
24 Program because we potentially are identifying a new
25 failure mechanism. Okay? Where the material is --

1 if it's conducted in the aluminum form -- you can
2 envision in your mind micro switches and such that
3 would be shorting out due to that. Or, if it's
4 aluminum oxide, it would be an insulator that would
5 be insulating the conduct. So again, that's another
6 reason we want to put this into the Generic Issue
7 Program and get a better understanding.

8 MR. MELLY: Yes, and if you can see this
9 panel here that's on the wall that's slightly at an
10 off angle, we did melt the hinges off that panel that
11 was 26 feet away from the bus duct itself. And this
12 bus -- or, you see this ventilation fan which was
13 newly installed for our testing. You can see the
14 color variation from the event itself. That one
15 still is white and despite the cleaning efforts.

16 MR. SALLEY: So, you can think back to
17 those earlier pictures we showed -- especially of the
18 bus duct. And you can see that the operating
19 experience with that bus duct, the damage was much
20 greater than we could reproduce in the laboratory.
21 So just looking at what we did in this video with the
22 test, you can envision what this -- this looked like
23 in the plants. And again, you know, as we learn
24 things from the research and the testing, it helps us
25 better understand what the plants were dealing with.

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1 Reading their LERs they'll talk about conductive
2 smoke, okay? And now we kind of get an idea, okay,
3 what that conductive smoke was and why it was doing
4 what it did. So again, we gained that from the
5 research.

6 So with all this material, what do we do
7 with it? Again, working with our international
8 partners, we took all the tests, we brought them
9 forward -- worked very closely with NIST and KEMA and
10 we published this report, which you can download
11 here. One of the things I wanted to have for you
12 today was the DVD with all this stuff on it. And we
13 have a lot more test video that we made public. But
14 we had a problem with RIFO (phonetic) and we'll see
15 if we can get that taken care of here and get those
16 redone and I will give you those videos. Anybody on
17 the webinar, just send your mailing address to Tom
18 and we'll be happy to mail it. Like I said, we made
19 that all public. So anyhow, the report is published
20 and this is our Phase I results of the research we've
21 done to date.

22 MR. MELLY: Moving forward, some of the
23 things that we've talked about was that this is a
24 one-size-fits-all model that's in Appendix M and
25 there's difficulty dealing with it. There has been

1 some postulation of mitigating these events with what
2 are called HEAF shields, referred to in some
3 applications for the transition to NFPA 805, which is
4 proposed shielding to limit the damage from a HEAF
5 event.

6 Typically what we've seen is postulated
7 metal barrier installed above an electrical cabinet
8 to protect the cable trays that are above, usually
9 leaving the -- or, driving the risk calculation of
10 the CCPD. Some of the questions that have arisen
11 during this testing is, what's needed to make those
12 HEAF shields successful? What's design basis,
13 acceptance ratings? The typical things that would be
14 associated with ensuring that these can work the way
15 that they're designed.

16 MR. SALLEY: And again, I think we've --
17 lessons learned from things like thermal lag and
18 penetration seals that you've got to have a clear,
19 you know, test standard and acceptance if you're
20 going, you know, credit this equipment. So again,
21 that piece needs to be developed here and it's just
22 something we want to flag that we've learned from
23 operating experience.

24 MR. MELLY: And what we've seen through
25 testing is that potentially a metal barrier may not

1 be the most effective at limiting these events
2 because you, again, can breach that metal barrier
3 directly with the products of the arc itself, or lead
4 another part to anchor on that barrier itself.

5 MR. SALLEY: And this next slide is to
6 why we get to the testing, which Nick is going to
7 describe to you here that, you know, as engineers we
8 can sit down and think things through and say, okay,
9 hey a solid top is going to stop it, or we're going
10 to have this nice laminar flow-off event for the
11 cabinet. And as engineers, we want to think that way
12 and postulate that. But when we run the experiments,
13 we see something different. Rich, Nick?

14 MR. MELLY: Yes. So that gets to another
15 effect that we've seen in some applications that we'd
16 -- a louvered design cabinet will direct the flow of
17 energy away from the cables that are above. Or, a
18 solid top will always stop the event from damaging
19 cables because the cabinet itself is serving as a
20 barrier. What we see from this test is that once the
21 event occurs, we can breach directly through the
22 louvers like they're not even there. And can breach
23 the cabinet top. In the event that we see here, this
24 was test 11, when we do the videos -- where the arc
25 is generally directed upward, or follows the magnetic

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1 path of the event itself -- the power direction --
2 and in this event a bend occurred there and directed
3 all the energy upwards. We actually lifted the cable
4 tray which we, at this point, had not bolted down --
5 lifted it, moved it and knocked all the cables out of
6 the tray during that event. But we see that these
7 are things we need to think about that general
8 engineering judgment typically is not always correct
9 when dealing with something as energetic as this
10 event.

11 So we discussed a little bit about the
12 Generic Issue. We are going to have two
13 presentations on that moving forward. It's
14 specifically focused in on the enhanced damage states
15 potential from the aluminum. And we are going to
16 discuss how we want to move that forward using a two-
17 phase approach, short-term actions and long-term
18 actions, as well as trying to get some feedback on
19 how to tackle this problem. So I am not going to
20 touch on it much here today because we have a few
21 presentations later today that will go over the whole
22 framework as well as how we want to move forward with
23 our fire protection program.

24 MR. SALLEY: So as a regulator, if
25 there's one thing we've learned Three Mile Island,

1 it's the importance of communication and how we have
2 to communicate what we have and get it out into the
3 public. As Nick and I sat down and started looking
4 at this, and the work with the internationals and
5 going back in time and pulling all the different LERs
6 that were coming out of the plants, basically, for
7 us, it was almost a connect-the-dots exercise. And
8 that's kind of how I refer to looking at that OpE.
9 So again, going through that OpE, we see a number of
10 these events. And we thought it was important that,
11 if we're seeing a trend here, that we communicate
12 that.

13 So the whole purpose of this information,
14 though is, with the aluminum HEAFs, was that we get
15 this together. This is what we're seeing and do we
16 have a trend here? And this is why we need to move
17 forward looking at this form of research. So again,
18 the whole purpose of that information was -- as you
19 know, there's no actions required by that information
20 notice -- but it was to communicate to the larger
21 nuclear community of what we're potentially seeing
22 here as a trend. Again, that was obviously last year
23 we issued that.

24 MR. MELLY: Yes, like Mark said, it is
25 connect the dots because these are rarely infrequent

1 events. And we are all reading the LERs and the CRs,
2 you see them scratching their heads during the root
3 cause as to why was this as damaging as it was? Why
4 did we see more damage than we would expect? And
5 what is this white material that's coating everything
6 in the room? There's also postulation as to where
7 did the -- were the bus ducts themselves -- were the
8 conductors thrown? Where did they go? So you see a
9 lot of questions being raised in the root cause, and
10 looking at the full picture, we wanted to communicate
11 that effect.

12 MR. SALLEY: So, moving forward in the
13 processes that we work, one of the tools we use for
14 expert elicitations is a thing is a thing called a
15 PIRT. A PIRT is a phenomena identification and
16 ranking table. And again, it's to look at something
17 like this in an expert elicitation and try to rank
18 the different things -- the different phenomena that
19 we're involved with. Kenny Hamburger, one of our
20 young engineers, ran this and what we did was we
21 brought all the international partners in, we spent
22 a week here. KEMA was with us, NIST, over in the
23 ACLS hearing rooms, and we had this discussion. From
24 that we documented the report. You can take a look
25 here. And again, the whole purpose of this was to

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1 start giving us a roadmap and to start guiding us
2 forward into the next areas of research and what we
3 needed to do. So again, that's a somewhat unique
4 process that we use in the nuclear industry and
5 moving forward with the expert elicitation.

6 Another important piece that we've got is
7 Japan. Japan has been a very powerful partner with
8 us. Steve Turner who is here, he has worked a lot
9 consulting with the Japanese. They have gone through
10 some regulatory changes here, post-Fukushima, as you
11 can well imagine. I know Dan, Dan Funk is here. He
12 has spent a lot of time over there working with them.
13 But they have a whole HEAF program that they are
14 trying to really understand what happened in Onagawa.
15 And they've been very gracious with us in inviting us
16 to come to KEMA with them, stick some additional
17 instruments in, get the data and learn from what
18 they're doing. Of course, the work is done and it's
19 in Japanese, which doesn't buy us much. But we do
20 have a vehicle, and it's a NUREG/IA through our MOU
21 with Japan. We're able to take this, write the
22 reports with them -- again, put it in English and
23 then put it out as publically available in the open
24 literature. So again, we can learn from the work
25 we're doing. And like I said, Japan has been a very,

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1 very gracious partner to work with on this one.

2 MR. MELLY: Yes, their initial insights
3 moving forward is they're going to be handling this
4 in Japan in a regulatory aspect requiring plant
5 changes to protection schemes rather than
6 understanding the PRA -- or, rather than focusing on
7 the PRA impact and dealing with it in a PRA
8 terminology.

9 MR. SALLEY: Again, so they're going to
10 work it out in their nuclear environment and they're
11 looking real heavy at the prevention piece, like we
12 showed earlier in the defense-in-depth approach.

13 So the next thing is, we went to the next
14 phase and getting close to where we're at right here
15 today. The test plan -- we put the test plan out for
16 public comment. You can see we got quite a bit of
17 comment on it and tomorrow Dave and Nick are going to
18 have a lot of discussion, but we want to understand
19 the comments and we want to understand the best way
20 for us to move forward. You can see we had 64
21 comments received through the public process. EPRI
22 liked it so much, it commented twice. So, thank you,
23 Ashley. And we've also got some small-scale testing
24 that we've come up with. And again, we're getting
25 some comments on that. I know we've extended the

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1 period of comment a little bit here for additional
2 comments. And again, we want to get involvement and
3 we want to get input and we want to move forward that
4 way.

5 MR. MELLY: And again, we have updated
6 the test plan that was first put out on June 30th, it
7 has been made available for this public workshop. I
8 believe it's -- the ML was put on the website
9 associated with this workshop, and it will be updated
10 again based on feedback from this workshop. So it's
11 an iterative process that we're working on. We want
12 to make sure that we have the parameters dialed in
13 that we need to test, and this is -- the primary goal
14 of this workshop is to have the discussion on the
15 current duration and things that we're going to be
16 testing so we can update this test plan.

17 MR. SALLEY: So, in conclusion -- and
18 whoa, we're just right on time. That was purely by
19 accident. In conclusion, this is where we're at
20 today. We've seen things and again, with research
21 like this, sometimes you're -- you're on a path and
22 you have to realize maybe you need to change the path
23 a little bit. That's one of the things we're
24 thinking. And again, it's so important, our
25 discussions we've had, the webinars with the NFPA,

1 that we just don't jump -- everything becomes a heap
2 and it becomes that worst case.

3 We are going to change direction a little
4 bit and Kenn Miller is going to have a good
5 discussion hopefully this afternoon on how we want to
6 do this. And also, we want to stay in process and
7 make sure we do this in a very methodical manner,
8 which is going to be the driver of the Generic Issue
9 Program. So with this document, it kind of -- like
10 I said, use it as a Reader's Digest version of where
11 we're at. And it's also got all our references in
12 there that if you want to take a look at some
13 particular issue, you can go through the ML number or
14 the link. So, if anyone has any questions? If we
15 don't have any questions, it will be time for a
16 break. Then we can pick it back up. Any questions?
17 Comments? Concerns? Complaints?

18 MR. MELLY: And again, this is -- we're
19 kind of just -- everything has come at you, a lot of
20 information here on what we did. Tomorrow, when we
21 go over the comments as well as some of the
22 information that Gabe put out for testing information
23 and things of how we're going to be testing, it is
24 going to be much more of a discussion format where we
25 really would like input moving forward.

1 MR. SALLEY: Any questions on the
2 webinar, Tom?

3 MR. AIRD: No.

4 MR. SALLEY: No questions, so with that
5 --

6 MR. TURNER: I have a question. On the
7 bus duct test, did we actually check if the white
8 stuff was conductive? You say in your slide ---

9 (Simultaneous speaking.)

10 MR. MELLY: We did not material testing
11 afterwards or collect the particulate from the test.
12 The indication came from the KEMA facility ---

13 (Simultaneous speaking.)

14 MR. CIELO: Yes, we didn't do any -- any
15 material testing either, Steve, we just ---

16 MR. MELLY: It is being done during the
17 small-scale testing, as well as -- we're going to be
18 doing it across --

19 MR. SALLEY: Yes, Gabe is going to have
20 a good thing. And that's something Sandia can look
21 at -- and it's really going to be fascinating what
22 you see when they start looking at it at the
23 microscopic level. And Gabe is going to get into
24 that in his presentation on small scale.

25 MR. MELLY: We are also going to be

1 leveraging Jose Torero from the University of
2 Maryland to try and look at the potential for
3 creating a model of the conductivity versus distance
4 of the cloud -- mix up. Anything else?

5 (No audible response.)

6 MR. MELLY: Take a fifteen-minute break
7 and I guess we'll see on the schedule. Be back in
8 here at 11:00.

9 (Whereupon, the above-entitled matter
10 went off the record at 9:47 a.m. and resumed at 10:12
11 a.m.)

12 MR. GARDOCKI: Well good morning. I'm
13 Stanley Gardocki. I'm one of the program managers for
14 the Generic Issues Program at the NRC. I've been in
15 the program for about two or three years now. I want
16 to give you a quick, high-level viewpoint of the
17 Generic Issues Program on this presentation. And then
18 the next presentation will go into a little bit of
19 specifics on this individual generic issue.

20 All right, next slide.

21 The purpose of the Generic Issue Program,
22 it was started a long time ago by Congress, mandating
23 the NRC to come up with a program to evaluate issues,
24 as they come in, for generic implications across the
25 board of problems. We've been doing it a long time

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1 and we've gotten pretty good at it and we've got a
2 good process down.

3 I would say the Generic Issues Program
4 itself, right now, is designed to take an issue,
5 screen it, assess it to see if it's significant enough
6 for the NRC and industry to spend money and time to
7 put it in what we call the last phase, the Regulatory
8 Office participation stage.

9 Right on time. We're way ahead of it.
10 You walked in -- perfect timing.

11 This is our supervisor of the Generic
12 Issues Program, Tom Boyce. So he is responsible for
13 the program and the branch chief.

14 MR. SALLEY: Tom, we got a little bit
15 ahead of schedule. So I apologize for that and you're
16 up.

17 MR. BOYCE: Well, thanks. If I had waited
18 a longer, I could have had Stan do the whole thing.
19 Unfortunately, I called him.

20 Well good morning. I'm Tom Boyce. I'm a
21 branch chief in Research. My branch does regulatory
22 guidance on generic issues.

23 The project managers, that's our core
24 capability. I don't know whether I should be sitting
25 down or standing up but you've already done the

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1 intros.

2 MR. TAYLOR: I think if you move away from
3 the SharePoint and put a mike on.

4 (Simultaneous speaking.)

5 MR. BOYCE: Well all right, so we're on,
6 I guess. Can you go to the first -- maybe this is the
7 first slide.

8 MR. TAYLOR: That's the first slide.

9 MR. BOYCE: All right, let's see.
10 Fundamentals -- sorry. It'll take me a second to get
11 caught up with you guys.

12 All right, well this is what we're going
13 to cover here in a little bit. We are going to cover
14 fundamentals and you'll see that on the next couple of
15 slides. Then we're going to look at the screening
16 criteria for proposed generic issues, and then we'll
17 look at some of the documentation that will come out
18 of the program.

19 This is really a process discussion. It's
20 to tell you where the HEAF with aluminum issue is in
21 the process. I'll try and field questions, process-
22 type questions. If you want to ask me something
23 technical, I'll definitely defer to my colleagues.

24 So the Generic Issues Program has been
25 around at the NRC for a long, long time. It

1 originally came from when we were licensing a lot of
2 nuclear power plants in the '70s. And what would
3 happen is is that we'd be going through the licensing
4 process and issues would come up, a variety of issues,
5 because it's the first time we've really done such
6 large-scale development of nuclear power in the U.S.

7 And as a way to manage these issues that
8 came up, the licensing process moved forward. Plants
9 were being built and the issues were put, I'm going to
10 call it a parking lot but they were put into the
11 Generic Issues Program so that they could be worked
12 aggressively. And as solutions developed over time,
13 they would be I'll call it backfitted onto the current
14 generation of plants in whatever stage of construction
15 that they were in. So, that's the origin of the
16 program.

17 There's been -- I may be getting ahead of
18 myself -- maybe close to a thousand generic issues
19 over the three decades that we've been running this
20 program. We're down to a handful, which is an
21 indicator of the maturity of the industry, as well as
22 I would give credit to the NRC staff, the
23 aggressiveness of us trying to work the issues off.

24 Okay, so there's now three stages of the
25 Generic Issues Program. The first stage is a

1 screening stage. In general terms when we get an
2 issue, what we're trying to do is validate that the
3 issues is worthwhile spending resources on. We'll
4 make a determination whether it's an allegation and we
5 need to deal with it in allegation space, or make sure
6 that it's got some kind of connection to safety. It's
7 not a very high-level comment like NRC should license
8 plants faster. That would be something that we would
9 screen out. We're looking for more technical content.

10 And we'd be trying to make an early
11 determination of the risk significance. Like a meteor
12 strike would have high consequences but would have a
13 low initiating event frequency. So that would
14 probably screen out a meteor strike. I'm just trying
15 to set the stage.

16 All right, once it passes the screening
17 stage and we say this has got sufficient risk/safety
18 significance, now we need actually to do some work to
19 develop the issue. What does it really mean?
20 Technically, what is the phenomenon that we need to be
21 concerned about? What are the systems that are in
22 place to address the issue? What are the potential
23 consequences? And what is the -- what are the
24 potential ways that we could take regulatory action?
25 Backfitting is not the ultimate answer. There's a

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1 variety of ways that we can address the issue, perhaps
2 working with industry.

3 Implementation, that's where we've
4 actually decided okay, after all this development
5 work, we've decided this issue actually does need to
6 be addressed in some way. And so examples of
7 regulatory actions may be as simple as an information
8 notice.

9 For example, there was an information
10 notice that we issued about a year ago, I think, where
11 we identified the HEAF with aluminum issue to
12 industry. It may be, after all development work, that
13 an IN or nothing is the answer. It could be a generic
14 letter. It could be a plant-specific order, or even
15 some kind of generic order across industry. It really
16 depends on what comes out of the assessment stage.

17 So here are some of the roles and
18 responsibilities. First of all, the Director of the
19 Office of Research, who is Mike Weber, provides
20 overall strategic direction for the program and
21 overall management. The Generic Issues Program
22 Manager is myself. And the responsible Project
23 Manager is, in this case, Stan Gardocki.

24 When the program was more robust, there
25 were a lot more project managers working on the

1 issues. Stan, to his credit, has worked off the
2 backlog. So he's an army of one at the moment. I do
3 have capability of hiring more, if we get more issues.

4 Okay, so how does this process really
5 work? It's not just up to Stan and me to say here's
6 the risk significance. We actually need to bring in
7 people that are more expert. So we bring in a variety
8 of different people and we call the panel that is
9 formed a Generic Issues Review Panel. It's got this
10 acronym called a GIRP. We might have done better if
11 we had thought about it but GIRP is what we came up
12 with.

13 So the purpose is really to bring the
14 resources to bear on the problem. In Research, we can
15 research an issue to death but that isn't really the
16 goal of this project. The whole point is to bring in
17 regulators, technical people, and bring the issue to
18 a state of maturity that we need to take regulatory
19 action. It's not a long-term research project. So
20 we're actually trying to drive resources to a decision
21 here.

22 So the GIRP panel includes people from
23 across the Regulatory Offices and Research but they
24 aren't necessarily the people who are doing the day to
25 day work in the assessment stage. They will meet

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1 periodically and provide direction, say what are we
2 missing, but there is a core group of people that are
3 actually doing the work who are the experts. I think
4 it's going to be Nick or maybe some other people that
5 are on the Assessment Team. These are the people who
6 are actually developing the information and will be
7 providing it to the GIRP for more robust
8 consideration. More robust, in this case, might be a
9 more robust risk analysis, for example, that the GIRP
10 would bring to bear.

11 If we get to the end of the assessment
12 stage and the decision is made to take some kind of
13 regulatory action, the GIRP just doesn't provide a
14 report and throw it over the fence to, in this case,
15 NRR probably, we actually expand the GIRP and form a
16 transition team so we don't lose knowledge as we shift
17 over into the regulatory arena.

18 So basically, the core group of people who
19 are involved in the assessment stage will form a
20 transition team and then we'd say okay, NRR, you take
21 the lead. The Generic Issues Program doesn't have the
22 lead anymore because we are in the Regulatory Office
23 implementation. And they're into more understood
24 processes between the utilities and NRR as far as
25 actual regulation.

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1 Next slide.

2 So everything I just said we tried to
3 capture in one slide. It's a little bit of an eye
4 chart but this is what we think is -- if we have to,
5 we can talk from one slide.

6 So if I work from the top, the three
7 stages that I just talked about are on the top line.
8 The organizations that are responsible are on the
9 second line. And you can see that in the proposed GI,
10 that's a terminology issue, in the proposed GI, and
11 this is a proposed GI right now, that stays a proposed
12 GI through the screening and the assessment stage if
13 we decide to take regulatory action. Then it becomes
14 officially a generic issue. Okay? That's just how --
15 our parlance that we use.

16 The next level down is who are the
17 decision-makers at each stage, try and identify that
18 so it's clear who is doing what.

19 And then the next stage down is who is
20 actually doing the work. Okay? So hopefully, it's
21 clear, based on what I had said previously.

22 Now the next level down, it gets a little
23 more detailed and we try and outline what are the
24 specific deliverables that are coming out of each
25 decision point.

1 I may end up needing to walk around. Can
2 I just pick this up and hold it for a minute?

3 So this right here below the colored
4 blocks, for those who are on the bridge, is the
5 milestone documentation. And you'll notice that it
6 says it's publicly available. And I'm pointing that
7 out because the question comes up are we going to see
8 it and the answer is yes. Okay, we tried to make the
9 process as transparent as possible.

10 So we get a proposed GI. We put that in
11 ADAMS and make it publicly available. And by the way,
12 this is all up on the website, also. I'll get to that
13 in a second.

14 Then there's a memo from the GI Program
15 Manager, saying hey, we're starting the initial review
16 and oh, by the way, we need resources to form this
17 Generic Issues Review Panel so please identify
18 resources.

19 The formality of the process actually
20 ensures that we get the resources from the Regulatory
21 Offices to work on it because they are very busy
22 taking care of operational issues at the moment.

23 And then we, at the end of the screening
24 stage, there's a memo from the GRIP panel to the
25 Director of Research saying this is what we found and

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1 we recommend either discontinuing further work on this
2 issue or continuation into the assessment stage. That
3 has been issued. So you are about right here in the
4 process, meaning just past that third arrow down,
5 again, for those on the bridge.

6 When we get to the assessment stage, the
7 documentation gets a little more robust because we're
8 heading into the potential to take regulatory action.
9 So here's a -- we have a summary memo and here's the
10 more specifics of what you might see in that memo.

11 One of the critical things is -- well
12 first of all, you've got to have enough technical
13 information to support any kind of regulatory action
14 but one of the things that we identify here is
15 something called a limited regulatory analysis. And
16 what that really is is a discussion of various options
17 for regulatory actions. Should we do an IN? Is that
18 sufficient? Should we do an order? Should we do a
19 generic letter? What is the form of regulatory action
20 we're talking about? Maybe it's simply inspections.
21 Maybe NEI might have stepped up to the plate and said
22 we would like to do some various things and maybe run
23 a pilot. Those are the types of pros and cons that
24 would be in a limited regulatory analysis. Okay?

25 When we get here, this is, again, when I'm

1 in the Regulatory Office implementation stage, this is
2 where they finally the Regulatory Office says okay, we
3 understand this issue. Thank you, Transition Team,
4 we're taking the regulatory action and we're moving
5 forward with it. Okay, that's where -- that's this
6 far right arrow.

7 So coming down here, the bottom line says
8 stakeholder engagement. Where can stakeholders
9 provide input? Well first of all, I think this
10 workshop is one of the primary means of providing
11 input. So I haven't been around but I hope you're
12 providing your opinions and insights along the way.

13 So here, public proposes a GI. The ACRS
14 has an opportunity to engage right here. The ACRS has
15 not indicated that wanted to engage just yet. I would
16 expect them, at some point, to engage.

17 They have another opportunity at the end
18 of the assessment stage. This is probably more likely
19 before we actually get into Regulatory Office
20 implementation.

21 And then here, before we take regulatory
22 action, our typical practice is to hold public
23 meetings and talk about it. In the case of generic
24 communications, we have in the past but not
25 necessarily required issue draft generic

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1 communications and invited public comment. So those
2 are the types of opportunities for public engagement.

3 And this is just in our formal process.
4 I think Mark and his team may provide other
5 opportunities, such as this workshop, to provide
6 additional opportunities to engage beyond just what
7 the GI Program is offering here as our standard
8 approach.

9 Yes?

10 MS. WETZEL: Will the limited regulatory
11 analysis go out for public comment?

12 MR. BOYCE: So the question is would the
13 limited regulatory analysis go out for public comment.
14 And it wouldn't be public comment, per se. This memo
15 would be made publicly available right here but it
16 wouldn't be out for public comment, per se. And I
17 would envision it just to be a pro-con type argument.

18 So the extension of your question then is
19 okay, when do we get to engage. And I would say that,
20 although it's not shown on this chart, the transition
21 team, when we get to the Regulatory Office, would
22 decide how much input they want into that regulatory
23 decisionmaking.

24 Like one option would be okay, like if you
25 were doing an analogy for rulemaking, which this is

1 not rulemaking. An Advanced Notice of Proposed
2 Rulemaking lays out concepts and invites comments.
3 That's one path the Regulatory Offices could take.

4 I would expect that they would actually
5 say this is the path we're choosing, here is our draft
6 whatever, and put the draft whatever out for public
7 comment. But I'm actually projecting what the
8 regulatory offices might do and they might choose a
9 different path.

10 So I hate to be fuzzy. We just,
11 everything seems to have a unique nature.

12 Other questions?

13 Okay, next slide and I'll stay standing.

14 So here are the criteria that the Program
15 uses. And this is really our screening criteria. If
16 an issue doesn't meet these criteria, we will actually
17 take it out of the Program. And so if we take it out
18 of the Program, there is a question about where it
19 goes but it generally would go into additional
20 research until it's ready for primetime if it warrants
21 it.

22 But to continue on in the Program, it's
23 got to meet these criteria at each of the stages and
24 I will try to go over them briefly.

25 First of all, the issue affects public

1 health and safety. So the example I give is when
2 somebody says go faster in licensing. Okay, good
3 comment. Doesn't meet the first criteria. We would
4 not take that comment and pursue it in the GI Program.

5 The second issue, it applies to two or
6 more facilities. A lot of times somebody says I found
7 a problem at Plant A and I think it applies to Plants
8 B and C. Well, maybe, maybe not.

9 But if we can establish that it applies to
10 Plants B and C, actually just B, now we have a generic
11 issue. So it's two or more plants, okay? It's not a
12 plant-specific issue is the point.

13 Number three, the issue is not being
14 addressed using other regulatory programs. So this
15 issue isn't being addressed in any formal regulatory
16 manner right now. That's why it meets this criteria.
17 If NRR, and I'm picking on NRR, had said I want to
18 move forward and do something, then we would say NRR
19 is doing something and it would not stay in the GI
20 Program because the Regulatory Office has assumed
21 dynamic control of the regulatory action associated
22 with it.

23 The issue can be resolved by a new or
24 revised regulation. It's not enough that we study it.
25 We have to be able -- it's got to lead to something or

1 else it belongs in some other process. We don't want
2 to just study something to death. We want to focus
3 resources and arrive at a conclusion.

4 The issues of safety significance can be
5 adequately determined. I don't know if this is the
6 best example but I used the meteor strike as the
7 example. Can we really assess the risk and safety
8 significance of a meteor strike? We can come up with
9 these qualitative estimates and maybe even put numbers
10 on them but it's probably not something that I would
11 say would meet this criteria right here. We're
12 looking for something more tangible. I could probably
13 do a better example, if I had more time.

14 Then the issues is well-defined, discrete,
15 and technical. Again, people tend to broad-brush
16 topics but if it can't be brought down to something
17 that is researchable and tangible, we would say okay,
18 this is interesting academically. It belongs in an
19 academic argument. When it's ready for prime time and
20 we can talk about nuts and bolts, then it meets the
21 criteria for the program.

22 Okay and then number seven is can we
23 actually do something with it. Again, that's the
24 specificity. Do we have enough of a nugget of
25 technical information that we can actually research?

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1 In the case of Al HEAF, I think Stan is going to talk
2 about some of the long-term, short-term test programs.
3 And we think it can clearly meet number seven.

4 Now going up to the next level up, the big
5 picture. Why did we put these screening criteria in?
6 Well, like I said there were about a thousand issues
7 in the Program and what happened is is that early on
8 we needed to get on with the business of licensing
9 plants and we were learning. So a lot of issues were
10 dumped into the GI Program.

11 And the problem is is that everyone felt
12 good because it was in a process but no one devoted
13 sufficient resources to bring in the issues to
14 resolution quickly. So then the problem became we had
15 issues that were just stuck in the program and not
16 moving forward and we realized that we weren't able to
17 apply enough resources and these were the types of
18 reasons why they were not coming to fruition.

19 So we took these screening criteria in
20 place to avoid the situation where somebody dumps an
21 issue into the program and doesn't address it
22 themselves. Like if an inspector in the field has an
23 issue, if a member of the public has an issue, there
24 are ways that need to be -- that should address it.
25 The GI Program is not intended to be a catchall for

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1 everything. It's intended to be just those issues
2 that merit doing research and working on.

3 Next slide.

4 Okay, the repository of knowledge for this
5 approximately thousand issues is in NUREG-0933. It's
6 available on the web. We do periodic updates of it as
7 we -- as issues are brought to maturity. We document
8 what we did as an agency here. So, I don't know,
9 Stan, you might be getting more into this in your
10 presentation. But this is available up on the web.
11 Okay, so if at any time you wanted to see some
12 examples of what we've done in the program, here it
13 is. Provide suggestions, anything like that. We'd
14 definitely like to get better.

15 Next slide.

16 This tells you -- this is also on the web.
17 It's a nice presentation. It's got some visuals.
18 These needles move like a speedometer when you
19 actually bring the page up. They kind of go over to
20 the far side, come back. It looks really cool. Works
21 like you're starting the engine. So we like it.

22 But the main point is is it tells you
23 about where you are in the process, and the process
24 being we've taken regulatory action. How many plants
25 have actually implemented changes to their plants? So

1 that's what the big needles are for.

2 So GI-191 has been around for a while.
3 And if you look visually, we're a little over halfway
4 at trying to implement changes at all the plants.

5 Now, there's a lot of plants that are
6 affected by GI-191. So this is a nice high-level look
7 but usually not actionable. So if you click on these
8 details -- we're actually doing a demo. That's great.

9 If you click on details, you get a
10 description of the program. For those on the bridge,
11 we're at the bottom of one of the dials. There's a
12 word called details and that's where we are. And what
13 it gets into is a description of the issue, a
14 description of the status at the end of the high
15 level.

16 And then somewhere down here, if you pull
17 down, there should be individual plants that are
18 affected. And then keep coming down. And then
19 there's milestones.

20 There's plants. You can pick each plant
21 and you can say what's the status of each plant. Now,
22 I'm further down the road than the Al HEAF issue at
23 the moment. Okay? Let's assume that something needs
24 to happen on the plants. This is where you'd find out
25 what's the status of each plant.

1 And then there's another section on
2 milestones. And the milestones would say okay, for
3 this group of BWRs, it doesn't apply to GI-191, but in
4 this group of BWRs, they're expected to submit their
5 initial response to the NRC by spring of 2019. And
6 I'm totally making this up.

7 The next stage would be GE completes a
8 study of the generic effects and issues topical
9 report, fall of 2019. The plants take action based on
10 topical report 2020. That's the kind of thing you'd
11 see in the plans of actions and milestones.

12 Anything else you think I ought to point
13 out, Stan?

14 Okay, so if you have questions on this, I
15 love it, Stan the Man, he's the guy to talk to. Stan
16 worked with our office as Chief Information Officer to
17 develop this. And so there's an awful lot of
18 information here. We're trying to be as transparent
19 as possible. If there's information that's not here,
20 again, please ask u.

21 MR. MELLY: Again, for those on the phone,
22 this is the Generic Issues dashboard on the NRC public
23 website.

24 MR. BOYCE: Thank you. Next slide.

25 So just to tell you, here's some of the

1 recent proposed generic issues. If you remember the
2 process slide I put up before, proposed generic issues
3 are not issues that have transitioned over to
4 Regulatory Office implementation.

5 So if you look, there's 20 proposed
6 generic issues. The one in bold -- the ones in bold
7 are the ones that are still open. Okay? So many of
8 these actually did not make it past assessment into
9 Regulatory Office implementation, for various reasons.
10 The documentation of the staff's assessment of the
11 issues is also available publicly. Okay?

12 Can you get to it on the dashboard, Stan?
13 I don't think --

14 MR. GARDOCKI: Publicly, no.

15 MR. BOYCE: Publicly, no. So if you want
16 to know anything about these, they are publicly
17 available and we can certainly get you the
18 information. But the message out of this slide is is
19 that actually the majority of the issues actually
20 screen out and don't make it into Regulatory Office
21 action. Okay?

22 Next slide.

23 So, if you ever want to know more, I
24 didn't tell you everything that you needed to know
25 today, we have some references. These are also

1 publicly available. We have the ADAMS ML number.
2 They are available in the NRC Library under document
3 collections. I find that a little easier to find than
4 the ML number. We have a Research Office instruction
5 that provides the next level of detail down in the
6 program. And it's also got that one-pager chart,
7 which I find useful.

8 Just to tell you how NRR looks at issues
9 in the short-term, they have an office instruction
10 called LIC-504. Remember I said sometimes an issue
11 should be addressed by the Regulatory Office directly?
12 This is the process document that NRR uses. Okay?

13 So if we aren't addressing it in the GI
14 Program, NRR should be evaluating it in an analogous
15 process in-house.

16 Okay and I already talked about NUREG-
17 0933, where the repository of knowledge is. That may
18 be my last slide.

19 MR. GARDOCKI: Yes.

20 MR. BOYCE: Are there any questions in the
21 room? Beth.

22 MS. WETZEL: So where is the backfit
23 process for the GI Process?

24 MR. BOYCE: So the question, for those on
25 the line is where does the backfit process show up.

1 And it really would come in in the Transition Team.
2 After we get past the assessment stage, let's assume
3 that the Transition Team decides that they're actually
4 going to take action, like a plant-specific, a generic
5 order, let me say, or a rule. Those individual
6 regulatory processes would engage the backfit process,
7 as appropriate.

8 Like in the case of rulemaking, there is
9 a backfit analysis that is already built into the
10 rulemaking process. If we went with an order, that
11 backfit process would also be part of the development
12 of the order. So, it would be part of the regulatory
13 process. It's not part of the generic issues process.

14 In the case of generic communications, not
15 all generic communications go through Our Committee to
16 Review Generic Requirements, or CRGR, but generic
17 letters, I believe, do for example, bulletins do. So,
18 if the agency decides to take regulatory action and
19 chooses that vehicle, then CRGR would be engaged early
20 on before issuance of those documents.

21 Did I get to what you needed?

22 MS. WETZEL: Yes.

23 MR. BOYCE: Other questions in the room?

24 Questions on the bridge?

25 Okay, then thank you very much.

1 Stan.

2 MR. GARDOCKI: Okay, thank you.

3 All right, so now you've heard what the
4 whole program is about. So where are we at with this
5 specific issue?

6 All right, first slide, we already did a
7 screening. So we accepted the GI into the Program
8 last year. We did the initial screening. We did what
9 they call a quick shot to see if there's an immediate
10 safety concern. And NRR looked at it and says do we
11 need to act on something immediately right now. And
12 they said no, not right now. You know take the time
13 to do an in-depth analysis and come back and let us
14 know what the analysis is and make the determination
15 a little bit later. But we do what they call an
16 immediate safety determine to see when somebody
17 identifies an issue if there's an immediate concern to
18 the plant safety, to take action right there in the
19 very beginning. We don't wait around for the process
20 to go through its churning of wheels.

21 So we did the NRR safety determination and
22 they found out, no, it's not an immediate concern but
23 you need to do something. And that's available on the
24 public documents called ADAMS in the ML numbers.

25 MR. MELLY: It is as well referenced in

1 the screening report that was issued. We reference
2 the ML associated with that NRR review.

3 MR. GARDOCKI: Correct.

4 Now you saw the dashboard on the public
5 side but we have a dashboard on the internal NRC side
6 and we list a lot of these documentations on that. We
7 don't put it on the public side because it's not ready
8 for GI yet. We're still in that determination stage.
9 So we put everything on the internal site until we're
10 ready to launch into the GI, per se, and then
11 everything will go onto the public dashboard.

12 But all the documentation that you saw on
13 that overall screen, those are all ML numbers in
14 ADAMS. So you can see all the documentation, the
15 screening report, the receipt inspection, the
16 immediate safety concern. All that is available, you
17 just have to go through ADAMS at the point to get
18 that. You don't have the quick links that the
19 dashboard provides.

20 So as far as this PGI, we screened it in
21 and we wrote a screen report. And you're available to
22 get that off of ADAMS. And now we're in the
23 assessment stage.

24 You know this is a, like I said, this a
25 review of the big overall process screen. We've gone

1 through the screening. We've got the proposed. We
2 did the screening report. We presented it to the
3 office manager. He says, good report; go to
4 assessment. He makes the final determination. And we
5 actually brought in the office's, NRR, office director
6 to make our joint decisions on important issues like
7 this.

8 So now we're into the assessment stage.
9 Okay -- we've got the screen review. Go back one.
10 There you go. Okay, there it is.

11 There's the screening review is complete.
12 Like I said, it's publicly available. It met all the
13 seven criteria. And we did a little bit extra work on
14 this so it can be more defined in the screening report
15 and we came up with some action plans, not just say
16 put it in assessment but our GIRP Committee says well,
17 when you go to assessment, here's a plan on how to
18 resolve the issue. Here's some short-term milestones
19 that we think you need to do in a two-phased approach
20 to get this assessment done to determine if it's risk-
21 significant enough to go to NRR. Okay?

22 And then at the very bottom, you'll see
23 the ADAMS number at the bottom of the screen.

24 Okay, like I said, the GIRP report and the
25 screening identify what they call short-term actions.

1 Now the short-term actions we generally say they're
2 going to be done in the assessment stage, which
3 usually takes between one and two years. We're into
4 what six or eight months into the assessment. So
5 we're getting a good kickoff what this means.

6 And I'm not going into every individual
7 task here. If you have specific questions on the
8 task, Nick is the coordinator for developing all the
9 actions needed to achieve all these tasks. But the
10 Generic Issues Committee said these are important
11 enough to identify them on the screening report as a
12 logical progression to resolve this issue.

13 And again, in the full report, the
14 screening report that was issued, some of these tasks
15 you'll see in parentheses if needed. So the
16 determinant, the development of an interim guidance,
17 to perform additional testing, and proceed to the
18 Regulatory Office implementation stage. These are
19 tasks if it's needed. If our assessment and
20 determination sees that we need to do these things,
21 we're going to move them forward.

22 The perform additional focused HEAF
23 testing, we have decided to move forward on that and
24 that's the purpose of this meeting. Again, with some
25 of the task 3 here, you'll see determine electrical

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1 fault characteristics. We're handling that in a
2 public manner through these workshops, as well as
3 through comments on the Draft Test Plan that has been
4 developed.

5 Again, there was a time table associated
6 with typical GIRTH assessment phases and we're trying
7 to move things quickly because test programs take a
8 while to get contract employees following the NRC
9 program. So we're moving in parallel and we're trying
10 to get as much industry involvement as possible.

11 MR. TAYLOR: If I can just add to that a
12 little bit.

13 Some of these actions aren't NRC-sole
14 actions. You know some of them we're looking for
15 participation with EPRI or other stakeholders to help
16 us work through the process. So, you know developing
17 a ZOI, we'd like to solicit some input from industry
18 to sort of help support that. But if we don't get any
19 support from stakeholders and whatnot, then we'll go
20 ahead and do that on our own.

21 So there are some actions that aren't sole
22 NRC responsibility.

23 MR. MELLY: Yes, in the next presentation
24 that I'll actually be giving on the potential to
25 involve pilot plants and have industry involvement for

1 the risk-safety determination is going to be a large
2 area where we're going to be looking for involvement
3 from the industry to have a robust assessment.

4 I'll give an example of some of the things
5 that we can do without industry involvement but it's
6 going to be beneficial for everyone involved to have
7 as much participation as possible.

8 MR. GARDOCKI: And I'll reiterate what
9 Nick and Gabe said. We're looking for industry
10 involvement. If industry doesn't get involved, the
11 NRC will gladly go out there and help you get it done.
12 Okay?

13 All right, long-term actions. I use the
14 word commonly here because it's a flexible program.
15 The Generic Issues is made to handle such a wide
16 variety of issues, we sometimes deviate from the
17 process a little bit.

18 So in this action here, regulatory action,
19 we typically send out generic communications during
20 this stage called Regulatory Office implementation.
21 But in this case, we sent out an IN last year. So we
22 actually issued an IN to the industry prior to getting
23 into the Regulatory Office implementation stage.

24 So the flexibility of the program is there
25 and we use it and utilize it to our benefit.

1 The long-term actions of the GIRP
2 identified -- you can see continuing on is those steps
3 revising technical guidance, as necessary, issuing
4 additional generic communications or orders, or
5 rulemaking. All that is going to be done in the long-
6 term actions in the next stage called regulatory
7 office implementation.

8 Okay, go to the next one.

9 There's a couple more long-term actions
10 that are identified in the report. I think the PERT
11 has been completed, is the publicly --

12 MR. MELLY: The PERT has been completed
13 and is publicly available. We don't have the ML on
14 this slide but we will provide -- or the ML is
15 publicly available in our ADAMS system. It was
16 published in August of this year.

17 MR. GARDOCKI: August?

18 MR. MELLY: Last year. It's been a long
19 year.

20 MR. GARDOCKI: So in the Generic Issue
21 Program, we try to be very transparent and make just
22 about everything publicly available at the appropriate
23 time. So if the screening report says they're being
24 developed and reviewed are not publicly available
25 until they are approved by the Office Director of

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1 Research and made publicly available.

2 Any more from Gabe or Nick on the long-
3 term actions?

4 MR. MELLY: So the long-term actions we're
5 going to discuss here. There's some overlap between
6 the short-term and long-term and that's based on the
7 level of effort that's going to be involved with them,
8 and specifically on how the test is performed and the
9 assessment of risk. There's different options of how
10 we can tackle that program, as well as the amount of
11 resources that's going into it. So that's why you see
12 some overlap between the short-term and long-term
13 actions is time line of when we can get things done
14 and what level of detail we can get them done to.
15 That's associated with the documentation that you saw
16 on the overall process of the Generic Issues Program.

17 We're here today and tomorrow to talk
18 specifically about the focused HEAF testing, as to
19 what parameters are of importance. What's realistic?
20 And what's representative of out there in the plants?

21 The assessment of risk, again, we're going
22 to be talking about the potential to have pilot plants
23 to work with, which I'll talk about next, but we see
24 that when we do get pilot plants and we get industry
25 involvement, everything tends to be much more

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1 successful moving down the road, rather than fighting
2 of what was done or what could be done.

3 MR. GARDOCKI: Okay, these are some
4 actions that are in progress or completed. Like I
5 said, the report was published by a GIRP. These said
6 these are our actions that we need to complete to get
7 the assessment done correctly and it's a phased
8 approach, stepped approach. And like I said, the
9 Regulatory Office implementation, those are projected
10 actions. We don't know for sure, until we get to that
11 stage, whether we'll do all those actions, some of
12 those actions, or additional actions. But the GIRP
13 will kind of think in advance in the future what
14 possibly could come out of the assessment stage. So
15 those are kind of proposed.

16 But here you can see how far we are in the
17 process and what some of the things that we have
18 completed. The dates and times are starting to get
19 developed. I think Nick and Gabe can talk more about
20 when actually the tests are proposed and dates.

21 MR. MELLY: Yes, in the Phase II
22 presentation that I'll be giving, we have some time
23 lines associated with testing and things moving
24 forward.

25 In terms of what's on the screen right

1 now, there was an informal survey performed by NEI,
2 essentially questioning how much aluminum is out
3 there. Again, that was informal, voluntary-based and
4 NEI performed that.

5 I have an ML in a later slide. It is
6 public. We have made that publicly available, what
7 has come in. The plant names are anonymous in that
8 report but that is one area where it was important to
9 our assessment for this issue is understanding how
10 much aluminum is out there in the fleet, to see how
11 big of a problem this is or could be.

12 Again, the next stage, also, is to invite
13 personnel to potentially join NRC expert elicitation
14 solicitation process, which will help determine the
15 zone of influence that will be used for that risk
16 assessment moving forward.

17 So essentially, the high level in 6850
18 Appendix M right now is the three-foot horizontal
19 five-foot vertical and the expert elicitation would
20 lead down to what it would potentially be for this
21 aluminum issue, taking into account the potential of
22 both conductive material as well as enhance the zone
23 of influence.

24 Like we said previously, we can perform
25 this in-house in the NRC but we'd like to do this more

1 open and with a semi-formal or some level of expert
2 elicitation to capture that issue.

3 Again, we're here to develop the future
4 test plans and this is the workshop that is on the
5 screen right now.

6 MR. GARDOCKI: Okay. As far as the
7 initial testing that was done, they identified an
8 issues with the aluminum in the cabinets or bus bars,
9 or even the enclosures. So we said okay, now we have
10 to additional testing to find out what extent of
11 aluminum causes what extent of damage. And we can't
12 really do any kind of regulatory actions until we know
13 that knowledge and that's why we're developing these
14 other test plans.

15 So that's why we're kind of developing our
16 assessment right now and we need further testing to
17 get further in the process.

18 MR. MELLY: And we also did focus on the
19 fact that this is an international program that we're
20 working with, the OECD and the NEA. We will discuss
21 the members who are going to be potentially in the
22 Phase II and we've also been doing these actions in
23 parallel with them, trying to figure out is aluminum
24 an international issue. And what we found is that not
25 very many other countries consider the -- or have

1 aluminum within their plants, either in the enclosures
2 for bus ducts or the cabinets themselves. It's very
3 country-specific what material was available at the
4 time and what they were requiring to put in the
5 plants.

6 We do see a large amount of aluminum in
7 Japan, specifically within their enclosures, however,
8 they do not have aluminum for the enclosures of their
9 bus duct material, due to seismic concerns during
10 their design phase.

11 So as we've learned more, we've seen that
12 the aluminum may be a U.S.-specific problem, rather
13 than the larger OECD international community. For
14 instance, Germany has found one plant that had
15 aluminum and it shut down.

16 So we're trying to tailor the next stage
17 of the program to take into account both this issue
18 and we may be taking the heavier lift, in terms of
19 resources, to solve the aluminum issue, rather than
20 the international countries.

21 MR. GARDOCKI: All right, I think that's
22 the last slide there.

23 There's not a lot of dates associated with
24 these steps right now because were still developing
25 the dates to perform the additional testing. And

1 based on some workshops, participation from industry,
2 we'll be doing some site visits and hopefully get out
3 and do an actual realistic PRA inside of a plant to
4 say if you extend the zone of influence from 10 to 15
5 or 20, what's the change in risk to the plant.

6 So we're actually looking for some plant
7 involvement and that kind of aspect. And Nick will
8 get a little bit more into that in our workshops. So,
9 I just put a plug in now that it would be very helpful
10 in developing what they call the risk significance of
11 this specific generic issue if we can get some actual
12 plant data, say.

13 MR. MELLY: Yes, in my next presentation,
14 I'm going to discuss some of the potential options
15 moving forward. This is the first time that we're
16 really engaging EPRI as well as industry on this path
17 forward. And we would like to -- we'll discuss some
18 of the pitfalls with doing it in-house and the
19 resources associated with moving forward to do this
20 risk assessment. And it will be something that we
21 definitely further engagement and potentially more
22 meetings to discuss how these pilots and things will
23 work.

24 MR. GARDOCKI: So that's a very detailed
25 approach on how we're getting to this issue. I know

1 it sounds like it's going to take a while but we want
2 to make sure we get it right before we make the
3 industry or regulations applicable. We don't want to
4 drive costs up anywhere that we don't have to or we
5 want make sure safety is important.

6 Any questions? Kenneth.

7 MR. FLEISCHER: Yes --

8 MR. GARDOCKI: Hold on one second.

9 MR. FLEISCHER: Yes, sure. Kenneth
10 Fleischer with EPRI.

11 So the item regarding international, what
12 was the level of rigor and detail into that
13 assessment, whether they have or don't have aluminum?
14 Did they do similar to like an NEI study, where you
15 got down to the actual individual engineering
16 organizations that really do their plant well or is
17 that just a high-level regulatory assessment?

18 MR. MELLY: It varied on country to
19 country. Germany held a workshop much like this with
20 their industry and it was a questionnaire form that
21 went out. But it very much varied from country to
22 country as to the level of detail they went into to
23 figure out if they had aluminum in their plants and to
24 what extent.

25 For instance, the cabinet we received from

1 Finland did have the aluminum in it and they
2 identified aluminum as being an issue for their
3 plants. However, it's very country-specific and there
4 was no formal process in figuring out how much
5 aluminum is out there.

6 We provided each country that was a part
7 of the OECD program with the questions and
8 questionnaire form that we provided to NEI and it was
9 up to each country specific how they wanted to engage
10 their fleet.

11 So that is something we will most likely
12 try and enhance in the Phase II of the program working
13 with the internationals is conducting the formal
14 surveys as to the extent possible.

15 MR. VERHOEVEN: Hello. Bas Verhoeven from
16 KEMA Laboratories.

17 The discussion about aluminum versus
18 copper, the use, it was my global experience when I
19 see it, and I traveled to many countries worldwide,
20 you see that use of aluminum in the sectors, not only
21 the neutral but overall, the use of aluminum is
22 increasing very rapidly at the cost of copper because
23 of lower rate and the cheaper design. That means that
24 much more systems generically will include aluminum
25 instead of copper. That's a trend that you see

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1 happening everywhere.

2 So an exhibit in Saudi Arabia, they
3 changed overnight, basically, that whole distribution
4 transformers should have aluminum wirings rather than
5 copper wirings. Cables are being transferred to
6 aluminum conductors instead of copper.

7 So it's happening everywhere. And
8 primarily, cost-wise, that's been the main reason and
9 secondary is the lower weight.

10 MR. MELLY: Yes, so we have seen some
11 international evidence of these high energy arcing
12 faults occurring as well as at different types of
13 facilities. However, for a different facility, if
14 they lose an entire room, the plant is shut down for
15 a day, rather than the risk -- the potential risk that
16 we have within the nuclear industry of larger
17 consequences.

18 Any other questions in the room?

19 MR. CHEOK: This is Mike Cheok from Office
20 of Research.

21 So when Nick talked about the risk
22 assessment, and so one parameter of it was the zone of
23 influence. So that's something that we want to look
24 at plant-specific data on.

25 The other element of it is the frequency.

1 So we also talked about this in the beginning. So we
2 talked about trying to you know characterize the arc
3 flash better, characterize what HEAF is and not all
4 arc flashes result in HEAFs.

5 So in a lot of this, we all try to get a
6 lot more information about this as part of the Phase
7 II testing and as part of the expert elicitation, as
8 part of looking at Op E and things like that. So
9 that's the other part of the risk analysis, which we
10 will be looking for a lot of input on.

11 MR. MELLY: Yes, and as Mike said, that is
12 the other piece, rather than we've kind of separated
13 it right now. We have the zone of influence part of
14 this and we have everything else, which is the
15 frequency, the circuit protection, some of the
16 durations, plant-specific design. And we plan on
17 capturing all of that.

18 Right now we have a memorandum of
19 understanding with EPRI and all of that, hopefully,
20 will roll into the work that we were planning to do
21 with Ashley and EPRI on the heat. If we're going to
22 be looking at frequency, 1E equipment versus non-1E
23 equipment and things like that will all be captured
24 under the MOU work that is planned for later this year
25 and next year.

1 Francisco.

2 MR. JOGLAR: So what you just said on
3 probabilities and frequencies, is that what that last
4 bullet means when you said the NRC will calculate
5 potential risk increase?

6 MR. MELLY: No, so the calculation of the
7 potential risk increase, that's what we're going to be
8 discussing next is the pilot plants and the risk
9 assessment associated with the GIRP and the assessment
10 work phase that we're in.

11 What we were discussing with frequency and
12 the definitions is currently the bin 16 is split bus
13 ducts, the electrical cabinets, as well as on the low
14 voltage and medium voltage equipment in Supplement 1
15 to NUREG-6850. We're talking about potentially
16 increasing that and doing more -- a little bit more
17 refined work there as to splitting out the arc blast
18 type occurrence versus the high energy arcing fault,
19 as well as the potential to roll in the safety-related
20 versus non-safety-related, and refining the
21 frequencies associated with those in our work under
22 the MOU.

23 But the calculation of the potential
24 increase I'll get to next as to an example of how we
25 would like to do that and through the potential of

1 pilot plants.

2 MR. GARDOCKI: And just to add on to that,
3 the Generic Issue Program, like you said, the seven
4 screening criteria, there's risk aspect of it.

5 So when we calculate the risk here in the
6 assessment stage, if it doesn't meet a threshold, it
7 will not go to Regulatory Office implementation. So
8 it's not risk-significant enough to go to that stage
9 to require regulations or industry to do any action on
10 it.

11 We use the threshold very similar to
12 what's in the Reg. Guide 1.174 for plant changes. If
13 a plant requests a change to the NRC and say we're
14 going to change something in our plant, they do a risk
15 analysis and says it's safe to do. Well, we reversed
16 that philosophy. If that risk is unacceptable, then
17 it should proceed as a generic issue into the
18 Regulatory Office.

19 So we use the same kind of screening in
20 that Reg. Guide but we use it in reverse. If it's not
21 safe to implement the design change, then it's
22 something -- a threshold that would go to Regulatory
23 Office for generic issues. So we use the risk in this
24 stage of assessment to go Regulatory Office, not just
25 -- we don't do it just qualitative. We try to do a

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1 quantitative analysis to get this risk increase.
2 Okay?

3 MR. JOGLAR: Thank you.

4 MR. GARDOCKI: Bridge line or more?

5 MR. FUNK: Can I just get a little
6 clarification on one point? I think it was in one of
7 Mark's earlier slides. He had highlighted general
8 design criteria 3 and then the single failure criteria
9 collection of blood and guts electrical engineering.

10 But in the generic issue right up to what
11 has been presented by Michael and what I see here
12 today, so far, it looks this problem is only being
13 approached strictly from fire PRA perspective or are
14 you back questioning is Class 1E traditional
15 separation criteria acceptable?

16 MR. MELLY: It is -- we have been focusing
17 on a lot of discussion on the NFPA 805, the
18 probabilistic aspect. However, the deterministic is
19 also identified in the safety evaluation, as well as
20 the information notice, as a potential area where this
21 can affect.

22 So it is both. It's not just
23 probabilistic. We have been focusing in on the zone
24 of influence and things like that for the
25 probabilistic design and the frequencies as well. And

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1 we're still trying to tackle how we are going to
2 assess the issue for the deterministic plants, the
3 separation criteria, as well as some exemptions to
4 that separation criteria that are in regulations.

5 So that is all still on the table at this
6 moment in time.

7 MR. FUNK: And by deterministic, do you
8 mean Appendix R deterministic or Class 1E Reg. Guide
9 1.75 determination?

10 MR. MELLY: I was referring to the
11 Appendix R right now. But again, I haven't given that
12 much -- I haven't looked at the overall picture to
13 know exactly what's going to be affected. But the 20-
14 foot separation criteria from Appendix R is what comes
15 to mind right now.

16 MR. FUNK: Thank you.

17 MR. PELLIZZARI: Francesco Pellizzari,
18 EPM.

19 Following along that line of thought, my
20 understanding of Appendix R was that it was generally
21 based on consideration of hazards that were floor-
22 based, where the floor area burned but it really
23 didn't consider explosive hazards.

24 So just a thought in terms of a concern
25 and the plants that are deterministic is like a fire

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1 barrier wrap that would be within the zone of
2 influence for ZOI. Essentially, that wouldn't afford
3 any protection from an explosive hazard. So I think
4 that's somewhere. That needs to be, obviously,
5 explored.

6 MR. MELLY: Yes, I agree and those are all
7 areas that we're going to be looking into, as well as
8 the other additional concern is that intervening
9 combustibles were generally as floor-based whereas, if
10 you have a bus duct, it typically would not have been
11 considered an intervening combustible because it's not
12 combustible. However, if you have a bus duct running
13 through your separation or across, this potential
14 issue can occur.

15 So these are all areas that we are going
16 to be investigating, as part of this program.

17 MR. GARDOCKI: In the screening report,
18 also, you can see there's a little differentiation
19 between the NFPA 805 plants and the Appendix R. So
20 there's a little bit of difference there and we
21 identified that difference in the screening report and
22 tried to come up with some different tasking to how
23 we're going to address those different aspects. So
24 some plants are Appendix R and some are NFPA plants.

25 MR. MELLY: The specific differences were

1 also addressed in the NRR assessment to the immediate
2 safety risk and I believe it's in the communication
3 plan moving forward.

4 Mike? Oh. Do we have questions from the
5 phone?

6 MR. AIRD: No, we just got a message that
7 if you're using a microphone, speak kind of loudly
8 into it because some people are having a hard time
9 hearing you.

10 MR. MELLY: We'll also start repeating the
11 questions.

12 MR. AIRD: That would help.

13 MR. MELLY: All right.

14 MR. SALLEY: Nick, before you move on, a
15 couple things.

16 MR. TAYLOR: Hold on Mark.

17 MR. SALLEY: So before we move on here, a
18 couple things before we get to the next presentation,
19 as you close this one out.

20 Dan, your question is on the electrical
21 engineers. That's specifically why we requested a lot
22 of the electrical engineers to come to this. And
23 we're doing that internally in Research also. You
24 notice Kenn Miller is here and we've got Ronaldo
25 Jenkins, and Tom Koshy, Bob Bailey. So we're trying

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1 to also, we see if this is a bigger issue and we
2 wanted to involve the electrical engineers. It
3 started out in fire protection but, again, we're
4 looking to bring the other ones on.

5 The question of aluminum, as we see, you
6 know we're taking the biggest problem first, and we
7 see the aluminum as the first place we really want to
8 go. And we are seeing that most of it is in the
9 United States, which would kind of beg the question if
10 I was German or a country that didn't have any
11 aluminum, why do I want to continue on with the
12 research. And I think talking with them and the other
13 countries is we can do a more accurate zone of
14 influence model for the copper ones and we can learn
15 more about it.

16 So I think everybody wants the most
17 realistic, most accurate model. So I think that's a
18 lot of the reason that we'll do it.

19 What you'll see here is probably parallel
20 pilot testing, where we do the bigger OECD program and
21 then we have some specific aluminum stuff that we need
22 to solve in the U.S. and Nick's discussion will get
23 into that.

24 And one final thing. I noticed our Office
25 Director, Mike Weber, has stopped in. Mike, if you

1 had any words or anything you'd like to say to the
2 group, we'd appreciate it.

3 MR. WEBER: May I have a microphone?
4 Thanks.

5 The only thing I would add is I'm happy to
6 see a crowded room. So this is good. You know we
7 really, as has been emphasized several times, we
8 really benefit from your participation, not just here
9 in the room but also on the phone.

10 We want this to be the kind of
11 experimentation, testing, and analysis that we do
12 where when we come up with our conclusions everybody
13 says well, yes, of course; we all agree this is
14 reasonable, this is appropriate, and it's focused on
15 safety. We're not trying to impose additional burden
16 that's not justified but we are trying to ensure that
17 the results of our experiments, or our analysis are
18 credible and that they ensure that we support the
19 overall Program results in accomplishing safe and
20 reliable operations.

21 So, that's the only thing I would add.
22 Thanks for participating.

23 MR. MELLY: Next?

24 MR. MILLER: This is Kenn Miller. Just to
25 piggyback a little bit on what Nick and Mark talked

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1 about, the deterministic separation criteria, from an
2 electrical perspective, from electrical design GDC 17,
3 it's been an issue in my mind as well but perhaps
4 drives us to issues with separation criteria and
5 division separation. Of course, that tempered with
6 the required criterion defined in GDC 17 but certainly
7 I would agree that that's on the table as well,
8 depending on what we find out from this research.

9 So, I just wanted to put that out there.

10 MR. TAYLOR: Any other questions from the
11 room?

12 Tom, is there anything on the Webinar?

13 Okay, so I think, Nick, you're up next.

14 MR. MELLY: All right, thank you, Tom.

15 So we eluded to this a little bit in the
16 previous presentation. This is a look at how we --
17 how I envisioned the pilot plants coming off for this
18 risk assessment. Again, overall, we are in the
19 assessment stage and, as part of that assessment, we
20 want to look at what the potential is and understand
21 what the risk from these events is to the current
22 fleet.

23 This is a very difficult problem because
24 the zone of influence, as well as the potential damage
25 is very scenario-specific, very plant-specific. It's

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1 a problem that can't be broad-brushed. We need to
2 kind of run sensitivity studies, and things like that,
3 and have an appropriate model when we get to a pilot
4 plant.

5 As we have looked at the risks from this
6 from a larger picture, we have the skyscraper chart
7 that EPRI has done as part of a study to look at the
8 risk drivers. And what you're seeing is primarily on
9 -- down the side here you see the different
10 categories. You have electrical cabinets, transient
11 heat, and you do see that HEAF is the third largest
12 risk driver. It kind of mirrors the electrical
13 cabinets, in that the overhead cables are a large area
14 of concern. They drive a lot of the risk and the
15 conditional core damage probability.

16 So this is one tool that we've used to
17 kind of try and understand what the current risk to
18 the fleet is. And if we focus in on just looking at
19 the HEAF, we see that it can range anywhere from 37
20 percent of the overall -- the total plant contribution
21 to risk to zero or to a little bit -- to a very low
22 value. So you can kind of see that it's all over the
23 board. It's a very scenario-specific problem and
24 we're trying to understand it without the broad brush.

25 So there are a couple ways that we can do

1 it and we'd like to work with industry to accomplish
2 this and select appropriate plants to use as pilots,
3 whether it be by design, PWR, BWR, or we use a tool
4 like this to look at three different risk drivers, or
5 a number of different risk drivers. It's selecting
6 one with a high level of risk, a medium level of risk,
7 and a low level of risk and adjusting our zone of
8 influence of damage for these aluminum-specific
9 components.

10 Some of the important drivers is also
11 going to be does that plant even have aluminum? Maybe
12 for these larger risk drivers, it's an all-copper
13 plant, all copper design, this isn't even an issue.

14 So it becomes a larger picture, one that
15 we want to work with industry hand-in-hand, as a pilot
16 program to really understand the risks.

17 There are ways that we can do it in-house
18 but they may be conservative or take a larger picture.
19 I hate to use the word conservative. It's a red
20 button word but if we're going to be trying to solve
21 this in-house without the resources that the industry
22 can provide of their plant models and things like
23 that, that is a fairly appropriate term.

24 And I'm going to discuss some of the
25 methods that we can do it in-house without using pilot

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1 programs to give you an idea of where we are trying to
2 head with this, some of the options, as well as why we
3 would really like industry involvement with this
4 program.

5 So one of the ways that we can do this is
6 we can use the SPAR All Hazards models that the NRC
7 has in-house. There are several plants that we have
8 fires associated with. We've used plant fire models
9 to enhance the SPAR models and give us an idea of fire
10 risk. In doing that, with the information that we
11 have in-house, I ran one of these assessments and I'll
12 run through some of the assumptions that I had to make
13 to come out with results, as well as the conclusions
14 of that analysis.

15 So we had a plant model in-house. And
16 when I went through this, I had to assume that every
17 component that had a HEATH identifier was aluminum,
18 without -- that every single cabinet had aluminum
19 inside of it. And I had to do that because I had no
20 way to differentiate whether it was copper internals
21 versus aluminum internals for the conductors or the
22 enclosed material.

23 Again, I say that's potentially
24 conservative. However, from the survey that's listed
25 here in the ML, there were a large number of plants

1 that had aluminum components.

2 The next assumption that I had to make is
3 that I had no way to determine where components were
4 located in the plant to come up with an increases zone
5 of influence. So from changing to the three-foot
6 horizontal to five-foot vertical, I had no way to
7 determine what components were four-foot, five-foot,
8 six-foot away with the internal information that we
9 have.

10 So I, instead, mapped every single HEAF
11 scenario to a hot gas layer scenario for that
12 compartment, which essentially involved all of the
13 components within the compartment that were not
14 protected by some other -- by some means of protective
15 barrier. That brings me much closer to an Appendix R
16 type analysis that is total room loss. So that is
17 inherently conservative. It essentially says that
18 everything within the room is damaged and I have to do
19 that in-house in lieu of performing the plant walkdown
20 or doing an evaluation of what equipment would be
21 damaged.

22 If we wanted to do this just in the NRC,
23 there are potentials that we could do walkdowns. We
24 could work with the inspectors and try and bring this
25 forward but right now, for illustration purposes, this

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1 is what I did. I mapped everything I did to a hot gas
2 layer scenario.

3 I also had to take away credit for the
4 automatic suppression or manual suppression. We had
5 no way to alter those within the current model. So
6 all non-suppression values were set to one. We had no
7 way to evaluate whether the sprinkler systems or any
8 suppression methods would be damaged by the event
9 itself.

10 The one area that is potentially non-
11 conservative is that the model that we had to work
12 with in-house had no bust duct scenarios listed. In
13 that scenario, at the time that we received the
14 information, the bus ducts were screened out of the
15 analysis using a sensitivity study. So there was no
16 way for me to map a bus duct scenario to any specific
17 room hot gas layer. I didn't know where the bus ducts
18 were in the plant.

19 So you can see from the SPAR model results
20 themselves, these are the rooms where you would
21 typically high energy arcing faults. We have our V
22 switchgear room, our turbine building room, the A
23 switchgear room, and HEAF identified scenarios in the
24 reactor auxiliary building.

25 On the left-hand side here, is the plant

1 fire CDF. You can see this was the core damage
2 frequency identified in the SPAR model prior to me
3 altering these events. And you can see the difference
4 compared to when I did change the event to a hot gas
5 layer damaging scenario which, essentially, would take
6 out the entire room. And you can also see the total
7 difference down here.

8 I only listed the compartments that had
9 HEAF scenarios identified and my change to the plant
10 model. But you can see prior to my alterations, the
11 total plant CDF was three to the minus -- or 3.06 E to
12 the -5. And with the increased zone of influence or
13 the mapping to a hot gas layer, we're down in the area
14 of 1.95E to the -4.

15 As you can see this large increase in
16 risk, which I necessarily don't believe is true or
17 realistic, based on the way that I had to make
18 assumptions and model it but, without eliciting help
19 from the industry through either EPRI or the
20 individual plants themselves to establish a pilot
21 program where we can work to really understand a
22 realistic risk increase, we're limited with our
23 ability to recreate these events without a larger,
24 more robust model.

25 So this is where we currently sat -- sit

1 right now with our level of analysis and what we can
2 do in-house. We can make this a little bit better
3 with plant walkdowns and working with the Regions and
4 actually going out to plants but I see that as Plan B.
5 Plan A is much more can we work collaboratively. Can
6 we leverage the plant models themselves and move
7 forward in a way that's really going to capture what
8 that interim zone of influence and that interim risk
9 could be?

10 So that's really what I wanted to stress
11 here with this presentation is that there are some --
12 as part of the Generic Issues Program, we must do this
13 risk evaluation and it would be much more beneficial
14 to do it with the industry as a collaborative effort,
15 rather than being potentially conservative on our own.
16 It will help understand the realistic risk associated
17 with the events involving aluminum and we can leverage
18 the existing plant PRA models with the use of pilot
19 plants.

20 How we select those pilot plants becomes
21 very important and we really need to work together on
22 how we do that selection. Again, we'd be following
23 the technical office instruction that Stan mentioned
24 earlier as to the threshold levels for if this --
25 where this risk assessment will fall and how we

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1 progress forward in the generic issues process.

2 So this is kind of what I wanted to
3 discuss is how we can select these pilot plants. So
4 we wanted to get volunteer pilot plants that have
5 identified aluminum components. As I mentioned
6 previously, the NEI survey that we have has anonymous
7 plant names. So right now, we cannot determine which
8 plants did have the aluminum from that survey.

9 And we also want to have volunteer pilot
10 plants that have modeled HEAF scenarios within their
11 PRA. What I mean by that is we need the volunteer
12 plants that have done a zone of influence approach
13 following Appendix M of 6850 as well as the bus duct
14 guidance that is in Supplement 1 to 6850, which is FAQ
15 07-0035.

16 That becomes very important because if
17 plants went and did a scoping approach, where they
18 already modeled their high energy arcing fault
19 scenarios to a hot gas layer, selecting them as a
20 pilot plant will not be beneficial because it will
21 show absolutely no change because they've already used
22 conservative methodology in their approach. And there
23 are several plants that did that because if they could
24 live with the risk, they did not move into further
25 stages of going to zone of influence approaches.

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1 Additionally, as I've mentioned before,
2 these may involve plant walkdowns and some NRC
3 interaction will be decided on the as-needed basis.
4 If we can receive all the information we need just
5 from interaction and meetings through GoToMeeting or
6 some other needs, we won't need specific walkdowns.
7 And we're trying to limit the amount of resources
8 necessary to perform a robust risk analysis.

9 Are there any questions on the pilot plant
10 approach? Rob.

11 MR. CAVEDO: Go ahead.

12 MS. LINDEMAN: So how many pilot plants do
13 you need? I thought you mentioned three but --

14 MR. MELLY: That's still up for
15 discussion. Our initial thought was that three may
16 provide a good picture, if we can get three that are
17 different enough where it would show us a range of
18 risk. As we've said, it's very plant-specific. It's
19 very scenario-specific. So we're still making the
20 determination of how many pilots do we need to really
21 understand what that risk will be on a broad brush.

22 Because, again, this assessment is
23 supposed to give us an idea of what the overall risk
24 and the assessment of risk for everyone, for not just
25 one plant-specific. So we need to select as many as

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1 possible to have a comfortable feeling of what the
2 plant risk is.

3 Three is our initial idea.

4 MR. CAVEDO: So I have a couple of
5 questions on this. I agree with you -- is this
6 causing the sound?

7 MR. MELLY: I don't know.

8 MR. CAVEDO: So I agree that we want to
9 get a realistic estimate of this and I also agree with
10 everything that you've been saying about it's very
11 important that we get the frequency right when we're
12 doing these bigger zone of influences.

13 Is your vision that this pilot effort will
14 be done when you have the frequencies corrected or did
15 you envision just putting in these conservative zone
16 of influences without adjusting the frequencies?

17 MR. MELLY: That comes down to a timing
18 issue. I believe the frequencies are going to be
19 handled in several stages. What I mean by that is the
20 safety-related versus non-safety-related is currently
21 being addressed in an FAQ. If that is ready in time
22 for the pilots, we can roll that in.

23 Additionally, if we can make the
24 differentiation with the definitions to frequency,
25 that can be rolled in as well.

1 MR. CAVEDO: I don't think it's a binning
2 issue, as much as a breaker performance issue.
3 Because if the breakers are going to work, then
4 they're going to be smaller. If they're going to be
5 failed and they're going to be larger, and those would
6 seem like they would be a much lower frequency, and if
7 that's not being addressed in here and you're asking
8 for people to volunteer and you're telling them
9 they're going to put conservative results in and see
10 big number changes, what's the reaction going to be to
11 the plant's management and among the NRC when they see
12 big number changes where they forced conservative
13 evaluations to be done?

14 So if we're doing frequencies at the same
15 time, then it's realistic, nobody can argue, and then
16 the results are what the results are. But if you
17 force conservatism in and you haven't addressed all
18 the conservative issues on the frequency side, that
19 seems like there could be some concerns.

20 MR. MELLY: I agree with you and I think
21 it's still down to a timing issue.

22 Now even before we get to the pilot
23 plants, there will be that expert elicitation that we
24 would like to perform with industry as to what that
25 zone of influence or what the increased area of damage

1 will be for the aluminum events. If the frequency is
2 also an issue that we want to touch on in that work
3 prior to going out to the public or to the pilot
4 plants, that is something that is up for discussion in
5 that effort.

6 MR. CAVEDO: I think that it would be
7 important to get that frequency thing done before you
8 go to the pilot plants because I don't know how other
9 industry members feel but I don't think you're going
10 to have a lot of volunteers who are going to be
11 interested in showing super high numbers for
12 conservative evaluations. That's a downside across
13 the board. I don't know if any other utilities want
14 to comment.

15 MR. CHEOK: So this is Mike Cheok again.

16 So I guess we all know that the risk
17 analysis has several elements, consequences and the
18 frequency. So I think it makes sense for us to, you
19 know when we present the risk numbers they come with
20 the correct frequency numbers.

21 And so also I think as we do more tests to
22 develop the characteristics of a potential HEAF
23 phenomenon that might also define what kind of plants
24 or what characteristics you're looking for in the
25 pilot plants. So it makes some sense but you know, we

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1 build a discussion.

2 MR. MELLY: Yes.

3 MR. AIRD: We also have a comment from Ken
4 Z from Jenson Hughes.

5 He says it would be important to have an
6 understanding of any latent sources of conservatism in
7 the pilot results before further decisions are made
8 related to the GI treatment.

9 MR. MELLY: I agree.

10 MR. AIRD: And he also says there needs to
11 be some level of assurance limitations related to the
12 schedule, which are not driving the GI action.

13 MR. MELLY: Agreed.

14 MR. TAYLOR: Any other questions?

15 MR. MILLER: First one back.

16 MS. WETZEL: I may have missed it, but
17 what kind of schedule are you looking at to get these
18 pilot plants?

19 MR. MELLY: Stan, can I lifeline you on
20 that one?

21 So this is part of the generic issue
22 process, which has a defined schedule and time --
23 milestones that are supposed to be met as part of that
24 process. And those milestones are in place so that a
25 generic issue process does not last for 10, 11, 12

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1 years, as some of them have in the past.

2 So the milestones are fairly aggressive,
3 which is where the timing issue that I was discussing
4 with Rob come into play but Stan can elaborate a
5 little bit.

6 MR. GARDOCKI: Typically for the
7 assessment for generic issue, we like to get it done
8 within a two-year period. It's pretty important. You
9 saw it was done within 6 to 18 months. So if it's
10 going to extend past the two-year mark, we would start
11 taking some action on the management level. That's my
12 role as the Generic Issues Manager -- Project Manager
13 for Generic Issues, make sure it doesn't drag on
14 forever.

15 So we would start taking actions. Well,
16 we can't get the pilot plants, we can't get this done.
17 Then, we start doing the conservative analysis and
18 that would maybe accelerate the process a little bit
19 and the other actions to say well, if we're not ready
20 to go the regulatory action, we could kick out of
21 generic issue, and put it into research, and then come
22 back, and then we're done five or ten years later.

23 So the time frame we're basically looking
24 for is try to get the assessment done before the two-
25 year mark. I mean that's not set in concrete but

1 that's kind of a target for the program.

2 So within the next year and a half, I
3 would say, we would try to get that pilot stuff done
4 so we can wrap up the assessments.

5 MR. CAVEDO: And I understand the need for
6 meeting the schedule. That's very important. But you
7 have accelerated the testing because you recognize
8 that we don't have a lot of insight as to what that
9 damage should be. And so you made that a high
10 priority and you're going to accelerate that within
11 the process.

12 All I'm saying is the frequency and the
13 damage go hand-in-glove. So whatever acceleration
14 you're planning on applying to the testing, put that
15 same level of acceleration on the frequency. Don't
16 just say we're going to use a conservative frequency
17 because that expedites things for the same reason you
18 don't want to -- you want to do the testing. You want
19 to have -- make sure you have correct insights and a
20 realistic evaluation.

21 MR. GARDOCKI: I understand that and I
22 think we got pretty much the testing done for
23 expanding the zone of influence. So you get the mark
24 to say go to the plant and say okay, the zone of
25 influence is 12, 15, 18, or 20 feet.

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1 Now as far as establishing the criteria
2 for --

3 MR. MELLY: And let me clarify. He's just
4 using those numbers off the top of his head. They
5 don't have any basis for what it potentially could be
6 coming out of that expert elicitation. So don't run
7 from here and scream 20. It's not where we're at.

8 MR. GARDOCKI: The only thing we see now
9 is the testing and you saw videos yourselves how far
10 the zone of influence has gone past what we saw when
11 we set up for the testing. So we need to do
12 additional testing to get a defined expansion of the
13 zone, if it's going to be expanded.

14 As far as the frequency, I don't think we
15 have an exact milestone in our plan for this frequency
16 evaluation. I thought we --

17 MR. MELLY: It's identified in the
18 screening report as a task. There's no set milestone
19 for it right now. It is an area where we'd like to
20 focus in on because I think that it can be done in a
21 quicker time frame. There are like limited events for
22 high energy arcing faults. And if we can establish
23 the correct definitions and what goes -- what's
24 considered the blast versus the HEAF, we may be able
25 to accelerate the frequency as well.

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1 Ashley or -

2 MS. LINDEMAN: I think it was Brenda
3 first.

4 MR. GARDOCKI: Brenda, yes.

5 MS. SIMRIL: So I think I know at least an
6 overview of this or a little bit about it. But just
7 to be blunt from the industry perspective, can you
8 give a little bit of a what's in it for us type of
9 feel for being a pilot plant?

10 MR. MELLY: I can give my perspective. I
11 don't know -- I'm not giving an NRC perspective at
12 this moment in time. And based on the initial
13 assessments that I have done using what we have in-
14 house, the results do not look very appealing to where
15 if I was to do this assessment as an analyst in-house
16 without plant resources as to what modeling changes I
17 can make, the numbers would look fairly dire, which
18 will then potentially lead to the risk -- the office
19 implementation stage, leading to regulatory changes.

20 Wherever we end up, I believe from having
21 done this assessment, that if we do have plant
22 involvement, we'll get a much better picture of the
23 risk, which will enhance things moving forward.

24 MS. LINDEMAN: Yes, I guess I'm still
25 confused about schedules. So I know we also talked

1 about the interim ZOI. And to me, this dovetails on
2 Rob's question. If you don't define the scenarios,
3 what are you defining the ZOI for the worst case? So
4 I guess they all need to be thought out in a parallel
5 manner.

6 I know we're working on it but to me I'm
7 just not sure of the schedule. I think that would
8 really help going forward is communicating all the
9 pieces and stuff.

10 MR. MELLY: Yes. And like I said at the
11 beginning, I think that this whole effort, the expert
12 elicitation that we are potentially doing, the
13 frequency, that all will come before pilot plant
14 selections. And we would like to get moving on that
15 in a relatively short time frame to have further
16 discussion on this potential.

17 MR. TAYLOR: What I started to put on the
18 board up here is action items for us to help clarify
19 issues or bring information. And the few things I've
20 put up there right now is GI milestones for all the
21 short- and long-term. It would probably be a good
22 idea to put something together that we can track
23 ourselves to and also communicate clearly on what our
24 expectations are from that program. And Stan
25 mentioned that earlier as well.

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1 And the other thing is just what Rob
2 brought up about the frequency, as well as what Nick
3 brought up on the classification to make sure that the
4 assessment that we do complete is as realistic as we
5 can with the information that we have.

6 Any other questions?

7 MR. MILLER: And I'm not hip on all this
8 stuff at all. So on the GI milestones part, is it
9 also the logical linking between the GI milestones,
10 how they're related and have to be scheduled together?

11 MR. TAYLOR: Yes, right. So that's a good
12 point. There will be. It would make sense to provide
13 some linking to that.

14 Obviously you guys weren't there during
15 all the deliberations but there was quite an extensive
16 discussion within the group of when they came up with
17 that, those milestones, the action plan, the short-
18 and long-term of how things would work. And I'm not
19 sure it got documented or report that well.

20 So I think we'll take that back and try to
21 come up with the milestones, the linking, and other
22 things to help support the GI Program -- proposed GI
23 Program.

24 MR. AIRD: We go to comments from the same
25 commenter before, Ken Z from Jenson Hughes.

1 His first comment is the current industry
2 of PRA results are constrained by methods acceptable
3 to the AGH. I hope the methods that are used to
4 address this GI do not impose the same constraints.

5 And then his second comment is I am not a
6 licensee but it is my belief that in order to get
7 licensees to volunteer, there needs to be some level
8 of assurance that constraints on acceptable methods
9 are not going to be driving results.

10 MR. MELLY: I think that we may be outside
11 of the acceptable methods for this endeavor because,
12 again, this is going to be a risk assessment for the
13 Generic Issues process that's going to be used --
14 that's going to use a zone of influence to predict
15 damage from an expert panel. It's going to be
16 conducted much more in terms of a sensitivity study,
17 rather than something that's going to drive any plant
18 changes for these pilots or things like that.

19 This is only for the Generic Issue Program
20 trying to do a risk assessment. It's going to be much
21 more of a sensitivity study than anything else.

22 MR. TAYLOR: Yes, if I could just add to
23 that. You know kind of what Tom Boyce brought up this
24 morning, I look at the GI Program as basically you're
25 walking a tight line and anything that's going to kick

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1 you out of it, you're going to go somewhere else and
2 do it.

3 So the way that it got structured for the
4 short- and long-term, we want to do this interim
5 review, this interim risk assessment to see whether it
6 is significantly risk significant to take it off into
7 the Regulatory Office for their implementation. So,
8 getting to the question, then, you know the method
9 that we do that interim review in, I wouldn't expect
10 it to be extremely detailed or high level because we
11 just don't have that much information right now to
12 advance the model or the methods that are currently
13 out there.

14 So it would probably be somewhat course.
15 Hopefully, it will be a little more refined than what
16 we currently have but it wouldn't be the final end
17 product that we would then expect licensees, in the
18 end, to implement in their PRA as an approved method.

19 So I guess you kind of look at it as a
20 tool for us to assess risk from an interim standpoint.

21 Any other questions from the room?

22 MR. MELLY: Or any follow-ups from Ken?

23 MR. AIRD: Yes, he has two follow-up
24 comments. It's more than ZOI. It's everything else
25 associated with the examination of the progression of

1 the event. For example, the HGL event is driven
2 because of the burning secondary combustible but we're
3 forced to use the HEAF NSP rate.

4 MR. MELLY: Yes, we're going to be
5 evaluating which aspects of the current zone of
6 influence that's in Appendix M of 6850 or the FAQ on
7 bus ducts as part of that expert elicitation.

8 So anything for the interim risk
9 assessment that we think would need to change from the
10 currently accepted methods will be evaluated from that
11 expert elicitation, moving forward to the sensitivity
12 study. That is the planned path forward.

13 MR. TAYLOR: And just to add you know
14 we're going to be focusing a lot on ZOI because that's
15 your initial explosive area, where you get damage from
16 the initial event. But there is also other
17 assumptions in Appendix M that we need to look at,
18 too. Assuming you that you have peaking release rate
19 as soon as the event occurs, you know that is
20 something that I view as being conservative and
21 there's probably room there to make some improvements,
22 especially from the first phase of testing, where we
23 had the calorimetry equipment taking measurement.

24 Anything else from the webinar? Okay, I'm
25 going to turn it over to Mark Salley.

1 MR. SALLEY: Yes, so we're all like thank
2 you. We understand the relationships and that and
3 what we're trying to work through with a lot of this,
4 it's kind of one equation and five unknowns and we're
5 trying to bring that together, as well as what comes
6 first on this. It would be nice if we had all the
7 testing done, we had a lot of the side pieces of it
8 and we could bring it.

9 Frequency, yes, I mean that's a big one.
10 That's kind of what you're going to see the
11 presentation this afternoon with Kenn Miller, where
12 we're changing horses a little bit and saying not
13 everything is a HEAF and we need to get it into the
14 correct bins for our arc flash, arc blast, and HEAF.
15 And I think that's going to be your biggest driver for
16 frequency so that we can get it right.

17 Again, we're seeing these kind of things
18 as we're moving on. And Ashley, I guess we got the
19 fire events database and we can go back and harvest
20 anything out from that to improve that. So, again,
21 there's a lot of different pieces that we're working
22 toward. These will be the discussions we have this
23 afternoon.

24 We're a little ahead of schedule, which is

25 --

1 MR. MELLY: Well Mark, on that point, we
2 realized we needed additional work in this area
3 because in briefing our internal management, when
4 we're discussing an event, it's well, was this a HEAF.
5 And the answer was it depends. It depends on the
6 damage states and things like that.

7 So the event that we discussed earlier,
8 that Turkey Point event, in the classical way that
9 we've defined it previously for Bin 15, Bin 16 fires,
10 yes, it was an arc. Yes, it held in for half a
11 second. Yes, it created that pressure wave that
12 opened the door. However, there was no fire.

13 So if that event came in for the event
14 review that we've done for NUREG-2169, yes, there was
15 an arc flash. Someone was damaged or someone was
16 injured during the event but there was no fire. So
17 that would have come close to being screened from the
18 event reporting in entirety.

19 So we wanted to find with these
20 definitions how do we bin these better so that we can
21 answer the question of and link it to how we model the
22 events.

23 MR. LOVVORN: Shannon Lovvorn with TVA.
24 I'm at the Browns Ferry Plant.

25 I'm just going to kind of tag on. I think

1 the idea of getting a pilot plant and helping with
2 sensitivity to help you with realistic is a good idea.
3 I think there's certainly conservatisms in what you
4 did.

5 For those of us in the industry that might
6 be -- it would help with that -- you know it would be
7 really important for us to make sure we think about
8 where we model ZOIs for HEAFs versus boring burns.

9 I think at Browns Ferry we have a mixture
10 of some places we did one or the other but it wasn't
11 consistent with every HEAF. So that could greatly
12 influence even the impact result for that pilot plant
13 in a conservative or non-conservative way. In other
14 words, it wouldn't necessarily be representative if
15 you always modeled a HEAF as a boring burn in places
16 where you didn't have a large CCDP and vice-versa.

17 And so it will be important to us on the
18 industry side to think about who has the right
19 modeling and the insights to be a pilot plant to maybe
20 help give you best information.

21 MR. MELLY: Yes, I agree.

22 MR. MILLER: Did you have a comment, Rob?

23 MR. CAVEDO: So I just want to be clear.
24 I'm not expecting the final frequencies that are going
25 to go into a NUREG. But I think for a pilot effort we

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1 can do exactly what you suggested, which is we have
2 fairly good insight about what the HEAF definitions
3 are. And if they are at Turkey Point, then that
4 wouldn't be the one that has the larger zone of
5 influence. That would just be the traditional.

6 So if we could just get the reduction
7 proportional to what we've seen in industry
8 experience, then that would be something that is
9 realistic and would be more easily sold to our
10 management as being able to volunteer for a pilot.

11 Because as I said, I don't think you're
12 going to be able to get anybody in the industry to
13 volunteer for a conservative pilot plant unless
14 they've done something where they always assumed that
15 it was a full room burn and they're going to show no
16 delta risk. And that's not going to give you any
17 insight.

18 MR. MELLY: Exactly.

19 MR. CAVEDO: So anyone who knows that
20 putting in this conservatism is going to show
21 unrealistic results isn't going to want to do it. But
22 if you've got something that's at least in the
23 ballpark of realism, then people will probably
24 volunteer because they want to see how things are
25 going to go early before it becomes something in the

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1 NUREG that we have to put in.

2 MR. MELLY: I agree and that's how I
3 envision the pilot program going, as a collaborative
4 effort so that we can understand the risk and instill
5 realism into the process with the expert elicitation.
6 Like I said, this is a sensitivity study. It's not
7 going to be a hard-in-stone NUREG or telling plants to
8 do something. This is just an effort to understand
9 where the current risk is.

10 So we do have the flexibility to have a
11 collaborative working process here where we can take
12 into account these things.

13 MR. SALLEY: Yes, so again, for the
14 discussion, Gabe's going to have a little bit I guess
15 this afternoon, Gabe, on the zones of influence or are
16 you tomorrow?

17 MR. TAYLOR: The modeling today.

18 MR. SALLEY: The modeling. So yes, this
19 afternoon Gabe's going to talk a little more about the
20 zone of influence.

21 And also don't forget about where we lock
22 into that three-foot, five-foot, some dimensional zone
23 that when we're talking about the conductive cloud,
24 that may be a whole different type of zone of
25 influence we need to keep an open mind to is the right

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1 way to do it. So again, don't put yourself in a
2 corner.

3 With that, I guess we're ready to take a
4 break for lunch here. It's ten to 12:00. We've given
5 I think an hour and 15 minutes for lunch. So if
6 people could be back at 1:15 downstairs in 2 White
7 Flint and we'll get back up here and get started at
8 1:30.

9 Now, if you're not familiar with the area,
10 a couple places you can go. When you go out the front
11 of the building, there's fast food across the street.
12 There's a McDonald's and Arby's. Then there's a
13 Mediterranean place.

14 Going the other way, there is a Harris
15 Teeter. Nick, you're going down to Harris Teeter?

16 MR. MELLY: I've got to do this here.

17 MR. SALLEY: Gabe is going down. So if
18 you guys want to go down to Harris Teeter with Gabe,
19 he can walk you down. We've got a few escorts here to
20 get you there.

21 And Mark Earley, if you could hang around
22 for a minute and talk with Kenn and I, we're going to
23 do some changes on the next presentation.

24 So with that, let's take a break. Let's
25 pick it back up at 1:30 Easter Time. And we're off

1 the record.

2 (Whereupon, the above-entitled matter went
3 off the record at 11:50 a.m. and resumed at 1:40 p.m.)

4 MR. SALLEY: Are you guys ready?

5 MR. MELLY: All right. If everybody's
6 ready, hold on a minute. You're going to want the --

7 MR. SALLEY: What do I want? Oh, the
8 microphone.

9 MR. MELLY: Yeah. The dead microphone.

10 MR. SALLEY: All right. For those on the
11 webinar, we are going to get started again very
12 quickly. I'm Mark Salley, and I'm going to open it up
13 real quickly.

14 Again, I'll have clarification on that
15 power plant discussion.

16 (Off-microphone comments)

17 MR. SALLEY: Okay. So, we'll welcome
18 everybody back here in the second half after lunch.
19 And we'll get started again.

20 A little clarification this morning on the
21 pilot piece. And we understand your concerns on that.

22 And we're looking at some of the questions
23 especially what Kenny had sent in via the webinar. As
24 we're talking about the pilot, you could actually
25 think of two pilots, okay?

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1 The pilot that Nick is referring to is the
2 piece that we need for the generic issue program. So,
3 that's the pilot there.

4 As far as if we develop the new method or
5 a new way to address the zone of influence or
6 whatever. That would be a totally different pilot.
7 And that's three years out.

8 So again, with the piece that Nick was
9 talking to here, was the piece that we need for Stan
10 to do the risk assessment and the generic issue.

11 So, they're two different pilots there.

12 MR. MELLY: Yeah. And with the part
13 associated with the generic issues process, it's much
14 more of a sensitivity study to look at the risk.

15 When we're looking at down the road after
16 the test program is complete, and potentially piloting
17 a new method for evaluating higher arc for both copper
18 and HEAF in a more dynamic approach that's not one
19 size fits all.

20 That's down the road three years for in
21 align -- it will be on the line with a new
22 methodology. An improvement upon 6850 Appendix M, as
23 well as the guidance that's in the back contract.

24 MR. SALLEY: And you know, a lot of these
25 programs, a lot of these ideas, a lot of these

1 concepts, a lot of these things that we're working on,
2 they're really moving in parallel.

3 I mean, the testing is a big one. And
4 that's a big part of it. But it's moving in parallel
5 with a number of other issues.

6 You know, case in point, the talk that
7 Kenn Miller is going to give you right now is
8 something that we alluded to earlier in Nick and
9 mine's presentation that you just don't have thermal
10 fires and HEAFs, okay.

11 There's a whole spectrum in between here
12 with arc flash and arc blast. And this is something
13 we really want to redefine it, so that we get things
14 properly identified.

15 And then we can get the proper frequencies
16 to it. And once we get that, we can then develop the
17 appropriate risk to the zone of influence.

18 So these are things that we've learned
19 from some of the fire PRA realism workshops. Some of
20 the thing we saw with 1015 and the ZFI plant, going
21 through it. And a number of those things.

22 So again, this program is dynamic. And as
23 we see something and we learn something, just like we
24 did in the testing, you know, we stop it. And we make
25 the correction and we move on.

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1 So again, when we looked at Bin 15 and Bin
2 16, we saw that wasn't going to get it. We reached
3 out to the NFPA, Mark's going to have a -- Mark
4 Earley's going to have a talk a little later.

5 And this is where we want to get the
6 refinement. So, to be able to do that one of the
7 first things we said, you guys all work from codes and
8 standards.

9 You've got to be able to define it to
10 understand it. If you can't define it then it's hard
11 to move forward. So definitions become very, very
12 important.

13 Any standard you pick up, any NFPA
14 standard or code, the first thing you see in the first
15 chapter is what? Definitions. When I say AHJ, this
16 is what I mean. When I say fire resistant, this is
17 what I mean.

18 So again, as we move into this high energy
19 arc faults and the arc flash, I think we need a real
20 clear definition so we know what we're talking about
21 and what we mean. Especially when we tie that to
22 risk.

23 So, without further ado, I'm going to turn
24 it over to Kenn Miller. And Kenn's going to take it
25 from here.

1 MR. MILLER: Yeah. Thanks Mark.

2 MR. SALLEY: Um-hum.

3 MR. MILLER: That's slide one. So as Mark
4 said, we took a stab at several items to define, again
5 for the purpose of common understanding.

6 First five up there. You can go to the
7 next slide. And then the three different, you've got
8 fault arc. Arc fault severity classifications.

9 And so again, I'm going to present to you
10 some proposed that we've come up with so far, proposed
11 definitions for these terms. And the idea is to
12 gather input from you folks, from the industry, from
13 our counterparts, and hopefully get to a good
14 definition that we all agree to.

15 And then if we can use as terms of
16 understanding and directing the research we're talking
17 about here. Go to the next slide.

18 So the first one here, arc or electric
19 arc. And you see the definition we've got here. An
20 arc is a high temperature luminous electric discharge
21 across a gap through a medium such a -- such as
22 charred insulation.

23 This term does happen to be defined in
24 NFPA 921. One of its definitions. Next slide.

25 The next one is arc flash. Arc flash is

1 a release of energy caused by electric arc,
2 characterized by a rapid release of thermal energy to
3 the vaporization and ionization of materials by the
4 arc.

5 This one was developed from NFPA 70E out
6 of the definition of an arc flash hazard. The term
7 itself wasn't defined. But kind of pull it from that.

8 Another note about it, when electrical
9 protective systems as designed, the arcing event is
10 typically loaded to a flash on the order of cycles
11 rather than seconds, depending on breaker subpoints,
12 or protective relay subpoints.

13 Arc flashes typically are associated with
14 self-extinguishing fire events.

15 MR. MELLY: That means these things that
16 you're seeing under here in the notes are our takes on
17 trying to match the classification and the definition
18 that we have with somehow how we treat them in PRA
19 space or modeled space.

20 So how we bend these and how we put them
21 put them on the report in the model mode.

22 MR. MILLER: Yes. Next slide. And we go
23 to arc blast. An arc blast being a rapid release of
24 thermal, mechanical, and acoustical energy caused by
25 a rapid heating and vaporization and ionization of

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1 materials resulting from sufficiently energetic arc
2 flash.

3 Arc blasts are more energetic than flash
4 events depending on electrical characteristics of the
5 system during the initiation event. Such as phase
6 angle current voltage characteristics.

7 This definition was also developed out of
8 NFPA 70E, although it wasn't defined specifically.
9 There's an affirmative Annex K4 that talks about
10 blasts.

11 Again arc -- and again, going back to the
12 PRA factors for it, arc blast can cause room over-
13 pressurization effects that could potentially lead to
14 missile damage effects from thrown equipment or
15 enclosure material.

16 Arc blasts are associated with flashes.
17 But not all flashes are blasts. And arc blast events
18 still occur when electrical protective systems work as
19 designed.

20 Next slide we've got goes to the HEAF. We
21 see our HEAF here, we've got a high energy arc fault,
22 it's a type of arc flash that persists for an extended
23 duration.

24 That duration indicative of a level of
25 circuit protection failure and/or protection design

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1 flaw. One of the comments we had early on, we had set
2 in there typically two seconds or less.

3 And it's kind of hard to, you know, pin
4 down an actual time. So, I changed the definition
5 just to say tying back to the premise that, you know,
6 the HEAF is probably due to some failure in the
7 protection circuit.

8 High energy arc faults are typically
9 associated with events contingent with a failure or
10 lack of circuit protection or adequate circuit
11 protection coordination.

12 High energy arc faults are associated with
13 arc flashes. But not all flashes are high energy
14 arching faults.

15 High energy arching faults may produce
16 varying levels of arch blast.

17 MR. MELLY: Yeah. And this issue of
18 duration that Kenn was talking about has come up on
19 several of our phone calls with NFPA, IEEE, and other
20 folks because the duration is very important to the
21 overall damage sustained.

22 In a lot of literature and for safety
23 personnel protection you'll see two seconds listed in
24 a lot of places. And we've been kind of digging into
25 where that two seconds comes from. And it's nowhere.

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1 It was generally defined from certain
2 people that were talking about is that's the typical
3 reaction time for a human hearing a blast event and
4 being able to react. And it was a general time frame.

5 So, there was no duration that we could
6 pinpoint as to what duration ties back to the amount
7 of energy released. And that's still something that
8 we're kind of working towards right now.

9 And that ties direct specs into the test
10 program as to what's the minimum duration that we are
11 going to be testing it at now. It gets to a lot of
12 the comments that we'll discuss tomorrow for the test
13 program.

14 MR. MILLER: You know, and again in terms
15 of, you know, protection system functioning, you know,
16 we're used to those kind of systems performing in
17 cycles versus seconds.

18 So, you know, a long duration is typically
19 indicative of some failure of some kind. A relay
20 failed, or a breaker's stuck, or the design itself is
21 flawed.

22 So, again that being a -- that failure
23 being a contributor to the creation of the HEAF. Next
24 slide.

25 So then breaking down a HEAF into three

1 different classes. The Class 1 damage is contained
2 within the general confines of the component of
3 origin.

4 These events are associated with minor
5 damage and minimal bus bar degradation from melting or
6 vaporization. So this will be the lowest level HEAF.

7 Next one, Arc Fault Class 2, at arc blast
8 or HEAF.

9 (Off-microphone comments)

10 MR. MILLER: This damage is contained
11 within the general confines of the component or
12 origin. However arch blasts have to the potential to
13 damage surrounding equipment through pressurized
14 effects, sever equipment defamination for doors to
15 create fire barriers.

16 Typically, they do not create ensuing
17 fires. Typically associates with the design and
18 electrical coordination breaker performance.

19 Pressure effects are highly dependent on
20 route configuration and electrical characteristics of
21 the event. So that's the medium level.

22 And the Arc Fault Class 3, damage includes
23 the component of origin as well as spread to
24 surrounding equipment within the fire zone.

25 This damage includes pressurized effects

1 on a severe equipment deformation from doors, degraded
2 fire barriers, which protect -- potentially can affect
3 equipment in other fire zones or in an electrical
4 world, other separation groups or divisions.

5 These events are typically contingent with
6 ensuing fire conditions. Typically indicative of a
7 level of circuit protection failure and/or design flaw
8 allowing for extended duration arc events.

9 And pressure effects are highly dependent
10 along the room configuration and electrical
11 characteristics of the event.

12 MR. MELLY: And in terms of what we've
13 been discussing earlier as to redefining these per
14 PRA, like right now we are trying to overall create a
15 definition that's not just nuclear specific.

16 But in terms of how we would use it in the
17 PRA community as well as nuclear. You can think of
18 Class 1 being -- Arc Fault Class 1 typically those
19 events would be included in the Bin 15 fire events,
20 where it's just the component of origin.

21 Class 2 and Class 3 are typically right
22 now how we look, or how we're classifying HEAFs. And
23 we want to make a specific effort to separate those
24 events which do not have this larger zone of influence
25 of damage from the ones that have potential pressurize

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1 effects.

2 So hopefully that will marry up with the
3 methodology on how we treat these events. We want to
4 be able to split the frequency, align the frequency
5 definition and the methodology.

6 And this is our attempt to do that and
7 align with the definitions.

8 MR. MILLER: So this next slide shows the
9 three arc fault classes and some pictures of, you
10 know, examples of each type. And some description of
11 the two levels, three levels.

12 MR. MELLY: Yeah, and again, you can tell
13 from the pictures here, we actually pulled these
14 events directly out of the fire events that constitute
15 the frequencies currently.

16 You can see that -- I pulled some of these
17 from Bin 15 fire events. And you see that there's
18 largely damage to the internal components.

19 There's some material degradation of the
20 bus bar stubs itself from the fault. But usually,
21 very limited duration of protection scheme works.

22 So you'll see smoke damage and potentially
23 the initiation of a small fire which may or may not
24 self-extinguish.

25 The Class 2 that we're talking about are

1 these ones that can have the pressure effects to the
2 room. Possibly contingent with a fire as well.

3 However, the fire that would be associated
4 with these Class 2 events, we wouldn't initially say
5 that it's at the 98th percentile of the heat release
6 rate curve at time T equals zero. So that's another
7 differentiation that we'd want to do to the method.

8 Then these Class 3 fires are what you
9 typically associate with how you're thinking of higher
10 arching faults that make Appendix M methodology. And
11 the -- and Supplement One to NUREG 6850 in the FAQs
12 for bus ducts.

13 So these are the larger damaging events
14 that have the ensuing fires. And the classical zone
15 of influence of damage outside the cabinet.

16 And so, visually it helps to picture what
17 these types of classifications look like.

18 MR. MILLER: And the last slide. Then the
19 last definition, electrical enclosure thermal fire.

20 Thermal fire is an electrical enclosure
21 fire in which the electrical unit does not
22 significantly contribute to the heat release rate of
23 the fire. Rather, the heat release rate is determined
24 solely by the chemical energy released by combustion
25 of the cabinet's contents, and classical fire

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1 dynamics.

2 MR. MELLY: And these would be the type of
3 fires handled through the Helen Fire work and the
4 Rachel Fire documentation.

5 MR. MILLER: So, again, our intent was to
6 put these up on the board for you all to see. And I
7 guess if there are any comments that you wanted to
8 provide to us at this point.

9 Or, you know, a day to think about them.
10 As we're doing stuff tomorrow, we can also revisit the
11 definitions once you've had a chance to think about
12 it.

13 But, that was the purpose of the
14 presentation. Yes?

15 MR. RHODES: Yeah, I'm Bob Rhodes from
16 Duke Energy. On your definitions, you need to put a
17 clarifier on there.

18 Because I can read your first one there
19 for the arc flash, and get down to an electrical
20 failure on 108 or 122/40 to a 36/18 volt transformer
21 inside a Hoffman box that nothing ever came out except
22 a little whiff of smoke.

23 And by that definition, I'd have to call
24 that an arc flash.

25 MR. MELLY: That's a good comment. We

1 currently do not have voltage electrical
2 characteristics built into this.

3 But that maybe something that we want to
4 do for threshold limits.

5 MR. RHODES: Voltage and power -- I'm
6 sorry. Voltage and power release or something like
7 that. Because I'm dealing with one of those right
8 now.

9 I'm trying to decide if that's an IMPO
10 reportable. And with that I'd have to classify it as
11 at least an arc flash.

12 MR. MELLY: That's a good comment.

13 MR. TAYLOR: Yeah. And I think their
14 original definition in 6850 is 440?

15 MR. MELLY: The original definition for
16 HEAF 440, we have seen indication from OPE
17 internationally that there was a higher arching fault
18 as they classified it in a 380 voltage piece of
19 equipment in Germany.

20 That is in the International Operating
21 Experience topical report. That was also one of the
22 larger comments from the international community, to
23 try and investigate the threshold of how low we can go
24 and actually create one of these events.

25 That becomes a little challenging just

1 because of the amount of resources you have to put in
2 for one test. That performing lower and lower test
3 voltages to get a threshold, eats up a lot of our
4 budget for actual testing.

5 So, it's something that we're considering.
6 But I don't know if it's necessarily going to be part
7 of this next test phase.

8 MR. FUNK: Dan Funk, I have a question.
9 Just a couple of points. On the two second that you
10 had brought up, I think I could be wrong here, but
11 that the basis of that was for IEEE applicable, IEEE
12 standards, mainly C37.

13 That's the basis for everything. For the
14 withstood rating of all the enclosures. So if you go
15 beyond two seconds with high energy, basically you're
16 out of warranty if you will.

17 MR. MELLY: We have --

18 MR. FUNK: And no guarantee that
19 mechanically that the switch here is going to stay
20 together. And then all bets are off.

21 MR. MILLER: Yeah. That's kind of getting
22 to what we were -- what I was saying earlier about
23 that, you know, in the protection world, two seconds
24 is an eternity.

25 And I can see why IEEE would assume two

1 seconds is the upper bound.

2 MR. FUNK: And that's the second -- in
3 cycles, a few cycles, five to ten cycles --

4 MR. MILLER: Right.

5 MR. FUNK: For your primary trips. So if
6 you're at 120 cycles, something's really, really
7 wrong.

8 MR. MILLER: so C37.

9 MR. FUNK: ANSI C37.

10 MR. MILLER: Yeah. Okay.

11 MR. FUNK: I would suggest getting
12 familiar with those. They will probably be fairly
13 helpful.

14 MR. MILLER: Yeah.

15 MR. FUNK: One other quickie on the
16 threshold. It could be -- again, I was not on this
17 committee, but the Arc Flash Committee, 1584 for IEEE,
18 and I know going all the way back to the 1970s when
19 they started requiring arc fault protection for large
20 load centers.

21 MR. MILLER: Um-hum.

22 MR. FUNK: There was a tremendous amount
23 of research that was done on the threshold for a
24 sustained arc. And so instead of retesting, you might
25 do a good literature search on that.

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1 And I know there's some really, really
2 good information out there.

3 MR. MELLY: That's a good comment. Any
4 more questions?

5 MR. MILLER: There's one up here. He was
6 next. This guy here was next. Mark was next.

7 MR. TAYLOR: Mark Earley, NFPA?

8 MR. EARLEY: Yeah, thank you. This is one
9 aspect of our program that we're doing a little bit
10 more work on.

11 Because we've done some tests at the lower
12 end. And had situations where we couldn't sustain it.

13 And now we're just trying to explore the
14 floor. And that is in the -- coming into the next
15 phase of our program.

16 So, we weren't convinced that the material
17 already out there in, was conclusive enough. Thank
18 you.

19 MR. MILLER: By floor you mean voltage or
20 energy?

21 MR. EARLEY: Yeah. The floor at which you
22 could sustain an arc. And I recognize that, you know,
23 there might be some qualifying conditions that make it
24 sustainable. Thank you.

25 MR. MILLER: Um-hum. Oh, Ken Fleischer

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1 had one.

2 MR. TAYLOR: Next comment from Kenneth
3 Fleischer.

4 MR. FLEISCHER: Yes. This is Ken
5 Fleischer from EPRI. I wanted to just leverage off of
6 what Dan Funk said.

7 Actually, there are switch gear standards.
8 They're two seconds. And circuit breakers are three
9 seconds.

10 And I can trace back to some of the IEEE
11 standards to help support that. That was actually in
12 our official comments on the draft test plans. So
13 they're also in there as well.

14 The second item too, in regards to the
15 high energy arc flash definition, I offer up that for
16 consideration when you talk about typically related to
17 lack of protection or circuit protection failure, I
18 recommend saying multiple circuit failure protection.

19 Because typically, when you start getting
20 into seconds, it means both your primary and your
21 backup probably failed.

22 MR. MILLER: Um, yeah.

23 MR. FLEISCHER: So, I would consider
24 multiple. In fact it gets into other things about
25 what are HEAF events.

1 Most of what I read appeared to be failed
2 multiple barriers on multiple accounts. And failed
3 protection, failed -- inadequate maintenance design
4 flaws, and human operator events.

5 So, I would think that even maybe adding
6 that as well considering multiple -- a failure of
7 multiple barriers.

8 That's all I have.

9 MR. MILLER: thanks Ken. Anybody else?

10 MR. TAYLOR: Bob Daley, Region II.

11 MR. MILLER: Mr. Daley.

12 MR. DALEY: Mr. Miller.

13 MR. MILLER: Be good now.

14 MR. DALEY: I'm just looking at your --
15 you've got these -- you've got the different
16 classification.

17 Then you go to the very last slide, which
18 talks about electrical enclosure of thermal fire.

19 MR. MILLER: Yep.

20 MR. DALEY: Well, what do we -- what was
21 your -- what was the purpose for including that? And
22 what are we talking about?

23 Are you talking about like low, or very
24 low energy and control circuits? Is that what we're
25 talking about there?

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1 Or are we talking about something else?

2 MR. MELLY: No. The --

3 MR. MILLER: I think this more about the
4 fire then --

5 MR. MELLY: Yeah. The reason that we
6 included this was just to be all encompassing for all
7 of the ends that we're talking about. What can happen
8 in an electrical enclosure.

9 And the regular thermal fire the way that
10 we treat it through the fire growth, heat release rate
11 profiles. We were trying to clean up and make sure we
12 had a definition or all our treatments.

13 This one may or may not be necessary in
14 the overall definition if we're going to focus in on
15 the arching behavior.

16 MR. DALEY: Yeah. Because the only --
17 really, I mean, a lot of this has. But if you're
18 talking about low energy control circuits and that,
19 then you're probably talking primarily just, you know,
20 talk about insulation type fires.

21 But when you start getting into anything
22 that's got something with higher energy on it, you're
23 getting into some combination of, you know, insulation
24 and electrical. Even if it starts with the
25 insulation.

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1 MR. MELLY: Right.

2 MR. DALEY: You know, or a combination of
3 both.

4 MR. MELLY: This was more trying to get to
5 that image that was during Mark's presentation of the
6 two potential paths for an electrical enclosure fire.

7 You have your thermal typical fire
8 associated with Helen fire, Rachel fire, as well as
9 the 6850 heat release profile treatment. Then you
10 also have this separate risk driver, which is the high
11 energy fault -- the faulting cases.

12 So this one may or may not be necessary.
13 But to be all inclusive, we included it here.

14 MR. MILLER: Other comments at this point?

15 MR. TURNER: I have a comment on it.

16 MR. MILLER: Okay.

17 MR. TURNER: I'm Steve Turner. I do a lot
18 of testing work. And we struggled with this a lot
19 too. How bad can things get and how to classify it.

20 I think one of the things you guys might
21 want to consider is you touch on a couple of things
22 here like this. Let's go back to hazard analysis 101.

23 I'm trying to figure out how bad the
24 hazard is with the potential. We can always relate it
25 to energy. Right?

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1 And ask for every height, how high is the
2 brick off the floor? If you can relate these to
3 energy somehow and you captured it some with the
4 duration thing here.

5 This makes something happen. But as
6 they're defined now, I can sort of see how to Bin it
7 in this category once it has occurred.

8 If I'm trying to analyze my plant, I've
9 got to think about the potential in some other way.
10 These kinds of subjective, this has been, that's been,
11 doesn't work.

12 So if you can relate it to energy, I think
13 that would help. Because for example, it relates a
14 little bit to Kenn's question. My energy is this by
15 the time the primary circuit fails.

16 But the secondary circuit that's in two
17 seconds. Now the energy is higher. And my HEAF is
18 worse. But my frequency is a lot lower.

19 So if we can get back to where we're
20 talking about energy, I think that helps a lot. And
21 your one definition for high energy arching fault, you
22 mentioned the duration.

23 But you could be having an arc maybe just
24 because a contact didn't close. So my arch's over two
25 inches. And my arc voltage is going to be so low that

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1 my energy is going to be pretty small.

2 And so duration itself doesn't capture it.
3 What we found after testing, I'll need to drop back
4 one.

5 The hard part about calculating what the energy
6 is, is we all know how to do a short circuit
7 calculations to figure out what our shorting current
8 is. So current's easy.

9 The hard part is, it's harder to do the
10 duration. And it's really hard to do the voltage.
11 Because the voltage really depends on the gap or
12 whatever decides to be arching.

13 And you can't predict that very easily.
14 And you can find that even in the tests where we set
15 it up a certain way. Predictably, I don't get the arc
16 voltage I'm looking for.

17 So the arc energy calculation is hard to
18 do. But even as random as arcs were, one of the
19 things we found out in our Japanese tests, and I think
20 they're leaning toward classifying what do we do about
21 this?

22 When is this a problem is, when we ran a
23 bunch of tests and what the point that we get internal
24 fires in the ca -- inside the cabinet.

25 And we ran a whole bunch of tests with all

1 sorts of configurations. And all sorts of currents
2 and all sorts of supply voltages, and ended up being
3 arc voltages too.

4 We pretty much found out if you didn't
5 have at least 25 megajoules in the cabinet, you
6 couldn't set the cables on fire.

7 Now so to them what they're doing, is
8 they're going back and they say okay everybody, don't
9 calculate your protective circuits. And if you get to
10 25 megajoules, you have to do something.

11 But if you're below 25 megajoules, we
12 don't think you get the cabinet for fire on this.
13 Kind of simplistic. More deterministic and not quite
14 what we need for the PRA world.

15 But, you've got to give us something to
16 calculate. These definitions I think are great once
17 we look at the picture and say oh yeah, that's a Class
18 2 because this happened and that happened.

19 Well, I'm trying to put down predicting
20 something in the PRA.

21 MR. MELLY: Yeah, but --

22 MR. TURNER: If you just go back to
23 energy.

24 MR. MELLY: I think you're two
25 presentations ahead of us right now.

1 MR. TURNER: Okay.

2 MR. MELLY: But we're going to be
3 discussing how we are going to be potentially using
4 the information of the test two and test one program
5 to create a dynamic model based on the parameters,
6 energy duration that configure to your plant.

7 That is absolutely where we're potentially
8 going to go with this. However, for the definitions
9 piece, I'm not sure about if we want to tie in the
10 energy levels there.

11 We can look at that. However, this is
12 more for binning the frequency once the event has
13 already occurred. We were in that mind set.

14 But it maybe something we can look into
15 whether an energy level can be directly tied in here.

16 MR. TURNER: If you're doing your binning
17 kind of based on this and looking to experience base
18 out there, you may not have enough duration data.

19 But, can you go back and calculate the
20 energy for those events? And be able to put on these
21 slides these were generally 25 megajoules to 40
22 megajoules in the --

23 MR. MELLY: Not from the operating
24 experience data.

25 MR. TURNER: You can once you do your

1 experiments containment.

2 MR. MELLY: Right.

3 MR. TURNER: But I think -- I think you
4 might end up having something a little fortuitous like
5 we had on our internal cabinet fires. Like hey, 25
6 megajoules seemed to be the magic number to fit.

7 We've got enough data points now that
8 they're actually regulated to that. But, I just feel
9 like when we're doing actual analysis and having this
10 sustaining effect that hazards 101 and say hey, what's
11 the energy you're dealing with?

12 That's how you look at the severity of any
13 hazard you have.

14 MR. MILLER: So you have an energy value
15 for Class 1, Class 2, and Class 3.

16 MR. TURNER: Yeah.

17 MR. MILLER: Successfully higher.

18 MR. TURNER: Yeah. And then that way when
19 people can -- that's actually something people can
20 calculate, because I think you'll get enough data
21 where even though it's very difficult to predict what
22 the arc voltage will be, probably for certain sizeable
23 equipment.

24 Say hey, it's medium voltage, you should
25 be having 700 to 1200 volts that you could put in as

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1 a distribution if you wanted to.

2 And the duration you could relate back to
3 the failures that we're taking about. You know, your
4 primary system this fast. And now your secondary
5 system acted that fast.

6 So, regardless of what the arc wanted to
7 be in duration, you can just let it go. As long as
8 you're protected from circuit response that everybody
9 knows how to do.

10 Let that be your duration. Give the
11 energy levels, put in these bins. That's why I was
12 commenting on cancelling.

13 When you look at your secondary system,
14 that might let it go three seconds. But that's a much
15 lower frequency.

16 So you might still be on the good side of
17 analyzing HEAFs. So, let's just go back to energy if
18 we can.

19 I think it just makes me feel like it's
20 more bounded in something quantitative than just these
21 observations of well, that was a lot of energy, and it
22 hurt this more than this. Or this door blew open.

23 If you relate it to energy I think that it
24 won't override the standby. And things that people
25 can kind of calculate.

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1 MR. MELLY: Yeah. Thank you.

2 MR. TURNER: Ahead of time.

3 MR. MILLER: One of these presentations
4 will be touching on that.

5 MR. TURNER: All right.

6 MR. MILLER: I think it's two
7 presentations.

8 MR. TAYLOR: Any comments on the webinar?

9 MR. MELLY: Just speak louder.

10 MR. MILLER: So any other comments or
11 input? Like I said, when we get into the other
12 sessions, if something comes up on definitions, we can
13 always take additional as you think, had a chance to
14 think about it.

15 MR. MELLY: And for this specific topic,
16 we have provided the full working list right now of
17 what is in here. And I know that we have had previous
18 calls with NFPA and IEEE. FM has also been included.

19 If we -- if you have any written comments
20 or anything that you would like to provide on this
21 Word document or a write up in either pdf or Word
22 format, that would be greatly appreciated. And we
23 would take those and try to work with those comments.

24 MR. MILLER: Let's see, I guess next we've
25 got small-scale testing. That's next? Is that next?

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1 MR. MELLY: Yeah. That's good.

2 MR. MILLER: Okay.

3 MR. TAYLOR: Okay. I'm going to stand up
4 if that's all right. My name is Gabe Taylor. I'm in
5 the Office of Research.

6 And what I want to go over here is the
7 stuff that we're doing out at Sandia National
8 Laboratories. And it's the small-scale testing
9 program.

10 It's a little different than what we
11 typically do in the fire research area where we do
12 testing. On account of especially when we look at
13 circuit analysis, we do small-scale and a lot of data
14 all effectively.

15 And then we go too large-scale and make
16 sure that the small-scale results match up with more
17 realistic type of thermal environments and what not.

18 So, here it's a little different. And
19 really, you know, why -- why are we looking at small-
20 scales? It really comes into the aluminum aspects of
21 these events.

22 The exothermic energy that we're getting
23 from the aluminum, we want to better understand that.
24 And one way that we can do that is by controlling the
25 variables in the experiments that we are going to

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1 perform small-scale.

2 Large-scale is not saying we can't control
3 experimental variables like voltage, current, or
4 duration, those sorts of things. But when you look at
5 the large-scale testing, we'll talk a little bit about
6 this tomorrow, our instruments have to be in the right
7 spot.

8 All right, so if your instruments on the
9 front of the gear and the arc blows out the side and
10 you don't have instruments there, well then you're
11 missing what you really want to capture.

12 So when we go small-scale, we can really
13 focus our instruments and get in closer to the arc.
14 And characterize not necessarily the arc itself, but
15 here we're more interested in the particles.

16 The aerosol and the different types of
17 vapor and molten material that's coming out of the
18 possible material. And the real reason why we're
19 interested in that is we want to understand what is
20 causing this extra energy from the -- when aluminum is
21 involved in these types of events.

22 So, it's a little different from what
23 we've been doing in the past where we're trying to --
24 we use scale experiments to try to get the same
25 results.

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1 Here, what we're doing is we're trying to
2 work with the University of Maryland, Dr. Jose
3 Trojero. And to develop a model that can predict or
4 estimate the amount of energy coming off of these
5 events from the aluminum reaction due to the particle
6 morphology and size of the particles.

7 So what we're trying to learn from the
8 experiments is listed on slide three. We're trying to
9 understand particle sizes, the distribution of
10 particle sizes.

11 How fast we're producing the particles at
12 a certain rate. Composition, morphology, degrade of
13 oxidization, as well as the trajectory.

14 One of the thoughts with the model was
15 that as the -- as you get further and further away,
16 the particles change. They coagulate. The morphology
17 is different than when they're close into where the
18 arc is.

19 And as they get out there's going to be
20 less and less energy that they're going to contribute.
21 So the trajectory is also important.

22 From this we're also going to take some
23 mass loss measurements that may help identify how much
24 mass is lost that can then be correlated to an energy
25 release. Probably need a small-scale event.

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1 So, how are we going to do this? Sandia
2 National Laboratories has a lightening simulator where
3 they've been looking into different types of
4 electrical discharges.

5 And they have a lot of toys out there that
6 are very high speed sophisticated that can
7 characterize the materials and the particles. So,
8 we're going to collect high speed videography, up to
9 five hundred -- or five million frames per second.

10 We probably won't need that type of
11 capability. But one million frames, maybe two hundred
12 thousand frames per second with neutral density type
13 filters so we can actually see the particles that are
14 coming off of the arc and off the bus bars.

15 And then they come right after their super
16 computers and come up with the trajectory speeds for
17 the different particles.

18 We'll also have a proof of concept type of
19 program with this small-scale. Is out there.

20 And I'll show you later one, but there's
21 black carbon tape and silicon aerial gels that will be
22 used to capture the particles. And once they capture
23 the particles they can then take it to their type of
24 spectroscopy and scan electron microscope tools to
25 then analyze the particles.

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1 So what we want to do here is test out
2 those processes, those post-test analytics to see if
3 they work. If they can characterize the particles.

4 If they do, then we want to employ it when
5 we go up to do the full-scale testing. To capture
6 that -- those particles and make sure it's the one to
7 one comparison.

8 To help support the model that we hope to
9 have from the University of Maryland. Next slide.

10 So here it is a picture of the
11 experimental stuff as well as the illustration that
12 was in the test plan. I'll get to the test plan in a
13 few slides.

14 But basically from the photo you can see
15 two vertical bus bars there. So, the arc will occur
16 near the top.

17 Because they're vertical, the thermal will
18 quickly shoot, you know, off and away. So, the arc
19 will be initiated there by a thin film -- or a thin
20 filament, it's basically a shoring wire that we use in
21 the full scale. But a thin filament here.

22 And then they have cameras at different
23 angles. So you can see a camera there. There's one
24 looking down. Here's one looking in this direction.

25 So on three axes there's high speed

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1 cameras. And then what's not shown here is where
2 they'll do the particle collection.

3 They usually get it pretty close to the
4 bus bars. They ran some shakedown tests, we like to
5 call them, just to make sure that they can capture the
6 particles, their systems are working and get the
7 information that we really want to do before we go and
8 actually do the tests.

9 The testing's not the expensive piece.
10 That we may can do probably 20 or 30 tests a day. The
11 expensive piece is the post-test analysis for the
12 material and their high tech equipment and post-
13 processing. Next slide.

14 So now we talk about some of the
15 experimental variables. We can -- now I have a test
16 matrix later on that I want to spend a little bit of
17 time on, getting your feedback on.

18 But, we can get a wide range of voltages.
19 Right now we're proposing those voltages, 48kV and
20 then some medium voltage, .48kV up to 10kV. And
21 currents at any range from .35kA up to 29kA.

22 One thing that we're limited on is
23 duration. So unlike the two plus seconds that we
24 probably be in authority at the KEMA facility, here
25 we're limited to milliseconds, is what they can do.

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1 And they're also making some modifications
2 to their power system to be able to get a tenth of a
3 second duration. So, it is quite limited on what the
4 duration is.

5 But, those durations, even with the 40
6 milliseconds, it's long enough to create the plasma.
7 And to emboss on aluminum from the bus bars.

8 And from their analytics they can then
9 look at the particles and tell whether it's the
10 filament or the actual bus bar that they're analyzing
11 on the particle side.

12 Bus bar material, we want to -- the focus
13 of this is on aluminum. But we want to also include
14 copper to get some comparisons.

15 Here's the current text matrix. And this
16 is what you've seen in the test plan. I basically
17 went over these on the previous slide.

18 But again, about 20 tests in total.
19 Varying voltage current, time and materials. Has
20 everybody been able to see this before? Are you
21 familiar with this?

22 So, here we can just get into this right
23 now. Going for a little bit due back and after the
24 meeting, or even tomorrow, you guys are welcome.

25 But certain things that, you know, kind of

1 came in towards the end of the development, the test
2 point is looking at DC.

3 Now on the DC case they're limited only
4 300 amps. Basically what kind of, you know, welding
5 type apparatus to perform that.

6 If you look at the Op E, there's not much,
7 if any, information on DC arcs. I'm not saying that
8 they can't happen or they aren't significant when they
9 do happen that that lasts awhile.

10 So you know the question that I'm
11 basically posing is, is it worth our time looking at
12 DC? And if it's not, can we reposition some of those
13 tests to get more replicates in other areas?

14 MR. VERHOEVEN: Hello, Bas Verhoeven from
15 KEMA. You talk about on durations of four
16 milliseconds. And how do I prepare that? Because you
17 call around as an AC.

18 Good. But in this time frame it is just
19 some kind of DC like current?

20 MR. TAYLOR: Right. Yes It is a DC
21 current. So these are -- these voltages are scale.

22 So basically on the wave form you're not
23 getting any so at least for these short durations.

24 MR. VERHOEVEN: And how is Sandia making
25 this change of current? Is a bus for a conductor

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1 running things?

2 MR. TAYLOR: So they have an MD set. And
3 they have a conductor and capacitors set up to provide
4 the source.

5 Question from EPRI?

6 MR. FLEISCHER: Yeah. Ken Fleischer here.
7 This maybe just more of an observation on the table.

8 It looks like items 8, 12 and 16 don't --
9 doesn't say which one's an AC or a DC test. The
10 columns are empty.

11 MR. TAYLOR: Yeah. That's a good point.
12 We'll get that fixed. So, it should have been AC in
13 there.

14 But as far as, you know, these tests here,
15 does anybody in the room at least see a need for
16 performing them?

17 MR. FLEISCHER: For performing DC?

18 MR. TAYLOR: Correct.

19 MR. FLEISCHER: It has been a very long
20 time, but I worked with an IEEE professor out of Rome,
21 Italy where DC arching faults can have severe damages.

22 And telephone substations that rely
23 heavily on batteries have been known to completely
24 burn down buildings from arching faults. But they may
25 be of a different nature.

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1 So from an -- if we're in experimental
2 space and exploratory, it may be worth trying those to
3 see what we get.

4 MR. TAYLOR: Okay. And again, you know,
5 this isn't a scaled program. So it may be worthwhile
6 just on -- from the particulate aspect to see there is
7 a major difference between the two.

8 MR. FLEISCHER: Right. The thing I forgot
9 to clarify. With a DC arching fault, the reason why
10 they can be so catastrophic is you don't have the zero
11 crossing as you do in AC current.

12 So therefore, you don't have that
13 momentary extinguishing and restriking the arc. In DC
14 they can persist.

15 MR. FUNK: Yes. This is Dan Funk. I just
16 want to second what Ken said.

17 I think from -- or it's pretty soft
18 testing. You know, the desert retesting we have
19 pretty good evidence that the DC can be pretty
20 damaging.

21 The other thing is, nuclear plants have
22 very large batteries. So the available fault arc can
23 be extremely high.

24 And you just work the energy numbers like
25 Steve was pointing to. You know, 10 thousand amps of

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1 DC with no zero crossing, and once we have those, a
2 tremendous amount of energy.

3 So, I think it's a good test to run. The
4 fact that you're limited to three hundred amps, I'm
5 not sure about that. That may not be great.

6 MR. TAYLOR: Okay. So I'm not hearing any
7 feedback to get rid of those tests. Any other
8 opinions in the room?

9 MR. MILLER: We just had -- we don't have
10 any OP B on DC events, right?

11 MR. TAYLOR: None that I'm aware of.

12 MR. MILLER: So Nick's the OP B man on
13 HEAF. So, he's shaking his head no. We don't have
14 any OP B for HEAF in plants.

15 But, you know, that doesn't mean it can't
16 happen or that it would be catastrophic.

17 MR. TAYLOR: I agree with that to some
18 levels.

19 MR. FLEISCHER: There was years ago an
20 AT&T -- I'm trying to think of when it was. Maybe
21 about in the mid 90s there was an AT&T. It's not
22 nuclear.

23 MR. TAYLOR: Right.

24 MR. FLEISCHER: But it was an AT&T
25 switching substation that had a tremendous amount of

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1 batteries that burned down from a DC arcing fault that
2 would not -- that was -- that did not self-extinguish.

3 If I can remember or find that OE, I'll
4 see if I can bring it up.

5 MR. TAYLOR: I guess the other thing that
6 I wanted to mention, and I don't think I have a slide
7 on it, is that -- could we go back to the diagram of
8 the set up? Right there.

9 So these were kind of the shakedown tests.
10 And you see the bus bars. They're fairly big.

11 I can't remember the size they used here.
12 But you know, you're basically looking at a
13 centimeter, by four or five centimeters, a rectangular
14 bus bar.

15 The one thing that they identified was
16 that when they tried to go and do the Raman
17 spectroscopy to look at how much material had been
18 lost or eaten away from the busses, they were having
19 some difficulty.

20 So one of the things that they wanted to
21 do, and it's in the test plan. But there are some
22 errors with the test plan associated with it.

23 Is basically scale down the bus bars to
24 make them smaller. And by doing that they should be
25 able to get better measurements of the mass loss.

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1 So what they proposed and the test when it
2 went out, is to do a one millimeter by three
3 millimeter bus bar. So that's pretty small.

4 And you know, I questioned them. You
5 know, is that so small that it's just going to deflect
6 away? Or, you know, blow apart and then you don't
7 have anything to go and measure anyway, because you're
8 picking pieces up and, you know.

9 So we're still working on that. They're
10 going to actually run a few more shakedown tests to
11 see if that is the case.

12 But again, we're trying to scale down the
13 bus bars such that we get a better, more accurate
14 measurement. So I know Ashley brought that up. And
15 Jeff Wagner from Southern Company brought that up as
16 well.

17 The other thing is that arcing -- in the
18 test plan there's an error in the arching wire. It
19 said we used six American wire gauge. We're actually
20 using a filament.

21 So a filament is like 10 to the minus 6
22 millimeters. Like it's really thin wire. It's what
23 we use in these experiments.

24 It's a copper filament. So, again, on the
25 post-test analysis we'll be able to make the

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1 difference between a copper filament and aluminum bus
2 versus -- and vice versa for when you have the copper
3 bus for the particle analysis.

4 Keep going. Go back to that test plan.

5 So again, if there's any comments or
6 feedback, we have three medium voltage that we're
7 testing. I don't really see too much 10kV at least in
8 the US plants.

9 International plants, I think there's
10 more. But you know, obviously we have 12, 13kV plants
11 out. Again, we're looking for some feedback here.

12 If you want to give it to me now that's
13 fine. If later after the meeting, send me an email.

14 The time line, which I'll get too later,
15 we're looking to do these tests sometime in late June.
16 This bar count.

17 So, we need that feedback fairly, fairly
18 soon. Also scale currents. Any feedback on that one
19 too.

20 Shannon Lovvorn from TVA.

21 MR. LOVVORN: Yeah. This is Shannon
22 Lavvorn with TVA. And I was just curious, do you guys
23 think that you're going to be to try to project
24 different voltages from this data?

25 Well, one thing that comes to mind is like

1 isophase bus, for example, you know, it's most plants
2 will be higher than 10kV. And sometimes with the
3 aluminum bus and trying to model isophase bus faults,
4 not exactly sure if we can project what this looks
5 like for those who are being thought and put in that.

6 MR. TAYLOR: That's a good comment. I
7 don't have the answer to it.

8 MR. LOVVORN: Okay.

9 MR. TAYLOR: We can take that back to
10 Sandia and see. Obviously the guys that work in the
11 lightening simulator have a lot more experience at
12 modeling.

13 And the extrapolation, it might be
14 possible. I just don't have a good answer for you.

15 MR. MELLY: That's also something that
16 we're looking for in the larger test program. If we
17 can do extrapolation across both of this incurrence
18 that we are -- have selected to test at.

19 And that's why we're trying to get a range
20 of currents and voltages in the test program. In
21 hopes that maybe we can do extrapolation beyond it.

22 MR. CAVEDO: So, we spend a lot of money
23 on 125 OTC coordination, evaluations, and I was
24 wondering from the electrical folks, because that's
25 not my background, but how difficult is it to have

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1 these higher current and volt allowed plant on 25 volt
2 DC system?

3 Because it seems like it would be much
4 less likely then at some AT&T station where they don't
5 have to do all the detailed evaluations. Is that
6 something where it's just not practical to happen in
7 a nuclear power plant?

8 Maybe we don't need to do this? Maybe we
9 could do testing in other areas that's more important?

10 MR. TAYLOR: Anybody want to answer that?

11 MR. FLEISCHER: Ken Fleischer from EPRI.
12 Yeah, historically I haven't seen a lot of arcing
13 faults in DC systems.

14 Usually they've been more three phase
15 bolted for three phase. They've been more like a
16 bolted or a low resistance fault.

17 But if we're in an exploratory space right
18 now, this would be the time to get it. We finally, or
19 if we want to go back to it, we'd have to re-contract
20 the facility, rewrite the test plan and all that.

21 But the thing is that when you do have an
22 arcing fault in a DC system, they're very nasty. So,
23 I'm not sure if I'm answering your question though.

24 (Off-microphone comments)

25 MR. FLEISCHER: Some -- there are -- the

1 newer DC systems do. Older DC systems may still only
2 have one fuse.

3 MR. MELLY: And since we are in DC,
4 everyone can look at the metro failures and problems
5 that we continuously have on our DC system.

6 MR. FLEISCHER: Yeah. No, no, you're
7 right. You're right. The single fuse are typically
8 in the 120 volt control power transformer fuses.

9 But yeah. Yeah, usually there's two
10 fuses.

11 MR. MILLER: Usually it's two.

12 MR. FLEISCHER: Yeah. Usually it's two.

13 MR. DALEY: Yeah, I don't -- I guess that
14 you'd almost have to look and see if they've done some
15 OA and see if they've actually had these type of
16 events.

17 I know Kenn Miller. I work with Kenn a
18 lot. We did a -- there's a NUREG and what's the
19 number on it? We gave it a number.

20 MR. MILLER: 6778

21 MR. DALEY: 6778, what we did. Because we
22 found out that the -- through a plant event that the
23 DC system was not coordinated properly.

24 And there was a lot of assumptions as far
25 as how -- what the maximum current you would see like

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1 at the actual charger.

2 So we went through at Brookhaven and did
3 a lot of short circuit testing. And you know, so we
4 got amperages, we got, you know, time to trip the
5 clear the -- yeah, clear the fault.

6 But I kind of agree with what you were
7 saying. I mean, if we -- if it's not that difficult
8 to do, why not do it?

9 So when the event actually comes up, we
10 can actually, I mean, we could actually -- we have
11 something. Right?

12 But I mean, if it's really a big problem,
13 then I think you'd almost just have to look and see
14 how many events we've had. If we've had no events,
15 then we just go from there.

16 MR. MELLY: That may bring up another
17 question. Is that the current large-scale, full-scale
18 HEAF program does not have any DC systems for planned
19 arcing.

20 Whereas we can do this. And this is
21 currently going to investigate the particle size
22 things and everything that Gabe went over as outputs
23 of this test program.

24 We have nothing in the large-scale
25 program, whereas it could be an option to add it in.

1 And again, we'll have larger discussions tomorrow.

2 But, it may, if we feel like it's
3 worthwhile to do, we may want to do a few.

4 MR. DALEY: It was not easy. As a matter
5 of fact I remember it wasn't really easy to get
6 batteries and to get everything, the equipment and
7 all.

8 MR. MELLY: We will have -- I believe KEMA
9 can speak to it a little bit. But they have the
10 capability of doing a DC system.

11 So, we can run the test without getting
12 the battery banks and things like that.

13 MR. DALEY: We don't -- yeah, we don't use
14 those.

15 MR. MELLY: Right.

16 MR. MILLER: Yeah. I guess to answer your
17 question, Bob, we had batteries and charges set up for
18 some other types of testing events. And we already
19 had the infrastructure in place to do this additional
20 fault test.

21 I guess the other thing too is that going
22 back too again, to the nature of a DC event versus an
23 AC event. And again, with the small-scale we're
24 looking at the physics of what goes on in the fault.

25 It would be interesting to see, I would

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1 think, the difference being able to compare AC and DC.
2 So again, I too would make the case that doing some
3 DC, I think, is worthwhile.

4 Plus, along with all the energy it's --
5 again, at a nuclear plant, they do have very large
6 batteries with many amp hours of capacity. So their
7 potential to drive an energy event is huge.

8 MR. FLEISCHER: Yeah. I used to do DC
9 short circuit ops. I've seen them go as high as 17,
10 18 thousand amps.

11 But again, we're talking -- that's a low
12 resistant fault. We're talking arcing faults which
13 have a characteristic in nature much different than a
14 low repeating fault.

15 MR. MILLER: But the energy is there.

16 MR. FLEISCHER: Yeah. That's going to
17 come back.

18 MR. TAYLOR: I think we'll go ahead and go
19 on the next slide. Again, looking for feedback on any
20 changes.

21 I haven't heard any yet. But if you do,
22 please get in touch with me.

23 Measurements, we went over this a little
24 bit. Videography, taking the high speed imaging. And
25 then they can put that in their computer system and

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1 actually track particles. You're already seen some of
2 that from the shakedown test.

3 Aerogels to collection, again, proof of
4 concept. If it works here we'll probably do it full
5 scale.

6 And then from those collection techniques
7 there are a bunch of different post-processing
8 analysis tools that they can use to characterize what
9 the aerosol is. So, I'm not going to get into all of
10 those.

11 But you see here, well it's small, but the
12 photograph to the left is basically showing you what's
13 the arc. For one experiment on the shakedown test.

14 And from that they can all use it. So,
15 one thing I found interesting with that is that they
16 can then look at that, put it in their system -- in
17 their tool, and they can look at the soot deflector.

18 And because it has a characteristic
19 similar to graphite, they can actually -- they say
20 they can predict what temperatures that the bus bar
21 has reached from the residual carbon on the bus bars.

22 You can go to the next slide now. And
23 then using our scanning electron microscopy, they can
24 then get into see what type of diameters.

25 They can look at oxidation levels. They

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1 can look at was it a vapor, was it a molten material?

2 Because of the characteristics of this,
3 they're seeing a lot of molten material in the
4 particles. So, it melted and it re-solidified.

5 So again, you know, surface area
6 oxidation, trying to understand what contributes to
7 that extra energy from the aluminum type of events.
8 Next slide.

9 Just touch briefly on the modeling.
10 Again, we're trying to collaborate with the University
11 of Maryland, College Park, Dr. Jose Trojero to develop
12 a fundamental energy model.

13 And some of the -- we met with him about
14 18 months ago. You know, the things that he needed
15 were really the particle characteristics that we're
16 trying to get from this experimental program.

17 So really, he has a model he's developing.
18 And we're -- this is the input that's going into the
19 model to help further develop that approach to
20 characterizing it.

21 And then towards the end here. You know,
22 there's advantages and limitations to everything that
23 we do.

24 Because it's small-scale we can get close
25 to the arc. And we can characterize the particles

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1 very close.

2 From that cost, it's a pretty cheap
3 experimental program from a, you know, the other types
4 of experiments that we've run in the past. You know,
5 it's probably less than one percent of what we spend
6 on HEAF in general.

7 So far a lot of different tools they can
8 use. They take the measurements and we control the
9 variables a little better.

10 Limitations. The biggest limitation is
11 duration. You know, milliseconds compared to what
12 we're trying to do full-scale, you know, it's much
13 shorter.

14 And also, we're only using a single phase.
15 So, you're going to get one or the other. In a three
16 phrase system, we get multiple arcs starting in the
17 same path.

18 Touch on the Federal Register Notice. We
19 put the draft test plan out for public comment 30
20 days.

21 The draft comment period closed April 4.
22 There's a Docket ID, NRC-2018-0040. You go to
23 regulations.gov you can find that information. The
24 direction notice has a plan.

25 There's already comments received. We did

1 receive two comments. On April 2 we got comments in
2 from an engineer at Beaver Valley .

3 And then on April 3 we got a request from
4 NEI to extend it an additional 45 days. We haven't
5 received anything from our admin or Federal Register
6 Notice Office on the extension.

7 So, because of limitations on our
8 contract, it can't be extended anymore. And also
9 budgetary constraints.

10 What we plan on doing is we don't want to
11 shut you off. So we're going to basically add another
12 30 days.

13 So if you can get me any comments on the
14 test plan by May 4, next month, I'll go ahead and add
15 those comments to the Adams. I'll make it publically
16 available.

17 And then we'll treat them just like we
18 treat any other comment that would have come in on the
19 Federal Register Notice. So again, my email is up
20 there.

21 And anything you have, you want us to
22 address, please send it to me by that date. And then
23 that gives us the team, the NRC and the Sandia team
24 enough time to thoroughly review the comments, access
25 them, make changes as needed.

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1 And then start the testing at the end of
2 June. And then the test plan -- our contract ends at
3 the end of September. So there's a lot of back and
4 forth and report generation.

5 And because we couldn't -- we tried to
6 extend it, and we couldn't extend the contract anymore
7 that's kind of our hard stop on this.

8 So again, basically a total of 60 day
9 public comment period. Get your comments to me if you
10 haven't done so so far.

11 And that's it for me. So are there any
12 questions on the small-scale testing? Anything on the
13 webinar?

14 MR. MELLY: We have one question.

15 MR. LOVVORN: Shannon Lovvorn with TVA
16 again. Looking over the test plan, I saw a discussion
17 of some of the testing being phase to ground. And
18 obviously the voltages we're talking about here are
19 phase to phase.

20 So, is it because of the test set up
21 you're going to do a say a 480 volt test, a 480 volt
22 phase to ground? Is that how you're doing the test?

23 Or is it just -- sometimes I'd read, you
24 know, voltages and phase to phase voltages. And then
25 I'd read, you know, phase to ground testing

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1 discussion.

2 I got a little confused in the test plan.

3 MR. TAYLOR: So the question is, is it a
4 phase to phase or -- is it a line volt or a phase to
5 phase volt?

6 MR. LOVVORN: Yeah. Well, is it -- yeah,
7 I guess I'm trying to understand why we're talking
8 about phase to phase voltages and phase ground
9 testing.

10 And is it just simply the test setup
11 that's driving that? Or --

12 MR. TAYLOR: So it is -- that's a good
13 question. It is the test setup. So the voltages that
14 we have here will be the voltages across the two
15 processes.

16 So basically a phase to phase voltage.
17 And not a phase down, or a line voltage. Okay.

18 Any other questions? Any other on
19 background? Bob Rhodes from Duke?

20 MR. RHODES: Yeah. This is Bob Rhodes
21 from Duke. Is your 480 volt test plan going to bound
22 the plants that have 600 volt weather control centers?

23 MR. TAYLOR: I'm not sure it will bound
24 it. You know, it does provide some data point at low
25 voltage.

1 MR. MELLY: Yeah. That's going to be
2 another question for extrapolation.

3 MR. RHODES: Can you extrapolate on that?

4 MR. TAYLOR: I think I'll have to take
5 that one back. I'm not sure. So, we can add that to
6 that.

7 MR. TURNER: What they're talking about
8 here is the supply voltage. That really makes a
9 difference in what amps are the plasma and melting
10 things is the arc voltage.

11 And that's generally set by the gap. So
12 whether you get it at 480 or 600, it probably isn't
13 going to change the arc voltage very much.

14 And I don't know what their predicted arc
15 voltage is. But that's really where you get the
16 energy from.

17 The same with the medium voltage tests.
18 You'll probably get close -- if you don't change the
19 gap, you're going to get about the same arc voltage on
20 those tests.

21 MR. TAYLOR: Okay.

22 MR. TURNER: You really look at the gaps
23 is what you're looking at.

24 MR. MELLY: Right. And for the full-scale
25 testing where we did low voltage, 480 volt tests, our

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1 arc voltage was on average around 380 volts.

2 For a medium voltage, our average was
3 right around 830 volts for the arc voltage itself.

4 MR. TAYLOR: Yeah. So that, I mean, that
5 brings another good point. And I have some slides to
6 get to what Mr. Turner's brought upon arc voltage and
7 separation distance, at least from our phase one
8 testing.

9 But, and I don't want to go too long,
10 because I'm already over my time. But, you know,
11 maybe that's another variable. Gap space.

12 Because right now, I don't think, they
13 plan on changing their gap spacing. So your arc
14 voltage is going to be what it is.

15 So, given that, you know, it might not
16 even be worth adjusting your medium voltage. Right?
17 It might be more worth where you have low voltage
18 testing, you have a medium voltage set point, and then
19 you do some variation in your gap spacing.

20 So, good feedback. Okay. I think we need
21 to move onto the next one.

22 Okay. I don't think this one's going to
23 take too long. Basically, you know, trying to look at
24 where we want to go with this. And why we're doing
25 all these -- this testing.

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1 You have to look at -- I say PRA modeling,
2 but what I really want to get at on this is the HEAF
3 modeling.

4 You know, what -- when I talk about HEAF
5 modeling, zone of influence is really what we're
6 concerned with right now.

7 So how -- how are you going to go and
8 improve upon the current method for the ZOI that we
9 currently have in 1650 to make it more realistic? To
10 maybe be more representative of the plants'
11 configurations.

12 So we need to just do a quick review of
13 the existing models. In 1650 you have two models.
14 You have the one that's in Volume Two, which looks at
15 the electrical enclosure.

16 And basically anything within the zone of
17 influence, which is one and a half meters in the
18 vertical direction, or five feet. And then .9 meters
19 or three feet in the horizontal direction.

20 You assume it's both damaged. Physically
21 damaged and it's also functionally failed.

22 And then you've got the fire that occurs
23 after that. So you assume ignition and then you
24 follow the typical, you know, classical fire modeling
25 approach that's in Appendix E and G of 1650, Volume

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1 Two. Next slide.

2 In Supplement One of 1650 we also have
3 segmented bus duct HEAF event. And in that you
4 basically assume that you have a failure.

5 You have the sphere that goes around the
6 bus duct that's one and a half feet. I think that's
7 -- is that a radius? I'd have to double check.

8 MR. MELLY: Yes. It is.

9 MR. TAYLOR: You have a sphere. And then
10 you also have this cone of death that has been
11 referred to.

12 And it's basically a cone with a 30 degree
13 down cone, or 15 from the vertical. And it goes down
14 until your diameter is, you know, you hit the ground
15 and your diameter is 20 feet or a total drop of 37
16 feet below the fault if you have that much room in
17 your configuring.

18 So those are the two ways that we model
19 ZOI right now. It is -- the next slide, it's
20 bounding. It's conservative. It's based off of, you
21 know, what they've seen from operating experience.

22 And with the aluminum, you know, the
23 question that comes to mind is, does aluminum fit this
24 model? Or is it something larger than this model?

25 And even if you exclude aluminum, you

1 know, let's assume we exclude aluminum, you know, this
2 doesn't capture all the variability that's in the
3 plant.

4 You know, you have a HEAF event, it
5 doesn't mean you're going to get this much damage.
6 And a lot of other events you look at, you don't have
7 that much damage.

8 Or you don't have some of the other
9 assumptions that go into the modeling of a fire
10 occurring. So, what we're trying to do here is
11 advance or improve the models to make them more
12 realistic. Next slide.

13 So, kind of the way that we've broken it
14 down, is potential pass forward. Is that we've been
15 sticking with the current approach and just refine it
16 to include aluminum, you know, bounding worst case.
17 That's one way that we could do.

18 Another thing that we could do is we could
19 start looking at what variables impact the heat and
20 the ZOI. Whether it's power energy volts, or voltage
21 current, the protection scheme that's being used for
22 the circuit material, safety class, what not.

23 I listed all the variables that could
24 potentially influence the categorization of the
25 equipment. But, for each of those categories then

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1 you'd have your own type of ZOI determination.

2 And again, this would be somewhat similar
3 to what was -- is currently modeled. You know, it
4 would have that, you know, physical dimension around
5 the equipment.

6 But based on the influencing plan or what
7 category it is, you have different ZOI dimensions. So
8 that's kind of the second, you know, way that we could
9 break it down.

10 And the third way that I've listed there,
11 it's similar to what they do in the arc flash
12 calculations in IEEE 1584. Where basically you have
13 system information on duration, voltage current, and
14 cap weight and incident energy.

15 And because that standard's worried about
16 human safety or physical protection, personal
17 protection, anything, you know, below 1.2 collars per
18 centimeters squared, I think that's the units, you
19 don't need protection. And anything above that, you
20 do, to alleviate second degree burns.

21 So, something like that, you know, could
22 be extrapolated to what we need here. You know, some
23 -- we'd probably follow something similar to what's in
24 IEEE or even the Lee approach that came out of the
25 80s.

1 And I think that's achievable. The one
2 thing that we still have to do on the back end then,
3 is what's your target fragility?

4 When are your cables going to be damaged?
5 When are you, I don't know, your pump or whatever
6 other equipment that's important to plant safety, when
7 is that going to be damaged?

8 And we do have current thresholds for
9 damage. But again, we're talking here about something
10 that's a high intensity, short duration.

11 And we're using the temperature thresholds
12 for possible fire, heat transfer. Do those match up?
13 Are there ways that we can use that information to
14 develop a target fragility for these HEAF type of
15 events?

16 That's something that we're looking at
17 what possible solutions or methods to try to
18 characterize that. But, we're not there yet.

19 So that's one of the -- one of the aspects
20 there for the dynamic ZOI.

21 MR. MELLY: And for the larger scale test
22 program, you'll see when we discuss how we plan on
23 instrumenting, as well as what information we're going
24 to collect, how we are heading down that path of
25 trying to create this dynamic zone of influence model.

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1 Where you can take the idea that that
2 Steve was discussing earlier, of going more scenario
3 specific. Of, I know what my voltage level is. I
4 know what my current is. I know my circuit
5 protection, my secondary circuit protection.

6 And I can postulate how long this arc will
7 hold in for. And what type of energy will be
8 released.

9 And trying to be eventually leading to
10 link that up to a scenario-specific zone of influence.

11 MR. TAYLOR: And I guess the other
12 question is, and I have a slide later, but you know,
13 how much time and effort do you want to put into
14 applying the method or even developing the method?

15 You know, if you can get away with a
16 bounding approach, then, you know, doesn't that work
17 for your plant? If you can't, you might want to
18 sharpen the pencil and have this approach available.

19 You know, if that doesn't work you might
20 even be able to use something like this. So, you
21 know, picking where we want to go.

22 We haven't said this is the route we're
23 going. We want to understand where we can do with it.
24 And make sure that we are collecting information that
25 will support any event.

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1 MR. MELLY: Yeah. And it's important to
2 realize that in the larger scheme of how we plan on
3 doing things in that if we are testing one piece of
4 equipment in the next test program at two seconds or
5 four seconds, we're doing it within mind that the
6 possibility to get to this dynamic zone of influence.

7 Rather than just slapping this is the
8 worst case that we saw. At an eight second duration
9 arc you have to then use this for every bounding case
10 in your analysis.

11 That's not our intention with the longer
12 duration events and the test program.

13 MR. TAYLOR: Yeah. And just to add on the
14 dynamic piece. Steve Turner brought it up earlier.

15 Is that if you look at both of these, this
16 is -- I modified it slightly just to make it more
17 anonymous. But this is the lead equation.

18 This is that accurately. And basically
19 you've got similar terms. You have voltage. You have
20 current. You have time and you have distance.

21 And down here you have the same thing.
22 You have time, distance, current, and they use the gap
23 spacing to estimate their arc voltage.

24 So, you know, those are the parameters we
25 know that's important. And we're capturing those in

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1 our testing.

2 We're trying to work with everybody here
3 in the room as well as other stakeholders to make the
4 testing realistic to support this. Next slide.

5 So, just getting into, you know, kind of
6 the pros and cons, worst case, the bounding current
7 model worst case. One size fits all.

8 Your damaging the right components in the
9 ZOI. And you assume you have your peak heat release
10 rate as soon as you have hertz.

11 So, if you don't think that is
12 conservative, I must have missed something. Or Nick
13 missed something when we talked about it earlier.

14 Although this is -- would be one of the
15 more simpler models of the approach. You need the
16 least amount of information to apply it.

17 It's not really that realistic. The
18 majority of the cases out there, at least from the
19 operating experience that we've reviewed, if we look
20 at, you know, a lot of the events like the Brunswick
21 event or the Turkey Point event, you know, it really
22 doesn't match what this model's doing.

23 So, you know, not much realism there. And
24 however from both the application as well as the
25 development costs, it would probably be the cheapest

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1 approach. Next slide.

2 The refined bounding ZOI. Again, you have
3 to break down equipment types, power, all the
4 different variables and understand how those affect
5 your ZOI.

6 So, you know, looking at the testing that
7 we're doing, as well as the testing that's been done
8 in the past, we have to collect a lot of information
9 to help us develop those ZOIs.

10 Because of, you know, you're basically
11 getting more information, you can make it more
12 realistic. However, as far as more information from
13 -- to apply the methods to your PRA, and also your
14 time to develop it.

15 And then the last piece is the most
16 complex, most costly to develop. But it also could
17 potentially provide the most realistic results.

18 I mentioned the fragility of being one
19 part of the equation that we're still working on. We
20 don't have a clear path forward for addressing that.

21 I'm not saying that it can't be. But I
22 don't want an obstacle we'll have to attack. And you
23 have a more physics of failure type relation to the
24 model.

25 So, it's not just the worst case. So,

1 pretty self-explanatory. Next slide.

2 So what do we need? You know, the NRC is
3 here concerned with this. Plant safety, reasonable.

4 You know, realism versus cost and time.
5 That's what we're really weighing here. You know, we
6 can't -- we want to wait and come up with a ZOI and
7 spend all this time and effort if the bounding one is
8 going to meet our needs.

9 So, we want to make sure we're aware of
10 what we can do. We're collecting data to meet the
11 needs of those categories.

12 And you guys are going to help us with at
13 least or the middle one. Especially making that one
14 realistic on equipment types, powers, you know,
15 maximum currents or realistic currents, all currents.

16 So, that's really where we'll weigh in
17 here in trying to figure out in the end what we'll
18 develop.

19 Any question about the modeling?

20 (No response)

21 MR. TAYLOR: It's not to say that there's
22 not other ones out there. But, these are just what
23 we're looking at right now.

24 And if there are others, that would be --
25 we'd be interested in learning more about those.

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1 MR. TURNER: If I could just make a
2 comment on the state of the art of these models,
3 reflecting on the other models he was talking about.

4 He's right. It's really expensive.
5 There's a lot of stuff out there that he hasn't
6 covered yet that the NRC could probably leverage off
7 of. There's been a lot of development. CFP models
8 for example.

9 Not that we would expect utilities to go
10 do CFP models of all their campus while their flux is
11 two feet away.

12 But there are two factions in the IEEE
13 publications that are out there, the published works.
14 A great number of them relate to the IEEE 1584 in
15 protecting people.

16 But there's a whole other school that does
17 nothing but computational fluid dynamic modeling. And
18 matching it to high energy arcing models.

19 Or developing fairly simple energy balance
20 models, which have the level of ability. A bunch of
21 manufacturers in Europe got together and put together
22 a pretty good model that all are actually duplicating
23 what we see in these experiments, the high energy
24 experiments.

25 The problem with most of those models is

1 they all are just maybe a 14th of a second or half a
2 second. They don't go for longer durations.

3 But, I've been modeling with Japan now on
4 longer durations and matching it up to data. So there
5 are CFP models out there that may help you predict
6 these things.

7 And I think we share that stuff with EPRI.
8 So they'll be able to leverage off of that. And
9 that's in addition to even the empirical models you
10 see.

11 And both factions in IEEE work just fine.
12 It's just a different direction that each one of them
13 have.

14 But just -- we're using hands as fluent.
15 And we're not even using the plasma physics model.
16 And we're coming up with some pretty good results.

17 So, the state of the art of the modeling
18 is actually pretty far along. And it is being shared
19 with the NRC. So they can leverage off of that.

20 MR. TAYLOR: I guess the last thing I
21 wanted to mention, and it's a very important point, is
22 that a lot of this modeling is looking at the thermal
23 aspects.

24 So, you know, the heat fluxes and the
25 energy fluxes that you are receiving at a certain

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1 distance away from the arc. As Nick mentioned from
2 the experiments, you saw the conduct of byproducts.
3 That cloud of material.

4 It's not like in any conductivity issues
5 associated with that. It's also -- and it's also not
6 looking at pressure, although there are models out
7 there that can estimate pressure.

8 And another thing that it's really not
9 looking into, and it's an important piece, and we
10 might only be able to capture it through uncertainty,
11 is the actual characterization of the arc.

12 There's a lot of parameters that affect
13 the arc. So, you know, we're not really looking into
14 that too much right now that support these, any type
15 of model development.

16 We're trying to make it applicable without
17 having to, you know, consult with CFP type -- I was
18 not saying that those aren't valuable.

19 I think if, you know, from some other work
20 that we've done, we may be able to leverage some of
21 the CFP work to support what we're doing here.

22 But again, you know, I don't think I would
23 expect the NRC to say -- or do CFP type analysis to
24 come up with the supporting PRA. That's just my
25 opinion.

1 Any questions from the room? Tony Putorti
2 from NIST?

3 MR. PUTORTI: So, Mr. Turner talked about
4 one side of the modeling. So, if you think about the
5 concept of the HEAF or the phenomenon making the
6 threat, making the thermal environment that threatens
7 other pieces of equipment, and you think about the
8 vulnerability, you could model both sides.

9 So he talked a little bit about trying to
10 model the generation of a thermal environment. But,
11 we can also use models to take a look at how those
12 thermal environments, what affects they have on the
13 targets.

14 And so there's been modeling and other
15 types of modeling you can do to take a look at what
16 the result is to the target. And some of that's
17 already been done, with cables, for example, and in
18 other areas.

19 MR. TAYLOR: Yeah. So, I think that's
20 getting into more of a -- at least from the zone of
21 influence or fragility side of assessing the nuclear.

22 MR. PUTORTI: I will put them both
23 together.

24 MR. TAYLOR: Right. Well, yeah. So like
25 we're not just looking at the source term and saying

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1 okay, this is how big the events can be. We want to
2 tie it together to the actual targets.

3 Any questions in the room? Again, this is
4 kind of just high level. There's a lot of good
5 research out there on a whole variety of things
6 related to this event.

7 But, if you look at the IEEE 1584, they
8 provide a lot of good information. But there's other
9 publications as well that get into the nuances of it.

10 Anything on the webinar? No questions on
11 the webinar? So I think we're a little --

12 MR. MELLY: A little behind. But we can
13 take a break.

14 MR. TAYLOR: No, we're ahead still. About
15 ten minutes, right?

16 MR. MELLY: Yeah. We are.

17 MR. TAYLOR: All right. So, let's go
18 ahead and take a break until 3:15. We'll get back on
19 schedule then.

20 So we're on break. Thanks.

21 (Whereupon, the above-entitled matter went
22 off the record at 2:51 p.m. and resumed at 3:16 p.m.)

23 MR. TAYLOR: All right, we will go ahead
24 and start. If everybody could take their seat. It
25 should be on now. Is the webinar running?

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1 MR. SALLEY: Okay, so we have the webinar
2 back up, and we'll get ready. Like I said, this
3 afternoon is about a lot of information we want to
4 share with you and exchange, and we're lucky to have
5 three guests to present with us.

6 The first one will be Mark Earley with the
7 NFPA, and Mark is the Chief Electrical Engineer there.
8 So he's going to present us some work they're doing
9 with the NFPA. It's interesting that we've been
10 working a little bit through some webinars trying to
11 share some information. It's been very profitable for
12 the NRC and also for the NFPA, and we want to continue
13 that exchange moving forward after this workshop.

14 We're also going to have Ashley Lindeman
15 from EPRI with the EPRI perspective, a presentation
16 after Mark. And then we've got Bas from KEMA from the
17 Netherlands, and he's going to give us some
18 information that they got from KEMA. Okay? So with
19 that, I'll turn it over to Mark, and you can take it.

20 MR. EARLEY: Thank you. It's great to be
21 here. Starting off with a new generic slide that we
22 have that shows our new theme, which is, it's a big
23 world, let's protect it together. However, I also
24 included this one, because this first slide is
25 uniquely unreadable. But it's a nice slide.

1 I'm going to be presenting the report in
2 place of Dr. Wei-Jen Lee who is responsible for a lot
3 of the scientific part. He is a Professor at
4 University of Texas at Arlington.

5 So who are we? The National Fire
6 Protection Association is a global non-profit
7 organization established in 1896 devoted to
8 eliminating death, injury, property and economic loss
9 due to fire, electrical, and related hazards. We are
10 the worlds' leading advocate of fire prevention, and
11 we are the sponsor of Fire Prevention Week.

12 We are primarily a publisher of codes and
13 standards, and we publish more than 300 consensus
14 codes and standards that are all about minimizing
15 possibility and the effects of fire and other risks.
16 We have a membership of about 50,000 from around the
17 world.

18 The National Electrical Code was also
19 founded in 1896. It did not become an NFPA standard
20 until 1911. But from its very beginnings in 1896, we
21 have included representation from around the industry,
22 including IEEE and the utility industry has been with
23 us for a very long time.

24 The first edition was published a little
25 over a year later in 1897. We are currently working

1 on the 55th edition of the NEC. We've been published
2 on a three-year cycle for 65 years.

3 When OSHA was first formed, the first
4 electrical standard that it adopted was the 1971
5 National Electrical Code. That presented some issues
6 for them, because the National Electrical Code has a
7 lot of installation requirements in it that have
8 nothing to do with safety in the workplace. They are,
9 for example, requirements for residential electrical
10 construction.

11 So, OSHA, along with IEEE, asked NFPA to
12 consolidate its electrical requirements into a new
13 standalone document. The original concept was that
14 they wanted something that was timeless and adoptable
15 by them. And what we found over time is that
16 nothing's timeless. That as experience is gained,
17 standards need to evolve to stay up to date.

18 So the result of this was NFPA70E, the
19 title of which was Electrical Safety Requirements for
20 Employee Workplaces, which is a title you can't recite
21 after you've had a few drinks. It has now been
22 renamed as Electrical Safety in the Workplace. It
23 has, however, become far more known as 70E than it is
24 by its name.

25 And that kind of puts it in the company of

1 most of the other NFPA documents, other than the NEC.
2 The NEC is known by its name, or by its acronym of
3 NEC, and rarely ever referred to as NFPA70 outside the
4 walls of NFPA.

5 NFPA70E evolved into four parts. The
6 biggest part is now gone. The biggest part was just
7 a regurgitation of electrical installation
8 requirements, but most specifically those that are
9 related to worker safety.

10 The entire standard is important, but most
11 of what you need to know for most installations and
12 most work is in chapter one. The arc flash phenomenon
13 has been in NFPA70E since about the 2004 edition. And
14 right around that time, IEEE formed a working group.

15 Actually, it dated back a little bit
16 earlier than that, but they formed a working group to
17 provide a method to quantify the phenomenon. And this
18 working group developed IEEE 1584.

19 What we know about arc flash phenomenon is
20 that over time, we've been noticing, or had noticed,
21 an increase in the number of arc-flash related
22 incidents. When NFPA70E was first developed, it was
23 all about electric shock. If you look out there in
24 the international community at IEC, most of what they
25 do is about electric shock in the 60479 series of

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1 standards under TC64.

2 And actually, calling those IEEE standards
3 --- excuse me, those IEC documents standards is
4 actually a misnomer. They are actually technical
5 specifications. They are not standards, because they
6 have not gained the required consensus in the
7 international community to be classified as standards.
8 But they are none the less widely recognized.

9 So what we've found happens with arc flash
10 incidents is they produce burn injuries, they produce
11 injuries from ejected materials, they produce in some
12 cases arc blasts with an accompanying pressure wave,
13 an intense amount of light, and rather intense sound,
14 as well as toxic metal dust.

15 And I found it interesting watching the
16 videos of the tests this morning, they were very
17 impressive, and you would get a sense of how loud they
18 are. But when you're in the booth next door and these
19 tests are going off, even though you know you're going
20 to hear it, you're rather shocked at just how loud
21 that event is. And they are very convincing of just
22 how much of a problem it is.

23 The IEEE standard was initially designed
24 around a series of about 300 tests that were valid
25 over somewhat limited range, and over time, it became

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1 necessary to extrapolate that out. And when one is
2 doing that, one wonders just how valid that
3 extrapolation is. So they were developed based on
4 some statistical relationships and seemed to work well
5 within that limited range.

6 But there were differences of opinion
7 between the members of the IEEE committee and the NFPA
8 committee on how to protect workers. So both
9 committees became concerned about the technical basis
10 for the analysis, and they both decided to pursue arc
11 flash research projects. Each committee recognized
12 that this was going to cost a lot of money, and that
13 they did not want to do it on a shoestring.

14 The first round of the tests, the 300, was
15 certainly done on a shoestring budget. NFPA was going
16 to pursue this project through our Fire Protection
17 Research Foundation, and IEEE was going to do things
18 a little differently by forming their own task group
19 to do it.

20 After a while, we both recognized that we
21 were going to be knocking on the same doors, asking
22 the same people to contribute to this project. It was
23 unlikely we would get any sponsor who would support
24 both projects. We also recognized how important it
25 was going to be to get industry buy-in and industry

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1 would not be well-served by competing arc flash
2 projects.

3 So the IEEE staff person contacted me and
4 asked whether or not we would be interested in
5 collaborating with them. We concluded that we were
6 both well-recognized in the industry for a number of
7 things, us for the National Electrical Code and
8 NFPA70E and IEEE for a whole series of electrical and
9 electronic standards and the code that affects the
10 utility industry, the National Electrical Safety Code.

11 For both of us, it's all about protecting
12 people, and we recognized the conflicting viewpoints
13 of committee members. And some of those were very
14 strongly-held positions. We chose a totally neutral
15 party in this to chair this research test planning
16 committee, Mike Callanan, who is Executive Director of
17 NJATC, which is now the Electrical Training Alliance.

18 What that is, is it is a training
19 organization that is jointly owned by the National
20 Electrical Contractors Association and the
21 International Brotherhood of Electrical Workers.
22 These members, with their strongly conflicting views,
23 were told to check your guns at the door. The
24 membership represented a number of different
25 constituencies from IEEE and NFPA committees.

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1 And we developed a pretty comprehensive
2 research plan, which formed the basis of the research
3 project. I believe the research plan was about 128
4 pages long. And we had unanimous consensus for the
5 research plan.

6 Chances are you don't recognize many of
7 those names, but we had here IEEE people, Underwriters
8 Laboratories, DuPont, Snyder Electric, more DuPont.
9 We had Ferraz Shawmut, which is now Mersen. We had
10 various American Chemistry Council members, and a few
11 different folks from the utility industry. So a very
12 broad group of people put this thing together.

13 So the primary goal was to work together
14 collaboratively so that we could capitalize on all
15 these various industry groups working together and
16 also, all these industry groups willing to punch holes
17 in it if they found them.

18 We're very pleased to get the sponsors
19 that we got. Platinum sponsors contributed
20 \$500,000.00 a piece, and the one at the top is a
21 Canadian utility, Bruce Power, and we had Cooper
22 Bussmann, which is now Eaton, Ferraz Shawmut, which is
23 Mersen. Wait, there's one missing. Oh, okay, yeah,
24 Eaton came in separately merged with Cooper Bussmann
25 later, so they are in effect a \$1 million contributor.

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1 And Underwriters Laboratories, and a
2 variety of gold contributors and silver contributors.
3 And one of the things that we talked about earlier
4 that was a big contribution from Bruce Power was they
5 had done some DC research. And so that is forming the
6 basis of some of the later research that we're
7 planning on doing.

8 So, okay. When did all this stuff happen?
9 The formation of the collaboration up through the
10 fundraising started between 2003 for the challenges to
11 the status quo up to 2006 for the fundraising stage.
12 And for the fundraising stage, we were fortunate to
13 have two people who were Vice Presidents of their
14 companies who were just uniquely positioned to go out
15 and meet with CEOs of organizations to ask them for a
16 lot of money.

17 It's one of those things that a lot of us
18 just, it's not in our psyche. I'm not likely to be
19 able to ask anybody for \$500,000.00.

20 The initial research phase had a couple of
21 PhDs working on it, Dr. Tammy Gammon and Dr. PK Sen.
22 Dr. Tammy Gammon is an independent consultant and PK
23 Sen is a Professor at the Colorado School of Mines.

24 For the testing period, we had Dr. Wei-Jen
25 Lee from University of Texas at Austin, and he has

1 worked with some various PhD candidates who did some
2 of their thesis based on this work.

3 Between 2013 and 2016, we have had the
4 model intensely reviewed by the 1584 committee. So
5 this has had quite a bit of a scrutiny. And so we've
6 met the criteria of the test procedures and protocols
7 committee. We hired a test manager. We contracted a
8 research manager. We've actually used a couple of
9 different laboratories.

10 And we conducted over 2,000 tests. And
11 they were all based on the RTPC task group work, and
12 we conducted low-voltage and medium-voltage tests. So
13 the test range was from 208 volts up to 14.3kV.

14 So the initial cost projections were \$6.5
15 million. We did not raise that much money, and so we
16 found a way to get most of it done a whole lot less
17 expensively. We estimated a fair number of laboratory
18 days. We got some used equipment for some of the
19 actual equipment tests.

20 And some of the --- and so we did focus on
21 the whole range of tests. We planned on LV, MV, AC
22 tests, and some DC tests. The good news was we had
23 that contribution information from Bruce Power, which
24 is helpful. But we are planning the DC tests at our
25 next stage.

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1 So we estimated some personnel costs. We
2 had we figured about 520 actual lab days, and we came
3 up with estimates based on how much money we were
4 likely to have in the program and what we would be
5 able to accomplish with that.

6 And so the good news is we've been able to
7 accomplish most of what we set out to do. So I know
8 this is another one of those pie charts, but this is
9 the range of tests. At the low end, 208 volts, we ran
10 67 tests. At 480 volts, which by the way is the most
11 common voltage where electricians are injured, at that
12 level, we ran 369 tests. Up at the top end, 14.3, we
13 ran 274 tests.

14 We ran tests in a couple of different
15 configurations. They were vertical tests with the
16 vertical electrodes in a cubic box, vertical
17 electrodes in a cubic box with a bottom insulated
18 barrier, vertical electrodes in open air, horizontal
19 electrodes in a cubic box, and horizontal electrodes
20 in open air.

21 And as far as publishing the researching,
22 well, there's been a number of papers published over
23 time, mostly in IEEE's industry applications
24 transactions. So we published on the visible light
25 intensity viewed from human eyes, and of course, when

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1 you're concerned about the hazard to eyes, you're
2 concerned about the potential of being blinded by the
3 light, but also the shrapnel is a huge hazard.

4 And despite all the requirements for
5 safety glasses in the workplace, we frequently see
6 people not wearing them. But with a real intense
7 blast, safety glasses could be easily punctured.

8 So we've published on that, the
9 magnetohydro. I will pronounce it. 3D
10 magnetohydrodynamic modeling of DC arcs in power
11 systems. DC arc model based on arc simulation. Arc
12 flash pressure measurement system design.

13 And in talking about system design, one of
14 the interesting things about this is when you consider
15 that you're measuring the effects of a big electrical
16 incident, you essentially have lightning in an
17 enclosure.

18 And so it creates some unique problems of
19 trying to make sure that you can measure the
20 phenomenon you're trying to measure without the
21 outside interference from this little thunderstorm
22 that's taking place in the box. And so Professor Lee
23 and his team had to come up with some unique ways of
24 measuring that phenomenon and filtering out all of the
25 interference.

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1 So again, the list continues. I won't
2 read all of these off, because you all have a copy of
3 this presentation. But we generated a lot of
4 information, and there is a summary of the DC work to
5 date. But we know this is an area that we have more
6 work yet to do in.

7 And this is the committee that we have
8 today. So we have some of the same organizations
9 represented. There's actually only two people on this
10 list from the original committee, but continuing to
11 move that forward. And now we want to do a
12 comprehensive DC arc flash model.

13 We believe we're seeing some things
14 telling us that we may be able to establish some
15 correlation between the AC tests and the DC tests, but
16 there are some factors to consider with DC. The
17 source can make a real difference. Rectified DC and
18 DC from a battery in terms of its, one of the fuse
19 people classified it as its stiffness, can be a
20 factor.

21 With rectified DC, you may wind up
22 destroying the rectifiers. And certainly, when you're
23 doing any of these tests, there's a lot of hazard to
24 equipment, and you usually wind up damaging quite a
25 bit of it along the way. And as in the case of KEMA,

1 the test cells as well.

2 So, that's a factor. The voltage and
3 current ranges are a big factor. And sometimes, the
4 voltage and current ranges are limited by what the
5 laboratory can provide, and sometimes by what they're
6 willing to sacrifice because of the potential damage
7 to equipment.

8 Gaps between electrodes and materials
9 certainly make a big different, as has been discussed
10 earlier today. So the hypothesis that we're working
11 on is that the incident energy is proportional to the
12 arc energy during the arc flash event for DC, and it's
13 possible to establish a relationship and use the AC
14 arc flash model for DC incident energy and arcing
15 current estimation.

16 So we want to do some initial scouting
17 tests based on about three to four days of testing and
18 see --- or I could have just asked Siri. And that was
19 mine. I don't have it set up to do that. Oh, it
20 actually came up with a website, okay.

21 Okay, so the proposed approaches are to,
22 according to the test configurations, perform some
23 computer simulations to obtain the estimated arcing
24 current, arcing voltage, and arc energy and see what
25 we can do about comparing the simulation between the

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1 two models and see if we can get reasonable results to
2 determine whether or not there is a good relationship
3 between the two.

4 If the proposed study does yield positive
5 results, we'll design some additional laboratory
6 testing and perform some more DC simulations. So if
7 we can get some good lab work, it will certainly
8 expand our ability to do modeling, which is a whole
9 lot less expensive than actual lab time.

10 So, where are we? We developed ten AC
11 models that we've been able to integrate into one
12 using five electrode configurations. We've done low-
13 voltage and medium-voltage AC tests. We have some
14 test results already and are looking at doing a few
15 more tests at the 208 volt level to see where the
16 floor of the model is.

17 Initially, when we ran some of the lower
18 tests, we would report them as failures, and later on,
19 it was decided, well, no, maybe those weren't
20 failures. What that was, was we were feeling around
21 for the floor. And so we have those results, and
22 we're going to be doing some further analysis to
23 determine where that floor is.

24 We developed instrumentation for
25 measurement of the thermal effects, the light effects,

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1 the pressure and sound effects, and came up with a
2 portable instrumentation unit. And as I indicated,
3 there are a number of IEEE papers, so there is a
4 myriad of research that is available.

5 So, mission of the collaboration was to
6 develop one model to ensure worker safety. I think
7 we've been successful with that. We have a working AC
8 model. Our next goal is to explore that lower
9 boundary, and the next step is a correlation of the DC
10 model with the AC model.

11 That's it.

12 MR. TAYLOR: Any questions in the room?
13 Dan Funk?

14 MR. FUNK: Are we -- I see this is
15 working. I guess it is. Obviously the reason we're
16 here today is because of the unexpected result of
17 aluminum conductor, and as Mark and Gabe and Nick and
18 the other folks familiar with their test program
19 relayed, copper behaved in a way that they feel
20 confident enough to characterize, but this aluminum
21 situation right now tagged as aluminum oxidation is
22 problematic. And that's obviously where a lot of the
23 focus is going to be for their test program in the
24 future.

25 What I struggled with, and I think some of

1 us that have been looking into this, is 1584 and 70E
2 don't make a distinction between the conductor. And
3 as you put it, you ran over 2,000 tests. Is there
4 some concept that you could help us with as to how you
5 didn't see any difference between the conductors in
6 all your tests, or if you did, how they were dealt
7 with?

8 MR. EARLEY: Most of our tests were
9 actually conducted with copper. We do know that
10 copper does splatter as well. In fact, we have a
11 photograph in the report of an arc flash involving
12 copper electrodes where you can see the pieces
13 spreading out.

14 Now, in discussion with the folks in the
15 fuse and circuit breaker industry, they are in fact
16 very well aware of the aluminum issue and where it can
17 go. I am less schooled with that, so I would have to
18 direct that question to Dr. Lee. But we are aware of
19 how aluminum can behave.

20 MR. FUNK: Thank you.

21 MR. EARLEY: You're welcome.

22 MR. TURNER: Okay, I have a comment on
23 aluminum. There's not as much mystery about why
24 aluminum behaves the way that it does. As a matter of
25 fact, we first saw the effect, we knew when we

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1 inspected. I don't want to get too much into just
2 metal chemistry, but if you look at something called
3 the Born-Haber cycle, this is a number that's produced
4 or how much energy does it take to go from a mole or
5 gram of a bust bar to melt it, vaporize it, and
6 oxidize it, what's the resulting energy? And for
7 oxidizing aluminum, that number is somewhere in the
8 range of 30 kilojoules per gram. And for copper, it's
9 about four.

10 So we very well expect it from the
11 chemistry. I actually talked to Jim Billups a bit
12 about have you seen this aluminum oxidation, and he
13 felt they hadn't run enough tests. But if you read
14 some of the IEEE reports, and it's all good work, some
15 of the aluminum tests support it.

16 They did come out and say, wow, that was
17 a little better than we thought, so we might need to
18 look at that more. So I think there is an awareness,
19 and I think that they're considering it, but they just
20 want to be careful about how they approach it. But
21 there's no mystery about what the phenomenon is in
22 terms of basic physics.

23 MR. FUNK: Yeah, no, I agree. I mean, and
24 that's in all the papers. My point is, it doesn't
25 show through the standards. Right. So my point is it

1 doesn't show up in the standards after spending \$6.5
2 million. So it seems like you've got a discontinuity
3 of it didn't make the front page, and now this is all
4 we're going to focus on. That's my point.

5 MR. TURNER: And that's what I said. I
6 called his colleague Jim Billups and said, are you
7 guys looking at aluminum, and he said we're thinking
8 about it. So I think we'll hear more of that.

9 MR. FUNK: Understood. But they do good
10 work. It's great work.

11 MR. EARLEY: Yeah, just a point, our
12 budget, our goal was \$6.5 million. We got a little
13 over \$3.5 million, and so we had to scale back some of
14 our expectations, because there was only so much we
15 could do, and you know, just like we had the
16 discussion here today about DC testing, there's a lot
17 of debate right now as to how much more we should do
18 in that are as opposed to making sure that we have
19 that AC floor well established, because know that the
20 AC floor is a real issue for us from a practical
21 standpoint.

22 DC tends to be less of an immediate
23 problem, but on the industrial side, it's becoming
24 more of a problem because of all of the green energy
25 systems out there with lots of energy storage coming

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1 online, and of course, what do PV panels generate?
2 They generate DC.

3 So that's certainly an issue. All the UPS
4 systems out there in the field are certainly an issue
5 for DC. But right now, it's become less of a
6 priority, again, because we didn't get \$6.5 million,
7 so we had to do what we could.

8 MR. TAYLOR: Question in the back.

9 MR. EARLEY: Yes?

10 MR. LEJA: I was just curious, I was
11 looking at the summary of the test. How did you guys
12 develop the gap range population?

13 MR. EARLEY: How did they develop the gap
14 range population? I think that's another one I would
15 have to direct back to Dr. Lee.

16 MR. LEJA: Okay, thank you.

17 MR. EARLEY: Thank you.

18 MR. TURNER: Okay, thank you. All right,
19 thank you. Ashley?

20 MS. LINDEMAN: Okay, I'm going to give a
21 little bit of the EPRI perspective on the HEAF issue.
22 I wanted to start off with EPRI published two white
23 papers on the subject, and the objective of the white
24 papers was to characterize the testing, the operating
25 experience, and some of the designs in nuclear power

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1 plants. And really, just put everything in one or two
2 spots to characterize the state of the arc.

3 So there's two papers. The first one is
4 focused on the testing observed to date as well as the
5 operating experience with a focus of United States
6 events. The second paper is really focused on the
7 electrical distribution system and how these systems
8 are designed to tolerate a fault.

9 So it was a collaboration not only within
10 EPRI. We used Tom Short who is in the power,
11 delivery, and utilization sector. He works heavily
12 with the arc flash work for personnel protection, but
13 we also used Penn Engineering and Ken Fischer and Dan
14 Funk have played in their contributions to the paper.

15 So, due to the importance of the subject,
16 EPRI normally doesn't make their research available to
17 the public, but in certain circumstances, we do. So
18 if you go to EPRI.Com, you can download the paper. So
19 you just need to memorize a really long number. So
20 it's 3002011922 and 1923. So these white papers form
21 the basis for my presentation, and feel free to
22 download and read the gaps.

23 MR. MELLY: And in a few minutes, we will
24 have all of the presentations available in ADAMS.
25 That will be the ML number associated with all of the

1 slides that have been presented today and tomorrow.
2 Gabe's working on that right now.

3 MS. LINDEMAN: Okay. So one thing that we
4 haven't talked a lot about is the different types of
5 electrical and distribution systems. Something that
6 we really haven't talked about is where we have seen
7 some of the more severe HEAF experience. So what
8 we've found is that the main generator can feed a
9 fault for several seconds.

10 And in a lot of instances, this is where
11 we've seen the long duration faults. So Ken and Jim
12 and his team, they went through a variety of station
13 diagrams and identified seven common power
14 distribution configurations and ranked their
15 importance most vulnerable to least vulnerable to
16 generator-fed HEAF risk. And we'll talk a little bit
17 specifically what a generator-fed HEAF is in a few
18 slides.

19 But out of the 19 sites we reviewed, we
20 found 14 of the 19 have low risks, designs five
21 through seven. So these were sites that either employ
22 a generator breaker, have good electrical separation,
23 or feed off-site power from the station transformer.

24 So this is what I mean when we talk about
25 the unit-connected design. This is specifically the

1 power system downstream from the main generator. So
2 it includes the main generator, the step-up
3 transformers, and the breakers in the switchyard, the
4 auxiliary transformer, and then the connection to the
5 medium-voltage switchgear.

6 In this case, it's the class for the
7 safety division, but another station systems that it
8 could be in the non-class. So faults in this system
9 are this scheme. If there's a stuck auxiliary
10 transformer, there may be a longer duration fault or,
11 you know, any other location.

12 So, from our experience, this is where we
13 found the longest duration events from experience.

14 So, as I foreshadowed, we looked at about
15 30 events, and we found that the most severe ones had
16 a very common theme, and that was the main generator
17 played a role in extending the duration of the fault.
18 So in this case, we found that the faults can last
19 several seconds, and as we talked about earlier,
20 normally we think about things in cycles, which are
21 very quick, and now we're talking about routines that
22 last several seconds.

23 We did find a few instances where the
24 plants had a generator breaker thus they can isolate
25 the energy source from the fault during the generator

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1 coast down. So that was a way to mitigate some of the
2 main generator-fed HEAF risks.

3 Some of the good news is --- maybe not
4 good news --- is each HEAF event is obviously a sever
5 event, but the ones that we've observed in the United
6 States that are generator-fed HEAFs impacted only non-
7 class equipment and non-class 1E locations, and they
8 all occurred in the medium-voltage range. So
9 typically, limited to turbine building and areas like
10 that.

11 We did find that a fire occurred in all
12 the instances. Of the 30 events, there was nine
13 generator-fed HEAFs. Fires in all of them. In eight
14 of nine events, we found that the equipment extended
15 beyond the equipment origin, which in Fire PRA, that's
16 really what we're interested in, is when the equipment
17 can cause damage to other targets. And again, the
18 events caused significant damage and were challenging.

19 So, the next paper really focused on
20 looking at the event review. What did the data tell
21 us? So we have a lot of well-documented fire event
22 history at U.S. nuclear power plants. I maintain
23 what's called the Fire Events Database, and it's a
24 collection of fire events occurring within the U.S.
25 industry.

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1 So, I review a span 1980 to 2017, and it
2 was roughly 32 events. So what we found is that the
3 HEAF events represent around two percent of the fires
4 within the U.S. nuclear power plant fleet, and you
5 know, this is not just the LER fires. It's the
6 potentially challenging and greater.

7 So we found that the HEAF experience
8 within the United States does not follow some of the
9 trends from the international data, which may have a
10 different reporting threshold.

11 We found that no flavor of a HEAF was
12 identical. We found a wide variety in the severity of
13 events. Not all of the events resulted in a fire, and
14 most of the events damaged only the equipment itself.

15 We did identify some key factors, and I'll
16 go over those in a minute. But similar to the thread
17 of the presentations early, we do believe that there
18 is refinements to be made in both the frequency and
19 the zone of influence based on the data that we
20 reviewed.

21 So this is some of the statistics we tried
22 to look at the information that was available on the
23 events and characterize them. So, the first thing we
24 did was look at if the equipment that initiated the
25 HEAF occurred in a class or safety-related or non-

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1 class equipment. And what we found is that most of
2 the events were in the non-class or non-safety-related
3 system.

4 There was one or two events in the class
5 system. And then there was an unusual event, and that
6 was a switchgear that was both class and not-class.
7 But anyway, 91 percent were in the non-class system.

8 We also found that 84 percent of the
9 events were in the medium-voltage range. So our
10 takeaway is the HEAFs that we see are primarily non-
11 safety-related medium-voltage concern.

12 So what about zone of influence and
13 damage? So we found that most of the events, two-
14 thirds, did not impact equipment beyond the equipment
15 of origin, and similarly, not all the events resulted
16 in a fire. Two-thirds of the events did result in a
17 fire.

18 We also found that no one equipment type
19 dominates the events that we've seen. It is quite
20 divided between busses and switchgear and circuit
21 breakers. So not one general prevalent trend of
22 equipment type.

23 We did find that a lot of the HEAF events
24 did involve preventable shortcomings. In other words,
25 the HEAF could have been prevented. So, human error,

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1 maintenance, design, installation, construction.
2 Those were all ways that we could have mitigated.

3 I know Ken has brought up multiple fail
4 barriers, and in a lot of instances, it wasn't just
5 one thing that went wrong. There was a series of
6 events that led to the severity of the event.

7 And circling back, we did find that one-
8 third of the events were associated with this unit-
9 connected design. So I think that's significant, and
10 we discussed that it probably deserves its own special
11 attention and treatment in the PRA.

12 I don't want to spend too much time
13 talking about the testing, but I think it's important
14 to characterize that the tests that were run, over-
15 current protection, which is typically there in the
16 plant was not in place for the test.

17 So kind of what has been characterized in
18 the test is pretty much the most severe and violent
19 that we can see. And in the real world, we over, we
20 design that over-current protection or some type of
21 protection will work, and the fault energies will be
22 considerably lower.

23 And if I had to summarize the tests that
24 have been done to date, the low-voltage testing, I
25 think we found the arcs didn't always sustain. Tests

1 with durations of two seconds usually didn't result in
2 fires, and that may line up with how the equipment is
3 rated and some of the IEEE standards. I think Steve
4 Turner said 25 megajoules was the threshold for a
5 fire. Yeah, I think we kind of agreed when we looked
6 at the tests, that that seemed to be the threshold.

7 When we look in the medium-voltage testing
8 insights, the threshold was higher. I think the
9 equipment at the medium-voltage range is more rugged.
10 And once initiated, the arcs sustained themselves for
11 a longer period of time.

12 We did observe a wide variety of damage in
13 these tests. There was external ruptures and breaches
14 between compartments, and I think the NRC has
15 demonstrated that in some of the pictures that they
16 showed this morning.

17 So the involvement of aluminum on this is
18 a primary reason why we're here, and I think the
19 testing to date has identified that as a significant
20 contributor to the total energy release. I just
21 wanted to stress that it wasn't always observed.

22 I think there was more than the two tests
23 that had aluminum, and I think in the new reg, that
24 was with the Japanese. At first, I think they tried
25 to take a cut of estimating the arc energy from

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1 oxidation, and we compared it to the arc.

2 And in the most severe tests, the release
3 from the oxidation was 2.6 times the estimated energy
4 released from the arc. So that was the most severe,
5 but we found it range from 0.34 to 2.6, so the high
6 oxidation scenarios were less common.

7 This was brought up in the last
8 presentation, but you know, why haven't we seen this
9 involvement of aluminum before? We have all these, we
10 have 1584, C37, 70E. I didn't want to answer your
11 question, Mark, but some of the theories that we came
12 up is, right, there may not have been aluminum tested.

13 The testing that's been conducted to date
14 outside of the nuclear industry typically tests of
15 shorter durations, so there's less melting of the
16 conductors. And that was kind of our best guess of
17 why this hasn't become a major factor.

18 But really one of the open questions is
19 that the threshold at which this oxidation of aluminum
20 occurs is really undefined. I'm not sure if we have
21 a rhyme or reason, is there a duration or a voltage or
22 an energy where this gets much worse? And to me, that
23 was a big open question that we had. So maybe
24 hopefully you guys can figure it out, because it just
25 didn't seem like it occurred in everything that we

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1 saw.

2 MR. GARDOCKI: In your database, did you
3 discriminate or were you able to discriminate events
4 that involved aluminum or no?

5 MS. LINDEMAN: So that wasn't one of the
6 factors we looked at. I think upon reading the event
7 reports, we noticed there was some mention of
8 aluminum, but it wasn't something that we specifically
9 looked for. So getting into Fire PRA.

10 We definitely suggested and we've worked
11 with the NRC to really redefine --- maybe not
12 redefine, but refine the ignition frequencies and the
13 scenario definition of what we will term a HEAF, which
14 has been 16.a, 16.b, 16.1, and 16.2.

15 And based on the data review, we believe
16 that there is subgroups and split factions to do a
17 better job of characterizing the risks. Right now, we
18 pretty much have low-voltage and medium-voltage which
19 is existing. And we also have bus ducts, but we
20 believe that adding in the safety classification, that
21 seemed to be a significant finding from our white
22 papers.

23 We also feel that there was also room for
24 split fractions on the extent of damage, if there was
25 a fire or not. And again, special treatment for a

1 vulnerability such as the unit-connected design where
2 protection may be absent or unprotected zones.

3 So we also did a sensitivity study to see
4 how the impact of a larger zone of influence from
5 aluminum might impact the PRA results. Obviously I
6 think as Nick said, it's definitely plant and scenario
7 configuration dependent. Obviously if you have a
8 well-separated plant with two different switchgear
9 rooms and good electrical separation, I think the
10 numbers will come out to a lower impact.

11 So the sample plant that we used had that
12 safety-related switchgear in separate rooms, and what
13 we found was the impact was minimal, which is in stark
14 contrast to the numbers that we saw. We ran it with
15 a lot of similar assumptions. We assume that the
16 oxidation failure resulted in a hot gas layer. And
17 for those not familiar, a hot gas layer essentially
18 damages everything in the room.

19 So that's what we did. I think we did
20 credit suppression and everything, but anyway, we
21 found that the impact was certainly less than 1E-4.
22 But obviously scenario and plant dependent.

23 So one thing I don't think we really
24 talked about is I think we do want to work on
25 understanding why these events happen, because I'm not

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1 sure if the answer is, well, the ZOI is 7.3 feet. It
2 seems that we want to make sure we have a strong PM
3 program and we're not deferring that maintenance,
4 because really, I think it's better to prevent the
5 events than to find out what the ZOI is.

6 These events are not only a safety concern
7 but may be an economic consideration of a large event
8 that could keep a plant offline for months, in
9 addition to the nuclear safety aspects that we
10 frequently worry about.

11 But the testing highlighted the importance
12 of making sure the protection schemes are optimized.
13 We do, if we have electrical abnormalities, we would
14 want to rapidly detect and clear the fault such that
15 it doesn't get to the severity of a HEAF.

16 Proper maintenance is prevention. The
17 white paper ending in 23 identifies several
18 maintenance practices. Refurbishment, testing, and
19 lock-downs to ensure that the equipment is operating
20 properly.

21 So that is kind of a summary of what we've
22 been doing. Our white papers are really a cut at
23 characterizing the issue and not to do any PRA type
24 numbers, although we can kind of see that as
25 definitely an area that we can work on.

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1 MR. TAYLOR: A question from Bob Daley,
2 NRC.

3 MR. DALEY: It looks like there's a lot of
4 really good stuff, and I haven't looked at the
5 documents, but I'm going to make sure I read them,
6 because I like Dan's fluid writing style. But I do
7 have one question. You talk about HEAF events
8 represent approximately two percent of fires within
9 the U.S. nuclear power fleet. Is that two percent of
10 all fires, or two percent of challenging fires?

11 MS. LINDEMAN: All fires. Well, so the
12 fires that court towards frequency, so the potentially
13 challenging and challenging. So all those events.

14 MR. DALEY: So it's not all.

15 MS. LINDEMAN: Yeah.

16 MR. DALEY: It's just 4:17:01. And the
17 4:17:03.

18 MS. LINDEMAN: Yes.

19 MR. JOGLAR: A quick clarification. It
20 would be very rare to find one of these fires to be
21 not challenged.

22 MS. LINDEMAN: What we were saying, well,
23 I think Bob was asking -- so, if you looked at 2169 --

24 MR. DALEY: I agree.

25 MS. LINDEMAN: Yes.

1 MR. DALEY: That's why I was asking the
2 question.

3 The second, you have another thing in
4 there that said wide variety and severity of events.
5 And it goes, "Not all HEAFs result in post-event fire.
6 Most HEAF events damage only the equipment suffering
7 the failure."

8 Were we able to extract, just based upon
9 plant that this happened at, whether the cable would
10 be thermoset or thermoplastic?

11 MS. LINDEMAN: No, we don't have that
12 clarity of data. And I should mention, when we drew
13 the box around the HEAF events, we tried to include
14 everything that had kind of the arc blast event. So,
15 things like the Palo Verde event, the Turkey Point, we
16 added those in just because, as Nick and Gabe said, we
17 actually really don't have any definitions of what's
18 a Bin 15 fire or what's a Bin 16 fire. And we felt
19 that if we were doing this data review, it would be to
20 our advantage to put those all in and deal with them,
21 and see if there's similar characteristics. So, we
22 did include those.

23 MR. SALLEY: Yes, this is Mark Salley,
24 while I'm here.

25 Actually, on your slide you had the PRA

1 and the risk, I think a couple of slides back. There
2 you go, PRA treatment.

3 MS. LINDEMAN: This one?

4 MR. SALLEY: Yes. That was some of the
5 stuff that Nick talked about earlier with the pilots.
6 Is there, I guess, something like a question you could
7 take back to EPRI? If there is some way we can work
8 with you on that to support the generic issue for
9 Stan, moving forward with that, I think that would
10 kind of meet your pilots and it would kind of get us
11 where we need to be, if we can work with you on that.
12 So, if you would please take that back, Ashley?

13 MS. LINDEMAN: Yes, I'll figure out
14 whether it's Victoria or me.

15 MR. SALLEY: Yes, that would be great.

16 MS. LINDEMAN: But I think we can
17 certainly help you out with the study.

18 MR. SALLEY: And, Stan, that would kind of
19 be what you're looking for to move us forward?

20 MR. GARDOCKI: Well, for generic issues,
21 we're trying to figure out across the board the
22 impact. And I know every plant has different
23 configurations. I saw your limited scope was
24 safeguards were in different rooms. So, that kind of
25 like zeroes out applicability to what we're looking at

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1 where that would go across either two trains or impact
2 a certain train as the initiator, and then, the single
3 fire would take out other important equipment --

4 MS. LINDEMAN: Yes.

5 MR. GARDOCKI: -- if we go that far with
6 it.

7 MR. MELLY: Right. So, I think it's
8 important, when we do eventually decide what our pilot
9 plants are going to be, is that we have this
10 discussion as to what are we picking that can cover
11 the range of possible plant designs as well as what
12 we're looking for. So, I think it will require a
13 follow-up meeting with EPRI, and potentially the
14 industry as well, as to how we're selecting and what
15 pilot plants can cover the range of these possible
16 very plant-specific questions.

17 MR. PELLIZZARI: Francesco Pellizzari,
18 EPM.

19 In doing the assessment, did you consider
20 these HEAF events when they occurred, what operational
21 state the plant was in where there would be a shutdown
22 or a power operation?

23 MS. LINDEMAN: We may have considered
24 that.

25 Dan, I don't know if it became a factor,

1 but --

2 MR. FUNK: Yes, I think most of them were
3 at power.

4 MS. LINDEMAN: I think most of them were
5 at power, though.

6 MR. PELLIZZARI: And then, another
7 question, it appears you're leading to a distinction
8 between 1E and non-1E switchgear buses. Is it
9 possible that the distinction you see might be due to
10 the normal loading of some of the buses as opposed to
11 true dedicated Class 1E buses? They might be get
12 particularly heavily loaded during power-ups.

13 MS. LINDEMAN: We discussed this a little
14 bit. I think it's the care and maintenance and some
15 of the operational practices. I'm not sure if Ken or
16 Dan has anything to add. But we did discuss that.

17 MR. SHUDAK: Tom Shudak from NPPD.

18 I'm curious on some of your data support,
19 numerous subgroups. It's not up there. I was
20 wondering if you looked at insulated or uninsulated
21 buses. Do you see any correlation there?

22 MS. LINDEMAN: I don't think we looked at
23 that.

24 MR. FUNK: No. Again, the LER data wasn't
25 ideal. We could get back into the 1980s and the early

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1 1990s. So, we were going from what data we had
2 available. And, of course, for a project like this,
3 you want more than what you generally wind up having
4 to work with. As part of the second phase, I think we
5 looked at, tried to do a drilldown on some of these
6 features, as we get smarter on what's driving the
7 equations.

8 It's a good comment.

9 MR. FLEISCHER: Ken Fleischer from EPRI.

10 I wanted to try to answer what I heard as
11 a part of maybe that question on the Class 1E buses
12 being maybe lightly loaded or the configuration.

13 Can we go back to slide 4 for just a
14 moment?

15 Although that's really intended to be very
16 simplified diagram, that's not the most common
17 diagram. As you can see, coming right out of the
18 auxiliary transformer and the station transformers,
19 you go immediately to a Class 1E division bus. That's
20 not typical of those plants. Most plants, there's
21 what we call the intermediate non-Class 1E bus and,
22 then, it goes to a Class 1E bus. There's also other
23 non-Class 1E buses that are maybe bifurcated and
24 dedicated to balance plant equipment. But, typically,
25 there is an intermediate non-Class 1E bus division

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1 before you get there.

2 So, when the paper gets into the seven,
3 what I call, scenarios, if I have an H-E-A-F or a HEAF
4 in zone 1 or 2, under those different seven
5 circumstances, we walk through how the protection
6 system is designed to work and what the ultimate
7 outcome is going to be.

8 The more common designs are an
9 intermediate bus, and almost 50 percent of them don't
10 even operate operationally off of the unit auxiliary
11 transformer. They're dedicated to offsite power at
12 all times.

13 So, we still evaluated those HEAFs, but
14 they were not generator-fed. I don't know if that
15 sheds any light on this.

16 MR. MILLER: Yes, you said "generator-
17 fed". The classification was only those that didn't
18 have generator breakers. If it had a generator
19 breaker, that doesn't mitigate that.

20 MR. FLEISCHER: The generator breaker will
21 mitigate that because that operates in cycles.

22 MR. MILLER: Right.

23 MR. FLEISCHER: And it will immediately
24 isolate the generator from both the unit auxiliary
25 transformer and the main power train.

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1 MR. MILLER: Those were not -- eventually,
2 you would save on those and generate a breaker --

3 MR. FLEISCHER: Yes. Okay, yes. But what
4 we also get into those scenarios are the multiple
5 barriers that fail. So not only do you have the
6 initiating event, which the HEAF, but now I also
7 postulate stop breaker. A lot of these designs have
8 a bus transfer system, as you can see. I show the
9 breakers normally closed, normally open. If I have a
10 HEAF in either fault zone 1 or fault zone 2,
11 particularly fault zone 2, and that breaker is slow to
12 respond or gets stuck, I will transfer over to the
13 station power or station transformers. And in this
14 case I just have one.

15 What will happen is that let's say
16 division 1 fails and that breaker sticks. Division 2
17 has a successful bus transfer, but it is going to
18 backfeed into that fault. Now I lose both divisions
19 to the diesels. So, that's kind of the thing that
20 you've got to worry about. And a lot of the HEAFs
21 that occurred were during bus transfers, so they were
22 complicated by that.

23 In fact, we leveraged off of the NRC
24 paper. If you're familiar with the Monshon (phonetic)
25 paper, you actually covered similar -- I think there

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1 was a Monshon event and you covered five or six other
2 scenarios with that. So, that was a good paper, and
3 we leveraged off of that. If you need, I can get you
4 the ML number. But we got a lot of our research out
5 of that.

6 If you read the paper, particularly if you
7 avoid the paper on anything else, read the seven
8 scenarios. I think as I walk you through them in
9 those scenarios you will see how each HEAF is treated
10 differently by a different configuration protection to
11 system design.

12 MR. TAYLOR: Any other questions? Yes?

13 MR. CAVEDO: I just had a comment. I
14 don't see how that could have caused the loss of the
15 two divisions. That doesn't make any sense. The
16 diesels aren't going to come back on until the feeder
17 breakers are open there. There's an interlock there.
18 So, I don't see that it could have the fault propagate
19 to both divisions. Now you could have damage that
20 goes across the proximity, but not through the
21 breakers.

22 MR. FLEISCHER: There are two bus transfer
23 schemes up there for each division. If I have a fault
24 in zone 2 and that breaker sticks, the one that says
25 "normally closed," okay, and that normally-open

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1 breaker now closes as part of the bus transfer design,
2 I have now connected that to the station power
3 transformer. I'm now feeding that fault with that
4 station power transformer.

5 MR. CAVEDO: Then, that other normally-
6 open breaker pops open and it must be energized. So,
7 then, the diesel cuts off. You don't lose --

8 MR. FLEISCHER: It can. It can become a
9 race at that point, and you may or may not. And I
10 think that's the way we wrote it, "may or may not".
11 We cover different scenarios in different -- I covered
12 different scenarios and different fault scenarios.
13 There are several of them in there. But you could
14 ultimately go to both diesels.

15 MR. CAVEDO: Not without that other
16 normally-open breaker there.

17 MR. FLEISCHER: Well, actually, that was,
18 in the Monshon paper, there was an actual event where
19 that did occur.

20 MR. CAVEDO: Where the breaker failed?

21 MR. FLEISCHER: Where the breaker failed.

22 MR. CAVEDO: So, it is possible --

23 MR. FLEISCHER: Yes.

24 MR. CAVEDO: -- but it is not likely.

25 MR. FLEISCHER: Yes, it is not likely, but

1 it happened once.

2 MR. MELLY: Then again, in frequency
3 space, one event is one event.

4 MR. CAVEDO: Yes, one event is one event.

5 MR. MELLY: It's handled in frequency.

6 MR. TAYLOR: Any other questions or
7 comments for Ashley in the room?

8 (No response.)

9 So, I'm going to check the webinar real
10 quick.

11 It doesn't look like there's any
12 questions.

13 So, I did have one quick question.

14 MS. LINDEMAN: Okay.

15 MR. TAYLOR: Nick did a lot of work when
16 he put together the information notice, Notice 17-04,
17 which was the one that Tom talked about, identifying
18 operating experience or test data on aluminum aspects.
19 We tried to do justice to come up with durations for
20 those events. So, on the second paper that you had,
21 were you able to find any additional or new
22 information on durations that we didn't already
23 identify? Was there any feedback on that aspect?

24 MS. LINDEMAN: So, we didn't focus so much
25 on the event review of duration. But what we did

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1 characterize is how the protection schemes performed.
2 So, I'm not sure if that provides you the duration
3 answer, but at least insights on what scheme actually
4 did and if there was failures in the primary or the
5 backup.

6 MR. TAYLOR: Okay.

7 MR. MELLY: This is very interesting work
8 in looking at this and how these faults persist for a
9 long time with unit-connected designs. We also do see
10 the situations like Fort Calhoun where the fault
11 persisted for 42 seconds and was postulated to have
12 released 80 megajoules of energy during that period of
13 time on the root-cause analysis. It was a very low-
14 current event, but it was stuck in and had to be
15 manually turned off by the operators themselves by
16 switching a breaker. So, there are several cases
17 where it doesn't require that many levels of failures
18 in order to have these events hold in for long
19 durations.

20 MS. LINDEMAN: So, I think that event as
21 also an instance where there are multiple fail
22 barriers.

23 MR. MELLY: There was one.

24 MS. LINDEMAN: There was more than one,
25 yes.

1 (Laughter.)

2 I mean, I think there was design
3 deficiency and there was more than one thing that --

4 MR. MELLY: It was 42 seconds.

5 MS. LINDEMAN: Yes.

6 MR. TAYLOR: Okay. Thank you. Thank you,
7 Ashley.

8 Bas, I think you're up.

9 MR. EARLEY: Just one more question?
10 Thank you.

11 I was asked a question about what was the
12 basis for the gap spacing in the tests that were run.
13 And the gap spacing was based on the product standards
14 for equipment of a certain voltage category and the
15 basic impulse level required. And there was a
16 specified minimum and maximum spacing for that.

17 MR. CIELO: I just want to do a real quick
18 introduction for Bas. He's actually visiting the U.S.
19 between travel to India last week and Dubai this next
20 week. Yes. So, he is our Global Director of Business
21 Development and Innovation for KEMA Laboratories.
22 KEMA Laboratories -- he's going to tell you a lot
23 about -- is a division of DNV GL.

24 We don't design, build, or operate
25 anything other than our test labs. But we test for

1 every manufacturer on the planet between our three
2 laboratories. So, we see, basically, all the
3 equipment that you have and any other industry has.

4 We've got decades -- we've been around
5 since the early 1900s. And Bas ran the High Power
6 Test Lab, the largest high power test lab in the
7 world. He ran it in the Netherlands for a number of
8 years.

9 He's also a member of the IEC, the Dutch
10 IEC Standard Committee, and he's one of the managing
11 directors of the Short Circuit Test Lab, or liaison,
12 STL, which is kind of a confederation of short-circuit
13 test laboratories all over the world that not only
14 work to the standards, but develop test protocols to
15 have common results from these labs.

16 So, I just wanted to do a quick
17 introduction. He's here from the Netherlands. He's
18 going to present a lot of data. There's a lot of
19 information here. It's a little bit of a long
20 presentation, but, hopefully, I think you'll get
21 something out of it.

22 So, thanks.

23 MR. VERHOEVEN: Yes, Frank, thank you very
24 much.

25 First of all, it is my pleasure being here

1 talking to you. And, also, the information I got from
2 all the discussions this morning and the afternoon so
3 far is really interesting.

4 I would like now to bring you a little bit
5 more a global approach. There are some global things
6 that I see happening or in our work we see happening
7 in the world.

8 Like you said, I do travel a lot. So, I
9 have a lot of frequent miles for my family. But, at
10 the same time, I talk very often to utilities. Just
11 last week, I was in India talking to the utility and
12 the former Secretary of the Indian Ministry of Energy,
13 talking about power system reliability, power system
14 performance, and all that kind of stuff. We'll do the
15 same next week in Oman, Qatar, and, then, Dubai. Week
16 four on that, it will be in London.

17 So, I have quite a bit of a background of
18 knowing what was happening in the world. There are a
19 few items that are generic, and I will address these
20 and, also, on other things with some data, what was
21 happening over there. Hopefully, it will give you
22 some additional information in your scheme of
23 discussion.

24 So, what I would like to do, very shortly,
25 is just an introduction of KEMA, KEMA Laboratories,

1 let's say our mother company. Then, we'll talk a
2 little bit about certification, a global approach. I
3 think all the world is dealing with the word
4 "certification," independent testing and
5 certification. It's slightly different than it is
6 normally done here in the U.S. So, maybe there are
7 some things to learn there.

8 Then, we will talk a little bit about
9 statistics on testing and certification of the
10 components, circuit breakers, cables, and instruments
11 as well as transformers, and so forth. And in that
12 statistical data, because we have a time spent of 20
13 to 30 years, there are some lessons. And then, we
14 will take some summaries and takeaways.

15 So, KEMA Laboratories, the name KEMA is
16 very well-known in the utilities all over the world.
17 It was established originally in 1927 when we started
18 building the High Voltage Laboratory and, later on,
19 it became the Short Circuit Laboratories. In 2012, we
20 were, let's say, acquired by DNV GL, and that's a
21 Norwegian-based company. Actually, it is a
22 foundation, fully independent. And that is dealing
23 basically to save lives, property, and the
24 environment. So, we do not serve any -- there are
25 printouts of my presentation? Can we share it --

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1 thank you -- for people who want to make notes? So,
2 everything that we do, we do not produce anything.
3 Only we provide services to ensure the safety of life,
4 property, and the environment.

5 Basically, it's what we call an industry
6 consolidation. So, let's say the mother company is
7 DNV by itself, a Norwegian foundation, over 150 years
8 old. We grouped with Germanischer Lloyd, also a
9 company active in the field of the maritime sector and
10 the gas and oil sector and safety-related matters.
11 So, the company KEMA, the Dutch company KEMA, was
12 integrated in the system as well.

13 And we have here some background. KEMA
14 has been in the gas world. So, a lot of our people
15 knowing about gas, gas behavior, wind field areas, and
16 also within the piping industry.

17 So, again, a lot of disciplines over here.
18 Like I said, 150 years old. With our maritime
19 background, we are in over 100 countries globally,
20 mainly at the main ports, and 100,000 customers, 12.5
21 thousand employees.

22 These are our business areas. Maritime
23 sector, basically, the ships, and they can be normal
24 ships, special ships, special laying ships, or
25 containers, or whatever, to ensure that the ships are

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1 up to the class.

2 Oil and gas, that is basically to
3 safeguard lives and the property in the environment of
4 rigs in the sea or on gas rigs in the sea. I think
5 here, with the discussion I've overheard this morning
6 and this afternoon, it is here we can make a
7 connection between the experience and the knowledge we
8 have -- oil and gas, where we have a lot of people
9 available and they have the expertise and the
10 calculation methodologies to see how, let's say, if
11 you have a gas explosion on a rig, how it is being
12 protected with safety barriers, and so forth, in that
13 field. I think when you talk about long-term
14 durations and propagation of heat and fire, there
15 could be a connection. So, that's an invitation to
16 you all to work on that.

17 And also, we have in this field of play
18 special laboratories in the UK where they are able to
19 have real gas, real high-pressure gas, gas explosions,
20 and to study these also.

21 So, I think that is already, Frank,
22 included in the proposal. That is something to look
23 at because there is a lot of information available
24 there that we need to combine.

25 So, energy is there. Business assurance

1 is taking care of the management, accreditations, and
2 so forth, that we talk about.

3 Let's jump to KEMA, KEMA Laboratories.
4 There are, basically, three of them. The main
5 laboratory, one laboratory, you could say, here in
6 Arnhem. This is the Netherlands. It's on the German
7 border. You could say it's the same as Amsterdam,
8 but, then, a one-hour drive to the east.

9 This is the largest laboratory for short-
10 circuit testing and dielectrical testing in the world
11 in terms of power. No laboratory is bigger in terms
12 of how we perform. And you can see from actual size,
13 it's a very large facility. Total estimate is maybe
14 even 600 million euros to make this happening.

15 This part over here is the short-circuit
16 part where we test the circuit for short-circuit
17 performance. The generators, the switchyard, the test
18 facilities and test base, and here on the top we have
19 the High Voltage Laboratory, and so forth,
20 dielectrical testing.

21 As you can see over here, we are located
22 to the River Rhine and with our own harbor, where we
23 are able to dock ships in with large power
24 transformers, so the big ones up to 800-kilo class
25 power transformers, the real big ones, so stationary

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1 transformers, where we can test these transformers for
2 their ability to withstand short circuit passing
3 through the transformer. Every power network has
4 several short circuits in a year, and these short
5 circuits pass through all the components, including
6 the power transformers. And then, we determine how
7 well this transformer behaves for those currents
8 passing through.

9 So, that's the largest one. We have two
10 more or less comparables, one in Chalfont -- that has
11 been referred to by this board already -- where we
12 have here the test cells where we did the execution of
13 the test in the last years. So, one of these was,
14 let's say, it can be vaporized by the dose particles,
15 generator hull, and the train passing by that was
16 referred to this morning. Comparable laboratory like
17 that we have in Prague, in the Czech Republic.

18 How does a High Power Laboratory look
19 like? Because the short-circuit testing, whether it's
20 for an for a durable arc or an explosion arc or the
21 physical performance test of the circuit breaker, you
22 need to have a huge amount of energy. And that amount
23 of energy is basically you cannot get it from the
24 network without having the network going up and down
25 a little.

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1 Especially when we talk about here in our
2 facilities, like I showed here, we are able to test
3 circuit breakers on their functional performance to,
4 let's say, switch of the short circuit current and
5 failure, at the same time having 800 kilovolts or even
6 1,000 kilovolts as the feeding network. If you do
7 quickly the math, the number of power that you need
8 for that is huge. You cannot take it from that way.

9 So, what we do, we do it differently.
10 Basically, we have here short-circuit generators, and
11 these generators, we bring them up because they are
12 using the power network energy. But we accumulate the
13 energy in rotating energy in the rotor. So, each
14 generator has a rotor with a mass of 55 tons of steel
15 spinning at 3,000 RPM, or if we have to do the test at
16 60 hertz, it will spin at 3,600. And that's basically
17 an energy storage. By the time we do this, we
18 energize the rotor winding here in the generator hull,
19 and the energy comes back out again as this electrical
20 energy.

21 So, that's basically how we generate the
22 power, our step-up transformers to perform this to any
23 level that we need. Or we can connect even the
24 generators from their 10-kilovolt supply in parallel
25 for testing the certification of generator circuit

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1 breakers.

2 Switch our test base, several test bases
3 over here. The harbor is there, in there for the test
4 certification.

5 Here is how such a generator looks like,
6 and this is a generator. It's about 10 meters long
7 and diameter, overall diameter of about 4 meters.
8 This generator can make a short-circuit power of 2,500
9 MVA.

10 For that power class, this generator is
11 very small, because we do not have the limitation of
12 the thermal properties. We run this generator. We
13 speed it up, of course, but the actual short-circuit
14 test normally takes about, let's say, max 1 second.
15 So, we don't have an issue with the thermal continuous
16 operation mode. That's why we can get really energy
17 out of this generator of 2.5 kilovolts.

18 Then, have a look at the power rating. We
19 installed six of those generators, which can be better
20 now. So, basically, our continuous power rating we
21 can make is 15 gigavolt or better. Basically, that is
22 sufficient to power the whole of the Netherlands for
23 about 180 seconds. You get a feeling of what kind of
24 numbers we're talking about. These are big numbers.

25 Our laboratory in Chalfont that I've

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1 already referred to, we have two generators, a bigger
2 one and a little bit smaller one, T-1 and T-2. They
3 can't be parallel. So, the maximum power we have in
4 the Chalfont is 2.2 MVA, or a thousand MVA available.
5 We have two generators that can be parallel.

6 That means that, if you are running tests
7 or you need the ultimate power and our Chalfont plant
8 is not available, there is this lab in the Netherlands
9 that is six times the size of Chalfont. The question
10 is, is that needed? Most likely, the power rating
11 that can be supplied by Chalfont is sufficient for
12 your kind of testing certifications. But, if you run
13 into limitations, don't worry, there is a backup, a
14 big one.

15 What is important, and that's why I added
16 it over here, that's laboratories that people use
17 normally have to have, let's say, a decent
18 accreditation. And normal accreditation is the
19 ISO 9000 series. I think everybody's familiar with
20 it. But there is a special one that is 17-025, so
21 that IEC 17-025, which is a generic certification
22 scheme for laboratories, any current laboratory. It
23 can be a short-circuit lab. It can be a high-voltage
24 lab, but also a lab for the testing of clothing or
25 blood samples, or whatever. So, it is a generic

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1 management organization for laboratories.

2 If you make use of a laboratory, ensure
3 that it is certified by 17-025 for sure, and that's
4 also the connection here with the NRC, I believe, that
5 there is a simplified method of using laboratories as
6 long as they have that form of 17-025 accreditation.

7 Many the laboratories in our field of
8 play, where you look around the world in the power
9 sector laboratories, most of the laboratories are
10 manufacturer-based laboratories. So, they use it for
11 their own testing and certification. These are
12 typically not certified by 17-025. They're just run
13 by themselves. The commercial, good, independent
14 operation laboratories, of course, all have the
15 17-025. So, also, our three laboratories at all
16 locations are accredited to that system.

17 And basically that means in the end that
18 you are connected to basically the methodology as pre-
19 described in ILAC. That is the informational
20 organization for accreditation of laboratories.

21 So, let's look a little bit about the
22 global approach of certification. Basically, the
23 certification is what we call a means of mitigation of
24 risk. And there are, of course, several ways how to
25 mitigate risks. And so, the global approach that I

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1 see happening in the world over and over again is
2 basically a two-step approach.

3 First of all, you have to assure that the
4 design of your power network or your powerhouse, or
5 whatever, basically, the conceptual design is okay,
6 that you have selected the proper voltage classes, the
7 proper single circuit or double circuits, having
8 managed work and managed tools, or whatever. That's
9 basically the design that will give you the function
10 that you need. And you need to balance that with the
11 criticality of the component and on the system.

12 Again, I expect for a nuclear power
13 station the reliability issues are even at the higher
14 level than a normal substation in the queue. So,
15 that's one.

16 The second, if you have designed the
17 system, and you go to build it, you have to buy in
18 components. You have to ensure that these components
19 are up to the task, that they will be able to
20 withstand the voltages, the currents, and that the
21 circuit breaker will open when it is supposed to open,
22 and so forth and so forth.

23 So, what is important? A good design.
24 Secondly, make use of components that have proven to
25 be suitable for it.

1 And maybe a little bit of difference in
2 understanding between the U.S. and the rest of the
3 world or other bigger parts of the world. Many
4 utilities in the world want to see the proof upfront
5 at the development process. And by saying, well, the
6 manufacturer says, well, yeah, this is one design; it
7 will work definitely, it's on the specs. So, when it
8 is off, you can sue me, or whatever.

9 Well, people or utilities in the world --
10 especially next week I will be speaking to SUN, SUN-
11 ELECTRIC Company, that simply said, every component
12 that will go to tender must have at the tendering
13 phase already the certified, independently-certified
14 performance check. That means an independent
15 laboratory, like KEMA or some other companies, have
16 tested those components to a standard. Most of the
17 time, it is IEC-based.

18 And that's basically what you see
19 happening quite often, that in the global market,
20 where you say, okay, when I'm tendering, I am going to
21 demonstrate with the type of documents, that it is
22 tested in an independent laboratory, not in the
23 country of origin. That's how the global play is more
24 or less conducted. And that independent laboratory
25 can be an STL member.

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1 So, what is the STL? STL is a voluntary
2 group of laboratories that operate globally, where
3 they said, okay, many of the standards that are out
4 there, whether it is IEEE, ANSI, or the IEC, sometimes
5 these documents are still political documents. That
6 means that they are not -- let's say the working
7 committee was not able to design really, okay, these
8 are the tests that have to be done, or there are
9 options. And every political solution in the test
10 standard, basically, it can be shown that you have a
11 clause for a certain performance criteria and that
12 you may choose between test 1, 2, or 3. That means
13 the committee could not decide what the real test
14 should be because the stakes of the people was too
15 high.

16 All STL was doing, the short-circuit
17 testing result, is basically doing a harmonization of
18 the implementation of the standards. So, if IEC
19 standards, basically, are given options, STL will say
20 to the testing laboratories, we will always go for
21 option 1 or 2, and this and this is the way how to be
22 executed. That means that the members of STL will
23 always perform the best in-depth specific guide.

24 Basically, it's looking at IEC. So, that
25 is that IEC standard, although sometimes I know even

1 in the IEEE and the ANSI there may be different
2 approaches, but we do see that both those standards
3 are becoming more and more closer. So, a lot of IEEE
4 standards that are there on a day-to-day will take
5 over sometimes even 100 percent IEC. I think that's
6 a good development.

7 So, who are STL members? There are
8 currently quite a few. But, basically, all these are
9 what's now shown on the graph, I understand. There is
10 a membership here, STL, the source of the test
11 liaison, "NA," this North America, that's a group of
12 laboratories there. KEMA Laboratories is over here,
13 and we are, of course, members, even a founding member
14 of the STL. But you can see our general approach and,
15 also, you can see here our laboratory, that it is part
16 of the STL.

17 That means that they work and operate,
18 they have to work and operate exactly in accordance to
19 the STL guides. And when you talk about STL, not any
20 laboratory can become an STL member, because you have
21 to prove that you are up to the task, that you're
22 knowledgeable, that you have been maintaining that
23 knowledge for a longer time. That's one of the
24 criteria of the laboratory. That's why the number of
25 laboratories that you see is limited.

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1 When you look at the STLNA, so the
2 American version, it's comprised of several
3 laboratories, manufacturers' laboratories, but also
4 independent laboratories. I mean, Eaton is there.
5 Cooper is there. LAPEM in Mexico is also part of this
6 group. S&C is there, Eaton, and then Gelfem
7 (phonetic) is there as well. So, it is important to
8 delegate, and the influence of STL is becoming much
9 more important globally.

10 So, how do many of the utilities look at
11 certification? They said, like I said just before,
12 they need to at least ask for an independent
13 certificate upfront in the tendering process. In the
14 IEC, and I think also in the IEEE, or many in the IEEE
15 standards, there's a section which is called five test
16 or design test. And basically, that comprises the set
17 of tests that components should be tested to, and when
18 these tests are done, basically, it will say, hey,
19 this component is up to its stuff; it can be used by
20 itself.

21 And this is a prospect that many utilities
22 demand that full type test to be executed upfront or
23 even during the delivery, depending on the
24 methodology. That is typically how it is done. That
25 means that the majority of the work we see in our labs

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1 in the Netherlands are always certification tests.
2 When the manufacturer is ready with the design, he
3 thinks, okay, I'm done, I'm ready, let's go to the
4 independent test and hope that I will receive it, and
5 with that, I can release it and do my marketing, and
6 so forth.

7 Also, a thing that came across with some
8 discussions I had with American manufacturers as well
9 is that the liability of the component is not
10 transferred by certification. Although we, as KEMA
11 Lab, said, okay, this circuit breaker is up to the
12 task, it fulfills the requirements as stated in the
13 IEC, I will not be responsible for that circuit
14 breaker. That remains with the manufacturer, of
15 course.

16 Also, a thing that's often discussed,
17 modeling in place test. The feeling is such that
18 modeling are important tools for the design of
19 components, very important tools. And it can be rules
20 of thumb. It can be numerical calculations or finite
21 elements, or whatever kind of calculations or models.
22 But always a model is just a simple presentation of
23 the real-life situation.

24 And especially in those areas when you are
25 in a phased transition from solid to plasma, your arc,

1 that is where modeling becomes extremely difficult.
2 Modeling is extremely difficult. There are models for
3 the arcing parts. There are models for the stationary
4 solar part, for the transition between those two, and
5 the phenomena, especially when you talk about zero
6 crossing of a current, when you go very quickly from
7 a plasma state, hopefully, through a solid state, and
8 then, if you have a retrigger to a plasma state again,
9 that kind of modeling is extremely impossible. And
10 computers, even the big super-computers, are not able
11 to calculate that kind of stuff.

12 Also, to prove that little bit, CIGRE
13 designed several years ago and said, okay, I'm going
14 to make a circuit breaker in a certain design, and
15 that design was given to several manufacturers, Real
16 Global, Abrandt (phonetic), and manufacturers. They
17 were asked, hey, calculate this circuit breaker when
18 it will seem like the goal breaker. And a simple
19 electrical breakdown on AC voltage, the most simple
20 thing you can imagine.

21 So, every one of those manufacturers start
22 to calculating, and the super-breaker was also built
23 and tested. And then, all the results were compared.
24 It showed that there was a very big scattering of the
25 results. We had a physical result of the test was,

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1 let's say, 100 percent, and there were calculations
2 weighed.

3 And why? Basically, it is also very
4 simple. Why? Modeling is so difficult to represent
5 the real-life situations. The majority of the cases
6 when something, let's say, has a breakdown or a
7 dysfunctionality, it is because of slight
8 imperfections in the materials.

9 If you have a pencil, you can calculate if
10 I squeeze it and put it under pressure. You can
11 calculate the stresses in the wooden pencil, but you
12 never can calculate where it will snap, on my left
13 thumb, right thumb, or in the middle. Because it will
14 snap at the point where it has a small imperfection.
15 And I push with my fingertip in the wood, or an
16 imperfection will do it. That is something that you
17 cannot calculate.

18 Then, let's go to some experience about
19 reliability numbers and statistics and failure rates.
20 This graph that I got from Eaton here in the U.S. --
21 and if you Google out Eaton's blackouts record, that's
22 a study being done by Eaton, and they calculate the
23 number of outages that is happening in the U.S.
24 What's the root cause of that? They do it year on
25 year.

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1 So, this is the 2016 graph; '17 is being
2 calculated, will be published, hopefully, in a month's
3 time or so.

4 But this is a very interesting picture.
5 Basically, it shows that in the U.S. there are, in
6 2016, almost 2,900 outages in that year. That means
7 the outages today. And they are trying to find out,
8 hey, what is the root-cause analysis of that failure?
9 It appears to be -- and this is basically, of course,
10 the data that is looking at the transmission and
11 distribution networks -- it means also the median
12 voltage lines throughout the city and the countryside.
13 So, it is the exposed system, medium voltage and the
14 lower and higher voltage.

15 So, 33 percent of the outages was caused
16 by weather incidents, a storm hitting over, snapping
17 a pole, or that kind of stuff. And 4 percent was
18 animals, the deers and the raccoons that climb into
19 the poles and there may be short circuits. Cars
20 hitting the poles and the pole snaps and breaks the
21 line. About 5 percent was planned. So, when you have
22 the radio feeder and go into an area -- and they had
23 to do some prepare; it was a planned outage. Because
24 the people were in the way, it could not be switched
25 over.

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1 More importantly is this number here, 24
2 percent. Twenty-four percent of the outages in the
3 West here is basically arrangement by faulty equipment
4 or human error, the mistakes made to maintenance, or
5 whatever. But that basically means that the circuit
6 breaker who receives the trip amount will not trip.
7 Twenty-four percent.

8 I'm talking about reliability of
9 components where you just put components in the
10 network without knowing that these are of decent
11 quality. You're demanding something from the network.
12 And I think the discussions here was, yeah, yeah, that
13 can be so, that we have circuit breaker that doesn't
14 trip or we have multiple layers of handlers. Well,
15 yes, it's 24 percent. And I think that's quite a high
16 number. I think that number that can be influenced by
17 the utility assuring that what you put in your network
18 is of proven technology, that it's up to the
19 standards, up to the task that it is designed for.

20 Then, when you look at that 24 percent,
21 historically, over the years, then you see this graph.
22 Basically, this is not percentwise, but an actual
23 look. So, in 2008, it was about 650 outages caused by
24 faulty equipment, and that is going up to now just
25 over 900 incidents.

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1 That means that more is happening. And a
2 few reasons are here on the left. One of the main
3 reasons is by interconnecting of power networks to
4 stiffen the network, to make it stronger, so that the
5 short circuit performs better and the voltage
6 fluctuation in the networks are slower. And you have
7 better, let's say, availability in terms of -- but it
8 also means an increase of short-circuit performance,
9 of short-circuit currents, can go from maybe 20-30
10 kilograms up to 40, 60, and there are already power-
11 nets working in the new world with short circuits'
12 current values of close to 90 kilograms, 9, zero; 9,
13 zero. That's a big one. That means that all of these
14 stresses are put on the components and are sitting
15 there. So, you see an increase of those parts.

16 I talked about CIGRE. I will refer to
17 CIGRE a little bit more. That's why I put this slide
18 on, because I do not know if everybody is aware of
19 CIGRE, because that's an international organization
20 from 1921, which basically it's voluntarily an
21 academic environment where they do a lot of studies,
22 a lot of imports, and working groups, in the power
23 sector. So, technology outlooks, but also a lot of
24 statistical data is there from how the power-nets are
25 performing.

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1 Also, people from the U.S. are, I think,
2 a member of CIGRE. But I definitely would advise you
3 to please have a look. And there's quite some
4 information freely available. A little information is
5 available. For some, you have to become a member.
6 So, you can sign up, become a member yourself or find
7 somebody in the U.S. who is a member, and then, get
8 that data.

9 One of the three datas that came out from
10 the Working Group A2-37 was to perform a reliability
11 study. That's basically looking at power
12 transformers, the bigger ones, all over the world, and
13 how do they function. What is the overall experience
14 in terms of reliability?

15 And here you see the graph that was coming
16 out. Here in the white/blue blocks, basically, the
17 step-up transformers. And depending on the voltage
18 class, that means that in the step-up transformers 1.3
19 percent failure rate per year. And the step-up
20 transformers, of course, are the most critical
21 component in a power station, where it jumps up to
22 power. So, if you have an issue in the step-up
23 transformer, your unit is out for, let's say, a year
24 or half-a-year, or a considerable amount of time. The
25 normal power transformers that are at substations

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1 always have a little bit lower tendency to have
2 issues.

3 But that means one out of two of the
4 transformers has an issue in its performance. That's
5 quite a high number, obviously. So, things happen,
6 and we don't expect it, or things that were not, real
7 importantly, does happen.

8 This report, by the way, it's a long
9 search, but this report is freely available. I can be
10 downloaded by anybody.

11 Another graph from the report is basically
12 looking at, hey, what are the root-cause the analysis
13 of the failure of power transformers? Basically, it
14 was 11.6 percent of the cases the failure was caused
15 by an exterior fault, and this, the next general short
16 circuit. The short circuit passing through the
17 transforming, shaking the windings, and a lot of force
18 on the windings, and that was basically the root cause
19 of the failure of the transformers.

20 So, design issues, a big chunk on aging,
21 of course, here. And after time, power transformers
22 are often 20, 30, 40 years old, or longer, and then,
23 the aging becomes an issue. But well before aging,
24 the external short circuit kicks in in this case.

25 And that was a study we found from EPRI on

1 the performance of power transformers, a reliability
2 study. And also there, inadequate short-circuit
3 strength was the major cause of failure.

4 The funny part is, if you look at how many
5 utilities are demanding short-circuit testing of
6 distribution of power transformers, that's relatively
7 low. They all think, well, my network is good;
8 there's no issues for me, or that the manufacturer
9 says, no, no, I don't want this test because it's too
10 risky. That's a very, very odd situation there, what
11 I see globally, but it is changing.

12 Here again from CIGRE, an overview, 13.08,
13 and the number of faults that are happening in power
14 systems. Because many people in our own industry say,
15 aw, short circuits hardly even occur, at least not in
16 my network; it's not an issue. But, if you look at it
17 from a global basis, basically, depending on the
18 voltage class, you have two to three short circuits in
19 the line. That means, if you have an extended power
20 network, you do have issues, things happening in the
21 power network that will have an effect on the overall
22 performance. So, that can happen.

23 Before I start on this part, this is the
24 part of the experience we have in the last 20 to 30
25 years with time testing of components. What is

1 important is to understand the following: that is
2 data when the manufacturer comes to our laboratories
3 for a time test. It means the full time test as it's
4 in the system for that specific component. Mostly,
5 it's to set a different course. That needs to be
6 short-circuit performance, dielectric performance,
7 temperature-wise, and sometimes also mechanical or
8 circuitry.

9 The manufacturers that come to us have,
10 let's say, completed their R&D phase. They are ready
11 with the design. They don't come to us for R&D tests
12 because we are too expensive. So, when they come to
13 us, they are ready with the design and say, hey, this
14 transformer or this circuit breaker is of high
15 standard, high quality. Okay, yes, please come and
16 miss the circuit breaker or miss the transformer.

17 And then, we will start with the time test
18 sequence. And then, we don't basically look -- when
19 there is one of the tests in that sequence of tests
20 fails, then we call it initial failure. That means,
21 although the manufacturer thought it is okay, it did
22 not at some point during the certification process.
23 Of course, he can do redesign and come back, and then,
24 maybe hopefully for him, it will be successful. But
25 we only count the first time and we see if there is an

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1 initial failure rate or if this is successful.

2 Before I show an overview, I would just
3 like to ask the question, out of, let's say, the 100
4 percent, out of all of the components that we started
5 time testing, how many is your rough feeling of
6 samples have that initial failure rate problem? How
7 well is this sector in this case doing? Or do you
8 think that the initial failure rate is 5 percent, 10
9 percent? So, five components out of the whole group
10 are not going well? Or is it a little bit more, 20
11 percent, 30, 50?

12 MR. FLEISCHER: Are you talking prototype
13 or production?

14 MR. VERHOEVEN: The real one, the real
15 production type.

16 MR. FLEISCHER: Oh, the real production
17 types?

18 MR. VERHOEVEN: No, no, no, no, not R&D,
19 no.

20 MR. FLEISCHER: Ten percent?

21 MR. VERHOEVEN: Twenty-five. So, all the
22 components, the experience we have -- and it doesn't
23 matter when you talk about circuit breakers, power
24 transformers, cables, enginators, or medium-voltage
25 panels or low-voltage power panels, they all hover

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1 around the 25 percent.

2 And if you compare that with another
3 industry, we're not so good. If you compare it to the
4 car industry or the computer industry, or some other
5 industries, this number normally in all industries is
6 around 3 to 5 percent. We are, as a sector, 25.

7 Then, the question is, how come? Are we
8 not smart enough as people? No, I think we are
9 educated persons. We have a lot of smart people. No,
10 I think one of the reasons -- and I will give you some
11 more proof later on -- but, basically, this 25
12 percent, it is happening that these components that we
13 are using in our power networks, and whether it was a
14 circuit breaker or a panel or a transformer, or
15 whatever, these are what I would call high-tech
16 components. It has to be built in good condition. It
17 has to be designed in good condition. Because they
18 are up to the task, and that is a strong task. A
19 circuit breaker normally has sit in the closed
20 position waiting for the trip command. Maybe it has
21 to wait five years for that. It has to come, and
22 within 2 mini-cycles it has to open. That's a very
23 special product that we are designing in our sector,
24 and that is basically reflecting the number of 25
25 percent.

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1 Let's look at some statistical data. So,
2 large power transformers, 20 MVA or larger, we started
3 testing these transformers in '96 up to last year.
4 Basically, this is the trend. So, the total number of
5 these big transformers we test and the individual
6 year-on-year performance. And you see that in this
7 case our average is 22 percent. So, one out of four
8 transformers fails to meet for short-circuit
9 performance. That exhibits how that will look like.

10 But we mention that you order power
11 transformers and you don't test for short-circuit
12 performance, you could say. If this is true for the
13 whole population of transformers, if you have four
14 power stations, one of the power stations is at risk.
15 If that's completely true, I don't know, but roughly
16 to get your mindset a little bit in this way.

17 Also, you see an increase in the number of
18 tests we performed over the last power transformer.
19 That is showing of the world, and these are utilities
20 basically in India, China, or in Europe it's France
21 and the Netherlands, that are more and more and more
22 asking for short-circuit performing testing.

23 MR. TURNER: Is some of it because the
24 standards are requiring testing at 100 percent of
25 expectations whereas in a real application it may only

1 be running at 60 percent of that? Is some of it
2 because the standards have --

3 MR. VERHOEVEN: No. I will go through the
4 standards.

5 MR. TURNER: So, what you're saying there,
6 in effect, if I build something, I can put four of
7 these things in there. When I try to commission the
8 plant, one of them is going to go down. That's just
9 not the experience people will have.

10 MR. VERHOEVEN: No?

11 MR. TURNER: So, where's the disconnect?
12 Are the standards too tough or people just aren't
13 running it near the standard limits, or something of
14 that nature?

15 MR. VERHOEVEN: It's complex. It is very
16 complex to answer that question very directly, but I
17 think a lot of data on the physical performance of
18 networks does not come together. And that's why I put
19 this graph here for power performance. These numbers
20 are quite higher than people expect. So, a lot of
21 data or information on things that are happening out
22 there is not, let's say, accumulated to today's
23 experience.

24 This is a time test on the short-circuit
25 performance of a transformer. It goes very fast.

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1 Where there is a secondary short circuit, together in
2 here we feed in, and here you see what is happening
3 due to the mechanical forces inside the power
4 transformers that are creating a short wave in the
5 transformer and starting vibrating of the -- then, you
6 start to vibrate. And basically, a leak inside the
7 transformer is pooling in the transformer on the
8 enginator, and you have the snapping moment in the
9 engine as it breaks. In normal life, it would be a
10 big fire.

11 The other one, it is also a transformer.
12 This will have, due to the short-circuit movements
13 inside of the core, and then, the windings, there's a
14 short wave in the well. The safety valve breaks open,
15 and here even the oil catches on fire due to
16 evaporation of the oil. Since we are able to
17 disconnect the transformer very quickly from our
18 feeding generator, we don't have an issue here.

19 MR. TAYLOR: Do you want your next slide?

20 MR. VERHOEVEN: Yes. So, what is
21 happening there -- and, also, this is in Exhibit 4 --
22 the power transformers, to explain a little bit more
23 what's happening and why this is so crucial, this kind
24 of testing. It just also popped to my mind, this is
25 also maybe applicable to the things that you were

1 talking about, those sparks that are seeing short-
2 circuit curves. It's basically mechanical forces out
3 there, and this is the basic force of the curves. And
4 two curves, depending on the propulsion actions
5 happening inside, the winding order, parallel
6 conductors in the bus box.

7 Especially when you talk about this as
8 global, the distance between the crossbar is becoming
9 smaller and smaller, and the forces go up. Since it's
10 a short-circuit test, it's clear of the current. So,
11 it goes up very fast.

12 The issue in the exhibit of what can
13 happen, so this is normal rate of currents, and this
14 is basically a short-circuit current going to the
15 stationary in back. And this is the DC offset.
16 Especially in networks that are getting close to a
17 generator failure, the DC component becomes quite
18 high. And you can have, let's say, between a normal
19 curve condition and short circuits, it goes up to a
20 factor 10 times or a little bit more.

21 But, if you looked into the forces, it
22 goes up and, then, it doubles in size because it goes
23 up. It means that the peak goes in the force maybe up
24 to 400 per unit in force in total. And that's a
25 tremendous amount of force.

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1 And what is even more critical, that is
2 not a steady-state force. That is a pulsation,
3 constantly hammering with each going up and down. And
4 actually, what is happening, the frequency also
5 changes during the decay of the DC component. So, it
6 goes from 150, slow, to a 50 or 60 hertz, the
7 vibration.

8 And this can create a huge amount of --
9 you can see in the exhibit where the inner lining of
10 the control and the outer lining of this, there was a
11 leak going out where the complete winding was
12 basically rotated. So, this length normally should
13 have been straight from the inner lining. And here,
14 you can see it was twisted. And that twist basically
15 will end up in the short circuit.

16 The force was on the left, and the
17 righthand picture shows the forces on the inner lining
18 of the transformer due to the electromechanical forces
19 that wants to make the inner lining smaller in
20 diameter. And then, it build this out here in the
21 linings.

22 On this slide, on the left -- we'll play
23 a movie -- this is what you see is a winding. It
24 actually is a line core that we tested for short-
25 circuit performance. You can see, when we applied the

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1 short circuit, you see that the core will start
2 vibrating. And that's the pulsating force of the
3 current passing through.

4 You will also observe that the motion
5 decays over time. And carefully look also to this
6 part where you see some of the support was just moving
7 out. Yes?

8 You see the pulsating force. The
9 frequency is changing, and there is no support of this
10 going out.

11 That means that over time -- maybe in the
12 first time it remains okay -- but the second time it's
13 gone. So, maybe the half unit or when the next short
14 circuit comes, it will create an effect. And also, it
15 can be possible, like I said, for burst bars, high-
16 energy burst bars, where they are chemically
17 supported, but where the forces are also there, you
18 have to pulsate your forces. Then, the suspension
19 engine may snap or will start cracking. At some point
20 of time, it will evolve from, say, a normal fault to,
21 at a completely different location, a secondary fault.

22 Things to look at: yes, I was a little
23 bit surprised by it when I first was introduced to
24 this high-energy arc fault. I was really shocked, as
25 I said, at those 6 seconds or 40 seconds of what has

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1 happened, extremely high in time.

2 So, while the displacement is over here,
3 let's move on a little bit. I will go to the
4 standards. If you look at 444, that's volume
5 transformers and that's developing the standard. It
6 is that it allows in the IEC -- you have to, let's
7 say, demonstrate the ability for short-circuit
8 performance by either a test or by calculation.
9 That's also applicable in the IEEE standard C75, which
10 also allows calculation of mechanical forces.

11 Well, ladies and gentlemen, these kinds of
12 forces that was just shown in the movies cannot be
13 calculated. What can be calculated are static forces
14 inside the core. There's usually an ideal treatment
15 of the core, perfectly symmetrical, and all kinds of,
16 let's say, transpositions in the core cannot be
17 calculated. Leaks from the winding to the online
18 depth changer or to the enginators cannot be
19 calculated, impossible.

20 That means that the standard is changing,
21 and not only for power control, it's also for arc
22 reports. They are saying, hey, you cannot calculate;
23 you must perform the test. So, the IEC and the IEEE
24 will change -- most likely, it will be done in 2019 --
25 where the option of testing is ruled out.

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1 Let's look at another component,
2 distribution transformers. So, up to 2000 kVA across.
3 Where you see power class, the initial failure rating,
4 on average, is 25 percent. And here, for the bigger
5 transformers, 2000 kVA or larger, there you see an
6 observation that the failure rate doubles the size of
7 the normal sized transformers.

8 When you go back to the manufacturer and
9 ask, "Hey, how come; is this about double bit stops?",
10 basically, it's, yes, it turns out their production is
11 here in the moments, in the skills. For 2000 kVA
12 transformers, they don't make that many of them. So,
13 there are much more design flaws in there or there's
14 much more, let's say, effect of people making it are
15 having less knowledge in making it. So, you
16 immediately see a high increase in the number of
17 initial failure rate. So, that's an interesting
18 observation, I would say.

19 Cast resin transformers, most of the time
20 these transformers are used in high-rise building due
21 to their fire properties, where you don't want to put
22 oil or an oil-filled transformer in a high-rise
23 building due to the fire things. So, you put in a
24 cast resin, and they are a little bit more expensive,
25 but, basically, it is assumed that there's no oil.

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1 So, there is no issue with fire.

2 And one of the tests is a volt, and if
3 this cast resin transformer is heated by a secondary
4 fire, will it catch fire and start to accumulate extra
5 fire damaging to the part? Or can itself ignite when
6 it is heated up? That's what we call the fire
7 protection clause in IEC.

8 And strangely, from the prior transformers
9 we test for the fire properties, half of them is not
10 meeting specs. And it seems a simple thing. And you
11 buy those transformers for their fire properties. You
12 put it in high-rise buildings.

13 And what happens? Our experience, 50
14 fails. It means that there's a special component.
15 You can't name it. You cannot use it any kind of
16 resin for making this transformer. You need to have
17 special resin that has the right properties for fire;
18 also, the right properties for the thermal things that
19 are happening inside the core, but also the electrical
20 fire. So, it is not that easy as it seems.

21 The cables, medium voltage and high
22 voltage. So, medium voltage, between 1 kV and up to
23 36 kilovolts. Cables, medium-voltage cables, 11
24 percent of the cables has initial failure rates. So,
25 that's unacceptable, as you know. But, if you look at

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1 high-voltage cable, it's 26.

2 And also here, how come? Because the
3 cable manufacturing problem is basically the same for
4 a medium-voltage cable or for a high-voltage cable.
5 The same making equipment is what you need.

6 But what we see happening -- and we've
7 talked to many cable manufacturers in the world --
8 basically, the result was somebody has an idea. Okay,
9 I'm going to start to build a cable manufacturing
10 plant in country XYZ. They call one of the German, or
11 Finnish cable extruder manufacturers. You order such,
12 and you will get it. Within one year, you are a cable
13 manufacturer.

14 And then, these people are there and
15 producing cable, selling cable. Then, they find, oh,
16 the margins, my financial margins are not extremely
17 well. I want to earn more money. And then, they
18 look, hey, the high-voltage cable sector. So, 66 or
19 32, or 50 kV and 500 cables are very more lucrative in
20 designing. So, they call the supplier of the
21 manufacturer and get some additional components, put
22 it on, and the next day they are a high-voltage cable
23 manufacturer. But they are still in the technology,
24 in their methodology of working and quality
25 surveillance, and feeling this process, they are still

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1 a medium-voltage cable manufacturer. That's why this
2 number is more than double. Very practical, simple,
3 and maybe just, yeah, it's understandable. But this
4 is really what was happening out there.

5 Fifty percent of the medium-voltage cable
6 terminations fail. That's the heat shrink technology,
7 a very simple, easy-to-use technology. If you use the
8 right materials and the right components, it is very
9 good. But what you see happening -- and that's why
10 this 53 percent -- these termination kits, and you see
11 an exhibit of these kinds of the termination types, if
12 you don't take the right materials, it will start to
13 decay due to the electrical field that is over the
14 tube. So, you need to have a special tube that can
15 withstand electrical stress, and that sort of stuff.

16 That means it is a little bit more
17 expensive. So, a lot of push on the market to show a
18 step that there's a lot of, let's say, not suitable
19 materials out there that show this high level of fill
20 rates.

21 If you look at, for the cables, medium-
22 voltage and high-voltage cables, here is data year on
23 year. In the graph, these are the results. The blue
24 square, the performance year on year for medium-
25 voltage cables and here for high-voltage cables. And

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1 the yellow triangles are the accessories, meaning for
2 high voltage year on year. And the lines are
3 basically the trendlines from these data points.

4 And what you see, that the trendlines are
5 flat or even erode, although everybody would expect
6 that the trendlines should grow. We have better
7 materials. We have better design rules. We have
8 better experience. We have better production
9 facilities. We know more. So, all, let's say, the
10 competence and the technologies that have become
11 available over the years are not put into the
12 components. Otherwise, these trendlines would go
13 down, go into the 5 percent, which is maybe more a
14 normal value. No, it's flat, and it stays flat.
15 Actually, it's even going up.

16 Then, the question becomes, how come? How
17 come is it that the trendlines are flat or, let's say,
18 do not go down significantly while we have better
19 performance of materials, we know to calculate, we
20 have the experience, we have the improved production
21 facilities, dah-de-dah, dah-de-dah? And there's only
22 one answer to that question, ladies and gentlemen.
23 Who knows?

24 So, everything that we learned and gained
25 is not going into performance improvement. Otherwise,

1 the lines would go down. It's all that knowledge and
2 experience is put into one thing only, into cost
3 reduction.

4 MR. PUTORTI: How many different cables
5 are within each year's dataset? In other words, some
6 years there's zero; some years 100 percent fail.

7 MR. VERHOEVEN: Yes. The total dataset is
8 900 samples.

9 MR. PUTORTI: I meant for a year.

10 MR. VERHOEVEN: That will be --

11 MR. PUTORTI: For most years, like maybe
12 one cable was tested?

13 MR. VERHOEVEN: No, no, no, no, it's
14 always at least 10-50. So, statistically, this data
15 is okay, although the correlation for the trendlines
16 is a little bit down. It's scattered. That's why you
17 see the scattering. That's why I call it the
18 trendline. The trendline is basically -- it is not in
19 the statistical correctness of this data.

20 Because I wanted to learn what the result
21 was, and just because there were many factors, and
22 basically, like I said, everything that we learned and
23 gained and improved so far is put into that one single
24 thing. It's cost reduction. It's simple.

25 And I think even I was talking to the

1 Indian people last week, and they said, yes, it is
2 becoming even worse. And the problem of purchasing
3 departments is becoming so strong, and the amount,
4 they are very open because they have to do an open
5 tendering. So, the specifications, let's say the
6 technical specifications have to become more simple
7 and easy, because you have to go into an open
8 international tendering.

9 So, in the past you could say, if you
10 would order a medium-voltage cable, you described the
11 cable and the technical requirements. Nowadays
12 purchasing departments says to their own technical
13 people, what's the most simple way of describing a
14 medium-voltage cable? Well, simply it's photographs.
15 You have in kV three-phase proper conductor of 250-
16 millimeter scrap. That's sufficient to order a
17 medium-voltage cable, but it has nothing to do with
18 the technical requirement and, thus, performance.

19 But sometimes it is said with a provision,
20 if you compare this with Windows, now we have Windows
21 10 for power-computers. If we would transfer this,
22 what we have done in our sector with this craft, and
23 to make that a comparison to Windows, we still, as a
24 sector, are using Windows 3.1 and the same stuff that
25 was put in the computer 20 years ago.

1 And they I say in an open discussion to
2 the industry, are we doing well as an industry? Or
3 should we be ashamed a little bit as an industry? I
4 think the latter is possibly it.

5 Let's move on for time's sake. Circuit
6 breakers, really the real course in the sector is to
7 disconnect the short circuits. Within the IEC, there
8 are many, many different duties a circuit breaker has
9 to comply to. So, it has to be capable of switching
10 in short faults, long faults, capacity switching, log-
11 to-log switching, inductive switching. So, a lot of
12 different tasks that the circuit breaker may see, and
13 all these tasks have a specific duty.

14 And here you see in the graph the
15 performance of the average of circuit breakers. Where
16 we have over 4, over 50 tests, you see the numbers
17 even go up very high, depending on the type of duty.
18 So, also, on average is the 20-25 percent.

19 And this is the one we are relying on in
20 a protection system. This has to clear the fault in
21 the end. After the typical response from the
22 protection system, the circuit breaker has to trip.

23 Then, let's move on a little bit to
24 closely what I've seen within the sector on a global
25 scale with regards to the internal arc test of medium-

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1 voltage panels. I would say what I have seen in my
2 experience is that most of the utilities see a growing
3 importance of this test for the safety of their own.
4 Too many, let's say, people have been doing switching
5 actually in substations all over the world and too
6 many have died. So, the utilities are more taking up
7 their, let's say, responsibility to ensure that their
8 assets are, let's say, sufficiently protective for
9 their people.

10 But, if you look at the IEC, but also I
11 know for internal protection with safety-related
12 matters, it's quite often it is the current value and
13 the duration. Quite often, in the standards you see
14 duration of .1 second, .2, or .5, and in extreme cases
15 1 in time, because they expect, if you go to 1 or 2
16 seconds, basically, the second or third stage of the
17 protection must have cleared fully.

18 But I hear in the discussion today here in
19 this room a different kind of discussion. So, I think
20 this is for sure something that we have to study and
21 look at. What's the origin that you come to these
22 incredibly long times?

23 How do these components -- first of all,
24 we do test them for the performance of the internal
25 arc, assuming that there is a guy standing in front of

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1 it and that the guy should not, let's say, be hit by
2 fumes or gases. Maybe he still dies of a heart attack
3 or of the sound, but that's something different.

4 Also, here we are learning the statistical
5 data of how many of those cabinets fail to meet the
6 internal arcing test. I can't show you a graph yet
7 because we are still data-crunching here, but it looks
8 that it is, again, in the famous 25 percent. So, 25,
9 one out of the four cabinets that is being sold on the
10 market basically has a rating or at least you are
11 buying with the hope that it will protect, but it
12 doesn't.

13 So, how do you test it? Depending on
14 what's put in here, you have those racks a short
15 distance from the panel. These indicators, there's
16 specific cloth, how basically you do the test, and
17 these clothes should not have burn marks. You put it
18 on the sides where people could operate.

19 Here you have the test that is running.
20 It is difficult to see, but now it is starting. And
21 then, you see the exhaust. Over here's the pedals,
22 and going through the exhaust of the whole gases and
23 the smoke coming out, protecting the people that are
24 basically here.

25 We have another one. You see the opening

1 of the shutter. Did you see it going in the
2 beginning? You see the shutter opening. The shutter
3 is opening, but this is a complete failure, of course.
4 So, the cabinet was not able to divert, let's say, the
5 fumes through the lid that was opening as an exhaust
6 escape. But it has fully blown out the doors here.

7 Another one, also, a lot of fire, I think,
8 but the guy that was standing here not affected by the
9 arc. Of course, surrounding materials can be, let's
10 say, for the personal safety, it is not very good.

11 Yes, what we see happening here with the
12 statistics, 25 percent, and I was referring, also, to
13 the cost pressure in the market. What we are starting
14 to observe, that the cabinet builders are basically
15 trying to reduce the cost of the cabinets. Thinner
16 materials, hinges lighter, simpler designs. But,
17 basically, they are just increasing the risk of having
18 a real big issue with the internal arc. So, there the
19 cost pressure is eating up this space already.

20 And also, more pressure reflection, seeing
21 these tests which have arcing times of maybe 1 half a
22 second, but I think most of it is .2. You see a lot
23 of fume and fire in this case the more you talk about
24 seconds. I cannot imagine the panel that can withhold
25 internally 30 KA for that amount of time. It has to

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1 be like tank think; you can't pay for it. There is
2 also no design there. So, you have to find a way to
3 make sure that the gases can go out in a safe place,
4 and that the cabinet by itself is sufficiently strong
5 and capable of doing that.

6 Another thing that struck me was what I
7 recall, and during the discussions this morning it
8 came to my mind, I know of one case where a utility
9 somewhere in Asia had also an issue with these kinds
10 of faults. Basically, what they put into the panels
11 was, you could say, sort of a crowbar system. So, it
12 was a switch sitting at the terminal. Basically, when
13 it saw an arc, bang, it shot an arc, both three-phase
14 short circuit and the panel. So that you have a
15 strong short circuit, protection will pick it up, and
16 the result, you have an arc in the panel. And that
17 arc, we see that; we test it. Yes, it's a crowbar.

18 So, these components are on the market,
19 and we have tested those on their effectiveness. So,
20 how quick can they pick up and how sensitive or
21 insensitive they are? But it might be something to
22 look at, although it, of course, is just introducing
23 a risk of failure as well. So, yes, it was done.

24 Some other components, here, disconnect
25 the circuit breakers, switches. Again, the failure is

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1 25 percent. Arcing norms and arcing times, again, the
2 same numbers.

3 Basically, to close down this presentation
4 for this more global overview, the 25 percent is what
5 we see for all the components. All the increase in
6 technical skill and processing, everything is put
7 basically in one thing, the cost reduction.

8 Where I have the idea of, are we doing
9 well as an industry, utilities, manufacturers, and
10 then, users? Modeling calculation is extremely
11 difficult, especially when you are talking about
12 phased transitions from a solid state to a more plasma
13 state, difficult transitions. And we believe that in
14 the end it is the test, the real test, that shows we
15 have compliant entities and specifications.

16 And by that, I would like to conclude.
17 So, just three minutes over time. Maybe we can have
18 some questions?

19 MR. TAYLOR: Any questions in the room?
20 On the webinar?

21 All right. So, in the last few minutes
22 here, we will open up the lines for public comment.
23 Can you unmute everybody?

24 One second while we unmute those on the
25 phone line.

1 If there are any comments, raise those
2 now. So, the questions can be from this presentation
3 or anything else that was brought up during the
4 workshop today. So, feel free to ask questions, for
5 those on the phone line.

6 And while we wait to hear from the phone
7 line, if there's anybody in the room for any of the
8 presentations?

9 Okay. So, not hearing any, Mark, do you
10 want to make the closing?

11 MR. SALLEY: So, it was a long day, a lot
12 of information, a lot to think about.

13 Bas, thank you very much for traveling
14 over. A great presentation.

15 A busy day tomorrow, a lot of discussion.
16 So, again, let's figure 8:00, 8:30, getting through
17 Security, getting up here. And again, tomorrow we'll
18 look for a lot of, hoping for a lot of interaction and
19 a lot of discussion in the path we move forward.

20 So, with that, we will call it a day.

21 MR. TAYLOR: I've got one last thing.

22 MR. SALLEY: One last thing?

23 MR. TAYLOR: So, for those on the line and
24 for those in the room, the slides will be made
25 publicly available. I've put the ADAMS session number

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1 up here on the tablet. So, if you're not here
2 tomorrow, please feel free to look up that ML number.
3 They won't become public until like Friday. So, if
4 you go home tonight, you're not going to see that ML
5 number be brought up, but this is the ML number. For
6 those on the phone line, it's ML 18108A210. And we
7 will also make note of that in our meeting summary
8 that we put to document this meeting. So, again, the
9 ML number is, the session number is ML 18108A, as in
10 apple, 210.

11 So, with that, we will see everybody
12 tomorrow. Thank you.

13 (Whereupon, at 5:50 p.m., the above-
14 entitled matter went off the record.)
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