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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 SUBCOMMITTEE ON FIRE PROTECTION

6 + + + + +

7 WEDNESDAY,

8 SEPTEMBER 11, 2002

9 + + + + +

10 ROCKVILLE, MARYLAND

11 + + + + +

12 The Subcommittee met at 8:30 a.m. in Room T2B3,
13 Two White Flint North, Rockville, Maryland, Stephen L.
14 Rosen, Chairman, presiding.

15 ACRS MEMBERS PRESENT:

16 STEPHEN ROSEN	Chairman
17 GEORGE APOSTOLAKIS	Member
18 MARIO V. BONACA	Member
19 THOMAS S. KRESS	Member
20 GRAHAM M. LEITCH	Member
21 DANA A. POWERS	Member
22 JOHN D. SIEBER	Member
23 GRAHAM B. WALLIS	Member

24

25

1 NRC STAFF PRESENT:

2 TIMOTHY KOBETZ Cognizant Staff Engineer,

3 Designated Federal Official

4 SUZANNE BLACK

5 DOUGLAS COE

6 MARK CUNNINGHAM

7 J.S. HYSLOP

8 MICHAEL JOHNSON

9 PETER KOLTAY

10 STEVE NOELEN

11 MARK REINHART

12 NATHAN SIU

13 SEE-MENG-WONG

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

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

2 (8:31 a.m.)

3 CHAIRMAN ROSEN: Good morning. This is the
4 meeting of the ACRS Fire Protection Subcommittee. I
5 am Steve Rosen, Chairman of the Subcommittee. The
6 ACRS members in attendance today are Dana Powers, Jack
7 Sieber, Graham Lietch, Mario Bonaca, Tom Kress, Graham
8 Wallis. The purpose of this subcommittee meeting is
9 to discuss the Staff's Fire Protection Research Plan,
10 the status of the Fire Protection Research activities,
11 the fire protection inspection process and findings
12 and other related matters, including industry
13 activities.

14 The subcommittee will gather information
15 analyze relevant issues and facts and formulate the
16 proposed positions and actions appropriate for
17 deliberation by the full committee. Tim Kobetz, is
18 the cognizant ACRS Staff Engineer and the designated
19 federal official for this meeting.

20 The rules for participation in today's
21 meeting were noticed in the Federal Register on August
22 21st, 2002. A transcript of this meeting is being
23 kept and will be made available as stated in the
24 Federal Register notice. It is requested that
25 speakers first identify themselves, use one of the

1 microphones and speak with sufficient clarity and
2 volume so that they can be readily heard. Chairman
3 Merserve will address the staff at 8:40 a.m. this
4 morning on the tragic events of September 11th, 2001.
5 I will ask the speakers to pause at the
6 time the Chairman begins to address the staff over the
7 public address system. We have received no request
8 for time to make oral statements or written comments
9 from members of the public regarding today's meeting.
10 We will now proceed with the meeting. I call upon Mr.
11 Mark Cunningham, Chief of the Problemistic Risk
12 Analysis Branch to provide some opening remarks.
13 MEMBER POWERS: Mr. Chairman, before we
14 start, I would note that we are going to hear several
15 presentations from people from Sandia National
16 Laboratories and they who are associated with that
17 institution, members should apply the appropriate
18 weigh-in factor to any derogatory or replauding
19 comments that I make.
20 CHAIRMAN ROSEN: We will do so as is our
21 normal practice.
22 (Laughter)
23 CHAIRMAN ROSEN: Mr. Cunningham.
24 MR. CUNNINGHAM: Thank you, sir. With me
25 this morning are Nathan Siu, from the PRA staff and

1 Office of Research, Steve Nowlen from Sandia National
2 Laboratories, J.S. Hyslop from the PRA staff in the
3 Office of Research. J.S. is going to be the principal
4 speaker this morning with help from the others.
5 CHAIRMAN ROSEN: Welcome to you all.
6 MR. CUNNINGHAM: Thank you. For the past
7 several years, we've had a fairly extensive research
8 program underway to improve the methods and tools and
9 guidance that could be used by a number of different
10 types of organizations and staffs to perform fire risk
11 analysis. We believe this is one of the most
12 important areas of needed improvements in PRA methods
13 and tools, so it's been one or two of the high
14 priority items in the group in terms of PRA research.
15 J.S. will talk today about the plan that
16 we have for that research. We developed this plan
17 originally a couple of years ago, updating it. We're
18 in the process no of updating it again to reflect a
19 look at what we ought to be doing over the next four
20 or five years. J.S. will summarize some of the
21 accomplishments to date, try to explain where we are
22 now in the program. We are very interested in getting
23 the committee's comments on the plan and what we're
24 doing, whether we should be doing it at a different
25 pace, doing some things with a higher priority, doing

1 some things that aren't in the plan at all or perhaps
2 if there's things in the plan that you don't think are
3 important, that we would be interested in hearing all
4 that type of feedback from the committee.
5 We want to use this event to help us
6 formulate and cement in our plans for the next two or
7 three fiscal years in this program. I think it's a
8 very wide ranging program, going from experimental
9 work all the way over into applications in -- by NRR
10 staff and the significance determination process,
11 potentially by licensees and the NRC staff in terms of
12 doing fire PRA's or supporting and using this in PRA's
13 and risk informed regulation in general.
14 With that kind of general overview, I turn
15 it over to J.S.
16 MEMBER POWERS: You mentioned the staff
17 doing fire PRA's. Does the staff have routine tools
18 for doing fire PRA's?
19 MR. CUNNINGHAM: One of the goals -- we
20 have tools today. We think those tools are in need of
21 improvement to better reflect the current state of
22 technology, if you will, and that's a big part of what
23 the program is; is to include the tools and improve
24 the guidance that goes with that, with those tools.
25 MEMBER POWERS: If I go out to the regions

1 and ask the senior reactor analysts for the risk of a
2 particular plan on one of the regions with respect to
3 fire, does he have a tool that he uses?
4 MR. CUNNINGHAM: One of the things we're
5 doing is, improving the tools that are now used in the
6 significance determination process by the regions for
7 inspection purposes and J.S. is extensively and Steve
8 extensively involved in the improvement of that tool,
9 that specific tool, as well as others.
10 CHAIRMAN ROSEN: One of the things I'm
11 going to be listening for and perhaps you can help me
12 with it as you go along, is what fire protection
13 research is pertinent to advanced reactors. We are
14 writing an advanced reactor research plan, we the
15 committee in general, not just the fire protection
16 subcommittee. We are writing a letter to the
17 Commission on the advanced reactor research plan and
18 clearly part of that plan should include some fire
19 protection research.
20 Now, you've got a separate fire protection
21 research plan but clearly some or much of what you do
22 can or should be applicable to advanced reactors. So
23 together today, let's think about that and do what we
24 can to discuss and highlight for each other where this
25 all leads in terms of advanced reactors as well.

1 MR. CUNNINGHAM: Yeah, that would -- you
2 know, from our perspective, we're not very far along
3 in some of the advanced reactor risk analysis
4 considerations at this point, so it's a little vague
5 from our perspective of being very precise about how
6 you would use this information that we're generating
7 in advanced reactor licensing reviews. But you're
8 right, I would agree that a lot of this information
9 should be very useful in that context, but we just
10 haven't -- we don't know enough about the advanced
11 reactors to say a whole lot at this point, but we can
12 certainly --
13 CHAIRMAN ROSEN: Let's not consider these
14 two things in isolation --
15 MR. CUNNINGHAM: Agreed.
16 CHAIRMAN ROSEN: -- fire protection and
17 advanced reactor. They need to be brought together at
18 some point.
19 MR. CUNNINGHAM: Yes, that's right.
20 CHAIRMAN ROSEN: And there are, you know,
21 of course, additional challenges with some of the
22 advanced reactor designs that are proposed. For
23 instance, the graphite rim.
24 MR. CUNNINGHAM: Yes, yes, exactly.
25 MEMBER WALLIS: You said at the onset to

1 Dr. Powers, that the inspectors have tools. Are you
2 going to tell us something about what those tools are
3 like during the course of the day.
4 MR. CUNNINGHAM: We can do that, yes.
5 MR. HYSLOP: Yeah, we can tell you a little
6 but my understanding is that NOR is on your schedule
7 later today to talk specifically about the SDP
8 revisions, so I would expect that they would provide
9 the detail that you're interested in.
10 MEMBER WALLIS: Okay, thank you.
11 MR. HYSLOP: At least the agenda that I saw
12 earlier, I presume that it's still the same.
13 CHAIRMAN ROSEN: Yeah, NRR will be here at
14 2:40 -- 2:30 to 2:45.
15 MR. CUNNINGHAM: Shall we proceed or shall
16 we pause because it's --
17 CHAIRMAN ROSEN: No, I'm suggesting that we
18 just proceed. We will hear the announcement.
19 MR. HYSLOP: Thank you.
20 CHAIRMAN ROSEN: I'm assuming we can hear
21 it. We may have a problem with hearing in here, and
22 so we'll find out and if we can't hear, we will move
23 outside.
24 MR. HYSLOP: Hello, my name is J.S. Hyslop.
25 I'm a recent addition to the Office of Research. I'm

1 a senior risk and reliability analyst. I've spoken to
2 this subcommittee before with respect to the Fire
3 Protection SDP. This is an interesting program
4 certainly in my mind and I'm coming on board and
5 learning it and I'll be referring to Nathan, who is
6 also listed on this presentation, and Steve, for some
7 areas, some technical details.
8 CHAIRMAN ROSEN: I believe that's the
9 announcement. We may have to go outside. So let's
10 pause now.
11 (Off the record.)
12 MR. CUNNINGHAM: Okay, J.S., please
13 continue.
14 MR. HYSLOP: The next slide shows the Eight
15 Line (phonetic) of our presentation. First of all,
16 I'll be talking about the status of the program plan.
17 As Mark has told you, it's currently being updated.
18 I'll talk about program objectives.
19 MEMBER POWERS: What is -- I mean, when you
20 say it's currently being updated, that means that
21 everything we see today will be replaced with
22 something else?
23 MR. HYSLOP: No, no, in fact, a lot of --
24 what you see today will remain in the plan. If you'll
25 look further down in my Eight Line you'll see recently

1 initiated task. Those tasks will remain in the plan.
2 We expect good things out of those tasks. I'll get to
3 that in a little bit more. So I'll be talking about
4 recently initiated tasks which will carry us through
5 '03. Plan potential activities, accomplishments, that
6 is the work that we've done in existing tasks, general
7 elements of the plan that we would expect to retain in
8 the update, events since plan development. We've had
9 regulatory related events, activities related to
10 communication of research results, and we've initiated
11 cooperative activities. And last, but not least, I'll
12 provide some concluding remarks.
13 As I said, the program plan is being
14 updated. The last version was for 01/02 and we're
15 considering a four-year plan for the new version to
16 take us through '06. We'll be providing a lot of
17 detail for the first two years and similar to the
18 previous plan, and less detail for the latter two.
19 The program objectives -- these objectives
20 are taken from the 01/02 plan and they're as follows;
21 to improve the qualitative and quantitative
22 understanding of risk contribution due to fires in
23 nuclear power plants, to support ongoing or
24 anticipated fire protection activities, including
25 development of the risk informed performance based

1 approaches, and to develop improved fire risk
2 assessment methods and tools. We would expect similar
3 objectives to follow in the new plan.
4 Now to get to your point, Dana, these are
5 some recently initiated tasks that will certainly stay
6 in the plan. The first task is the fire risk for
7 quantification studies. And when I say "recently
8 initiated", I'm talking about the technical
9 activities. There was much groundwork done before May
10 '02 where we held the kickoff on the requantification
11 studies. We have a detailed presentation on these
12 studies following this overview of the research plan
13 so right now I'll just give you a few high level
14 points about those studies.
15 First of all, these are joint NRC research
16 EPRI studies. They represent the integration of many
17 tasks in our research plan and again, we'll get to
18 those task in the detailed discussion. We have many
19 objectives including developing new methods, and we
20 certainly expect this to support the ANS fire risk
21 standard which as just gotten underway.
22 MEMBER WALLIS: A requantification, that
23 means you're now going to be able to calculate things
24 in a different way. That's what requantification --
25 you're getting a number in some new way.

1 MR. HYSLOP: In a better way, yeah.

2 MEMBER WALLIS: Just because the old

3 numbers were lousy or because they were inadequate for

4 the task or too much uncertainty associated with them

5 or what was the problem with the old numbers?

6 MR. HYSLOP: Well, there was a lot of

7 uncertainty associated with the old numbers. The old

8 numbers were used in the IP EEEs and there was

9 certainly a lot of questions back and forth between

10 the staff and industry. There was -- some issues were

11 resolved for the IP EEEs but that's not clear that

12 that would be good enough to get an absolute value --

13 MEMBER WALLIS: So they varied a lot

14 between different people in the different -- they were

15 coming out with quite different numbers for apparently

16 the same thing?

17 MR. HYSLOP: There were various methods

18 used from IP EEE to IP EEE. So there's a lack of

19 standardization.

20 MEMBER POWERS: Dr. Shaq (phonetic) is not

21 with us but he in fact, has gone through the IP EEE

22 insights document and done a regression analysis

23 looking at the risk estimated by the various methods,

24 really following up what you did in there, your

25 insights document in a quantitative fashion and comes

1 up with a fairly quantitative conclusion that the risk
2 estimates are proportional to the method that is used
3 and that the higher -- the more qualitative the
4 method, the higher the risk. And this is not earth
5 shaking news to you, is that the more qualitative
6 methods tend to be more conservative and I mean, he
7 gets numbers out of these things but this is kind of
8 what we always thought and kind of what your insights
9 appendix or chapter says.
10 But it's fairly -- it's surprising how
11 clear-cut it is, but the cruder the method, the more
12 conservative it is, at least in that direction and not
13 the other.
14 DR. KRESS: Did he have a base quantitative
15 -- what quantitative was versus quantitative?
16 MEMBER POWERS: Well, they categorize them
17 and I forget all the details. It's basically five,
18 augmented five and fire PRA are the three categories
19 they use and then he just looked at the three
20 categories, looked at their estimates, compared sister
21 plants, compared other things.
22 DR. KRESS: He just looked at the same
23 distance apart on --
24 MEMBER POWERS: Sure, sure and did an order
25 statistic, you know, non-parametric statistic on it

1 and comes up with a conservatism associated with each
2 one of the methods and well, he wrote it up in an e-
3 mail to me and the upshot of it is that, I mean, what
4 Shaq was asking the question, we come out from the IP
5 EEE saying, the risk from fire is commensurate, I
6 think, was the word we used with risk from normal
7 operations and Shaq was questioning that.
8 And, in fact, he comes up with a
9 conclusion that when you use a real honest to God fire
10 PRA maybe the risk is not so high and whatnot and that
11 just adds impetus to what they're trying to do here
12 is, is get better measures on this thing because in
13 some sense we are allocating resources, inspection and
14 regulatory resources, according to risk and if that's
15 inappropriate, then not only are you making a mistake
16 but you're probably neglecting something that is very
17 risky.
18 CHAIRMAN ROSEN: Well, I think there's
19 another conclusion one can come to to supplement what
20 you said then and that is that if you believe that
21 fire risk is comparable to internal events risk, and
22 there's some doubt about that, based on what Dana's
23 just said, but if you did believe that, and you also
24 put that together with the Chairman's and the
25 Commission's expectation that future plants, advance

1 reactors will be safer than the current generation,
2 and that the way that they'll be safer is because
3 they're be mainly passive, a lot of passive features,
4 so that that will mainly effect their internal events
5 PRA numbers, this will mean that the overall CDF for
6 these new plants will be mainly dominated by fire. Is
7 that something that you would conclude as well?
8 MEMBER POWERS: I'll -- I certainly
9 understand where you're coming from on that and it's
10 a logical conclusion. I know one of the members,
11 people at the table has toyed with, if not explicitly,
12 advanced the concept that if we really are serious
13 about advanced reactors, we ought to be designing them
14 so that fire is no longer a reactor safety risk, that
15 it is strictly a property and life safety risk and
16 that based on some of the insights that have been
17 gained out of the NRC research program, it ought to be
18 possible to do that.
19 CHAIRMAN ROSEN: It's not apparent to me
20 how one would reach that goal, that fire would not be
21 a risk to an advanced reactor. Any time you have
22 electrical systems, you have fires and it seems to me
23 any time you have people, you have fires, and surely
24 in advanced plants, you'll have both.
25 MR. NOWLEN: This is Steve Nowlen. This is

1 actually something that I've actually put forward. I
2 think that the goal for advanced reactors or a goal
3 for fire protection would be to try our best at least,
4 to relegate fire back to the domain of life, safety
5 and property protection through appropriate design.
6 You're right, you're never going to get rid of fires.
7 You're still going to have fires.
8 The objective would be to insure that
9 fires cannot create a nuclear safety challenge.
10 You're still going to have the life safety, property
11 protection issues and that's never going to go away.
12 It's the nuclear part that I think we can attack and
13 hopefully virtually eliminate.
14 CHAIRMAN ROSEN: All right, let's go on.
15 MR. HYSLOP: The next task that's been
16 initiated is the fire risk standard. The Office of
17 Research is providing two members of the Writing
18 Committee, Nathan Siu and Steve Nowlen here at Sandia,
19 my understanding is I'll be supporting Nathan. We had
20 a kickoff meeting held recently at the Fire Protection
21 Information Forum in Seattle which I attended a little
22 of. I had to get back over to the Fire Protection
23 Forum.
24 The next task is the Fire Protection SDP
25 revision. NRR is managing that activity and research

1 is supporting the NRR direction to revise. And I'd
2 say this is a fairly comprehensive review. We're
3 looking at all the elements of the SDP and we've
4 identified issues and identified challenges for those
5 issues.
6 The last task is something that Steve is
7 supporting plant systems and NRR with and that's to
8 develop risk related guidance to support inspection of
9 fire protection circuit analysis issues. Now, we're
10 going to be giving a lengthy presentation of circuit
11 analysis later and so Steve will be able to give you
12 some insights about -- from the circuit analysis
13 program which he's using in developing this report.
14 MEMBER POWERS: On the subject of circuit
15 analysis, it's not your research, it's not your
16 domain, but we've not been enforcing findings which
17 were associated to circuit analysis. And that's been
18 going on for what, two years now or something like
19 that, a long time.
20 MR. HYSLOP: Yeah, John, is it that we
21 haven't been evaluating the findings or that we
22 haven't been inspecting for associated?
23 MR. HANNON: John Hannon, Plant Systems
24 Chief. Back, I believe it was in November of 2001, we
25 did stop inspecting in the area. We focused our

1 resources into other areas where we had good guidance
2 and the intent was to allow industry initiative to
3 provide better guidance.
4 MEMBER POWERS: Are we still waiting?
5 MR. HANNON: Yes, they a have recently
6 revised their guidance package based on staff
7 comments. We're supposed to be getting it in the next
8 couple of weeks.
9 MEMBER POWERS: So in the meantime we have
10 a problem with -- potentially have problems with the
11 circuitry in the plants.
12 MR. HANNON: The inspection activities have
13 been halted while the industry initiative was underway
14 to try to define the guidance we could use to
15 inspecting that area. We don't know if we have
16 problems or not because we aren't looking right now.
17 Once we get the guidance settled, we'll resume the
18 inspection activities and that's planned for next
19 year, 2003.
20 MR. HYSLOP: I'll talk a little bit about
21 the planned activities and then the potential
22 activities that we have for the Fire Risk Research
23 Plan. The first three are planned activities.
24 They're in addition to the bench marking and
25 validation, which we've been doing, we're going to

1 perform some testing. The testing is going to consist
2 of looking at cable tray (phonetic) in a compartment
3 and my understanding from speaking to Monte Day
4 (phonetic) who is leading this task, is we'll be
5 looking at more unique configurations for nuclear
6 power plants also.
7 The next task has to do with gaseous
8 diffusion.
9 MEMBER POWERS: Let me ask a question. You
10 say you're going to look at unique configurations for
11 power plants. Why? I mean, why should the NRC do it?
12 Why not just tell the industry, "Show us the
13 experimental data that says this is a good
14 configuration"?
15 MR. HYSLOP: As far as how does it, I'm not
16 sure of the answer to that.
17 MEMBER POWERS: But really, the question
18 I'm getting to is how do we decide when the NRC does
19 experiments and when the industry does experiments?
20 MR. CUNNINGHAM: As you probably know
21 already, there's no clear-cut statement as to how that
22 works. It's a -- tends to be an issue specific type
23 of thing, topic specific. In this case we saw
24 opportunities where we could take advantage of
25 experimental work being done in other industries or

1 other countries.

2 MEMBER POWERS: Okay, so this is a special

3 circumstance.

4 MR. CUNNINGHAM: Yeah, and I think in both

5 -- let me back up a bit. The benchmarking work that

6 we're doing and the code validation and experimental

7 work that we're doing in large part, there's a

8 substantial part of it which is inter-governmental

9 with the National Institute of Standards and

10 Technology, NIST, whatever that stands for. NIST is

11 in the building fire business. They have developed

12 very sophisticated models and run experiments to

13 benchmark those models, so we want to take advantage

14 of that. So Dr. Day, that J.S. has eluded to, has

15 been on a part time assignment to NIST to learn how --

16 to bring their technology in effect, back to NRC and

17 to see how it could be used in safety applications.

18 MEMBER POWERS: I mean, hey, that's great.

19 In your research plan, you really ought to seriously

20 think about articulating "Here is when we do

21 experiments and here is when we ask them to do

22 experiments and in all cases, when we can piggyback

23 and things like that, we'll do so, but" --

24 DR. KRESS: Yeah, in the absence of special

25 circumstances, I could just mention it seems to me

1 that the answer to that question lies pretty much in
2 the regulatory analysis area in the sense that here's
3 something where there's research needed and you say,
4 now who's going to do it. Well, do we require ask the
5 licensees to do it or do we do it? Well, it's like a
6 backfit.
7 So if it fits the backfit rules, then you
8 ask them to do it. If it doesn't, then you have to
9 decide whether it's worth enough of your money and
10 effort for you to do it yourself. It seems to me like
11 that's the answer to Dana's question, but there are
12 special circumstances, like you said, which may
13 override that.
14 MR. CUNNINGHAM: In cases where we -- in
15 this case we began with it's either inter-governmental
16 or inter-country, if you will. There's extensive work
17 that's being done in terms of fire code development
18 and validation in Europe and we're using -- we're
19 leveraging, if you will, our resources here, fairly
20 modest amount of resources here to get the
21 considerable work that's being done in Europe.
22 DR. KRESS: I think that's an excellent
23 reason.
24 MR. CUNNINGHAM: So in a sense, if you
25 think of the reg analysis as part of it, as a cost

1 benefit.

2 DR. KRESS: As part of this.

3 MR. CUNNINGHAM: In this case here we saw
4 tremendous benefit for a relatively modest cost. And
5 the one last example is you'll hear a little bit today
6 about tests on circuit analysis and this is where
7 there was work done by the industry that we
8 piggybacked on, if you will, to do some additional
9 work, so in that case, it was a joint, if you will,
10 fairly common set of work supported by us, by EPRI and
11 NEI.

12 MR. HYSLOP: And I'll talk a little bit
13 more about these joint activities because we have
14 international work going on with circuit analysis
15 also.

16 MEMBER WALLIS: You mentioned cable tray
17 fire testing and the Chairman earlier said where you
18 have electricity you're going to have fires. Why is
19 that? Why aren't these cables insulated with
20 something which doesn't burn so readily?

21 MR. HYSLOP: Well --

22 MEMBER WALLIS: Do we not have a long, long
23 history of trying to do that?

24 MR. NOWLEN: Well, yeah, I'll jump in. The
25 materials that we're using in the U.S. are reasonably

1 fire resistant. You know, they are thermal plastic
2 type materials. They're actually thermal sets.
3 They're good materials but they do burn if you get
4 them hot enough. So, you know, the problem we still
5 face is, there are other ignition sources besides the
6 cables.
7 We have the motors and the switch gear and
8 the transformers and all the other stuff and if we get
9 a good enough fire going that exposes the cables, then
10 you can get the cables burning. But as an initiator
11 themselves, they're pretty difficult to get to light
12 off. You can light a small fire but it's very
13 difficult to --
14 MEMBER WALLIS: So a candle won't do it.
15 MR. NOWLEN: Well, not against the cable,
16 no.
17 MEMBER POWERS: How about a welding torch?
18 MR. NOWLEN: Sustained, sure. Momentary,
19 no, it won't do it. A welding torch won't be enough.
20 DR. KRESS: I could probably set graphite
21 on fire with that.
22 MR. NOWLEN: I'm sorry?
23 DR. KRESS: I could probably set graphite
24 on fire with a welding torch.
25 MR. NOWLEN: Again, it has to be sustained.

1 MEMBER POWERS: No you can't. You guys at
2 Oak Ridge showed you couldn't do that.
3 (Laughter)
4 MEMBER WALLIS: It depends on the form of
5 the graphite. You can light steel if it's in steel
6 wool.
7 DR. KRESS: This is two dimensional metal
8 block.
9 MEMBER WALLIS: Oh, that's very different.
10 You can light a two-by-four if it's dry enough.
11 MEMBER POWERS: A two-by-four is easy.
12 MEMBER WALLIS: Not if it's wet.
13 MEMBER POWERS: I can light a dry two-by-
14 four with a cigarette lighter.
15 MEMBER WALLIS: Or a match if it's dry
16 enough.
17 MR. HYSLOP: Okay, the second task is the
18 gaseous diffusion plants task and there the issue is
19 what's combustibility of the liquids used in the
20 process and we also have a task under there looking at
21 guidance of testing of in-service sprinklers.
22 The next task has to do --
23 MEMBER POWERS: Let me interrupt here. You
24 have gaseous diffusion plant but I don't see you
25 addressing the MOX fuel fabrication facility and the

1 MOX fuel fabrication facility is -- or the ACRS
2 subcommittee that looked at that said the only real
3 risk that exists in this fire, I mean, it's fire in
4 the kerosine, it's fire from the fuel cladding. It's
5 fire from the furnaces for the centering. I mean,
6 it's fire, fire, fire raging all about. How come that
7 doesn't show up on your list?
8 MR. SIU: This item showed up on the list
9 maybe, what is it, a year or two ago based on
10 discussions with staff and NMSS. This was an area
11 that they'd expressed interest. I don't know that
12 we've gone back recently and had any extensive
13 discussion to see if they've updated their views as to
14 what we should be working on. Obviously, that will be
15 part of what we do as we update our --
16 MEMBER POWERS: Well, I'd sure look at that
17 one because the subcommittee came back with two
18 things. One, the dominant hazard to the facility that
19 could have consequences to the public, okay, where
20 public was -- it's a pecular definition because the
21 facility is located on a government reservation. And
22 the normal public is located 30 miles away but there
23 is an earth stats (phonetic) public which are the
24 workers at the government reservation that are not
25 associated with the facility, per se and there are

1 25,000 of them, a bunch of them.

2 And what they also said was not only is

3 there fire risk but there doesn't seem to be a good,

4 well articulated definition of what the design basis

5 should be for fire protection. That is, in nuclear

6 power plants, we have effectively a design basis that

7 says, "Thou shall be able to shut this plant down and

8 keep it shut down even in the event of a fire that

9 damages one of your pathways for shutting down".

10 Okay, they have an equivalent type of

11 definition, even though that, as far as the committee

12 could see, was the only way you were ever going to

13 effect the public with -- I mean, fire was the only

14 way to get to them.

15 DR. KRESS: Presumably the models that

16 you're developing would be sufficiently generic that

17 there might be, you know, some adjusting, applicable

18 to the facility like the MOX.

19 MR. SIU: Yeah, in fact, of course, as J.S.

20 mentioned, the notion of the properties of the liquid

21 combustibles was obviously an input that you would

22 have into your fire model. After that, you run your

23 fire model. Again, what we do in this program

24 includes fire modeling but lots of other things. So

25 we'd have to look at the sprinkler systems as well,

1 and whatever -- as Dana says, whatever defense
2 strategy.
3 MR. HYSLOP: The next task is fire risk
4 assessment for precursor analysis. There the task
5 indicates that we would need to review existing
6 simplified models and approaches. There's an approach
7 developed by Nathan while at INEEL, a report by
8 Budnitz (phonetic) and Apostolakis, I believe and then
9 the STD us undergoing revision. All of these could be
10 fodder for a precursor analysis method.
11 The next two bullets are place-holders.
12 We're not actively doing anything with those now, but
13 we would expect the last bullet, advance guidance to
14 come out of the requantification studies.
15 CHAIRMAN ROSEN: How about the rulemaking
16 support? Clearly, you're going to be doing something
17 about that. The NFD 805 has been certified to the
18 Commission.
19 MR. HYSLOP: As I said, we're participating
20 in the development of the ANS standard. I've just
21 categorized it differently, but in that sense you
22 know, better techniques, more complete techniques for
23 fire risk analysis, all of those things would
24 eventually come into play to support a PSA analysis
25 which the rulemaking would require -- would allow.

1 CHAIRMAN ROSEN: We don't have on our
2 agenda today a discussion of rulemaking and the status
3 of the rulemaking. Is there someone that can tell us
4 where that is now or --
5 MS. BLACK: Yes, Suzanne Black, Deputy
6 Director, DSSA. The Commission paper went to the
7 Commission the 15th, July 15th and so they have it
8 before them for consideration at this time. And when
9 we get an SRM approving it, we'll put it out for
10 public comment.
11 CHAIRMAN ROSEN: It sound like -- is there
12 any -- we don't want to prejudge the Commission,
13 obviously, but is there any sign that there would be
14 some difficulty with it because I'm thinking that my
15 understanding was that there would, you know, likely
16 be an SRM which would mean that the fire protection
17 people in the agency would have quite a bit of work to
18 do on rulemaking. It would become a significant work
19 load for these guys.
20 MS. BLACK: Yes, but, no, we don't have any
21 negative indications that they aren't going to approve
22 it.
23 CHAIRMAN ROSEN: I mean, I think you
24 should be thinking that it's going to be a workload.
25 MS. BLACK: Right, we're working with them

1 to develop a plan on that.

2 MR. HYSLOP: Let's talk a little bit about

3 the accomplishments, that is what we've done so far.

4 The first two bullets talk about circuit analysis and

5 fire detection suppression and there are detailed

6 presentations given by Steve Nowlen later, so I'll

7 skip those for now. We have a fire modeling toolbox

8 which we've developed and that includes a collection

9 of references for heat release rates, cable

10 fragilities, ignitability.

11 The next task is frequency of challenging

12 fires. There we've produced a model for handling the

13 early stages of fire development. It's a mechanistic

14 model. It looks at fire starting, fire spreading,

15 it's a step by step and it relies on expert judgment

16 to provide some of these probabilities.

17 The next is experience from major fires.

18 Basically, that's been renamed to be risk methods

19 insights. And there we found out that the fire risk

20 analysis framework captures the chain of events

21 observed real fires, with some exceptions, one of

22 which is multiple fires. Those aren't currently

23 analyzed to my knowledge.

24 CHAIRMAN ROSEN: Before you get off of that

25 multiple fires --

1 MR. HYSLOP: Yes.

2 CHAIRMAN ROSEN: -- is there some thinking
3 going on, on how one would incorporate that in a fire
4 model, with the idea that you're going to have hot
5 shorts and you know, the San Onofre experience, for
6 example? It seems to me that the fire risk analysis
7 would be incomplete unless we include in some way in
8 a probablistic sense likely, some module that is
9 required for people to, once having done their
10 analysis, to consider in some way the potential for
11 multiple fires igniting from the original fire,
12 resulting on phenomena that cause additional remote
13 fires.

14 MR. SIU: I think the short answer is I
15 don't quite know what we're going to do along these
16 lines. It's, as you can imagine, extremely
17 challenging. We had hoped to have some exploration
18 on the requantification study but frankly, I don't
19 know how we would go about doing that at this point.
20 J.S. and Steve are going to talk about the
21 requantification study later and talk about some of
22 the issues they've identified. I don't know, is this
23 one of them that's covered?

24 MR. NOWLEN: Not really, no. If you go
25 back to the event review that we did, we concluded

1 that in a sense you could capture multiple fires under
2 the existing framework of the PRA. That is there's
3 nothing that says you can't postulate damage in
4 multiple locations. The problem that we have is
5 understanding why and when and where multiple fires
6 might occur and being able to do that in a statistical
7 analysis. The knowledge base is very weak in this
8 area and so this is one that's going to take a bit of
9 work. I don't believe we're going to get there in the
10 quantification studies. I don't think we're going to
11 try and tackle multiple fires yet.
12 CHAIRMAN ROSEN: What troubles me about not
13 putting intellectual horsepower on doing something
14 about this is that there is clearly no way to conclude
15 that what we calculate without it in the analysis is
16 conservative. We have to conclude that whatever we
17 calculate may be non-conservative and that's very
18 troubling because we usually don't do that. We
19 usually do just the reverse.
20 We usually say, "Well, we know it can't be
21 as bad as this. It feels uncomfortable. We see an
22 analysis that we believe is as bad as it can be is
23 acceptable.
24 MR. SIU: I guess another example, which
25 was raised yesterday where we've kind of lived knowing

1 that there's an issue that hasn't been addressed is
2 that there's errors of commission in PRA's. We've
3 gone forth saying we know that certain errors have
4 occurred in real events. We have very hard times
5 developing a tool to predict the occurrence of those
6 errors and so we have PRA analysis that don't -- they
7 have boundary conditions if you will. And this is one
8 of the boundary conditions, the multiple fault of
9 fires, I guess the one saving grace is that they don't
10 occur very often.
11 Out of the many hundreds of events that
12 we've had in the fire data basis, a relatively small
13 number, what, less than five, thereabouts --
14 CHAIRMAN ROSEN: Five or five percent?
15 MR. SIU: No, five, five out of the several
16 hundreds of events.
17 CHAIRMAN ROSEN: So it's a one or two-
18 percent event based on --
19 MR. SIU: It could be but then, you know,
20 on the risk side you have to say, if I happen to have
21 multiple fires in a certain situation, could that be
22 risk significant, and, you're right, we don't have the
23 answer to that question.
24 CHAIRMAN ROSEN: Well, I think your
25 response is interesting, that the merits of commission

1 are in the same class of things which could make the
2 circumstances much worse than we anticipated. I'm not
3 sure that they're exactly analogous. I have to think
4 about it.
5 MR. SIU: It just meant that there are some
6 things that we don't have in our models at this point
7 and we try to be very clear about that but the models
8 aren't perfect.
9 MR. HYSLOP: The next task for which we
10 have accomplishment is the fire model bench marking
11 validation. There we've compared models versus one
12 another for cable tray fires and find them consistent.
13 And we're looking at turbine hall (phonetic) fires
14 with large oil sources now. Monte's doing this work.
15 The next task is the integrated model and
16 parameter uncertainty. The following task is
17 significance of smoke effects where we've -- Steve
18 Nowlen's done a review of literature.
19 MR. NOWLEN: I find that the threshold
20 smoke level for damage for digital circuitry is very
21 high concentration, films protection and then we have
22 some evidence from San Onofre and other events -- or
23 San Onofre anyhow, that the high voltage is vulnerable
24 to smoke arching.
25 MEMBER POWERS: The question now that is --

1 occurred to me is in October I have a fire at a
2 facility, smoke goes every which way. In December, I
3 find my contacts on every relay in the plant have been
4 corroded and that impact because you get these smoke
5 particles that transmit everywhere and they're
6 aggressive acidic little puppies. They usually have
7 sulfuric acid, a little HCL associated with them.
8 They get on the contacts, they start doing things in
9 remote parts of the plant, well, removed from the
10 location of the fire that cause me headaches. Do we
11 know anything quantitative about that?
12 I mean, this is just a presumption on my
13 part that this occurs just because I know the
14 particles are corrosive.
15 MR. NOWLEN: Yes, the simple answer is,
16 yes. It is observed. We see it in practice. It's a
17 fairly well-known phenomena. There are actually
18 businesses out there that specialize in post-fire
19 recovery. They've developed techniques for cleaning
20 equipment, for identifying what equipment needs to be
21 cleaned. So it's a fairly well, research topic. I
22 think, you know, there are clearly issues there but
23 again, people know how to deal with it.
24 The other thing that makes me less
25 troubled about this is that in a sense, what you're

1 doing is you're increasing the probability of random
2 failure somewhere down the road, due to environmental
3 insult. That -- you know, if you have a single
4 component that has a random failure some time
5 downstream that's not necessarily risk challenging.
6 The thing that makes the fire challenging is the
7 preponderance of several failures concurrently.
8 MEMBER POWERS: What I'm driving at is the
9 fire, we take care of it, everybody's happy, that's
10 done. Now, if I'm at San Onofre and I'm running my
11 risk monitor, I got to go in and change all
12 probabilities in my risk monitor for -- on the
13 reliability of various pieces of equipment because
14 some of them lost their reliability and I don't have
15 a clue how to change those.
16 CHAIRMAN ROSEN: Well, that might be true
17 but if NRR gave -- if research gave NRR some guidance
18 in this area and NRR put in their inspection manuals,
19 wherever an appropriate place of fire, that if a
20 facility, a licensed facility, has a fire with smoke
21 effects that go from different spaces, that part of
22 the inspection job is to make sure the licensee views
23 these services or takes into account the likelihood of
24 remote effects and you know, that's a way of getting
25 some of this knowledge into practice. Can you do

1 that?

2 MR. NOWLEN: I can't speak for industry

3 practices but I would concur that this is one that's

4 going to be easier to fix than quantify. You know,

5 appropriate post-fire recovery inspection efforts can

6 fix a problem. They know what to look for.

7 MEMBER POWERS: Steven, suppose the --

8 again, I'm at South Texas. I've had a fire. I call

9 in the cleaning agencies. They've polished down

10 everything. They conclude, don't I still have to

11 adjust my PRA because there's some probability that

12 they missed the critical thing that is going to mess

13 me up six months down the road?

14 CHAIRMAN ROSEN: I don't know. I guess it

15 depends upon how much confidence you have in the

16 protocol for cleaning up and testing they can do after

17 that.

18 MEMBER POWERS: Testing doesn't do anything

19 for me because nothing happens to the electric

20 circuit, to the electric contacts till six months down

21 the road.

22 CHAIRMAN ROSEN: No, I mean, you do the

23 cleanup efforts and you polish them up and you do

24 everything that's risk significant, and then you do

25 the testing beginning, you know, monthly, to show that

1 there's no effect.

2 DR. KRESS: I have trouble visualizing

3 going in, cleaning all the relay contacts and all the

4 switches and --

5 MR. NOWLEN: That's actually true. There

6 are criteria. Some of these things can be cleaned

7 fairly simply, soap and water, if it's amenable to it.

8 DR. KRESS: Yeah, but there are thousands

9 of them?

10 MR. NOWLEN: Well, yeah, again, it depends

11 on where your fire is, what got exposed, but there are

12 certainly criteria where --

13 DR. KRESS: Well, that's one of the issues.

14 If you have a fire, will you know how much smoke got

15 where? How will you know that?

16 MR. NOWLEN: You usually go by antidotal

17 reports of the people at the scene, you know, was

18 there smoke in this area and if there was, they'll go

19 in and they'll do a survey and --

20 MEMBER POWERS: You just insult Dr. Kress

21 and his career of work on aerosol because he can

22 calculate these things down to three significant

23 digits.

24 DR. KRESS: Dr. Powers is reading my mind.

25 Why don't you guys put some aerosol physics in here

1 and we won't worry about smoke.

2 MR. NOWLEN: Yes, well, it's certainly

3 possible. One of the things that the recovery

4 companies will tell you though is getting it right

5 away, getting it within 24 hours is the ideal and they

6 try to take actions right away so if you let things go

7 for very long, you know, long enough, for example, to

8 do an aerosol calculation, disbursal and whatnot, you

9 may already have lost the battle, and you will be

10 replacing your components. At that point, it's an

11 inspection for what needs to be replaced, not an

12 inspection for what needs to be recovered.

13 So there is a trade-off, and yes, in a lot

14 of cases in an application like this, you're probably

15 going to see them say, "Hey, look, don't clean it,

16 just replace it. We've got one in the warehouse".

17 And so, again, it's a mater of going in and

18 identifying what those pieces are, what got exposed

19 and what needs to be replaced.

20 CHAIRMAN ROSEN: Okay, thank you.

21 MR. HYSLOP: The next task has to do with

22 fire protection STP support which occurred before the

23 revision was undertaken. And there research provided

24 a model for roughly quantifying the effectiveness of

25 actions or remote shut-down and it was basically an

1 order or magnitude estimate based upon looking at
2 combinations of influences.
3 And then finally there's been 805
4 development support, name by Nathan. I want to run
5 down the general elements of the plan; objectives,
6 background, you know there, you know, we would think
7 to continue including the initial prioritization of
8 activities by the different offices and certainly
9 continue to relate these activities to our risk
10 informed regulatory improvement plan.
11 Program outputs and regulatory uses remain
12 important. Relationship with other programs and
13 activities such as HRA, that would be important,
14 technical objectives, task milestones and a
15 communication plan.
16 MEMBER LEITCH: Could you go back to the
17 previous one for just a moment, the fire protection
18 SDP support? The last bullet talks about a model for
19 quantifying the effectiveness of manual actions with
20 the remote shutdown panel.
21 MR. HYSLOP: Yes.
22 MEMBER LEITCH: Just having heard about the
23 human reliability analysis at a meeting yesterday, it
24 seems as though a lot of this is based on simulator
25 performance and I guess my question really is, how is

1 the data for this generated? Many plants don't really
2 have simulators of the remote shut-down panel. How
3 was -- how did you quantify the effectiveness of these
4 manual actions?
5 MR. SIU: This activity again is just
6 indicated for SDP report and necessarily it was kept
7 at a very simple level. Basically it's an
8 elicitation. You looked at the various factors that
9 could effect the performance of the crew, such as the
10 location of the panel or their distractions and what's
11 the kind of indications are available on the panel.
12 And so you come up with a modification factor to the
13 SDP number.
14 Just a point of clarification, yesterday
15 we haven't been using simulator data extensively in
16 our work. We plan to go in that direction. We're
17 showing the feasibility of doing that.
18 MEMBER LEITCH: Yeah, yeah, thanks. Okay.
19 MEMBER WALLIS: This plan you showed us,
20 you say it's general elements of plan. It looks to me
21 like elements of a general plan no matter what the
22 topic. Is there anything that distinguishes this plan
23 from any other plan that any other organization might
24 put together? It looks like a blueprint for an
25 undergraduate project or something and this is --

1 MR. CUNNINGHAM: Well, it's the elements of
2 a general plan.
3 MEMBER WALLIS: Yes, is there anything
4 special about your plan that is worth talking about or
5 is it just the blueprint for a general plan applies to
6 yours and we knew that anyway.
7 MR. HYSLOP: Well, my next slide talks
8 about that a little bit.
9 MEMBER WALLIS: It does say something that
10 distinguishes this from other?
11 MR. HYSLOP: Well, from others. You know,
12 I think these are good elements, you know. Certainly
13 they're common elements but the next slide talks about
14 relationship to regulatory applications. It talks
15 about communication. Why don't we go there?
16 MEMBER WALLIS: I was just wondering if
17 there are certain outputs which would distinguish it
18 from others.
19 MR. HYSLOP: Let's go to the next slide and
20 maybe I'll address that. Events since plan
21 development, you're aware of the 805 and the
22 rulemaking plan. There's the plan to revise the fire
23 protection SDP that's been developed. Industry has
24 submitted NEI 00-01 on circuit analysis. We've
25 identified potential needs for non-reactor

1 applications.

2 MEMBER WALLIS: This circuit analysis that

3 you keep talking about, what circuit are you talking

4 about here?

5 MR. HYSLOP: We're talking about the

6 circuits that control the equipment in the power

7 plant, MIV circuits.

8 MEMBER WALLIS: Electrical circuits.

9 MR. HYSLOP: Yes, yes.

10 MEMBER WALLIS: Oh, okay.

11 CHAIRMAN ROSEN: When you say "events since

12 plan development", which plan are you talking about,

13 the 2001/2002 plan?

14 MR. HYSLOP: I was really talking about

15 since the first plan which was '98. Was it then or

16 was it -- since 2000, oh, okay.

17 CHAIRMAN ROSEN: The current plan which is

18 the 2001/2002.

19 MR. HYSLOP: Okay.

20 CHAIRMAN ROSEN: Which is a fiscal year

21 plan, all right, so this plan ends the end of this

22 month.

23 MR. HYSLOP: The points that you raised, I

24 think these last two major bullets address your

25 comment. Under relationship with other programs and

activities, that's kind of special. We have moved forward in our formal arrangements with EPRI and we have a memorandum of understanding with EPRI that addresses or that identifies the requantification studies. It identifies cooperation on circuit analysis and it identifies cooperation with respect to fire modeling, that is we reviewed the fire modeling guide. It's pretty unique.

It also talks about interactions with international folks, the COOPRA, there we're doing circuit analysis. We're going to be, I believe, participating in some tests that they're going to run. And then the other group is WGRISK and we're in the process of formalizing interaction with them, with respect to fire vent data. The fire modeling is pulled out also because again, there's an international exercise beyond EPRI. So cooperation with our fellow technical folks is at least at this level is pretty unique or pretty good.

The next bullet I talk about the workshop we had on the Fire Risk Research Program. There research has gone out. We've had a public meeting. We had industry attend. We had the user offices in OR. We had the Regions attend and we presented where we were on many of these issues and we got positive

1 feedback. These folks had a better understanding of
2 what we were working on. We saw progress. Of course,
3 like everyone, they wanted to know, "When are we going
4 to get the answer, what is the answer". And that
5 wasn't there, you know, in many of these, but there
6 was progress so they appreciated it. So I think those
7 two major bullets are unique.
8 MEMBER LEITCH: A question about the
9 potential needs established for non-reactor
10 applications; do you mean by non-reactor applications
11 decommissioning sites and ISFSF facilities?
12 MR. HYSLOP: Well, I was thinking of
13 diffusion plants.
14 MR. CUNNINGHAM: It's other licensed
15 facilities such as gaseous diffusion plants but not
16 reactors.
17 MEMBER LEITCH: Well, then what about, have
18 you thought or do you intend to think about
19 decommissioning facilities and ISFSF?
20 MR. HYSLOP: Decommissioning and what?
21 MEMBER LEITCH: And independent spent fuel
22 storage facilities?
23 MR. CUNNINGHAM: There is a separate
24 activity looking at the risk associated with dry cast
25 storage of fuel, on site dry cast storage of fuel and

1 part of that, in that we looked at potential for fire
2 effecting those dry casts. That's part of a somewhat
3 different program that overlaps with this.
4 MEMBER LEITCH: And the status of that
5 work, that work is complete and --
6 MR. CUNNINGHAM: we have a draft report
7 that's been out that's being reviewed, being peer
8 reviewed and being reviewed by our customers at MNSS.
9 We expect the work to be done by the end of this year.
10 MEMBER KRESS: It's a pretty big gasoline
11 truck there.
12 MR. CUNNINGHAM: Or airplanes, yes,
13 accidental impacts from airplanes and things and the
14 fire that would be associated with that, but you're
15 right, the bottom line, if you will, it's very hard to
16 damage those things in any credible way and to get to
17 the point where you would get offsite relations.
18 MEMBER LEITCH: My question, though, also
19 goes to decommissioning facilities, that is facilities
20 that are in the process of being decommissioned that
21 are may be non-reactor. Maybe the reactor is down the
22 road someplace. Is there -- it seems to me there's a
23 difference then of fire risks associated with that
24 kind of an activity and I just wondered if you've
25 looked at that. It's a destruction environment

1 instead of a construction environment and that brings
2 a whole new set of factors into play.
3 MEMBER KRESS: Certainly, they've got fire
4 protect people.
5 MEMBER POWERS: A lot more cutting and
6 welding.
7 MEMBER KRESS: Probably a lot of transient
8 --
9 MEMBER WALLIS: Perhaps some impact on fire
10 protection systems.
11 MR. CUNNINGHAM: That has not been part of
12 it, but that's a good point. We'll put that on the
13 list of things to think about.
14 MR. NOWLEN: I think there's a point at
15 which you basically delicense a facility. It's no
16 longer a nuclear facility, so once again, you're in
17 practice it kind of relegates things back to the life
18 safety and property protection realm which is less
19 NRC's role here.
20 MEMBER LEITCH: But I think there's a
21 window of maybe five years until a reactor is finally
22 shut down and gets into the phase that you're speaking
23 to.
24 MR. CUNNINGHAM: This is before that
25 happens.

1 MEMBER LEITCH: It's before that
2 delicensing portion.
3 MR. CUNNINGHAM: Yes.
4 MEMBER LEITCH: I think there's a lot of
5 variabilities in there because circumstances are
6 constantly changing, staffing is changing, equipment
7 is being impacted, you know, you wonder about power
8 supplies, the fire pumps and fire headers and all that
9 type of thing as the activity proceeds.
10 MR. CUNNINGHAM: Before you go on, J.S.,
11 you went past quickly two acronyms, COOPRA and WGRISK.
12 Just to be clear on that, COOPRA is NRC's
13 international Cooperative Research Program and Risk
14 Analysis. One piece of -- it's a program of about 17
15 countries. One piece of it is fire, cooperative
16 research on fire. WGRISK is a OECD CSNI international
17 cooperative program that Committee on Safety of
18 Nuclear Installations used to be known as PWG-5.
19 People recognize it as PWG-5 and don't recognize it as
20 WGRISK.
21 MEMBER KRESS: Is COOPRA a hew name for
22 what used to be called C-Sharp (phonetic) or not?
23 MR. CUNNINGHAM: It's an analogue to C-
24 Sharp in the PRA.
25 MEMBER KRESS: Okay.

1 MR. CUNNINGHAM: Yeah, but it's PRA as
2 opposed to severe active.
3 MR. HYSLOP: Concluding remarks --
4 MEMBER POWERS: Another generic slide.
5 MR. HYSLOP: Yeah, but I thought it was so
6 good. I thought if we met these bullets every year,
7 I might want to put this up every year because I think
8 it's success.
9 CHAIRMAN ROSEN: Well, the key bullet of
10 the generic slide is more research in needed. Okay,
11 well, unless there are any other comments, we will be
12 in recess until 10:00 o'clock.
13 (A brief recess was taken.)
14 CHAIRMAN ROSEN: Now, we have a little
15 problem. This clock says it's 10:01 and this one says
16 it's 9:59, so I'll take the average.
17 MEMBER POWERS: A PRA guy worries about
18 that kind of error.
19 CHAIRMAN ROSEN: I worry, I worry. I'm
20 averaging the numbers.
21 MEMBER POWERS: Getting the right day ought
22 to be good enough for a PRA type.
23 CHAIRMAN ROSEN: You'll notice that both
24 are palindromic numbers, 9:59 and 10:01.
25 Now, we'll talk about the Fire Risk

1 Requantification Studies. Again, we have J.S.

2 MR. HYSLOP: These are joint NRC/EPRI Fire

3 Risk Requantification Studies and we're working

4 together on these and I'll talk more about that in my

5 presentation. I'm going to be giving this with the

6 assistance of Steve Nowlen and we intend to occupy

7 most of the hour with this presentation since the risk

8 method insights is a brief update.

9 Background, as I said before the first

10 step towards more formal cooperation between research

11 and EPRI occur with the development of a memorandum of

12 understanding between the two entities. It's a

13 general MOU. It talks about working together, sharing

14 information, and PRA took advantage of this general

15 MOU and developed a fire risk addendum.

16 The Fire Risk Requantification Studies are

17 one of several technical elements on this addendum.

18 It also identifies cooperation on circuit analysis.

19 Mark Cunningham talked about cooperation we have with

20 the testing that's being done and Steve's going to

21 talk a little bit about that. And then there's fire

22 modeling that's also an item on the addendum.

23 The objectives that we have for the

24 requantification studies are on the slide; to develop

25 state of the art fire risk estimates with our new

1 improved methods, tools and data, to develop --
2 determine the qualitative and quantitative impact of
3 these methods, tools and data on predicted fire risk,
4 to develop guidance for conducting FRA, to develop
5 guidance on strength and weakness of these methods,
6 tool and data and implement of technology transfer.
7 At NRC we're certainly interested in transferring our
8 technology to NOR and the Regions and we're also
9 interested in having industry use improved methods of
10 tools and data.
11 The scope of the studies are full power,
12 including estimates of large early release frequency.
13 This includes low power and shutdown, spent fuel pool
14 accidents, sabotage and Level 3 estimates of
15 consequence.
16 CHAIRMAN ROSEN: You see, that's a problem
17 to me.
18 MR. HYSLOP: What is?
19 CHAIRMAN ROSEN: Those exclusions,
20 especially the low power and shutdown loads exclusion.
21 Not that what you're doing is wrong, I just think it's
22 incomplete and I understand you do, too, but my take
23 on low power and shutdown risk for fire is that it is
24 significant and potentially as significant as fire
25 during operation modes.

1 MEMBER SIEBER: They're more likely to
2 occur in shutdown.
3 CHAIRMAN ROSEN: Clearly more likely to
4 occur for a lot of reasons and maybe potentially more
5 hazardous because of things like open containers.
6 MR. HYSLOP: That's not to say that that
7 wouldn't be a topic for a later requantification
8 studies but this is the current topic.
9 CHAIRMAN ROSEN: I understand that. My
10 comment is that part of the job is being done. We
11 need to do that whole job at some point, so perhaps
12 in your planning for the 2003 through 2006 prime
13 window you ought to be thinking about this.
14 MR. HYSLOP: Thank you.
15 MEMBER LEITCH: I guess my question is, if
16 this is a requantification though, am I current in
17 assuming that there is a current quantification for
18 those low power and shutdown modes and that you're
19 just not requantifying them at this time?
20 MR. HYSLOP: Well, we're not requantifying
21 them at all. They're out of scope.
22 MEMBER LEITCH: They're out of scope, okay.
23 MR. HYSLOP: They're out of scope for these
24 requantification studies, low power and shutdown.
25 MEMBER LEITCH: Okay.

1 MEMBER POWERS: But the substantive
2 question, aspect of the question, is there a primary
3 quantification for fire during shutdown?
4 MR. HYSLOP: We have some examples that
5 were done. I don't remember the plants but NRC did
6 some examples. Do you know that, Nathan?
7 MR. SIU: Yeah, there was a study done for
8 surrey but for the two particular plants that are
9 being investigated, I'm not sure what the status of
10 that is. Steve?
11 MR. NOWLEN: Yeah, the two plants that
12 we're dealing with, I don't believe they've looked at
13 low power shutdown fire risk at all. As far as I know
14 they haven't.
15 MR. HYSLOP: The next slide talks about
16 participants in these requantification studies. NRC
17 and EPRI will be working together to develop improved
18 methods. The pilot plants are Millstone 3 and D.C.
19 Cook and they will utilize the methods to update their
20 FRAs and then there's six non-pilot participating
21 plants. Their function in these studies is to perform
22 a review of methods.
23 We have a process for resolving
24 differences of view on technical issues and the major
25 points are that it provides a clear process to allow

1 consideration of all parties' views in the development
2 of these methods. We strive for consensus at many
3 points in this process. However, we do recognize that
4 there may be some technical issues where we'll have
5 differences in view and those differences in view will
6 stick and so each party maintains its own point of
7 view if a consensus is not reached.
8 Products, research will produce NUREGs on
9 insights and methods. EPRI wil produce an updated
10 fire PRA Implementation Guide. They currently have a
11 fire PRA Implementation Guide but they will be
12 updating that with these improved methods and tools
13 that come out of the requantification studies. And
14 the pilot plants will develop updated FRA, Fire Risk
15 Analyses. I wish to add that a new form of review of
16 the Fire PRA guide is planned in this project.
17 CHAIRMAN ROSEN: Leave that up for a
18 minute.
19 MR. HYSLOP: Yes.
20 CHAIRMAN ROSEN: The pilot plants will
21 develop updated FRAs. Now, what will the non-pilot
22 plants do again?
23 MR. HYSLOP: The non -- there are six non-
24 pilot plants. Their role in the structure of the
25 project is to perform a review of the methods that

1 come out of the EPRI and NRC deliberations. So they
2 will perform a review function of those methods.
3 They're not at the top of the structure. I've got a
4 backup slide if you want to see the full structure but
5 basically there's EPRI and NRC developing methods.
6 The non-pilot participants reviewing methods and then
7 there's an additional level EPRI and NRC in the whole
8 process.
9 CHAIRMAN ROSEN: I think maybe you ought to
10 show us the slide. I'm having trouble, see if you can
11 pull it out, understanding what the whole structure of
12 this thing is.
13 MR. NOWLEN: Right, I think a little bit --
14 the pilot plants have basically paid for a seat at the
15 table. Their seat at the table is being used as a
16 peer review function for the methods development task.
17 That's their opportunity to have input into the
18 process. That is they get to comment on the methods
19 development activities that we're doing, procedures we
20 write to do a specific analysis task. They will
21 review those, provide us with comments and the team
22 will consider their comments.
23 It was an opportunity we decided to take
24 advantage of basically. These all have boxes around
25 then that you can't necessarily see. What we have is

1 a process --

2 CHAIRMAN ROSEN: Wait, stop, stop.

3 MR. NOWLEN: Is this working? Okay, we
4 have a process and this is basically the process we
5 use for resolving the technical challenges, the
6 methods, if you will. So we have a series of
7 technical tasks to perform as a part of the PRA and we
8 begin by initiating a discussion of this particular
9 task, whatever it happens to be. We then go through
10 a process where EPRI and NRC together draft and intent
11 to resolve this particular issue.

12 We then send that intent out to the peer
13 review panel just to give them -- and this is where
14 the non-pilot participants play a role first here and
15 they come in down here again. So we run through a
16 process of first identifying that we're going to do
17 this issue, we're going to work it. We then go out at
18 as a team. EPRI and NRC develop a draft procedure and
19 they work to achieve consensus among the technical
20 area experts between EPRI and NRC. The peer review
21 panel can provide input to that team to say, "Well,
22 gee, we have some ideas here we'd like you to
23 consider". Basically, that's what this function is.

24 We then go down and depending on whether
25 or not we reach consensus amongst the technical team,

1 EPRI and NRC, we can follow one of two branches. If
2 we don't reach consensus, there is a process here for
3 trying again to reach consensus in which we sort of
4 bring in a higher level of management to mediate the
5 dispute, if you will.
6 If we do reach consensus, then we run on
7 through the rest of the process. On both of these
8 legs, there's a branch for the peer review panel,
9 which again, are these non-pilot participants to have
10 input into the process of trying to finalize these
11 procedures. If we've reached agreement and we agree
12 as to what the procedure should be, the pilot -- the
13 non-pilot participants still have an opportunity to
14 say, "We have problems with that", and we have agreed
15 to hear and consider all their comments. Same thing
16 on the other side.
17 We seek consensus and the peer review
18 panel has an opportunity to have input to that process
19 and finally, again, J.S. has mentioned the bottom set
20 of boxes here is that if we've not reached consensus
21 initially but we succeed, then we have a method. If
22 we do not reach consensus, ultimately we agree to
23 disagree, then we drop down. The EPRI people
24 basically have the final say in recommending what the
25 pilot plant should use, these are the plant PRAs after

1 all. They are going to be the owners but we have the
2 opportunity to maintain our opposing position. If we
3 simply disagree with the method, then we have that.
4 So again, peer review, right here, here
5 and here and that's the non-pilot participants.
6 CHAIRMAN ROSEN: And they are which plants?
7 MR. NOWLEN: Do you have the list?
8 MR. HYSLOP: If you know how to interpret
9 the acronyms. Hold on a second. Yeah, I've got it.
10 Exelon.
11 MR. NOWLEN: Oh, they're here.
12 MR. HYSLOP: Yeah, right there.
13 MR. NOWLEN: Exelon, Southern Cal Edison,
14 gosh these names change so quick, Duke, Florida Power
15 and Light, Nuclear Management Corporation, what's OPG,
16 Ontario Power Group, yes, so that is the six
17 participants there.
18 I want to note Dennis Henneke from Duke is
19 also involved on the ANS standard, he's leading the
20 writing group for ANS. So there's a lot of cross-ties
21 here. Does that cover it?
22 CHAIRMAN ROSEN: Yeah, I'm just looking at
23 the slide.
24 MR. NOWLEN: Yeah, this one is a little bit
25 different. You have basically our management

1 structure. At the top you have the joint managers at
2 NRC and EPRI, Bob Kasawara and J.S. We have the
3 oversight committee --
4 CHAIRMAN ROSEN: That's all right, you
5 don't need to go through it. I'm asking Tim Kobetz to
6 get me a copy of this slide and the prior one with the
7 issues resolutions?
8 MR. HYSLOP: We provided you all the
9 program plan that was developed jointly and both of
10 those slides are in there, so you have them.
11 CHAIRMAN ROSEN: Okay, okay.
12 MEMBER LEITCH: I'm still trying to
13 understand the process here. What we're trying to do
14 here is to requantify the risks from fire associated
15 with -- I mean, full power risks associated with fire
16 as it effects CDF and LERF (phonetic). Now, suppose
17 in this requantification process we find that our
18 original work was flawed and that the contribution is
19 much higher than we thought originally; now how does
20 that proceed, how does that information impact the
21 industry? What's the process there?
22 MR. HYSLOP: Well, we're publishing NUREG
23 documents on insights and methods so if there are
24 insights to be found, which we certainly expect there
25 will be, then they will be published.

1 MEMBER LEITCH: But published for
2 information, not necessarily having any force in
3 regulation?
4 MR. HYSLOP: Yeah, this is the Office of
5 Research. You know, it's a technical task and we're -
6 - the two pilot plants are requalifying their fire CDF
7 and LERF and we're going to develop insights,
8 technical insights and that's what our role is.
9 MEMBER LEITCH: Yeah, okay.
10 MR. HYSLOP: I'll talk about the
11 demonstration studies. These studies are analyses,
12 plant specific analyses performed jointly by NRC and
13 EPRI using case examples from pilot plant fire risk
14 analysis. An example may be circuit analsysis for a
15 significant portion of the control room. The purpose
16 is to demonstrate that the methods can be implemented
17 successfully fire risk analysis, that is we develop a
18 procedure for the methods. We test it in the
19 demonstration studies. If the licensee says, "I don't
20 understand", or, "You missed something", that's
21 important feedback for us.
22 So then we'll go back and we'll take
23 another shot at the demonstration studies and
24 straighten that out. The other purpose is to
25 implement a technology transfer. You know, the goal

1 certainly is for licensees to do -- to understand and
2 to do this themselves. And the demonstration studies
3 comprise NRC's full direct involvement in the pilot
4 plant FRA. Now, we're going to assist them so they
5 can understand and this may take one study, it may
6 take more than one study but -- and the reason that's
7 important is because the next bullet. NRR retains its
8 independence in review of applications based on this
9 pilot plant FRA, since much of the pilot plant FRA
10 would be done by EPRI in the pilot plants themselves.
11 CHAIRMAN ROSEN: What do you think is the
12 likelihood that plants will -- other than perhaps the
13 ones involved in the study or the peer review, will
14 actually use the new guidance to revise their fire
15 risk analyses?
16 MR. HYSLOP: The expectation is that they
17 would use it when they had an application that they
18 wanted to submit and it required better methods,
19 better standards.
20 MR. SIU: Just a comment along those lines,
21 NEI sent us a letter a little while ago talking about
22 the expectation that a number of plants would adopt
23 the risk informed rule when that's in place, which
24 involve the high risk assessment, high risk assessment
25 methods. One of the important things that we're trying

1 to drive towards, of course, is good guidance and
2 eventually good standards so that we can have methods
3 that we can be comfortable with when the application
4 comes in. And they, of course, don't need to know
5 what the target is, so I think that this is a
6 necessary step in leading towards that conclusion.
7 But again, our understanding right now is
8 that there are a lot of -- there are folks out there
9 interested in using these tools.
10 CHAIRMAN ROSEN: Okay, let me check. From
11 my understanding here, when NFP 805 is promulgated
12 ultimately, codified, plants who elect to become 805
13 plants will do fire modeling, fire risk analysis and
14 they will use the new techniques defined by the
15 requantification process. Is that your expectation?
16 Does that put all of the stuff together that we're
17 talking about?
18 MR. SIU: Yeah, I'm just not sure about the
19 time scale involved. There are going to be things
20 that will be learned along the way that will feed into
21 the writing of the standards. I'm not sure about
22 whether everything will be wrapped up in time to meet
23 this nice neat orderly process. Right now, the ANS
24 fire standard is scheduled for completion in I believe
25 2004. That was the time schedule put out by Dennis

1 Henneke. So depending on the rulemaking schedule, I'm
2 not sure if that's supportive. We've had some initial
3 discussions with NRR but no -- John, do you want to
4 elaborate on that?
5 MR. HANNON: John Hannon, Plant Systems
6 Branch Chief, it's our current goal to have both of
7 these efforts merge such that sufficient guidance
8 would be available to any utility who wanted to adopt
9 805 and use the risk informed part of it. Of course,
10 if that didn't happen, they could still adopt 805 and
11 use the performance base techniques until the adequate
12 package was available.
13 MR. HYSLOP: Okay, we'll talk about the
14 schedule. The first bullet, I omitted and that's that
15 EPRI and NRC develop the joint plan for this program.
16 And that was done in May 2002. We then kicked off the
17 technical work at Millstone shortly afterwards. We
18 have a kickoff or D.C. Cook, the other pilot plant in
19 October after the PS 02 conference and I want to
20 advertise that there is a panel session on the
21 requantification studies where EPRI and NRC will
22 participate that the PS 02 conference.
23 We plan to complete Millstone in September
24 '03 and Cook in November of '03. EPRI plans to update
25 their guide in December '03 and NRC will produce

1 NUREGs afterwards. And then we have a workshop which
2 time is to be determined. You know, it's possible
3 that we would do that with EPRI. We just haven't
4 really investigated that yet.
5 The next slides are Steve Nowlen's and
6 I'll turn the presentation over to him.
7 MR. NOWLEN: Okay, this is an update of
8 where we are technically. Currently, we're focused on
9 two areas and that is defining a consistent set of
10 analysis steps that we can all agree to and that is
11 what is it -- what's the process of doing the fire
12 risk assessment and then what we're doing is we're
13 writing procedures for each of those steps. Right now
14 we're focused on the early steps.
15 What we're trying to do is we're trying to
16 break this overall process of a fire risk analysis
17 into manageable pieces, small chunks that we can take
18 and work. That's a bit of a challenge of trying to
19 break a big task into little tasks and yet, keeping
20 all of the tasks self-consistent. So there are some
21 challenges there.
22 The early task, for example, in past PRA
23 we would typically talk about qualitative screening.
24 That one step has been broken into several steps
25 including plant partitioning, the selection of the

1 critical equipment, the fire PRA equipment list, if
2 you will, selection of critical cables and circuits
3 and this gets you towards the circuit analysis issue,
4 what are the pieces of equipment you need to be
5 concerned with there. And then development of a fire
6 PRA data base to consolidate and collect your PRA
7 information. So again, the idea is that we're
8 breaking this up into small pieces and then we're
9 attacking each piece individually with a sight to the
10 overall thing fitting together when we're done.
11 MEMBER WALLIS: How good is the technical
12 modeling behind this and if you have a fire somewhere
13 in the room, do you make the gross assumption that
14 everything in that room burns and all the functions
15 are demolished in some way or do you have a more
16 realistic analysis of what happens in that room?
17 MR. NOWLEN: Well, the fire PRA is a
18 progressive process. You may begin with the
19 assumption, for example, qualitative screening, yes,
20 you will assume that you're going to lose an entire
21 room or a set of rooms, for example, depending on how
22 you've partitioned your plant. And you will assess
23 whether or not that has nuclear safety implications
24 for you. As you work through the process, you
25 eliminate the things that don't matter and retain the

1 things that do matter and in the end, you hopefully
2 have an analysis that quantifies specific fire threats
3 in specific locations, impacting specific equipment
4 sites. So it's a progressive thing.
5 MEMBER WALLIS: Is that a really
6 predictable sort of technology, where you set a fire
7 in a waste basket in this room and predict what will
8 happen in the room and what will happen to the
9 circuits in the room and so on?
10 MR. NOWLEN: Yes, we hope so.
11 MEMBER WALLIS: You hope so or --
12 MR. NOWLEN: We certainly hope so. If we
13 can't then we're fooling ourselves. I thin, yes, we
14 can.
15 MEMBER WALLIS: But can you now or is that
16 what you're going to be able to can do in the future?
17 MR. NOWLEN: Well, I think it's a matter of
18 yes, we can do it now. The question is how far can
19 you go in the refinement before you're beginning to
20 lose resolution and validity? Can I tell you that a
21 trash can in the specific corner over here, you know,
22 10 hours from now might -- no, you know, I mean, there
23 are certainly limits to what we can and cannot
24 analyze. Certainly we can do it today. The IPEEEs
25 did it.

1 They did it to a certain level of
2 resolution. We're trying to refine that resolution to
3 improve our confidence in the answers that we get and
4 to reduce the uncertainties associated with those
5 answers.
6 CHAIRMAN ROSEN: I think a more direct
7 answer to this is, yes. I mean, there is a code that
8 we saw described at the Seattle Fire Protection
9 Information Forum called Magic that the people at
10 Point Beach used to describe a fire, how it
11 progressed, whether it burned. You know they even
12 generated a little video, the computer code generates
13 a little video of how the fire progressed, and it's
14 based on fundamental fire physics.
15 MR. NOWLEN: Yeah, there are a range of
16 such tools available. Magic happens to be one that
17 was developed on France by the utilities there. EPRI
18 has an agreement to utilize that model. We expect to
19 use Magic in our requantification studies. There are
20 others. NIST has a set of models, you know, from
21 simple zone models that are comparable to Magic to the
22 full-blown 3D fire field model.
23 CHAIRMAN ROSEN: Dynamics models, I mean,
24 the answer to Graham's question is, yes, it's a
25 complex science.

1 MEMBER WALLIS: Do we know is it validated
2 by comparison with large scale tests?
3 MR. NOWLEN: All models are validated to
4 varying extents, yes. And there are a range --
5 MEMBER BONACA: I had a question on that
6 issue. In the previous presentation, one of the
7 program objectives presented was developed improved
8 high risk assessment methods and tools. Are those
9 methods going to be used for this project? I don't
10 think so because this --
11 MR. NOWLEN: Oh, yes, absolutely.
12 MEMBER BONACA: Oh, they are.
13 MR. HYSLOP: That's what this project is
14 about is developing those methods. I was referring to
15 this project.
16 MEMBER BONACA: Okay.
17 MR. SIU: If I can enlarge on two points
18 here; first, as J.S. pointed out, there have been a
19 number of achievements of this program and part of the
20 point of the requantitative is to bring those into the
21 fire PRA state of the art with applications, hence the
22 work on developing the procedures and so forth, make
23 sure that these improvements really can be applied in
24 the field. So there's a full intent to do that.
25 Along the way, of course, they're going to find out

1 that we have still issues to address as they do the
2 studies, so that things will have to be done and that
3 is what J.S. is referring to, developments in the
4 field to actually perform the study.
5 Regarding the fire modeling, you know, I
6 don't think we should over-simplify the situation.
7 There are models, certainly, you give them input and
8 they'll give you output. There is a certain amount of
9 validation. I think we can probably feel confident
10 with early stages of prediction. We certainly can
11 feel confident with if you prescribe an input, heat
12 generation rate, what's going to happen, how is the
13 surrounding -- how the temperature field develops, how
14 the heat flux field develops and you can predict, of
15 course, the thermal response of a target exposed to
16 this.
17 Predicting secondary ignitions and
18 subsequent progress of the fire, obviously, starts
19 getting more complicated. You're uncertainties start
20 to magnify and I think that's a challenge that we're
21 trying to address. J.S. referred to in some ways this
22 international fire modeling program which is intended
23 to validate fire models. That's a somewhat long-term
24 effort. Some of the results of that, I think, will
25 feed into the requantification study but certainly not

1 all just because of the time scales involved. So I
2 think there are significant uncertainties in fire
3 modeling. Part of the job of the requantification
4 studies is to make sure we at least try to quantify
5 those uncertainties and their effect on the final
6 results.
7 MEMBER POWERS: When you analyze these
8 fires, especially when they involve cables, do you try
9 to keep track of the chemical speciation that you're
10 releasing?
11 MR. NOWLEN: Current fire risk assessments
12 don't typically deal with that, no. Some of the fire
13 models have that capability and it's still an
14 undetermined factor to what extent we'll try and deal
15 with that. I believe for the requantification
16 studies, the extent that we'll be able to extend the
17 current state of the art is probably to tracking smoke
18 as a species and trying to predict where the smoke
19 might go and whether or not that might present
20 problems for exposed equipment and manual firefighting
21 for example. I don't think we're going to get into
22 tracking acid gases for example.
23 MEMBER POWERS: When you calculate smoke,
24 do you attempt to do it in some sort of mechanistic
25 sense or do you just say that there is so many grams

1 per second of smoke generated?

2 MR. NOWLEN: It's a little of both.

3 Typically, the way it's handled in the current fire

4 models is you specify a grams per gram of fuel burned

5 for smoke particulate generated and then you treat

6 that as a species that you transport along with the

7 oxygen and all of the other things. So the technology

8 there is a little bit limited. There are some

9 attempts being made to advance the state of the art in

10 being able to do first order, for example, predictions

11 of how much smoke might be predicted under or

12 generated under certain burning conditions but those

13 have not yet matured to the point where we try to

14 apply them in the study.

15 MEMBER POWERS: And particle size in the

16 smoke is assumed?

17 MR. NOWLEN: Particle size is generally

18 assumed, yes. You usually assume a distribution for

19 the particle size. And the way that most models treat

20 it, it's actually masked. You're looking at an overall

21 smoke density which you can correlate to, for

22 instance, visible distance in the smoke field, how far

23 you can see. That's about the limit of what we do

24 today. Okay.

25 One thing to recognize is that the level

1 of advancement that we're attempting to achieve here
2 varies depending on the task that you look at. In
3 part, it's relating to our comfort zone. Some of
4 these things we're reasonably comfortable with the way
5 we do it already. Others are simply related to areas
6 where we feel that there are advancements available
7 that we can take advantage of. At the bottom level,
8 I guess, it would be the consolidation of existing
9 methods and this would apply to things like plant
10 partitioning, the screening process, and
11 documentation.
12 We have a pretty good idea of what we're
13 comfortable with there. It's a matter of
14 consolidating this and providing some consistent
15 consensus, guidance for how those tasks should be
16 done. The next level up would be what you might think
17 of as in incremental improvement. These are things
18 that we do reasonably well. We're looking to make
19 some advances here. Things like a fire PRA database,
20 this is actually something that EPRI has been working
21 on for some time to try and bring together a
22 consolidation of the information that use in the PRA
23 and the information you'd take away from the PRA.
24 And I think that's a very good advance.
25 It's not incredibly challenging but I think in terms

1 of having the information accessible and useable it's
2 definitely a good idea. Fire ignition frequencies is
3 another case. The methods of fire ignition frequency
4 are fairly well established. We are attempting to go
5 further towards a compliment based ignition frequency.
6 That is the very earliest methods looked at a room or
7 a building and estimated the fire frequency for that
8 room or that building and then sort of parsed it up
9 around the room by area or whatever.
10 More recently there's been a drive towards
11 a more component level fire frequency look that I have
12 five pumps in this room and that's my fire shouce, so
13 let's talk about the fire frequency of these five
14 pumps. There are issues with being able to do that,
15 population issues, for example. How many pumps does
16 a typical plant have? If I only have two and that
17 plant has five, does that directly translate to the
18 plant with five pumps having higher frequency, maybe,
19 maybe not. So there are some issues here but we're
20 trying to drive the fire frequency further in this
21 direction of component level.
22 Uncertainty and sensitivity analysis is
23 another one that I would -- this one is kind of a
24 tough one. The extent to which you would call this an
25 incremental improvement versus substantive, which is

1 my next list I think is still a little bit of a
2 debate. You know there are areas where we know how to
3 do uncertaintivity and sensitivity analysis certainly.
4 The questions are, there are aspects of fire that we
5 haven't typically propagated formally through a fire
6 PRA that we're going to attempt to propagate formally
7 this time and also to gain in some cases where we're
8 not formally propagating uncertainty to at least bring
9 a qualitative view of what the uncertainty associated
10 with some of our tasks is.
11 In some of the other areas we believe that
12 we're really making significant advancements, the
13 plant fire-induced risk model is one area. In this
14 case, the typical practice has been to grab the
15 internal events model, simplify it a little bit and
16 that's now your fire model. What we're trying to do
17 here is we're trying to bring in a view of fire and
18 its unique challenges in the development of the plant
19 model. There are issues, for example associated with
20 circuit analysis that may not be captured in the
21 internal events models, spurious actuations in
22 particular, human factors or human reliability
23 analysis related issues like instrumentation that may
24 not be captured in the internal events model.
25 Remote shut-down is another one that we

1 typically kind of plug into the internal events model,
2 trying to take an explicit look at how we deal with
3 remote shut-down for a specific plant. So, in this
4 case, I think there are a number of things that are
5 going to happen that are going to represent a
6 significant advancement in the way we treat the plant
7 model for fire.
8 Circuit analysis is another one that is a
9 significant improvement area. The identification of
10 critical cables and circuits, the performance of a
11 detailed circuit analysis and then doing the
12 quantification of the circuit fault load and its
13 impact on risk, these are the elements of the circuit
14 analysis task that we see and in each area there's
15 been a lot of work recently looking at the issue of
16 circuit analysis, the behavior of circuits on fire, on
17 given fire damage, how the cables behave given cable
18 damage, how the circuits behave.
19 So we've got a lot of new information.
20 We've got to talk later in the day that will cover the
21 insights we gained from the recent testing program and
22 again, in the requantification studies we're going to
23 be consolidating this and putting it into practice.
24 Detection and suppression is another area.
25 You're going to have a presentation on that coming up

1 later this afternoon, so I don't think I'll spend any
2 time there for now. The HRA work, I believe you heard
3 about that yesterday. We are going to be bringing to
4 bear advanced methods of HRA for the fire PRA.
5 They're developing list of issues specific to fire,
6 for example. What is it that's unique about fire
7 analysis, what are the issues that are needed to be
8 resolve, what do we know, what do we not know, and
9 then also the fire modeling. And in this context, I
10 want you to take a very broad view of fire modeling.
11 Fire modeling incorporates a lot of different things.
12 Fire modeling has to do not only with the application
13 of a code like Magic, it has to do with what you
14 assume for your input parameters, what kind of
15 characteristics are you going to assign to this fire
16 that you've postulated?
17 How does detection suppression interact
18 with it? How are you going to deal with severity
19 factors and a practice of saying not all fires are
20 severe? How do we reflect that in our fire PRA?
21 There's different levels of fire modeling. You can do
22 very simplistic fire modeling, the sort of thing 5
23 did, spreadsheets, correlations, back of the envelope
24 kinds of things. What role do those have to play in
25 a modern fire PRA? So this fire modeling task

1 actually rules up a number of things, so I'd ask you
2 to take a very broad view. And I think in many, many
3 areas, we're going to be making some significant
4 advances here.
5 So that's where we're at. Unless there's
6 any comments, that's the end of the presentation.
7 CHAIRMAN ROSEN: Well, I'm not really clear
8 about your first bullet on the significant
9 advancement; plant fire-induced risk model, how that
10 differs from what we are doing now.
11 MR. NOWLEN: Well, again, the current
12 practice is to simply take the internal events risk
13 model. It's typically simplified. Some things are
14 removed. You look at specific initiators, specific
15 accident sequences and you then run with that with
16 fire. And so along with the internal events model
17 come the human liability analysis features of the
18 internal events model. And you may go in and re-
19 examine some of those.
20 You typically credit the same human
21 actions but you may assign different reliabilities
22 depending on where the fire occurs. So again,
23 basically the current practice is to simply take the
24 internal events model, do some simplification and
25 modification and apply it in fire.

1 Our concern is that the internal events
2 model does not capture all of the things you would be
3 interested in in the fire context. And the biggest
4 example is this spurious actuation issue. And
5 internal events model will not typically postulate,
6 for example, that a valve will spuriously operate
7 randomly because that's not something that's going to
8 happen just randomly, but fire can do that to you.
9 Fire can cause a valve to reposition, for example.
10 Fire can cause systems to start with no other
11 intervention. So it's bringing those kinds of
12 features into the plant model in a fairly formal way.
13 How do we identify what unique things the fire might
14 to do us, how do we then incorporate those items into
15 the fire risk model in such a way that we can actually
16 quantify the fire risk.
17 And again, the other example is the human
18 reliability issues. Fire can compromise your
19 indicates and instrumentation in the control room, for
20 example, that may not be captured in the internal
21 events model. For us it may be important to capture
22 those kinds of features when we do the human
23 reliability, human response analysis for our fire
24 situation. Can they rely on their instruments, have
25 they lost instrumentation, have they lost it in such

1 a way that it's going to be obvious that the
2 instrument has been damaged, those sorts of questions.
3 CHAIRMAN ROSEN: Okay, thank you on that.
4 One of the things that's obvious to me is that during
5 -- in a typical internal events analysis, one credits
6 operator actions in recovery and other things. When
7 you have a fire in the plant where it's in a time
8 period when there is very little support available,
9 late at night or something like that, the -- in many
10 plants, the fire brigade is also the plant -- the
11 operating staff of the control room. So the workload,
12 the task workload on the same people is enormously
13 magnified in the case of fire. Is that something
14 that's going to be thought about in HRA when you talk
15 about fire?
16 MR. NOWLEN: Yes, absolutely. It's typical
17 practice, there is one member from the operating staff
18 assigned to the fire brigade. Most of the rest of the
19 fire brigade is typically made up from security and
20 maintenance personnel or dedicated personnel who do
21 fire protection for the plant, you know, the people
22 responsible for the maintenance of the systems and
23 whatnot, but yes, clearly there are issues of staffing
24 and communication.
25 Many plants rely on remote actions, for

1 example, given certain fires in certain areas, the
2 fall back is to send an operator out to take a manual
3 control action. You know, have they thought
4 adequately about their staffing for those kinds of
5 actions, have they thought about timing communication
6 of those actions?
7 CHAIRMAN ROSEN: What I'm worried about is
8 we had a human factor subcommittee meeting yesterday
9 and we talked again about things like shaping factors
10 in many of them, including stress and task work load.
11 You know, clearly in a fire there plant damage, trips
12 the plant which is normally what happens in a serious
13 fire or can happen in a serious fire. Well, those
14 things get, you know, impressed on the staff and in
15 addition, some of the key resources for the crew that
16 will be dealing with the shutdown is pulled out to
17 fight the fire or be part of the fire brigade.
18 So human performance under those
19 circumstances can be very challenging. So who do we
20 look to, to make those -- to get the properly
21 reflected in the PRA and then the fire PRA. I think we
22 really have to start here.
23 MR. NOWLEN: I agree entirely. There is an
24 explicit task to do improvements in HRA for fire PRA
25 as a part of the requantification studies and again,

1 both NRC and EPRI will be bringing their experts to
2 bear on the problem and we will be addressing this.
3 MR. SIU: And by the way, these are the
4 same people who are working for us on the other
5 aspects of the HRA projects, so it doesn't sound like
6 we're getting different folks with different views.
7 CHAIRMAN ROSEN: Okay.
8 MEMBER LEITCH: Just as an addition to
9 Steve's thought, if there's a serious fire, a lot of
10 times that drives you into an emergency condition
11 where there are certain actions that are necessary,
12 notification of the number of people and so forth and
13 I guess all I'm doing is just reinforcing what Steve
14 says is that this increases the workload on what might
15 be a very limited number of people. They've not only
16 got the operational aspects, the firefighting aspects,
17 but you have the actions that are necessary to support
18 the emergency plan implementation.
19 MR. HYSLOP: Steve will be presenting our
20 update on the risk methods insights. I believe he's
21 given you a presentation fairly detailed before.
22 MR. NOWLEN: We did do a presentation on
23 this in October 2000 and in that presentation we
24 covered the objectives approach and resulting insights
25 of this task. At that time, the presentation was

1 based on a public draft that we had issued for comment
2 of the report that we had written on this task.
3 This is the last slide in the
4 presentation. Just to let you know as an update that
5 we did receive some comments from the public but they
6 did not substantively change any of our conclusions
7 that we had reached. We got comments from within NRC
8 and industry but our conclusions basically remain the
9 same, mostly in the form of editorial changes. The
10 report has been published. It's out as a NUREG CR
11 6738 so it's available to you. And we've gotten a lot
12 of good feedback on this one. So I hope you all get
13 a chance to read it and that you enjoy it. And that's
14 it.
15 MEMBER LEITCH: That was, to me at least,
16 one of the more interesting documents. I thought it
17 was very worthwhile reading and I would recommend it
18 to those that perhaps, haven't had a chance to read it
19 yet. There are portions of that that reads like a
20 novel.
21 MEMBER POWERS: I wish you wouldn't say
22 that. I have to live with this guy. He gets a big
23 head and becomes insufferable.
24 MEMBER LEITCH: It was interesting though,
25 that a number of these incidents are for turbine

1 building associated and I'm sure you're taking a look
2 at that.
3 MR. NOWLEN: Yes.
4 MEMBER LEITCH: We tend to look at just the
5 reactor portion of the plant but a number of these
6 real serious fires started in the turbine building and
7 promulgated to other sections but --
8 MR. NOWLEN: Yeah, the turbine building is
9 an interesting case. We've -- as fire protection
10 engineers, we've long recognized that the turbine
11 building has some real fire sources up there. You can
12 get real challenging fires there. In the PRA context,
13 we have perhaps tended to dismiss the turbine building
14 a little bit early in the process. So again, tying
15 back to our requantification studies, one of the
16 lessons learned from the event review was to take a
17 more careful look at areas like the turbine building
18 that might present challenges to you that you wouldn't
19 normally expect; in turbine building, at secondary
20 sites, the power generation side, sometimes there's
21 things there that can catch you. So, yeah, again, in
22 requantification we're going to be taking a specific
23 look at turbine buildings for the two plants.
24 I have no idea what we'll find. I don't
25 know what the turbine buildings these plants have in

1 them but --

2 MEMBER LEITCH: Well, I just read an

3 interesting one about an event that happened at a

4 power plant within the last month, I guess, and they

5 had a fire in the generator hydrogen dryer and the

6 hydrogen dryer fit in an ordinary sized suitcase. I

7 mean, you're not talking a big piece of equipment.

8 But somehow this thing caught on fire. They got it

9 out without any trouble apparently but you know, when

10 you say hydrogen and fire in the same sentence, it's

11 interesting. That's scary.

12 MR. NOWLEN: Yeah, you have -- you know a

13 turbine building you have the hydrogen, obviously.

14 You also have large inventories of hot turbine oil,

15 turbine lube oil and there have been -- yeah, there

16 have been a couple of events associated with turbine

17 blade ejections that have led to fairly severe fires,

18 yes. So, yeah, it definitely presents some

19 interesting possibilities. Again, the question is, is

20 it a risk problem or is simply a classic severe fire

21 problem.

22 MEMBER POWERS: It seems to me that most of

23 it -- it would be an unusual plant where you would

24 have critical systems crossing with the turbine

25 building, wouldn't it?

1 MR. NOWLEN: Well, I don't know how usual
2 it is. I would relate that in the IPEEE process we
3 had two plants conclude that they found
4 vulnerabilities, both were associated with issues in
5 the turbine locker.
6 MR. SIU: I'll add to that, that if you
7 look at the rankings of buildings or areas in the
8 IPEEEs, you'll find a surprising number where the
9 turbine building is somewhere up in that list.
10 MEMBER SIEBER: You have air compressors
11 where the instrument air comes from the turbine,
12 usually service water, compound cooling water, pumps,
13 so there is safety related equipment.
14 MR. NOWLEN: Well, we also occasionally
15 find switch gear depending on the configuration of the
16 plant, how it's laid out. You can also end up with a
17 lot of cables routed through the turbine building just
18 getting from the control building to the reactors. So
19 those were the situations we ran into in IPEEE. They
20 were both associated with cable routing.
21 MEMBER LEITCH: One of the very interesting
22 episodes is describe in the NUREG there is the
23 situation where somebody got hydrogen and compressed
24 air mixed up and it led to the incident that we were
25 talking about earlier where you get several fires in

1 different locations. They said, "Well, you had
2 hydrogen in your compressed air system".
3 MR. NOWLEN: Yeah, that was an interesting
4 one. It was a maintenance error that cross-connected
5 the house compressed air system to the hydrogen system
6 associated with one of the diesels, I believe. And so
7 guys -- it was during a shutdown and guys out in the
8 plant running their air tools suddenly had flames
9 coming out of their air tools. They caught it right
10 away obviously, and but it's one of the multiple fire
11 events as well.
12 You had the potential for having fires in,
13 you know, virtually anywhere the house air went. So,
14 yeah, that was very interesting.
15 CHAIRMAN ROSEN: What I thought was
16 particularly interesting about that report was the
17 descriptions of many of the non-domestic fires. And
18 in that light, listening in Seattle to some of the
19 international participants that I remember in
20 particular from China and from Bohia and I guess
21 that's Czech, Czechoslovakia, that made comments that
22 were, I thought, interesting and instructive because
23 they were different, their approaches were somewhat
24 different than the traditional approaches in the U.S.
25 You know, not to say they're better or not as good, I

1 think is not the point. The point is the differences
2 cause you to think about what we're doing.
3 In one particular case, the fellow from
4 Czechoslovakia talked about training of fire brigade,
5 first responders, and he talked about noise. And that
6 the simulators that they use have the capability of
7 replicating or simulating the noise of the fire which
8 was a new question to me. It's very important to
9 communicate during fires and I know how hard it is to
10 communicate with all of the equipment fire responders
11 put on. We've seen them don their bunker gear for
12 example, and have to tap each other on the glass to
13 get each other's attention and so on.
14 And that's just in the assembly area.
15 That's not even in the fire. Communications of a team
16 during a fire is very difficult without any noise but
17 the fact of the matter is that it can be very noisy,
18 I assume in a fire --
19 MR. NOWLEN: Oh, yes, yes.
20 CHAIRMAN ROSEN: And I never heard of that
21 before, the point being that this particular country's
22 fire responders are trained in a facility that can
23 simulate noise as well, and I thought that was
24 interesting.
25 MR. NOWLEN: Yeah, I saw that presentation

1 as well. It was interesting. You know, when you go
2 in a plant, there is a lot of noise. There's
3 operating equipment all over. Some areas can be
4 noisy. They're are echo chambers, so, yes,
5 communications is a challenge. In that particular
6 case they were interested in the noise associated with
7 gaseous suppression system discharge, in particular
8 with a CO2 system which is what they were using. When
9 you discharge CO2, you're discharging a lot of CO2 in
10 a very short period of time and the noise can be
11 pretty horrendous and if you've never heard it, the
12 first time you hear it, it's fairly shocking. So,
13 yeah, I thought it was very interesting that they were
14 training their brigades and actually simulating that
15 noise level, so that when they got in the real plant,
16 they wouldn't have that initial, "What the heck is
17 that", sort of response. It was interesting, yes.
18 MR. NOWLEN: Well, the general comment was
19 that we have a lot to learn from others, not to get
20 insular in thinking about the only fires that we can
21 learn from our fires that occur in domestic nuclear
22 plants.
23 MR. NOWLEN: Agreed. In the report that we
24 wrote, the international events were very interesting.
25 We saw some very interesting insights from those

1 fires.

2 MEMBER POWERS: It seems to me that one of
3 the biggest questions is the transferability of
4 information from countries with different fire
5 protection standards, different fire protection
6 regulations, different significances attached to fire.
7 It seems to me that damage caused by a fire is fairly
8 transferrable. It's physics, but fire frequency, it
9 seems to me, is not a transferrable measure.

10 MR. NOWLEN: Yeah, yeah, two points. The
11 fire frequencies, we certainly saw at least in a
12 couple of the events, things we would not expect to
13 see in U.S. plants in terms of ignition source. The
14 self-ignited cable fires were -- one in particular,
15 the Europeans and Soviets, for example, still use a
16 lot of PE/PVC cables. We tend not to use those any
17 more. They're easier to ignite. They tend to burn
18 more easily. So we also saw that impact some of the
19 fire behavior in certain of the incidents.

20 There was one incident in particular that
21 was a rather severe control -- it started in the
22 turbine building, propagated to the control building
23 and caused extensive damage throughout the control
24 building. You know, a number of things that we would
25 not expect to see similar behaviors in the U.S. for

1 that kind of an event. In fact, our cables are less
2 flammable. Our fire barrier penetration seals have
3 received a lot of attention and I think we can give a
4 lot more confidence in those.
5 And you know, the speed with which the
6 fire propagated through the control building, I think,
7 was something we would not expect in the U.S. So,
8 yes, you have to look at the international events and
9 be careful about trying to extrapolate directly what
10 happened in the U.S. or what might happen in the U.S.
11 Certainly, I think there were still lessons to learn
12 from those events, but we did also try very carefully
13 to call out where we weren't real confident about the
14 direct extrapolation.
15 MEMBER POWERS: There was a period of time
16 where fire frequency data bases were sprouting across
17 the landscape like mushrooms, international fire
18 frequency and I'm always very suspicious of that
19 because again, I don't think frequencies are
20 transferrable. But I don't see data bases on fire
21 damage sprouting up with the same intensity yet, I
22 think that is transferrable. Where do we stand on
23 data bases that say we have a fire of such and such a
24 nature and it does these kinds of things?
25 MR. SIU: Let me take a shot at that. J.S.

1 mentioned that there is a fire modeling tool box.
2 That was one of our early tasks. My understanding
3 there's a double CD-ROM version that's available that
4 has some of that information. That's from, of course,
5 culling information that we've gathered in the course
6 of our work. He also mentioned a WGRISK activity.
7 That activity right now, you may not like to hear, is
8 indeed aimed at developing fire event data bases or a
9 fire event data base. And I guess lacking better
10 information, I can certainly see that for maybe
11 countries with dramatically different practices in
12 terms of maintenance, dramatically different kinds of
13 equipment, you could argue whether that data is
14 transferrable. Certainly, we'll know where they are
15 coming from.
16 Other countries it may be that the data
17 are indeed much closer to --- or come from situations
18 much closer to what we've got. We -- NCR, as part of
19 this activity pressed the working group to think about
20 exactly what you were talking about, a data base that
21 covers parameters that we use in other out parts of
22 the fire risk modeling effort. The generally feeling
23 initially from the other members of the working group
24 is no, we want to concentrate on fire events. They
25 haven't said that the working group won't address that

1 but right now the focus is indeed on fire events. So
2 that's where we stand.
3 MEMBER POWERS: The problem I see is it's
4 very easy to take fire events, say Slovenian fire
5 events and say okay, we don't have the data on the
6 frequency of large fires but they had one and so we'll
7 make the probability of fires of a certain size this,
8 and once you've done that, the origin of that fire,
9 the peculiarity of its environment is lost within a
10 probability number that doesn't have all of the
11 appropriate units.
12 MR. SIU: Which gets back to your point, of
13 course, this is in the data base and we have to make
14 sure that we have the attributes assigned to each
15 entry so that we can indeed do that filtering. I
16 honestly don't expect us to literally take the data
17 there and just simply crunch out averages and use
18 those averages. On the other hand, there have been
19 some jokes today and yesterday perhaps about
20 availability of data for PRA in general and one of the
21 problems we have, which I'm not sure whether we'll get
22 to in this set of presentations, there's been mention
23 of severity factors.
24 This is a took that is used in fire PRAs
25 to adjust the fire frequency to account for the

1 observation that not all fires that occur have any --
2 have the potential to cause damage. Some of them are
3 very incidental fires and we really have no
4 expectation that they would lead to anything. The
5 trouble is, of course, how do you translate that
6 concept into practice. How do you actually estimate
7 those severity factors. The fact of the matter is we
8 have a relatively small number of fires in plants that
9 actually have the capability to cause extensive
10 damage.
11 So the question and I don't know what the
12 answer is, is to what extent can we take information
13 from other sources and use that if we're talking
14 about, for example, switch gear fires. We'll perhaps
15 some of that information is indeed transferable to our
16 situation. Of course eventually you'd like to have
17 something along the lines about what we talked about
18 yesterday, a more fundamental understanding of the
19 whole fire process, from ignition all the way through
20 growth over the initial fuel and then propagation to
21 other fuel objects in the room but we're not real
22 close to that yet, I think.
23 The initial phase of the fire is a real
24 challenge. J.S. had mentioned that actually we had a
25 study done on that and it's one of his

1 accomplishments. He talked about the frequency of
2 challenging fires and essentially that ended up with
3 a proposed elicitation process for characterizing the
4 initial phase of the fire. I'm not sure if we're
5 going to be able to use that in the requantification
6 study. So again, this is a challenging area for us.
7 CHAIRMAN ROSEN: Well, I brought up the
8 whole issue of international data and experience and
9 insights and the purpose of bringing it up was to
10 encourage this to continue to build those interfaces
11 and to use that data appropriately of course, with int
12 the caveats that Dr. Powers so eloquently mentioned
13 but that fire us a universal phenomenon and we need to
14 pay attention to what happens elsewhere as well as in
15 the United States.
16 Okay, we're up to the next presentation on
17 fire detection and suppression analysis.
18 MR. NOWLEN: Yes, so this is a discussion
19 of the results of a task we've been working on, on
20 detection and suppression modeling. I want to go over
21 the objectives that we had in performing this task,
22 how we approached this and basically this is going to
23 be a description of our task structure and then I'm
24 going to go through the results that we obtained
25 basically by-pass and the provide you with some of the

1 general insights that we came away from this with.
2 So the objective of this particular task
3 was to provide an improved modeling framework and data
4 for estimating the reliability, including
5 effectiveness to the extent possible of automatic and
6 manual suppression activities. To develop estimates
7 of these conditional probabilities for current
8 operating nuclear power plants and to identify and
9 quantify key uncertainties in these estimates.
10 The approach and there's a more detailed
11 task structure but at the higher level, we were
12 looking at the modeling framework, that is how do we
13 do detection and suppression modeling, how does it fit
14 into the PRA. We performed a number of information
15 gathering and data analysis sub-tasks, looking at
16 various data sources and the information we could
17 glean from that and then documentation of our results.
18 Again, probably a pretty good master's thesis outline.
19 With regard to the modeling framework, the
20 first activity was to review current practices and
21 what we saw there is basically there's two primary
22 methods you'll find in current fire PRAs for doing
23 this sort of a detection/suppression analysis and the
24 first method is the direct application of historical
25 event data and this has an advantage in that it

1 inherently captures your experience relating to long
2 duration fires, for example. It has a disadvantage in
3 that it's difficult to tailor the results to a
4 specific application.
5 That is if I'm at a specific plant and I'm
6 looking at a fire involving a specific piece of
7 equipment, it's difficult to tailor these generic
8 estimates to that particular case. The second method
9 is to estimate the fire brigade response time and this
10 basically assumes that the fire brigade is really your
11 ultimate line of defense for fire suppression and so
12 the focus is placed on the fire brigade and how long
13 it would take the fire brigade to respond to a fire in
14 a particular location. The advantage of that
15 particular approach is that at least nominally it's
16 case specific.
17 You're looking at a specific fire and
18 specific plant, and specific fire brigade. The
19 disadvantage is that when you put it into practice,
20 you see very, very little variation in the estimates
21 of how long a fire is going to last. It also has the
22 potential to minimize the importance or the potential
23 importance of long duration fires. You may
24 prematurely assume that all your fires are going to be
25 out within 15 minutes, for example, and so you may not

1 consider the 20-minute fire and the 30-minute fire.

2 MEMBER WALLIS: How do you model the

3 probability of success of the fire brigade in putting

4 out the fire?

5 MR. NOWLEN: That also varied from

6 application to application. This particular method

7 was the most common one we saw in the IPEEEs. Most of

8 the IPEEEs did it this way.

9 MEMBER WALLIS: They assume the fire

10 brigade gets there, the fire gets put out?

11 MR. NOWLEN: That was a common assumption

12 initially. Typically, the questions that we would ask

13 in the review process, which I was also involved with,

14 would be, okay, the guys have arrived but they still

15 have to assess the situation, they have to plan an

16 attack. They have to have a critical number of

17 brigade members before they can execute the attack and

18 then they actually have to actually execute the attack

19 and how did you deal with that in your quantification?

20 The answers we got back would typically say, yeah,

21 we'll do a sensitivity to look at what happens if we

22 extend the fire duration by some period of time and

23 again, for the purposes of the IPEEE, we considered

24 that acceptable.

25 Again, IPEEE was a vulnerability search.

1 For the fire requantification studies, we don't
2 consider that to be acceptable going forward. We
3 think we can do much better here.
4 So our conclusion with regard to past
5 practices was that a more mechanistic approach might
6 capture the advantages of both methods. I mean, each
7 method has its advantages and the idea would be to try
8 and capture that and our conclusion was that a
9 mechanistic approach would be the way to go about
10 that.
11 The next slide just as an illustrative
12 example, this is a historical data approach kind of
13 look at things. It's a classical statistical
14 modivazian approach but this is basically a plot of
15 the duration of fires from the current EPRI fire data
16 base. This curve captures all of the fires happening
17 within the plant buildings. So this excludes the
18 outdoor fires and the offsite fires and it hasn't
19 tried to parson them out in any way at all. It's just
20 simply all the fires that have occurred within the
21 plant lumped together, all the ones that report a fire
22 duration and plotted up on this --
23 MEMBER WALLIS: There are not 651 points on
24 the curve.
25 MR. NOWLEN: No.

1 MEMBER WALLIS: So the others are presumed
2 beyond 120 minutes?
3 MR. NOWLEN: No, there's a few beyond 120
4 minutes. You can see the curve hasn't quite reached
5 1 yet, for example, but there's also -- you know,
6 you'll have maybe 50 fires that report 5 minutes so
7 there's a bit of adding there.
8 MEMBER WALLIS: So there's bundling.
9 MR. NOWLEN: Yeah, there's a lot of
10 bundling here.
11 CHAIRMAN ROSEN: Let me see if I understand
12 what that's telling me. It says that probability --
13 if you have a fire that will be -- it's an 80 percent
14 chance it will last less than 20 minutes, is that
15 right?
16 MR. NOWLEN: Yes, yes, 80 percent of all
17 the fires that have occurred for which I have a
18 duration estimated, were less than 20 minutes and on
19 the other hand, 10 percent or six, seven percent, were
20 over an hour. So yeah, and again, this is a
21 historical approach. You look at this and one way to
22 do it is to simply apply this curve or you can parse
23 it up. You can say, "Well, I don't want 651 events".
24 The data base contains 1300 events total and I have
25 651 of those which were inside buildings and gave me

1 a fire duration, so about half of the events gave me -
2 - you know fit that category.
3 Well, I may want to look at battery fires,
4 pick anything. So I could parse this out and come up
5 with a smaller set of events and do the same kind of
6 a duration curve. You can also look at it a different
7 way. I want to look at fires that were manually
8 suppressed. And those are some of the things that
9 we've done in the task here is to parse these out and
10 look at fire durations.
11 MEMBER KRESS: What would you do with that
12 information?
13 MR. NOWLEN: Well, you could -- typically,
14 your fire growth and damage analysis --
15 MEMBER KRESS: Yeah, but there are some
16 sort of concentrates modeling, based on the duration
17 of the fire?
18 MR. NOWLEN: Yes, exactly. You look at the
19 duration of the fire, you model the fire and you may
20 have damage occurring to different pieces of equipment
21 at different times in the fire. So if for example, I
22 were to lose one important cable in the first 20
23 minutes, I could say, well, the likelihood that that's
24 my damage state is .8. That's 80 percent of my fires
25 give me that damage state.

1 MEMBER KRESS: You have some other data
2 base to go with this then.
3 MR. NOWLEN: There's other modeling results
4 that go along with this, yeah. Yeah, you fold this in
5 along with your modeling results as an estimate of how
6 long the fire lasts because then there might be a
7 second cable that you're interested in but because
8 it's more remote from the fire source, maybe that one
9 takes an hour to damage. So you might say, well, the
10 damage -- the likelihood that I reach that damage
11 state is only six percent. You know, you move out on
12 the curve and you can look at the different damage
13 times and begin to bring in more damage --
14 MEMBER KRESS: Somehow implicit in
15 durations state the magnitude of the fire, it's sort
16 of implicit in there?
17 MR. NOWLEN: Yes, there's -- I'm going to
18 cover that in a minute. There's links between how you
19 get your fire frequency, for example, and the duration
20 that you should then assume, so if that's the
21 direction you're headed, I'm going to get there in a
22 minute.
23 MR. SIU: But I think also a short answer,
24 we don't have real strong mechanistic links right now
25 between the propagation and the suppression phenomena.

1 This is largely a statistical approach.

2 MR. NOWLEN: Okay, so again, we're looking

3 for a mechanistic way of dealing with dealing with

4 detection/suppression and if you search the

5 literature, one of the things that will pop up is a

6 Siu and Apostolakis paper from 1983 that proposed a

7 mechanistic model for doing detection/suppression

8 analysis. This is presented as a network model. I

9 should probably use this one.

10 MEMBER WALLIS: It's covered with these

11 weird Greek symbols.

12 MR. NOWLEN: Those Bayesian guys.

13 MEMBER POWERS: The alternative symbol

14 would not be more edifying.

15 MEMBER KRESS: I know who Siu is but who is

16 this double P, Apostolakis.

17 MR. NOWLEN: Did I misspell his name, oh,

18 my God. George, I'm sorry, even though you're not

19 here. Apostolakis, is not in my spelling dictionary

20 yet. It will be after this.

21 MEMBER POWERS: Apologize.

22 MR. NOWLEN: Yes, I formally apologize to

23 Dr. Apostolakis for misspelling his name.

24 MEMBER SIEBER: We ought to change his

25 name.

1 MR. NOWLEN: Okay. I usually catch those
2 kind of things. So anyway the model begins with the
3 ignition of the fire and this postulates the question
4 of whether or not you have an immediate detection. In
5 some cases you do, you know, right away you know
6 you've got a fire and if you do, then you by-pass the
7 other detection paths.
8 MEMBER KRESS: It's detected immediately
9 because somebody is standing there or for some reason?
10 MR. NOWLEN: Yeah, or perhaps you heard an
11 explosion in the plant, you saw a flash of light, you
12 had a fire watch there. There happened to be someone
13 in the area, they saw it when it started, a lot of
14 reasons that could happen.
15 MEMBER KRESS: So that Greek symbol,
16 there's a probability that --
17 MR. NOWLEN: Yes, that's the likelihood
18 that that occurs and the compliment is the likelihood
19 that you don't detect immediately in which case, you
20 have to go to some other means of detection and in
21 this case, you asked the question whether or not you
22 have automatic detection systems available, yes or no.
23 That's basically a yes, no answer and then if you do
24 have them available, then you've got a possibility of
25 automatic detection, a delayed local detection or a

1 delayed remote detection that if someone happens upon
2 the fire and calls in the fire alarm, this would be
3 for example, the plant operator sees some funny things
4 going on, on their control board and they speculate
5 that there's a fire and they --
6 MEMBER KRESS: That's not necessarily an
7 automatic system them.
8 MR. NOWLEN: No, this is --
9 MEMBER KRESS: That's what confused me
10 coming out of the A.
11 MR. NOWLEN: Right, well, this asks the
12 question of whether there's an automatic system
13 available or not. If there isn't then all you've got
14 is the delayed local and remote paths. If you have a
15 system available, then you also have the opportunity
16 of detecting automatically but that system has a
17 likelihood that it would fail and there's at time
18 factor here.
19 MEMBER KRESS: The -- what is the figure at
20 that end?
21 MR. NOWLEN: Here?
22 MEMBER KRESS: Yeah, I don't understand
23 what that is.
24 MR. NOWLEN: In this case, it's basically
25 a yes, no.

1 MEMBER KRESS: It's just a yes, no, okay.
2 MR. NOWLEN: Yes, do you have automatic --
3 MEMBER KRESS: I understand that.
4 MR. NOWLEN: Yes, yeah. In this case it's
5 a probability.
6 MR. SIU: Yeah, it's probability. The
7 other -- there are time constants associated with the
8 other processes. So you've got competing processes
9 you can detect in one of three ways on the upper
10 branch. Whichever gets you first is the one that wins.
11 MR. NOWLEN: Right. So anyway, those take
12 you to detection. You then have various paths to get
13 ultimately to suppression. In this particular case --
14 by the way, we're going to go through this model in
15 some detail, so we don't have to go through every link
16 here. But --
17 MEMBER KRESS: Is that also a yes, no, that
18 two coming out of there?
19 MR. NOWLEN: This one, no, is a probability
20 and this is the probability basically that someone
21 intervenes in the fire manually very quickly. Yeah,
22 in this particular case the way this model was
23 written, this is the manual fire brigade. That the
24 manual fire brigade intervenes promptly and wins the
25 battle and puts out the fire. We've changed that a

1 little bit so I'll come back to it.

2 If they fail to do that, then you're back

3 to your automatic or fixed systems.

4 MEMBER KRESS: That's a yes, no.

5 MR. NOWLEN: This is a yes, no. Yes,

6 that's correct.

7 MEMBER KRESS: And the -- if there is one

8 there, what's the --

9 MR. NOWLEN: Transition times.

10 MEMBER KRESS: Transition times.

11 MR. NOWLEN: Yes, yeah, the idea is what's

12 the likelihood that you put out a fire within a

13 certain period of time. Following these different

14 paths, you can have multiple answers to that question.

15 MEMBER KRESS: Okay.

16 MR. NOWLEN: So given that you have a

17 system available it may or may not actuate and

18 suppress the fire, so if this is basically the fixed

19 suppression failure path, and this is the success

20 path, the final element here is what they refer to as

21 large scale manual suppression which basically was

22 off-site fire brigade arriving to support it. Yeah,

23 a fire truck shows up from off-site.

24 MEMBER WALLIS: And that includes that it

25 will essentially burn itself out, too.

1 MR. NOWLEN: Well, we'll talk about that.
2 So that's the model that we started with. Our
3 conclusions; this does have key features that we
4 really like. You know, it's mechanistic. It has the
5 paths that we think are most important to the PRA. So
6 we decided to move forward with this. We did identify
7 some desirable modifications based on our examination
8 of the events that have occurred. In particular -- it
9 looks better on yours than on mine -- add a path for
10 self-extinguished fires. This model basically doesn't
11 have a self-extinguished fire path, so that was
12 something we thought would be important. We
13 definitely see that in fires. I'm going to cover that
14 in a minute as well.
15 We combined the local and remote manual
16 detection paths. Basically, you're looking at --
17 well, I've taken it away, but the detection path had
18 two possible ways of delayed detection by personnel,
19 local and remote and what we saw in the data was you
20 couldn't tell which of those paths had been followed
21 in any particular event with very, very few exceptions
22 so you really couldn't support a statistical estimate
23 of what that split might be. We do see both in
24 events. We do see events that report that the control
25 room saw something odd on the control board and

1 concluded there was a fire. So you see it but you
2 can't do it statistically.
3 CHAIRMAN ROSEN: Is that only something odd
4 on the control board or is it a an annunciation of a
5 fire in a fire area? Plants have fire detection
6 systems with fire zones that annunciate when one of
7 the detectors goes off in one of those zones. It's
8 not odd, they see an alarm. So Fire Zone 21, okay,
9 it's either a real fire or it's a spurious actuation
10 of the fire system but they send somebody down to
11 look.
12 MR. NOWLEN: But that a separate path.
13 That's the fixed detection path. There's an explicit
14 path to allow for so a fixed detection system picks it
15 up and the operator then takes action. This is other
16 stuff that might lead them to conclude that there was
17 a fire.
18 Okay, and we also decided to revise or
19 redefine, depending on how you look at it, the manual
20 suppression paths. Again the original model had --
21 MEMBER KRESS: When you say you have a
22 manual detection path, can I read that to say somebody
23 happens onto the thing?
24 MR. NOWLEN: That would be the manual
25 local, yes. The delayed local is someone goes by the

1 area and smells smoke.

2 MEMBER KRESS: But it just means that there

3 is a person that picks it up.

4 MR. NOWLEN: Picks it up at or near the

5 location of the fire. The remote is the implication

6 that someone picks up the presence of a fire but

7 they're not anywhere near it, they're somewhere else

8 in the plant.

9 MEMBER POWERS: You may get to this and

10 maybe this is your point, I mean, one of your points,

11 of course, is that Apostolakis and Siu got it wrong

12 and I appreciate that, but --

13 CHAIRMAN ROSEN: If it's wrong, it's

14 Apostolakis that got it wrong. Siu probably had it

15 right but he couldn't --

16 MEMBER POWERS: The other question is, the

17 more substantive question is you have a lot of ways to

18 get to the success path here.

19 MR. NOWLEN: Yes.

20 MEMBER POWERS: And you don't have a lot of

21 data to support those ways of getting to the success

22 path.

23 MR. NOWLEN: We're headed there.

24 MEMBER POWERS: Are you doing one of the

25 more classic things that we see so often in

1 probabilistic risk assessment of breaking down that
2 rare event into a bunch of component events and
3 artificial probabilities down here?
4 MR. NOWLEN: I hope not. Let's go through
5 the presentation because I'm specifically headed in
6 that direction, and you judge. So again another
7 modification we decided to revise or refine these
8 manual suppression paths. The original model had two
9 that were basically the local fire brigade and the
10 off-site fire brigade. What we saw when we looked at
11 the event data is that you often see off-site fire
12 brigades responding to fires at plants. It's fairly
13 common, they have cooperative agreements. An alarm
14 goes out, they respond.
15 But from the event data, you can't tell
16 whether that did any good in terms of putting out the
17 fire. So what we did is we changed those to two
18 alternate paths and what we've done is suggested that
19 there's a prompt manual suppression path and there's
20 a delayed manual suppression path. The prompt path
21 would cover things like a fire brigade or I'm sorry,
22 a fire watch that happened to be at the site of the
23 fire. They put the fire out right away or a security
24 person doing their rounds found a fire and put it out
25 right away, grabbed an --- that's that path.

1 The delayed manual is when the fire
2 brigade gets involved. If a fire brigade is called
3 out and fights the fire, that's the second path. We
4 don't distinguish with whether or not the off-site
5 fire brigade shows up and does any good.
6 We also added a suppression path for
7 removing power or isolating fuel from a source when
8 that's possible. A lot of electrical fires are put
9 out because they simply trip the breaker, isolate the
10 electrical energy that's supporting the fire and the
11 fire goes out. You see the same kind of thing at
12 hydrogen fires. You close it out and somewhere the
13 hydrogen leak stops and the fire stops, so we added a
14 path for that.
15 MEMBER WALLIS: Don't these cases, the
16 manual and immediate suppression may put out some of
17 the fire and then the large scale suppression later
18 puts out the rest of it.
19 MR. NOWLEN: Yes.
20 MEMBER WALLIS: That is suitably modeled in
21 your -- dealing with these fires. They're not sort of
22 complete success fires. They could be partially
23 success or something.
24 MR. NOWLEN: Yes, that's correct.
25 Hopefully all fires eventually go out somehow.

1 MEMBER WALLIS: Well, they don't all
2 eventually go out.
3 MR. NOWLEN: It's a question of time, yeah,
4 time is a very important factor.
5 MEMBER WALLIS: In the ground in West
6 Virginia, they go on forever.
7 MEMBER POWERS: You certainly had one in
8 the Ukraine that went out all right, but 12 days later
9 may not be -- may not fall into your category of
10 promptly going out.
11 MR. NOWLEN: I agree, time is of the
12 essence.
13 CHAIRMAN ROSEN: I also heard of a tire
14 fire at a tire disposal that just won't go out.
15 MR. NOWLEN: There are other applications
16 where fires may burn for years and years and you know,
17 coal seams will start on fire and I don't think we
18 have those --
19 CHAIRMAN ROSEN: Not treated in the data
20 base.
21 MEMBER KRESS: You wait till you get a
22 graphite moderator.
23 MR. NOWLEN: Okay, so again, back to the
24 framework, another thing that we concluded is the fact
25 that they had formatted this as a network model, which

1 is a potential barrier to acceptance, is that people
2 aren't familiar with network models. So what we
3 decided to do is to translate this to an event tree
4 model and that was possible because there's no
5 feedback paths in this model which event trees can't
6 deal with very well, and we were hoping that this
7 might improve the acceptability and the use of the
8 model. So what we've done, the next two slides
9 present a fire detection event tree which is
10 essentially equivalent to what you saw before with the
11 modifications and the added, and again some of these
12 are yes, no questions, some of them would have
13 probabilities and each would have transition times
14 associated with it so that you can follow through this
15 path and you know, assess how you got to detection and
16 each of those paths would have a time associated with
17 it and a probability that that's the path you took.
18 MEMBER KRESS: And then there would be
19 attached to that some sort of consequence.
20 MR. NOWLEN: Yes, yes, you're still linking
21 to the same vision of consequence where you're fire
22 modeling and you're looking at how long does it take
23 for critical damage to occur and so I'm trying to
24 weigh what's the likelihood that that occurs versus
25 what's the likelihood that I put the fire out before

1 it occurs. And similarly for the --

2 MEMBER KRESS: I think this is what Dana

3 was worried about you breaking up the overall

4 probability and a series of probabilities.

5 MR. NOWLEN: Yeah, I haven't triggered him

6 yet, so that's the next slide, I think. This is the

7 suppression event tree. Again, it basically follows

8 the same model. Some of these are yes, nos, some of

9 those there are transition times associated with each

10 one and we've put in the modified suppression paths so

11 you see the prompt suppression, the self-suppressed

12 fires, manual brigade all of these things and you'll

13 notice that in each of these there is suppression

14 fails outcome and again, that's in the context of a

15 time, you fail to suppress it within a certain time.

16 MEMBER SIEBER: Why is the self-

17 extinguished in the detection tree instead of the

18 suppression tree?

19 MR. NOWLEN: Oh, I'm sorry, yes, that's

20 true. We did put the self-extinguished fires in the

21 detection tree and the idea there is that if the fire

22 self-extinguishes, and you don't need to detect it

23 necessarily, it's out. You may, in fact, detect a

24 fire after it occurred. That happens fairly

25 frequently. We see, you know maintenance folks

1 dispatched down to take care of an equipment problem.
2 They get down on the site and find that the components
3 burned itself, but it's out. There is no fire. So
4 yes, that actually was a variation.
5 We moved that particular suppression path
6 up into the detection group. In a sense this is --
7 current PRAs will often apply a factor to the fire
8 ignition frequency that says, "Well, you know 10
9 percent of my fires are self-extinguished and I don't
10 care about those in a risk context, so I'm going to
11 apply a .9 multiplier on my frequency to get rid of
12 those". In a sense, that's a different path. We've
13 allowed for it explicitly to --
14 MEMBER SIEBER: It matters when they self-
15 distinguish.
16 MR. NOWLEN: Well, yes, in our definition
17 we would say it would be self-extinguished with no
18 damage beyond the initiating component. That would be
19 the typical kind of criteria you'd use is that if all
20 I lost is the particular item that failed and
21 initiated the fire, then that would be the self-
22 extinguished fire. If it grew beyond that, I -- we
23 didn't run into any case where it grew beyond the
24 initiating component and still self-extinguished. The
25 only exception would be cases where they explicitly

1 allowed a fire to burn out because it wasn't causing
2 any harm and there was a recent hydrogen fire for
3 example, where they simply allowed the hydrogen
4 inventory to bur off so the fire went out on its own,
5 but it was a conscious decision. Beyond that, we
6 wouldn't see any cases like that.
7 MEMBER SIEBER: You don't care if you do
8 have, for example, manual suppression is unsuccessful.
9 You eventually run out of fuel and it stops on its
10 own.
11 MR. NOWLEN: Yes.
12 MEMBER SIEBER: You don't want to make that
13 explicit distinction again?
14 MR. NOWLEN: Well, again, that becomes a
15 risk question because if --
16 A VOICE: It's a time question, too.
17 MR. NOWLEN: Yeah, but if I were doing my
18 screening appropriately, I would tell you that I don't
19 care if that fire burns for 10 years, it's not going
20 to cause you any harm. There's nothing there that I'm
21 worried about in the risk context. So hopefully
22 before we ever got to this level of fire analysis
23 where we're actually doing a detailed fire growth and
24 damage and detection/suppression analysis. We've
25 gotten rid of those ones where we don't care that it

burns for a long duration. Those have been eliminated. So we would hopefully never get there in this part of it.

So given that, we moved onto our data gathering and analysis tasks. We did this --

MEMBER WALLIS: I'm sorry. So the end state where we subsequently stopped worrying about it isn't necessarily where it's suppressed. It could have been decreased in size by some initial action which made it harmless but it still needs to be suppressed fully but the actual risk stops at an earlier stage than your final outcome.

MR. NOWLEN: That's correct. There is a big debate about what we really mean by suppressing a fire. And in the risk context we typically are satisfied with controlling the fire to the point where it's not causing any further damage to my plant systems and components. So in a sense, we're really looking at fire control. We do have to put them out and there's a chance that if you don't do that, it reflashes and there are a lot of issues there, but yes, we're really interested in ending the damage and making it so nothing more is going to fail.

Okay so we -- again, information gathering, at the time Jim Houghton had a draft data

1 base out within NRC. We utilize that data base. It
2 covered a period from 1986 to 1999. At the time it
3 was the most recent data base available. That's not
4 really any longer true. There's new versions of the
5 EPRI data base out but --
6 MEMBER SIEBER: Yeah, and he's working on
7 an update of this.
8 MR. NOWLEN: Yeah, I've heard that as well.
9 But these particular analyses, this was the data base
10 that we used. So what we did is we went through the
11 data base. We parsed it and then analyzed it. Here
12 we go. So we were looking at things like the method
13 of detection, the manual versus automatic fixed
14 systems, indoor versus outdoor fires, fires for key
15 locations, et cetera. So, you know, basically this is
16 the PRA, cut the problem up into little pieces and
17 analyze each little piece. So here's where if we made
18 the mistake, this is the place.
19 What we then did is we looked at the fire
20 direction --
21 MR. SIU: Sorry, Steve, it seems to me that
22 it's a little bit different here in the sense that
23 especially when you're talking about looking at
24 duration times for fires, it's not the question of
25 parsing them and making duration times shorter. What

1 you're doing is if you think of those transition rates
2 on that diagram, you're increasing your uncertainty
3 and your estimates of those -- each of those
4 transition rates as the amount of data you use to
5 estimate them goes down, so if we do this right, then
6 the uncertainties for the scenarios should increase.
7 Now, there's a point of diminishing
8 returns of course, but if you were to use that global
9 curve you saw at the very beginning, you say I know
10 that curve very well, the historical data, I know it
11 very well, but so what? Should I really apply that to
12 my particular fire in a particular switch, that's the
13 question.
14 CHAIRMAN ROSEN: One of the things that has
15 been troubling me about all of this is this implicit
16 assumption that the arrival of the fire brigade will
17 always be a good thing. There are cases where the
18 first brigade can make things worse. Does your
19 modeling take that into account at all?
20 MR. NOWLEN: That's a very difficult
21 question. In general, for PRA, we presume that the
22 arrival of the fire brigade is, indeed, a good thing.
23 There are questions of spurious well or misdirected
24 manual suppression efforts, for example, that might
25 spray the wrong equipment.

1 CHAIRMAN ROSEN: Yeah, I mean, the guy's
2 got a fire hose in his hand which is basically fairly
3 damaging. I mean, he can damage equipment.
4 MR. NOWLEN: He can, yes. We look for that
5 in the events. It's one of the things we couldn't
6 find in the events. You know, why we don't find it is
7 certainly open to debate but we did not see events
8 where that was occurring. Now, part of that maybe
9 because we have incomplete reports, you know. We
10 don't get a real good feel for what was damaged in a
11 given fire event and what caused that damage, whether
12 it was a fire or perhaps, you know, flooding or impact
13 by a hose stream. So that particular question is a
14 very thorny one for us and I will admit that, no
15 problem.
16 It's a very difficult question to answer
17 and I won't say we have real good methods in that area
18 yet.
19 CHAIRMAN ROSEN: Well, I think you
20 shouldn't neglect it. You should park it some place
21 and make it explicit that you're not treating damaged
22 operable safety equipment that occurs as the result of
23 a fire brigade or other fire equipment actuation.
24 MR. NOWLEN: Yes, agree.
25 CHAIRMAN ROSEN: I mean, we've talked about

1 that in a lot of context, one of them other than just
2 a host stream is the actuation of a CO2 system in a
3 cable spreading and in fact, it's so shocking to the
4 equipment operatable or operating safety equipment
5 that it's a factor.
6 MR. NOWLEN: Right, and we've actually seen
7 a couple of cases of that during pre-operational
8 testing, freezing of relays and things like that.
9 Again, we have to say something about this in
10 requantification. We're not quite sure yet what it is
11 that we're going to say. This task did not bring
12 anything in the way of new insights there.
13 We tried and it's one of the areas where
14 we didn't succeed. The data won't tell us --
15 MEMBER WALLIS: There are incidents where
16 activation of a fire suppression system when there was
17 no fire has obviously, led to compromising some safety
18 systems.
19 MR. NOWLEN: Yes, yes, clearly.
20 MEMBER WALLIS: Is that model somehow in
21 your analysis?
22 MR. NOWLEN: Not in this particular one.
23 That's a little bit different question. You're now
24 looking at a suppression system that goes off when
25 there is no fire present. This is looking explicitly

at putting out fires.

MEMBER WALLIS: In a way that is risk associated with fire, isn't it?

MR. NOWLEN: It's associated with the fire protection systems yes, and there have been looks at that in the past. The fire risk scoping study, for example, looked at that issue. The IPEEEs, each IPEEE looked at it at some level.

MR. SIU: Typically, the internal flooding analysis will pick up the water based actuation. What I don't know right now who's got the --

MEMBER WALLIS: As long as you've got the right sequence of events, the water hammer even that is --

MR. SIU: Yeah, exactly right.

MEMBER WALLIS: -- which probably wasn't modeled in this internal flooding.

CHAIRMAN ROSEN: Well, flooding is one thing and I'm less worried about that because of the flooding, extensive flooding analysis we've done. But I'm more worried about the CO2 actuations and in particular I'm worried about manual actuation -- manual hose stream damage. A fire fighter in a difficult circumstance is apt to potentially lose control of a hose that has very high pressure water.

1 MEMBER SIEBER: My suspicion is that that
2 wouldn't be reportable, because half the time, even if
3 they do damage something, they don't realize they did.
4 MR. NOWLEN: That's where --
5 CHAIRMAN ROSEN: My question, Jack, is not
6 about reportability, it's more about when you're doing
7 modeling --
8 MEMBER SIEBER: Do you have to have data --
9 CHAIRMAN ROSEN: -- do you take that into
10 account and I don't see any of that. I don't see ll
11 these things progress out, you know, without ever
12 having a branch that says, fire fighters trip the
13 operable off speed water pump by spraying it when they
14 went in to put fire out, when they went to put the
15 fire out in the adjacent feed water pump that was
16 burning.
17 MR. NOWLEN: Yes, we agree it's an issue.
18 Again, this particular task didn't give us any new
19 insights there. We tried and didn't -- the data
20 didn't support anything new. So again we have to deal
21 with it in the requantification studies. I can't give
22 you an answer as to where we're headed now. It's
23 certainly on our table.
24 CHAIRMAN ROSEN: That kind of question,
25 that kind of action is why fire brigades always

1 include an operator and he is in control -- constant
2 communications with the control room because it may
3 very well be that the shift manager would say, "Let
4 the damn thing burn because I'm getting water to the
5 steam generators from the adjacent auxiliary feed
6 water pump and I need that now". It's a very
7 difficult decision for him because he knows that the
8 source of water he's using now is being threatened by
9 the fire, but on the other hand, he doesn't want to
10 make it inoperable but that's the point of having good
11 communication between the brigade and the control
12 room. These decisions are not -- can't be made -- a
13 fire brigade decision isn't made in isolation.
14 MR. NOWLEN: Yes.
15 CHAIRMAN ROSEN: I mean, for a lot of
16 reasons, that one I've just described but also the
17 other one, the control room has to say if this is
18 going to be a threatening fire for the life of the
19 fire brigade to fight and whether or not he wants it
20 fought depends upon whether the fire matters to him
21 from the safety related perspective and equipment
22 protection because it just may be that there's nothing
23 safety related in the area, it may be that there's no
24 significant loss of equipment or potential economic
25 damage. It's the decision of the control room. It

1 may very well be to let it burn, self-extinguish.

2 MR. NOWLEN: Okay, here's where we started

3 to run into our limitations. The data that we had

4 available certainly does have limitations. I think

5 people have heard this before. The kinds of things

6 that we ran into is fire detection times are typically

7 not available or not reported. It's often very

8 difficult to figure out when a fire really, really

9 started. What we typically know is when they figured

10 out they had a fire. What we don't know in most cases

11 is when the fire actually began. There are

12 exceptions, you know, the case of the explosion.

13 You heard the explosion, you know when it

14 occurred. They tend to be tied up with the ones where

15 you detected it immediately. You can occasionally go

16 back and reconstruct from an event log, for example,

17 that there was a blip in the reporting of something

18 and you can postulate back to that, that that was in

19 fact, the fire starting. That's happened a few times

20 but it's pretty rare. So again, detection times are

21 a real challenge for the fire event data base and that

22 means we need independent means for detection time

23 analysis or we must treat it implicitly, that is we

24 incorporate it into our modeling assumptions.

25 When we model the fire, we assume that the

1 starting point is -- it's conditioned at detection not
2 the incipient little fire that's been ignited. So you
3 know, there's two ways of going about this. The
4 requantification studies will probably try a little
5 bit of both frankly. We'll look at trying to do some
6 detection time modeling. We'll probably also be
7 looking very closely at out modeling assumptions and
8 trying to update those to the point where we are
9 starting at detection.
10 MEMBER SIEBER: Why is that important?
11 MR. NOWLEN: Because again, it's a horse
12 race between damage and suppression. And for a lot of
13 fires detection time could be extended and if I give
14 a fire -- you know, if I begin with a little incipient
15 fire in an electrical component in a panel for
16 example, that's a tiny little fire that isn't going
17 anywhere but if I give it 15 minutes to grow before I
18 know I've got a fire, I could now have a substantial
19 fire. So the detection time is important and when I
20 link that to may model for example, if I assume that
21 my fire starts out as this little candle in the panel
22 and it slowly grows but that I essentially activated
23 my fire brigade immediately, then I would typically
24 assume with high reliability that 15 minute time
25 period, fire brigade is going to put it out in that

1 time. High reliability.

2 So this link between you know, figuring

3 out that you have a fire and the state of the fire at

4 the point that you realize that you've got one is

5 important. It's a horse race and often it's a pretty

6 tight race. For the critical scenarios, it tends to

7 be a tight race.

8 MR. SIU: It's a matter of consistency.

9 The fire models need to start with some initial

10 condition and typically some initial size of fire.

11 And so simply speaking, are you going to start with a

12 fire size really as Steve says incipient or are you

13 going to start with that one that was detected and

14 those are two different sizes.

15 MEMBER SIEBER: Right, I understand that,

16 but it would seem to me you won't know you have a fire

17 until you detect it, okay.

18 MR. NOWLEN: Yes.

19 MEMBER SIEBER: Something happens in the

20 plant or you get a fire alarm. And then the

21 appropriate assumption if you're modeling this would

22 be to say every fire I detect because of the nature of

23 the detector, has to be at least this big, right?

24 MR. NOWLEN: Yeah, but there are --

25 MEMBER SIEBER: I mean, if you don't know

1 those other things, I mean, you understand they're
2 watching it and waiting -- looking at your watch and
3 seeing when the fire alarm goes off and you say, oh,
4 I'd better extinguish this thing. I think all these
5 protectors have to have a certain size input, fire
6 input for it to actuate, so you already know what
7 those numbers are if you've got a detector.
8 MR. NOWLEN: Well, the difficulty is that
9 it's very situation specific. For example, one of the
10 conclusions that came out of the control panel fires
11 back in the mid-'80's was that if you have a detector
12 within the control panel it's extremely effective at
13 picking up overheating components basically. You
14 know, you get a component overheated to the point
15 where you're getting a little off gassing, that
16 detector will pick it up right away.
17 MEMBER WALLIS: Or a detector steam leak,
18 it's not really a fire.
19 MR. NOWLEN: Yeah, there are issues with
20 that too, false alarms, trusting the alarm that you
21 get, but, you know, the same fire that occurs in a
22 room where there's no detector in the panel but it's
23 on the ceiling, a very different response. If that's
24 now hanging on a pendant below the ceiling it's an
25 entirely different response again. So again, you

1 know, it's a fairly challenging question that has to
2 be tailored to the specific scenario you're
3 postulating. The room, the fire, the fire how big it
4 is, how quickly to grows, all those things link up and
5 in PRA, we want to consistent.
6 You know, for example, if we're using
7 severity factors, there's another one. I've thrown
8 away all the little fires, so by definition, I'm
9 dealing with bigger fires. Well, that has
10 implications for detection as well and certainly for
11 suppression. My success putting out the little fires
12 is better than my success putting out big fires in a
13 given time period, so lots of links here.
14 Okay, continuing with our limitations, we
15 had very limited data on fixed suppression system
16 actuation and in particular the timing reliability and
17 effectiveness. When you look at the data base, fixed
18 suppression systems don't come into play in very many
19 events. The vast majority of our events are put out
20 manually and very few have these systems. So it's
21 very hard to then try and gain insights into how
22 effective the systems are, how long does it take
23 before they respond to the fire, and do they fail and
24 why. So that was another area where we really fell
25 flat.

1 It didn't provide us insights on
2 suppression, success/failure paths. That is, this --
3 either the network model or the event trees, however
4 you look at it, you can follow different paths. Some
5 things may succeed, some things may fail, and so
6 there's various ways of getting from ignition to
7 suppression. The data base didn't give us a lot of
8 information on that. For example, initial attack with
9 a manual fire extinguisher versus with a follow-up
10 attack from the manual fire brigade with a hose
11 stream. You don't see that. What you typically get
12 reported is that the fire was put out by the fire
13 brigade with a hose stream. So following the path,
14 you know, the success/failures in a given event was
15 very, very difficult, very few cases where we saw an
16 elucidation of a path. It was simply the success --
17 you know, what was ultimately successful, not the
18 successes and failures.
19 We also found that we couldn't fine tune
20 our suppression analysis path based on the fact path
21 to detection. Again, this was tied up largely to the
22 lack of good information on detection and as a result,
23 since we didn't know a lot about detection, we
24 couldn't say, you know, having promptly detected a
25 fire, what was -- is there a difference in the

1 likelihood that I now suppress it within a given
2 amount of time.
3 There was a little bit of exception in
4 that particular case with the prompt detection and the
5 fact that if you have prompt detection, then the
6 likelihood that you get prompt suppression is much,
7 much higher. You're catching the fire at an incipient
8 stage, for example, but other examples, you can't get
9 that information out of events.
10 So given the limitations we simplified the
11 event tree and we basically collapsed a number of the
12 branches into a single detection/suppression tree.
13 This tree, we believe, can supported by the event
14 data but it doesn't have all of the paths that the
15 other trees had. You know, again, the limitations in
16 the data make those other trees -- I mean, you could
17 quantify them. You can always put numbers on things.
18 You can always put lots of uncertainty in it but in a
19 practical sense, they're not currently quantifiable
20 with confidence.
21 So this is the event tree we ended up
22 with. We think we can support this one with the data,
23 and so again, what we'll probably doing is in the
24 requantification studies we'll trying to exercise
25 this.

1 MEMBER WALLIS: Did any of your fires end
2 up in the bottom category, suppression fails?
3 MR. NOWLEN: Yes, again, you have to look
4 at it's a time question, does suppression fail within
5 a time period.
6 MEMBER WALLIS: We talked about that
7 before.
8 MR. NOWLEN: Yes.
9 MEMBER WALLIS: What if suppression fails
10 here, what happens after that?
11 MR. NOWLEN: Well, then we've reached our
12 damage state. Then we propagate on through the risk
13 models.
14 MEMBER WALLIS: So you've got a big enough
15 fire that's actually damaged something which has
16 caused core damage?
17 MR. NOWLEN: Some upset to the plant.
18 MEMBER WALLIS: There's risk there.
19 MR. NOWLEN: Yeah, I've tripped the plant
20 for example, I've lost enough equipment or they've
21 initiated a manual trip. I now have a safe shutdown
22 challenge to meet, so, no, it doesn't mean that you've
23 reached --
24 MEMBER WALLIS: But the fire is still going
25 on.

1 MR. NOWLEN: Yes, but again, in the risk
2 context, I am interested in some specific set of
3 components that's exposed to the fire. Once those
4 components have been lost, the fire is less of
5 interest. I'm still interested because I could still,
6 for example, introduce a new set of components through
7 spread to an adjacent area, for example.
8 CHAIRMAN ROSEN: I would have answered
9 Graham's question by saying at that point when
10 suppression fails, you're right at the start of where
11 we used to with a deterministic analysis. Assuming
12 if you have a fire, that suppression fails that
13 everything in that room of the fire is lost, that's
14 the way that a deterministic analysis --
15 MEMBER WALLIS: That doesn't mean that
16 everything in the whole building is lost.
17 CHAIRMAN ROSEN: No, it means everything in
18 the fire area.
19 MR. NOWLEN: Well, not even necessarily in
20 the fire area. I may postulating that a fire is
21 impacting a particular set of components within that
22 fire area. For example, I may interested in a
23 switch gear fire that's damaging the cables directly
24 overhead but I've found other basis to conclude that
25 the fire won't grow sufficiently to cause sufficiently

1 to cause things on the other side of the room to
2 damaged, for example. So it's again tailored to the
3 specific application. You have to think about you
4 know, what is the damage set that represents success
5 or failure.
6 If I lose this set of components, that's
7 failure to suppressing and time. That's what
8 suppression fails means here. I have lost the
9 components I'm postulating might lost. Now, again,
10 I might introduce a new scenario that says what
11 happens if the fire spreads to an adjacent area and in
12 a sense -- well, explicitly I develop a new analysis
13 that now focuses on putting out the fire before it
14 spreads to the adjacent area and causes damage there.
15 So you do this for each scenario that you're
16 developing and for each damage set basically. So
17 again, it's all tied to time. It's this race between
18 damage and suppression.
19 MR. SIU: Personally, I think perhaps the
20 descriptions might a little misleading. I think
21 what you've got essentially is the delineation of
22 different scenarios, each with a characteristic
23 distribution of times to suppression. And so that
24 sort of thing is going to linked in with the fire
25 growth model, then you'll do the growth versus

1 suppression comparison and come out with what's the
2 fraction of time to put out the fire before damage
3 occurs. So there are characteristics associated with
4 each of these scenarios and so he's identified what
5 are the different classes that he has to address.
6 MEMBER WALLIS: Well, there's a time axis
7 which we don't see in the total.
8 MR. SIU: That's right.
9 MR. NOWLEN: That's right, yes, there is a
10 time axis. Okay, so getting down to the insights,
11 again, the limitations of our event data remain an
12 obstacle to more detailed analysis in this case. We
13 did see some interesting things on detection methods.
14 Nearly 25 percent of the fires in the Houghton data
15 base at least reported prompt detection, the fire
16 watch sort of thing, explosions that you hear right
17 away. That's a pretty significant fraction.
18 Only six percent of the fires in this
19 particular data base, again, all this is tied to the
20 data base you use, so but about only six percent were
21 reportedly picked up by fixed detection suppression --
22 fixed detection systems. That was a little
23 surprising. We assumed that number would higher.
24 We have --
25 MEMBER WALLIS: Fixed detection systems you

1 mean automatic detections systems?

2 MR. NOWLEN: Yes.

3 MEMBER WALLIS: And the only thing non-

4 fixed detection systems are people who walk around?

5 MR. NOWLEN: Yes, basically. You can --

6 yes, you know, fixed and --

7 MEMBER WALLIS: You mean automatic.

8 MR. NOWLEN: Well, with suppression systems

9 you usually think about automatic and fixed manual.

10 With detection systems, by definition they're

11 automatic so the trade jargon is usually a fixed

12 detection system. It's simply a matter of trade

13 jargon is all. There's nothing real magical about

14 that.

15 But again, a relatively low fraction

16 there. What that implies, if you take those two

17 numbers, you're left with the majority of the events.

18 The other paths we have available are delayed manual

19 detection. In the original model it was local and

20 remote. We combined those in our revision but then

21 again, all the events no modifier was detected so --

22 MEMBER WALLIS: And if you had an advanced

23 reactor you'd would have far fewer people there, there

24 would far fewer of these mobile detection systems,

25 presumably, and you have to have better fixed

1 detection systems.

2 CHAIRMAN ROSEN: Well, that's right and I

3 think one of the conclusions I drew from the six

4 percent is that we've got the detectors in the wrong

5 place, places.

6 MR. NOWLEN: Well, careful, careful.

7 We put detectors in the critical places. Now what

8 does this say? That may say that we're doing a very

9 good job of preventing fires in the critical places.

10 I mean, there's an alternate that could good news

11 here. So you can't conclude that necessarily that

12 we're putting them in the wrong places. We're putting

13 them in the places that we know are important from an

14 operational standpoint. We put them in places like

15 the cable spreading room.

16 We don't have a lot of fires in the cable

17 spreading room, so, you know, maybe this is good news.

18 I don't know.

19 MEMBER WALLIS: Maybe the people who cause

20 the fires are the same people who detect them.

21 MR. NOWLEN: That happens a lot. That

22 actually happens a lot. You know, the fire watch is

23 there or the person who started it and again, the

24 prompt detection.

25 With regard to the suppression methods,

1 this is just a rough parsing -- two significant
2 figures, I guess not too rough, but again, given the
3 data base, this is how you see the suppression -- the
4 path that was ultimately reported as successful split
5 out. The one that leaps out obviously is manual
6 suppression. Self-extinguished a fairly high fraction
7 there as well, the power removed fuel isolated wasn't
8 a small number either but the fixed systems and here
9 I'm saying fixed automatic and manual systems, only
10 about three percent of the fires report that that's
11 how they were suppressed. Again --
12 MEMBER SIEBER: What kind of insight do you
13 get with the combination of the fixed detection system
14 at six percent effective and fixed suppression system
15 at three percent effective?
16 MR. NOWLEN: Well, no, no, no.
17 MEMBER SIEBER: Does that give you insight
18 --
19 MR. NOWLEN: You can't use those numbers
20 that way. No, it's not -- this is not an
21 effectiveness number. This is -- given the events,
22 this is how they were reported to have been
23 suppressed.
24 MEMBER SIEBER: Okay.
25 MR. NOWLEN: The others may -- again, they

1 may occurring in areas where we don't have fixed
2 systems present. We don't have detection, we don't
3 have suppression. So we put them out in other ways.
4 That's another area where you can't really tell from
5 the event data. It would possible to go back
6 through the events and to try and back out whether or
7 not a fixed detection system was available. For
8 example, you could look at if you know the plant name,
9 if you know where the fire occurred, you could look
10 and see whether that systems available. The fire
11 reports don't always tell you that, so I don't know
12 from the reports whether a fixed suppression system
13 was present and failed to go off, or whether there
14 simply wasn't a system present. So you can't take
15 this as an effectiveness number. That's not what this
16 number is.
17 CHAIRMAN ROSEN: I also go back to your
18 response to my point was that fixed distance only put
19 out the fires in three percent of the cases because we
20 only put fixed systems where it's very important and
21 in those areas, we're very careful about not having
22 transient combustibles or other sources of ignition.
23 MEMBER SIEBER: It seems to me that was
24 have a lot of fixed suppression.
25 MR. NOWLEN: Absolutely, that's probably a

1 factor. I'm sorry?

2 MEMBER SIEBER: I said it seems to me as I

3 recall in the plants where I worked, there's a lot of

4 fixed suppression because of the insurance companies.

5 The insurance company says you've got to have fixed

6 suppression everywhere.

7 CHAIRMAN ROSEN: Sprinklers every place,

8 yeah.

9 MEMBER SIEBER: So well, I can't draw a

10 conclusion either but I was interested in your

11 insight.

12 MEMBER WALLIS: Yeah, this says something

13 about the extent and duration of the fire, too. The

14 long term fire is probably more likely to put out by

15 a fixed system, so the fires that really matter may

16 actually in this three percent.

17 MR. NOWLEN: That's possible, yes. Again,

18 this is a statistic that we observed. We haven't --

19 MEMBER SIEBER: I wouldn't jump to that.

20 MEMBER WALLIS: No, I'm just saying that

21 it could that these manual suppression ones are

22 relatively trivial fires.

23 MR. NOWLEN: Right. That is possible. I

24 mean, certainly some of these are trivial fires and

25 many of the ones that are manually suppressed, the

1 prompt manual suppression --

2 MEMBER WALLIS: If I light a match, I've

3 lit a fire. If I put out the match, I've put it out.

4 MR. NOWLEN: Yeah, I've put it out,

5 protection prompts suppression. Yes. The point here

6 was again, in fire PRAs we tend to focus on the manual

7 suppression path and from the experience, that may not

8 such a bad thing. It does seem to the dominant

9 path that we find to success for putting out fires, so

10 again, putting a lot of focus on our manual

11 suppression is a good thing, I think for PRA and we've

12 already hashed this one pretty well, you know, why the

13 fixed detection and suppression systems aren't

14 involved in more of these fires does remain an open

15 question and with that I'll conclude.

16 CHAIRMAN ROSEN: Well, I'd like to

17 congratulate you on a very interesting presentation

18 and you colleagues as well as being right on time.

19 MR. NOWLEN: It depends on which clock you

20 pick.

21 CHAIRMAN ROSEN: That's right, well, no I'm

22 averaging the clocks. One is 12:01 and one is --

23 MEMBER POWERS: Do you realize how

24 difficult you're going to make it for me next week?

25 I mean, couldn't you find something to criticize?

1 MR. NOWLEN: You'll have to give me a
2 bigger office for my head.
3 MEMBER WALLIS: I was going to say, you had
4 about as much fire and passion as the human liability
5 folks yesterday.
6 CHAIRMAN ROSEN: Well, let me just say that
7 we have had an opportunity and I'd like to give you
8 another opportunity if you have anything else or go
9 back to the earlier presentations or any questions on
10 that from the committee members?
11 MEMBER WALLIS: Well, I think the thing I'd
12 like to know -- this is very interesting work -- it is
13 really solving the problem that needs to solved?
14 How far is it going along the path that we need to go
15 along? I'd like a perspective on that.
16 MEMBER POWERS: Yeah, it seems to me we're
17 missing a vision of what we want, our risk assessment
18 capabilities to in the area of fire. And in that
19 regard, I mean, I think we genuinely recognize that
20 our abilities to calculate risk due to fire initiators
21 or due to fire as a consequence of other initiators,
22 is not well developed especially the latter one. That
23 is something initiates an event in a plant and that
24 leads to a fire and the combination of the two lead to
25 core damage are not well developed. And I struggle

1 with Graham in understanding where it is that we want
2 to go with that capability.
3 And one of the areas that continues to
4 perplex and concern me in the overall strategy of fire
5 risk assessment is the tendency to screen fire areas
6 and say, "Okay, here's some areas. There's no
7 ignition source in here, consequently, I don't have to
8 need to worry about the probability of fire in this
9 region", but there are adjacent fire regions that can
10 have fires and there is some non-zero probability that
11 that fire will propagate into the region that you've
12 screened out, but when you've screened it out, it's
13 gone from the analysis in its entirety. And you rely
14 on excellence in the analysis to make sure that kind
15 of situation doesn't arise.
16 I contrast that with what's then in PRAs
17 in -- for normal operations where I don't think they
18 have such a dedicated screen step in their analysis
19 and maybe they're just not as explicit as the fire
20 risk assessment people. I suspect that's really the
21 case but you have this screening methodologies that
22 are peculiar and especially this guaranteed non-
23 propagation that occurs seems to excite the public a
24 lot.
25 And this committee has enjoyed several

1 complaints about fire barrier penetration seals being
2 assumed to 100 percent effective and things like
3 that. That overall strategy, where is it that we want
4 to , what is it going to take us to get there, I
5 think is something that's just really missing here and
6 it's especially missing in the way you get your fire
7 research funded, which tends to a lot of piecemeal
8 activities each well-designed and well-conducted but
9 I don't know that we have an overall scheme that we're
10 working to here that says, okay, I should able to
11 calculate fire risks to some level of confidence and
12 whatnot.
13 The other aspect of that is who does the
14 calculation. Are we -- are we on a pathway that says,
15 okay, there will always these guys at headquarters
16 that do fire risk analyses for plants or is it
17 technology that we want eventually to give out clear
18 to the level of the inspection staff and let they do
19 that risk analyses or certainly to the senior reactor
20 analysts in the regions and they do that risk
21 analyses, or are they forever to dependent upon
22 headquarters folks doing these things?
23 And those kinds of questions just aren't
24 answered.
25 MEMBER WALLIS: To get back to this

1 screening out areas with no ignition source, it
2 reminds me I was concerned with this thing excluding
3 sabotage. Now, so the disgruntled employee -- this is
4 a traditional thing a disgruntled employee does is to
5 leave oily rags around and things and try to promote
6 fires. I mean, this is one of the traditional
7 sabotage things that happens in industry. And yet,
8 you've sort of left it out and you've start screening
9 out areas and say there's no ignition source, then
10 that's probably a likely place where there might a
11 sabotage.
12 MR. NOWLEN: Yeah, I'd a little careful
13 about assuming how quickly we throw things away and
14 never revisit. For example, the lack of ignition
15 sources is usually not a sufficient criteria for
16 screening an area out entirely. We always have
17 transients, you know, fire might happen almost
18 anywhere. You can argue about how well we handle that
19 and sabotage is another one that can happen anywhere.
20 In fact, if you have a smart disgruntled
21 employee, they can pick their spot which is
22 undesirable. We don't do that.
23 MEMBER WALLIS: Maybe they don't want to do
24 much damage.
25 MR. NOWLEN: Yeah, possible. The other

1 point, I think on screening is, when we screen areas,
2 we always do explicitly retain room to room scenarios.
3 Now. Again, you can argue about how well we do the
4 room to room scenarios when we get down to it and what
5 we assume for the reliability of the fire barriers and
6 things like that, but we do retain them. Beyond that,
7 I'll defer to the NRC.
8 MR. SIU: Yeah, let me get to the sabotage
9 question first and then the overall scheme. Yes, it's
10 really hard to address things like, "Well, gee, I've
11 got a vault with a locked door but somebody motivated
12 could bring something into that room". I don't know
13 quite what we'll do there. I will say that some of
14 the events in the fire data base represent things that
15 you might have been due to somebody's actions
16 intentionally and we haven't left those out.
17 MEMBER WALLIS: Arson isn't exactly
18 sabotage. The first suspect in arson is the fire
19 suppression guy.
20 MR. SIU: So we haven't taken those events
21 out but developing the scenario, I think that's what
22 J.S. is referring to in terms of leaving that outside
23 the scope of this particular work. You know, from the
24 NRC standpoint, I think an important objective of this
25 requantification task is to make sure that the tools

1 we've developed, methods we've developed, actually can
2 work out in the field. Making sure that we've
3 addressed every scenario and this gets to the low
4 power and shutdown issue for example, is not has not
5 been the primary objective of our research program.
6 Obviously, EPRI as well wants to develop
7 guidance that others can use to develop these upgraded
8 fire PRAs. In a way, I think our terminology
9 requantification test perhaps focuses too strongly on
10 the bottom line number that's going to result out of
11 this. We certainly expect the number to reflect the
12 technology we apply to it but also we're applying
13 boundary conditions to that analysis and the operating
14 regime and the issue of sabotage, these are places
15 where we decided given the resources we're throwing at
16 the problem what we can and cannot do.
17 It doesn't mean that we shouldn't look at
18 this as a down the road issue. That was a good
19 suggestion by the committee that we'll certainly
20 consider.
21 Regarding the overall scheme for how we've
22 identified tasks, this is something basically where we
23 are is where we were when we presented to the
24 committee in the last few years, how we identified the
25 research efforts. We had gone through some initial

1 effort, this was back in '97, identifying potential
2 issues in fire risk assessment, where improvements
3 were needed and we had a basis for identifying these
4 areas. We prioritized based on our own considerations
5 and discussions with user offices and came up with a
6 list of activities that we felt we had to address and
7 they were across the board, indeed, in fire risk
8 assessment. Every aspect of fire risk assessment we
9 felt that there was something we needed to get us over
10 some major hurdles. Some of the hurdles we saw in the
11 IPEEE reviews.
12 But so if there is a strategy, it's
13 largely trying to address the issues that we see that
14 we've been faced with and we anticipate when folks
15 come in with risk informed applications using -- if we
16 weren't to do what we're doing now, then we would
17 probably see something close to IPEEE technology when
18 the applications come in and we felt that there were
19 some places, we just had to address, so that's
20 essentially been the principle.
21 Now, the stopping rule that you asked
22 about is more difficult. Steve has indicated one
23 stopping rule but it's one that we had only after we
24 did the work which was the data just won't support
25 further developments in this area and either we go out

1 and develop physical models, say for detection which
2 is possible and we hadn't really talked very much
3 about that, or we say well, this is what the data
4 supports right now and that's where we have to in
5 the short term but I know that doesn't interest the
6 long-term issue or vision.
7 CHAIRMAN ROSEN: It doesn't address the
8 advance reactors issue. You don't have any data on
9 advanced reactors, fires in advanced reactors.
10 MR. SIU: Yes.
11 CHAIRMAN ROSEN: You have to have a
12 modeling technique that's not dependent on what data
13 it has because when we began PRA work, we didn't have
14 any data either. We used estimates and expert
15 elicitation and then over time, used basically an
16 update to improve the answers.
17 MR. SIU: I think fire risk assessment as
18 we know it, in general terms the framework of fire
19 risk assessment, how we approach things is probably
20 applicable. There are technical issues that certainly
21 need to addressed and I guess we had thought about
22 forming a view graph and we didn't do that, talking
23 about potential issues with advanced reactors.
24 We've heard about smoke, for example, and
25 the effects of smoke on equipment. You would have to

1 talk about fiber optics or you don't have to but
2 that's a potential issue that you have to address.
3 And you know, all the work that Steve's going to talk
4 about this afternoon on spurious actuation is clearly
5 dealing with electrical cables and what happens. So
6 you can come up with a list of issues but the -- in
7 may ways, I think dealing with these issues are --
8 it's part of the framework already that we've got and
9 we're saying now we have to modify the particular tool
10 we've got or the data we've got to address that issue.
11 CHAIRMAN ROSEN: The two issues I'm
12 thinking about are digitization or digital equipment
13 in advanced plants and the increased vulnerability to
14 different failure modes or multiple common cause or
15 common mode failure due to fire in advanced plants,
16 and the other issue is graphite, graphite dust in all
17 its forms in advance plants, perhaps.
18 MEMBER SIEBER: You're also going to find
19 a lot of fiber optics in advanced plants, so we need
20 to know what happens to that.
21 CHAIRMAN ROSEN: But I think the idea that
22 you're enhancing the modeling capability in what
23 you're doing now and getting experience with that will
24 lead to better fire analysis for advanced plants, too.
25 It's applicable. Some of the phenomena will

1 different, some of the things you model and the way
2 you model might different, but clearly what you're
3 doing is good. I mean, I was excited in listening to
4 what you were talking about and thinking about this
5 afternoon also and being in Seattle and seeing the
6 breadth and the interest of tons of people and some of
7 the things that are being done by utilities and
8 consultants and others, I think the state of fire
9 protection research and interest if very good. We
10 need to continue to encourage it because of the
11 importance of fire risk to the overall risk but I'm
12 encouraged by what I see.
13 MR. HYSLOP: I'd like to make one statement
14 regarding the use. You know, we're certainly
15 interested in transferring this technology to all the
16 users, to the regions as well, eventually. They do
17 analysis, they have inspections, you know that require
18 exacting analyses and you know, the better off they
19 are in performing those analyses, the better off we'll
20 .
21 CHAIRMAN ROSEN: Yeah, I think so and there
22 is one question or a note that was offered in Seattle.
23 I'm not sure -- I don't remember who exactly said it,
24 but -- no, I do, Najaffee (phonetic). He said that
25 one of the difficulties with fire modeling is that in

1 the hands of -- in a user that really don't know what
2 they're doing, it can misused. And it's a difficult
3 -- you know, it's like thermal hydraulics in a sense.
4 MEMBER WALLIS: I wondered when that was
5 going to come up.
6 CHAIRMAN ROSEN: You can create models
7 without momentum equations and think you're getting an
8 answer that's meaningful.
9 MEMBER POWERS: There are lots and lots of
10 models in this world that do not have a momentum
11 equation in it.
12 MEMBER WALLIS: And they work very well --
13 MEMBER POWERS: And they work extremely
14 well.
15 MEMBER WALLIS: -- for some purposes.
16 MEMBER POWERS: That's right, you have to
17 know when to do it and when not.
18 MEMBER WALLIS: That's right.
19 CHAIRMAN ROSEN: Well, with that, I would
20 say we will conclude for the morning and stand in
21 recess until 1:15. We'll catch up the -- we'll try to
22 end on schedule anyway.
23 (Whereupon at 12:15 p.m. a luncheon recess
24 was taken.)
25

1 A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

2 CHAIRMAN ROSEN: We are back. We're going
3 to have an unscheduled presentation by Fred Emerson of
4 NEI. That will after the staff completes its
5 presentation on circuit analysis which I will invite
6 you to proceed with now.

7 MR. NOWLEN: Very good. Okay, well, the
8 topic is circuit analysis. This topic remains a focus
9 point for NRC and industry. We did give you a
10 presentation in October of 2000 on the circuit
11 analysis task that we had been conducting under the
12 research program and I'm not going to repeat that
13 here, that's not the purpose. What I want to do today
14 is go over what's new and what's new is the
15 performance of the joint cable failure modes and
16 effects testing during 2000 and 2001 with industry
17 with NRC participation.

18 I guess before I jump into the heart of
19 the presentation, let's put this in context. This is
20 circuit analysis, so again, this is the question of
21 fires doing odd things to your circuits and systems in
22 the plant. In a PRA we're interested in potentially
23 different modes of circuit faulting. You may have a
24 loss of function, for example. That's the one we
25 typically deal with, you know, the system is simply

1 unavailable to us, it's uncontrollable. It's either -
2 - it's lost its motive power, whatever. For whatever
3 reason, it's just unavailable. But the circuit
4 analysis topic brings in the potential that there are
5 other fault modes that might occur, spurious actuation
6 being the one we always hear about, and the question
7 that we ask is how likely are those things to occur
8 and given that, how important are they to the overall
9 fire risk. So that's the topic that we're talking
10 about here, is how do we deal with circuit analysis in
11 the PRA world?
12 MEMBER WALLIS: Excuse me. These are the
13 circuits that actually do things like starting and
14 stopping pumps. They're not the circuits that measure
15 things or are they also the circuits --
16 MR. NOWLEN: It's all the circuits.
17 MEMBER WALLIS: All of them, all of them,
18 good, thank you.
19 MR. NOWLEN: Yes, potentially, we'll get
20 into some of that but for example, instrumentation and
21 indication as it impacts human reliability.
22 MEMBER WALLIS: Okay, thank you.
23 MR. NOWLEN: Permissive signals, automatic
24 actuations. You're also dealing with the power
25 circuits that provide motive power to equipment and

1 also controller fits, those that do the opening and
2 closing controls. Okay, so that's where we're at.
3 So again, we have this new set of tests
4 that I want to tell you about. These were initiated
5 by industry, EPRI and NEI in particular. NRC was
6 invited to and did participate in these tests and
7 their participation included every phase of the
8 program from test planning to the execution of the
9 tests and the analysis and interpretation of the data.
10 It was agreed right up front that we would
11 share all data. So we were given full access to the
12 NEI data. They were given access to our data, so that
13 worked very well, and each party agreed that we would
14 perform our own analyses of the data and our own
15 interpretation of what the data has told us. So what
16 I'm going to do here today is discuss our initial
17 analysis of the test data results and there's two
18 sources listed here, the primary sources and NUREG CR
19 on on the circuit analysis. It's a draft report
20 that's currently under review and I believe you were
21 provided with a copy of that and then there's also a
22 supporting test report that was published by Sandia
23 for NRC on the Sandia portions of it. And I think you
24 got that a little bit late in the process. We decided
25 to send that over as a supporting information.

1 Okay, so what was done and this is also
2 going to feed into the test that Fred Emerson will
3 present. Fred has agreed or requested the opportunity
4 to present some more detail on the industry portions
5 of these tests, that is the instrumentation and
6 diagnostics that they did. My presentation focuses on
7 the NRC portions of the test, so I have incorporated
8 what we've learned from the NEI portions as well, but
9 it's not the focus of this presentation. So what I'm
10 going to tell you here about the tests applies to both
11 of the presentations you'll see this afternoon.
12 So what was done is there was a series of
13 18 tests total, all of them were conducted with a gas
14 burner diffusion flame, a range of fire intensities.
15 The tests were conducted in basically a steel room, it
16 was a steel plate room, 10 feet by 10 feet by eight
17 feet high. All tests conducted with natural
18 ventilation and in fire jargon means it's an open
19 doorway as opposed to a forced ventilation system.
20 MEMBER POWERS: Let me ask, Steve, in a
21 nuclear power plant, how many free standing steel
22 rooms are there?
23 MR. NOWLEN: Loaded question, obviously.
24 None, really. The idea here was not an attempt to try
25 and reproduce the conditions in a typical nuclear

1 power plant room. The idea was to construct some
2 fires that would lead to cable damage and then to
3 observe how that cable damage manifested itself. So
4 we were not real focused on trying to create a
5 representative room and in fact, the effect of the
6 steel, the fact that it's a steel room means that the
7 heat losses from the room were much larger than what
8 you would expect in, for example, a concrete room, but
9 it was also a relatively small room. We also don't
10 have a lot of 10 by 10 by eight-foot rooms in nuclear
11 power plants.
12 So for a lot of reasons the room is not
13 typical and, in fact, a steel room looks a lot bigger
14 in effect than would an equivalent size concrete room,
15 you know, we are losing a lot more heat than we
16 normally would. So, you know, our interpretation here
17 is don't look at these as a typical enclosure. That
18 was not the intent, but we don't think it compromises
19 the validity of the insights relating to cable
20 failure.
21 MEMBER WALLIS: What you're really looking
22 at is the cables.
23 MR. NOWLEN: Yes.
24 MEMBER WALLIS: The cables subjected to a
25 flame.

1 MR. NOWLEN: To a fire, to heat, hot layer
2 or a plume, yes, exactly, and so the room, you know,
3 again you have to cognizant of the conditions of the
4 room, and we recognize they weren't representative,
5 but that's okay.
6 MEMBER KRESS: Excuse me, was the fire
7 necessary for this test? Couldn't you just stick them
8 in a heated compartment and --
9 MR. NOWLEN: Theoretically you --
10 MEMBER KRESS: -- and control the
11 temperature and --
12 MR. NOWLEN: Theoretically, you could. The
13 advantage of doing the fires, even though it's a gas
14 burner, it is a diffusion flame that has radiant in
15 and convective properties. It also allows you to have
16 a much larger set of cables. Doing an entire cable
17 tray in an oven in effect, is --
18 MEMBER KRESS: Yeah, an oven with a radiant
19 heater, it's not --
20 MR. SIU: Yeah, part of the issue here is
21 the thermal environment is clearly important even
22 though, as we said, the particular room
23 characteristics may not have been all the important,
24 but you're concerned about, for example, exposure to
25 the plume of an actual loaded cable tray, not just a

1 single cable in some sort of idealized environment, so
2 differential heating across the cable, direction, the
3 speed of the gases moving by the cable, all these
4 things we felt that having real fire is important to
5 try to get to those effects.
6 MEMBER WALLIS: That's the question I had,
7 how do you characterize this flame then? Do you
8 characterize it by temperature and velocity and do you
9 characterize its chemical composition? What would you
10 need to do to characterize a flame?
11 MR. NOWLEN: Well, again, the way it was
12 characterized for the test was simply a gas flow rate
13 basically, that leads you to a theoretical heat
14 release rate. You can also get information on the
15 flame heights. There were some measurements of
16 temperatures, although again, our focus was not on the
17 fire. Our focus was on the cables.
18 MEMBER WALLIS: Doesn't it make a --
19 another question, is the cable tray put on top of the
20 flame?
21 MR. NOWLEN: In some tests. Yes, we tested
22 both configurations, where the fire was directly below
23 or where the fire was off to the side so that you're
24 getting more of a hot layer exposure.
25 MEMBER WALLIS: That makes a difference.

1 That makes a difference when I'm boiling something in
2 the kitchen, whether I put it on the flame or the
3 side. So it's different.
4 MR. NOWLEN: Yes, and we're jumping ahead
5 a little bit. It certainly makes a difference in
6 time, how long it takes for the damage to occur. The
7 question that we were asking is, does it make a
8 difference to the mode of failure that I observe once
9 it fails. So, you know, again, we can deal with time
10 through our fire models. The question was, should I
11 postulate a different likelihood of a spurious
12 actuation for a plume exposure versus a hot layer
13 exposure. That was the question that we --
14 MEMBER WALLIS: It depends on the method of
15 degradation the room. Is it a question of oblation?
16 MR. NOWLEN: Yes.
17 MEMBER WALLIS: Or does to boil off, does
18 it -- you know, all that kind of stuff.
19 MR. NOWLEN: Right. So -- and that's where
20 we've been. So if we -- hopefully, I'll answer your
21 question as I go through this.
22 Okay, again, let's see, there was one
23 cable tray in each test. Some were vertical and some
24 were horizontal trays and some of the tests also had
25 a conduit, so there are cables inside of a conduit.

1 The test focused primarily on multi-conductor control
2 cables, and these were often typically bundled with
3 single conductor light power cables. So it was
4 typically a bundle and I've got some illustrations of
5 that for you here in a minute.
6 We looked at both thermal set and thermal
7 plastic cables that this is a characterization. It's
8 a very -- it's sort of the highest level split you
9 make with insulation materials. Thermal plastics melt
10 and will resoliditify. Thermal sets do not melt. So
11 we also looked at armored and unarmored cables.
12 This is the general layout of the room.
13 You -- the doorway here --
14 MEMBER WALLIS: Is this looking down on it?
15 MR. NOWLEN: Looking down on it, yes, this
16 is a plan view. Sorry. Okay, the cable tray was just
17 located along one corner supported on concrete block
18 pillars at each end and there was actually a chain
19 holding it up to the ceiling back in the corner here.
20 The burner was typically either located right in the
21 middle of the room, which would have been our hot
22 layer exposure, or it was moved underneath the corner
23 of the tray back here to give you the plume exposure
24 and varied in intensity.
25 The doorway was also varied in its height

1 of the opening to vary the conditions of the fire
2 somewhat. That was kind of on an ad hoc basis during
3 the testing. And so --
4 MEMBER KRESS: Is the room pretty well
5 airtight from the door?
6 MR. NOWLEN: Reasonably so. The walls and
7 corners were certainly airtight. They were welded
8 together so this is a test room that was available at
9 the facility and now it wasn't welded to the floor or
10 anything but any air gaps that were there would have
11 been trivial compared to the size of the door, so
12 yeah.
13 MEMBER KRESS: But was the sprinkler head
14 valve just by coincidence?
15 MR. NOWLEN: No, it was placed there for a
16 purpose. From a testing perspective you like to
17 able to, you know, if the fire gets out of control,
18 you want to have something that you can snuff it with,
19 but it was also there for the purposes of testing and
20 some of the tests, they actuated the sprinkler to see
21 whether or not it had any additional effects on
22 failures. So --
23 CHAIRMAN ROSEN: It tends to invalidate the
24 results if your fire facility burns down, fire test
25 facility burns down.

1 MR. NOWLEN: It does.

2 MR. NOWLEN: People look on that as --

3 MR. NOWLEN: Yes, well, you've gotten a

4 data point you probably didn't expect to gather.

5 MEMBER KRESS: I would have had a guy

6 standing up there with a fire extinguisher.

7 CHAIRMAN ROSEN: You know, it's more likely

8 to effective, the data we saw earlier this morning.

9 MR. NOWLEN: Okay, again --

10 MEMBER KRESS: Do you factor that into --

11 CHAIRMAN ROSEN: I'm going to gavel myself

12 into silence here in a minute.

13 MR. NOWLEN: There were a number of cable

14 configurations tested during the tests. The most

15 common is the one that you see here, which is a seven-

16 conductor, multi-conductor cable with three single

17 conductor cables bundled with it. That was the

18 predominant one, but there was also an eight-conductor

19 armored cable, there were some five-conductor cables.

20 These two are instrumentation type cables. This is a

21 two conductor with a shield and drain and this was

22 three twisted shielded pairs. There were some three

23 conductor cables and then there was, I believe, on

24 with a 12-conductor cable and three singles, so,

25 again, a range of configurations for the different

1 cables.

2 There were also a number of arrangements
3 exercised for the raceways. This just gives you an
4 idea. The variations are the numbers of rows of
5 cables from a single row upwards to four rows of
6 cables. The most common configuration is here, as you
7 can tell just by the number of tests that were done.
8 The cable that is marked here as IR that's one of the
9 two cables that the NRC tests were monitoring. The
10 other is in a few of the tests there was an instrument
11 cable included in the tests and I'll get into that in
12 more detail.

13 So this gives you an idea of where the
14 different locations. In some cases we were in the
15 conduit for example, in this particular test, we were
16 looking at three/three conductor cables located in the
17 conduit with an instrument wire there as well. There
18 was a particular purpose to the industry tests in this
19 regard and so we basically relocated to an
20 electrically isolated location for that one. So
21 again, a range.

22 Some of them were again here in the
23 conduit. Here were on top of the bundle, again, on
24 top of the bundle, some of these are against the tray,
25 so just the idea that there's a range of

1 configurations here, trying to explore how these
2 things might impact the failure modes and likelihoods.
3 The next slide, I don't think I'll go into
4 any detail. This particular system is a set of input
5 and output switching relays that allow us to energize
6 a cable bundle. This is our test bundle over here so
7 in this case we're illustrating, for example, the
8 seven conductor, multi-conductor cable with three
9 single conductor cables and what this whole rig
10 allowed us to do was do insulation resistance
11 measurements for specific conductor pairs.
12 I could pick, by energizing one conductor
13 on the input side, and connecting another conductor
14 through on the output side, I could measure the
15 insulation resistance between that conductor and the
16 conductor connected down here. By reversing the
17 process and connecting in the opposite set, for
18 example, this one on this side and the other one as
19 the output, I get an independent measurement of that
20 same insulation resistance and what we did is we would
21 go through a switching logic that did these pairs in
22 sequence. And by taking the two as a set, the
23 one/eight and the eight/one for example, we can also
24 identify not only the insulation resistance between
25 these two conductors but also from each conductor to

1 ground.

2 Basically, we end up with enough
3 independent measurements that we can get the full set
4 of IR results. So again, this was exercised in each
5 of the tests with whatever bundle was available and we
6 made a lot of measurements of insulation resistance.
7 The next one in your package probably won't show up
8 real well on the reproduction because it's going to
9 black and white and this really takes color to
10 understand.

11 This just happens to test 3 and these
12 are the results for the conductor to conductor
13 insulation resistance for the conductor we called
14 Number 1. This is -- you know, it was a somewhat
15 arbitrary choice. We know which one that is, but in
16 this particular case, it's considered Number 1. So
17 you see the insulation resistance between 1 and 2, 1
18 and 3, 1 and 4, et cetera, et cetera. Eight, 9 and 10
19 are the single conductor cables bundled with it. One
20 through 7 were the multi-conductor cable in this case.
21 Okay, so this is again our typical configuration.

22 Now, what's interesting is you see the
23 cable sort of dancing along here, not a lot of effect,
24 a little bit of degradation in the insulation
25 resistance. Our threshold by the way was about 10 to

1 the fifth ohms. Anything above that we really
2 couldn't sense so in reality the cable starts probably
3 up in this range, but our sensitivity just wasn't that
4 high. As the fire progresses you eventually see these
5 two come into play with Number 1. Well, you jump up
6 here and that's Number 7 and this one is Number 6. So
7 what we saw in this particular case, Number 1 happens
8 to the center conductor. Okay, if you remember the
9 seven-conductor cable has six around the outer ring
10 and one in the middle. Well, Number 1 happens to
11 the center conductor and 6 and 7 are two of them next
12 -- right adjacent to each other in the outer ring.
13 So in this particular case, the first
14 fault that we saw, the first failure of the cable was
15 a short that formed between conductors 1, 6 and 7.
16 This is stuff we didn't have before. We didn't have
17 this kind of data on the behavior of cables and you
18 can progress through here and see when the other
19 cables begin to fall into these shorting groups.
20 CHAIRMAN ROSEN: Hold on for a minute.
21 Let's focus on that for a minute. You said the first
22 fault was between Conductor 1 and 6?
23 MR. NOWLEN: One, 6 and 7 shorted together.
24 CHAIRMAN ROSEN: One, 6 and 7, it's three
25 different cables, right?

1 MR. NOWLEN: Yes. No, three different
2 conductors in the same cable.
3 CHAIRMAN ROSEN: Three different conductors
4 in the same cable. Those three cables all
5 simultaneously shorted together?
6 MR. NOWLEN: Yes, that was the first thing
7 that happened.
8 CHAIRMAN ROSEN: I would thought that most
9 likely it would the two cables would short together
10 rather than three.
11 MR. NOWLEN: Yes, well, sometimes intuition
12 -- well, we'll get to that.
13 MEMBER SIEBER: Let's careful, sometimes
14 his intuition.
15 MR. NOWLEN: Okay, this is this bundle
16 right here. This was a test like this. Number 1 was
17 -- and again, this is a seven-conductor, multi-
18 conductor control cable, okay? These are three
19 individual single conductor cables bundled along with
20 that one. Number 1 is this conductor right here. Six
21 and 7, you know, were a pair of them next to each
22 other on this outer ring and may have been this pair
23 or this pair, it doesn't matter, but so what we had
24 was these three conductors formed a short together.
25 That was the first failure mode right there.

1 MEMBER WALLIS: What if 6 and 7 shorted out
2 together first and then one of them went to 1?
3 MR. NOWLEN: Well, I can -- in this
4 particular case, I pulled the one that had the -- that
5 -- well, in this particular case, they shorted
6 together. One, 6 and 7 went at the same time. Now --
7 A VOICE: What's the difference between the
8 measurements?
9 MR. NOWLEN: That's where I was just
10 headed. The time frame here is on the order of a few
11 seconds. You know, a few seconds of time in this
12 particular case is for all intents, simultaneous in
13 our analysis. Because of the switching cycle, it
14 takes a little time to get through that switching
15 cycle and so these -- for the purposes of our
16 measurement to our resolution, it was essentially
17 simultaneous.
18 MEMBER SIEBER: Was that the thermo plastic
19 or thermo set?
20 MR. NOWLEN: Test Number 3, I don't recall.
21 MEMBER SIEBER: That would make a
22 difference, wouldn't it?
23 MR. NOWLEN: It does make a difference and
24 I'm going to get into that. I just pulled this one to
25 illustrate the nature of the data that we're

1 gathering. I don't recall the exact conditions on 3.
2 I'd have to look it up. So again, what we have is we
3 have these kinds of plots for every one of these
4 conductors, so I've got the same plot for conductor 2
5 and for conductors 9, so there's a set of 10 of these
6 for every test. Taking them all together and looking
7 at the times, we can distinguish when these different
8 shorts occurred in which combinations and what sort of
9 transitions they made. So given all of that --
10 MEMBER SIEBER: Now, this, if it were an
11 actual cable in a plant, that would give you a
12 spurious actuation?
13 MR. NOWLEN: Maybe, maybe not. Yeah, it --
14 MEMBER SIEBER: Or a trip.
15 MR. NOWLEN: Well, and again, this is where
16 the NEI portions of the test were a great compliment
17 to what we're doing here. When I look at a pair of
18 conductors, I'm taking it out of the context of the
19 circuit. Certain combinations of conductors in a
20 particular circuit can lead to a spurious operation.
21 MEMBER SIEBER: Right.
22 MR. NOWLEN: I've divorced that part of the
23 problem here. I'm looking at the cable as a system.
24 MEMBER SIEBER: Well, sooner or later in
25 the process of cooking this cable, they all short

1 together, right?

2 MR. NOWLEN: Yes, that's -- yes, they --

3 MEMBER SIEBER: Sooner or later.

4 MR. NOWLEN: Sooner or later, as the fire

5 keeps going, they all short to ground, in fact.

6 MEMBER SIEBER: That would better.

7 MR. NOWLEN: From a hot short perspective,

8 sure. Yeah, because that trips control power

9 typically, yeah. So, yeah, again, you have to take

10 this and put it in the context of a specific circuit

11 and a specific cable. Some circuits have certain

12 combinations that will lead to actuation. You know,

13 other circuits have their own combinations.

14 What we were looking at are things like

15 this. In the trays, what we saw is that 80 percent or

16 more of the faults, the initial failures of these

17 multi-conductor cables were conductor to conductor

18 shorts. Okay, well, that tells you something. Now,

19 again, a conductor to conductor short does not

20 necessarily mean you're going to get a spurious

21 actuation, but it does say that that particular event,

22 conductors shorting to each other is a high

23 probability event.

24 Conductor to conductor shorting groups

25 vary. We had some fairly complex behavior in this

1 case.

2 MEMBER WALLIS: They short by touching each

3 other or does the insulation break down into some

4 conducting component?

5 MR. NOWLEN: It's a little bit of each but

6 given the low insulation resistance here, I mean,

7 we're talking 100 ohms, that's basically contact

8 between the conductors. There was some speculation

9 going into the test that the charring of the

10 insulation might leave substantial insulation

11 resistance and so you might have, you know, high

12 resistance, you know, low quality faults, shorts.

13 What we saw were the behavior with the

14 fairly abrupt transition backing up to here, these

15 abrupt transitions where we went from on the order of

16 1 to 10,000 ohms down to 10 to 100 ohms, every test

17 that's what we saw. If it failed, this is the way it

18 failed. It degraded to a certain point and then boom,

19 down it went. So we believe that this indicates that

20 there's contact. And in fact, when you do the post-

21 mortems, you can see that when you take the cables

22 apart. The thermo plastic cables in particular --

23 MEMBER WALLIS: Did you observe anything

24 else of the physical condition at this point where

25 this collapse occurred?

1 MR. NOWLEN: No, this is an ongoing test
2 that continued to burn for some time, so, you know, we
3 didn't stop the test at this point and run in to see
4 what it looked like or anything like that. This -- it
5 just continued, so the condition that we would see
6 would out here when we went in and did a post-mortem
7 on the test.
8 MEMBER SIEBER: Now, that time, I take it,
9 would very important from the standpoint of modeling
10 what goes on.
11 MR. NOWLEN: Yes, but again --
12 MEMBER SIEBER: That's like 45 minutes,
13 right?
14 MR. NOWLEN: Yes, yeah, many of these, and
15 I'll make that observation in a minute, a lot of these
16 were extended damage times.
17 MEMBER SIEBER: Yeah.
18 MEMBER WALLIS: I'd like to know whether
19 I'm paralyzing the cables or boiling them or whether
20 I'm actually burning them off or what's happening in
21 there.
22 MR. NOWLEN: Well, okay. The termo plastic
23 cables were melted. They melt.
24 MEMBER WALLIS: So they melt and then they
25 slope into it somehow?

1 MR. NOWLEN: Yes, a little bit. The
2 insulation would soften and the way cables are
3 manufactured, they twist as they go down through the
4 manufacturing, so there's a little bit of residual
5 tension there, okay. And we think what happens is
6 that as the material softens that residual tension
7 brings the conductors together. There's also the
8 gravity effect. I've got a single conductor next to
9 it and gravity can kind of draw that down through the
10 softened insulation and create contacts.
11 Now, the thermo set materials which
12 actually are more common in U.S. practice today, the
13 newer cables are almost all thermo sets, they don't
14 melt. They burn and char. And but again, I believe
15 it's this twisting and the residual tension that draws
16 the conductors together and we get shorts, that
17 combined with the gravity effects. Some of the cables
18 had cables on top of them pressing down. So there is
19 various things that draw these things together.
20 MEMBER SIEBER: These cable trays did not
21 have covers.
22 MR. NOWLEN: Correct, that's correct.
23 Again, the one thing -- or another thing that we saw
24 was that these conductor shorting groups were very
25 complex in some cases and they were transient. You

1 don't see two conductors short together and stay that
2 way forever. The groups would two or three or four.
3 You might have another group of two over here and then
4 they go -- now you've got six and now you've got
5 eight, now you've got 10 and then they all go to
6 ground. You know, there were these complex transitions
7 among these conductors. So it's not a simple behavior
8 at all.
9 We generally saw that the outer ring of
10 conductor, the multi-conductor would short first and
11 there was some speculation as to whether that would
12 observed, whether we would see the rather intimate
13 involvement of the center conductor with the rest of
14 the conductors creating more likelihood of shorts to
15 that center conductor. Well, what we learned is that
16 it's the outer conductors that tend to fail first.
17 They're getting the worst thermo exposure. It takes
18 time for the heat to conduct in and that was the
19 dominant effect there.
20 We also saw in the shorts generally
21 observing nearest neighbors like the case that I
22 showed was 1, 6 and 7, those were all right next to
23 each other. We didn't see shorts jumping all the way
24 across the cable as an initial fault mode. That would
25 happen later in some cases.

1 MEMBER WALLIS: Now, because of thermal
2 expansion does the cable itself bulge or -- it doesn't
3 just stay straight and it isn't just a question of the
4 twist. There's also significant thermal expansion,
5 isn't there, during this?
6 MR. NOWLEN: There are, yeah. I don't know
7 how big a role that played. You often see bubbling of
8 the jackets, for example, and you'll see off-gassing.
9 MEMBER WALLIS: I mean, the metal itself.
10 They get longer, then you know, whether or not they're
11 pushed together is going to an influence.
12 MR. NOWLEN: Good point. Yeah. I hadn't
13 thought about that one myself, actually.
14 MEMBER SIEBER: I think if you look at some
15 of the thermo set cables after they've been fried, and
16 I never saw them coming out of the fire, but I've seen
17 where they were partially aged and overheated so much,
18 they failed and what you see is the thermoset
19 insulation breaks apart which I think comes from the
20 expansion of the metal conductor and you see these
21 gaps and little pieces of spaghetti with openings in
22 it and I've seen a fair number of cables that looked
23 like that.
24 MR. NOWLEN: Yeah, I've seen that as well
25 in the aging context with, you know, as the material

1 has aged they oxidize and become more brittle and,
2 yeah.
3 MEMBER SIEBER: Just a very extremely hot
4 place underneath the generator and it wasn't shielded
5 in any way. It was an old generator.
6 MEMBER KRESS: Did they have thermo-couples
7 stuck around in these trays anywhere?
8 MR. NOWLEN: Yes, I don't know how deep
9 Fred's planning to get into that but there were
10 thermo-couples in the room in general, in the tray.
11 Where were some attached to the cables themselves, so
12 along with all of this stuff, there is a whole rash of
13 thermo-data that we've even scratched the surface of.
14 So, Fred can talk further to that, I think.
15 MEMBER WALLIS: But they're free cables at
16 the end, so they can expand, they can just grow
17 lengthwise or are they tied down at the end?
18 MR. NOWLEN: They -- well, they were not
19 tied down at the end. The ends were quite long and
20 they were run out of the room to give us electrical
21 access.
22 MEMBER WALLIS: So they probably could
23 expand some, then they could grow. If they're held
24 at the end, then they do all kinds of stuff.
25 MR. NOWLEN: Yeah. In this case, again,

1 the tray itself was --

2 MEMBER WALLIS: That expands, too.

3 MR. NOWLEN: -- about 12 feet long, is

4 that right, Fred, total length, roughly 12 feet.

5 MEMBER WALLIS: And that expands, too.

6 MR. NOWLEN: Yeah, everything is going to

7 expanding, so in that sense, it was probably fairly

8 representative of what we'd really see in a plant, a

9 local exposure on a long length of cable.

10 Okay, this was a point that was raised

11 before. If the cables failed during a test, all the

12 conductors eventually shorted to ground. We had

13 persistent fires. We didn't put the fire out when we

14 saw failures. So again, with the continuing fire,

15 they did all go to ground eventually. And the

16 transition times ranged from seconds, you know, a few

17 seconds, to several minutes. In some cases, the

18 shorts would last longer than others.

19 MEMBER SIEBER: By going to ground, you

20 mean shorting out to the cable tray?

21 MR. NOWLEN: Correct, yes, the ground plain

22 in this case was the tray. And it was -- yeah, it was

23 grounded. And we saw a number of factors that

24 influenced the cable failure mode behavior and, again,

25 this is not timing. This is given that the cable

1 fails, how does it fail.

2 MEMBER WALLIS: Did you get -- out of all

3 this, did you get something quantitative like calories

4 (phonetic) per gram added is enough to melt and do

5 something to it?

6 MR. NOWLEN: No, that's wasn't --

7 MEMBER WALLIS: Were you quantitative about

8 it instead of just looking and seeing it?

9 MR. NOWLEN: Not for these tests, no.

10 There's certainly a potential to look at the heat

11 transfer behavior between the fire environment and the

12 cables from these tests but that hasn't been done.

13 MEMBER WALLIS: I would think that would

14 the key thing.

15 MR. NOWLEN: Well, again, from a timing

16 standpoint, yes, it's -- you know how you deliver heat

17 to the cable and cause it to fail is a key question

18 for timing. The focus here again was not timing. The

19 focus here was given that we are going to induce

20 failure, how does that failure manifest itself? Do in

21 our context, we would perhaps call that an influence

22 factor. If I heat it up quickly versus I heat it up

23 slowly, that may change the manner of failure, the

24 mode that I fail.

25 MEMBER WALLIS: Well, in an hour, it would

1 take 3,000 seconds for this to happen? That suggests
2 that there is some kind of diffusion process. It's a
3 rather slow process going on.
4 MR. NOWLEN: Yes. Well, and in particular,
5 you know, that's fairly consistent with our past
6 understanding of cable failures. In a lot of these
7 test, the temperature that the cables were exposed to
8 hovered right at where we expect the failure to . You
9 know, 400 degrees, centigrade for example, we were
10 hovering right in that range for a cable that we
11 expect to fail at about 400 degrees centigrade, so
12 these extended times are consistent with that
13 behavior. If you emerse it right at its threshold, it
14 takes a long time for it to heat and respond.
15 MEMBER WALLIS: It's firelizing (phonetic)
16 whatever the word is, and then sort of the gases are
17 diffusing out and all that.
18 MR. NOWLEN: Right, and the heat is --
19 MEMBER WALLIS: Don't you have a model like
20 that?
21 MR. NOWLEN: There are models.
22 MEMBER WALLIS: What happens to cable
23 insulation.
24 MR. NOWLEN: There are models of that, yes.
25 Again, it was not the focus of these particular tests.

1 Okay, let's see factors. One of the things we saw was
2 that the routing in the conduits appears to increase
3 the likelihood of shorts to ground. This would at
4 the expense, for example, of spurious actuations. A
5 short to ground doesn't typically give you that.
6 There are some specific configurations where multiple
7 shorts to ground might get you there, but this --
8 again, there was some speculation as to whether the
9 prevalent ground plain that the conduit itself
10 represents would tend to drive things to ground or
11 whether the nice uniform even support that a conduit
12 provides the cable might actually make it more likely
13 that you'd see internal shorting.
14 It seems that the ground plain won out on
15 that battle. There's a little bit of contradictory
16 information there that we're still trying to short out
17 but in general we saw fewer interactions.
18 MEMBER SIEBER: Did the cable last longer
19 before failure in the conduit or armor than in an open
20 tray?
21 MR. NOWLEN: No, not especially.
22 MEMBER SIEBER: So that didn't do anything
23 for it.
24 MR. NOWLEN: It's not a fire barrier, no.
25 No, not at all.

1 MEMBER WALLIS: Is this time to failure
2 very variable between tests?
3 MR. NOWLEN: Yes.
4 MEMBER WALLIS: Very variable.
5 MR. NOWLEN: Very variable. Some happen
6 quickly, some lasted well over an hour.
7 MEMBER WALLIS: Order of magnitude?
8 MR. NOWLEN: Yes. And again, it was tied
9 to the exposure mode and the fire intensity. The ones
10 with high intensity fires directly under the raceway
11 failed very quickly. The ones with a lower intensity
12 fire or even some of the fairly high intensity fires
13 off to the side where it's a hot layer exposure, took
14 well over an hour. I think Fred will probably get int
15 that a lot more, too.
16 MEMBER SIEBER: Did the flame ever touch
17 the cable itself?
18 MR. NOWLEN: We avoided that. I don't
19 remember -- I think one of the early tests that
20 happened but in general, we were not interested in the
21 direct flame exposure mode. We chose not to focus on
22 that one.
23 MEMBER KRESS: Could you correlate the
24 failures with the temperature rather than time and --
25 MR. NOWLEN: Yes, we've made some initial

1 attempts at that. Again, it wasn't really our
2 objective here but we've already done some of that.
3 If you look at the test report that we published, in
4 conjunction with each of the failure diagrams, there's
5 also a temperature plot.
6 MEMBER KRESS: A temperature/time chart.
7 MR. NOWLEN: Yeah, and I think, in fact,
8 Fred has -- the NEI effort has taken a deeper look at
9 the temperature behavior than we have.
10 MEMBER KRESS: You might able to
11 rationalize the time out.
12 MR. NOWLEN: Oh, I think you certainly can,
13 yes. Yes. Again, I don't see these -- you know, the
14 time to failure here, given the exposure temperature,
15 they're consistent with what I would have expected.
16 In some cases, I think they lasted longer than I might
17 have guessed but looking at the temperature data on
18 the back side, I'm not that surprised.
19 Okay, we also --
20 MEMBER WALLIS: You keep saying that
21 something was not the focus of the tests. Presumably,
22 this was rather a try it and see type test where you
23 said let's make some sort of typical cable trays and
24 put a fire somewhere and see what happens. It was not
25 -- so you didn't have a hypothesis to test or a

1 mechanism to test.

2 MR. NOWLEN: No, I wouldn't say it that
3 casually, I guess, I would say we had a specific
4 objective. And the specific objective was to look at
5 the mode of failure for cables. We were -- to meet
6 that objective, we did not work to have a fully
7 representative room or a fully representative fire.
8 You know, we didn't consider that necessary to the
9 objective that we did have. We did have a specific
10 objective though.

11 MEMBER POWERS: Graham, you'll remember
12 that some time back maybe a year ago, maybe a half a
13 year ago, we had an argument presented in front of the
14 committee that said multi-conductor cables will just
15 fail to ground, a quite insistent presentation that
16 said they would only fail to ground.

17 MEMBER WALLIS: That was a pretty bold
18 statement.

19 MEMBER POWERS: It was a very bold
20 statement and they eventually do.

21 MEMBER SIEBER: They eventually do.

22 MEMBER POWERS: I mean, it was true but
23 the implication was that that would not happen
24 otherwise. And an argument presented that this was a
25 result of a careful experiment and on so in many

1 respects this test stands as a counterpoint to that
2 previous presentation to us.
3 MR. SIU: If I could just add to that,
4 Steve eluded to an earlier presentation. Some of the
5 work we did under this task was to identify factors
6 that might effect the failure mode of the cable and so
7 the experimental design actually explored those
8 factors. What we don't have in this program is a
9 physical model of the cable or the cable tray and we
10 haven't been aiming at development of a mechanistic
11 model of the failure mode given the cable damage.
12 In PRA, fire PRAs typically the likelihood
13 of a hot short spurious actuation has been teating
14 using a probability number and it's estimated and so
15 what we're trying to do is come up with a better basis
16 for that the probabilities were assigned based on
17 physical characteristics of this.
18 MEMBER WALLIS: This morning we were saying
19 that besides there trees, there's a very important
20 time element here.
21 MR. SIU: That's correct.
22 MEMBER WALLIS: There seems to a very
23 important time element here, too, and if the fire is
24 put out before the cables failed --
25 MR. SIU: That's right. The probability

1 number I'm referring to is that conditional
2 probability of the hot short and spurious actuation
3 given cable damage. We say cable damage has occurred.
4 We have other models that tell us what's the
5 likelihood of cable damage and that's exactly what
6 you're referring to, the competition between the
7 growth and suppression.
8 MEMBER WALLIS: So you can predict this
9 time to failure that's evident in this --
10 MR. SIU: That's how we treat it in the
11 models now and now so there's this additional element,
12 how does the cable fail given that it has failed.
13 MR. NOWLEN: Right, and so that's the part
14 we were attacking here. So again, another factor we
15 saw as important is the armored cables. The behavior
16 here was similar to conduits. The armored cable
17 typically has a spiral wound metal sheath over the
18 insulated conductors that often then has an outer
19 jacket over that but that spiral sheath seemed to
20 again, a very prevalent ground plain. They're
21 typically a grounded practice. And so we saw
22 predominantly shorts to the armor rather than
23 conductor to conductor shorts. I think in this case
24 the armored actually was a little more pronounced than
25 the conduit. The conduit is still a little

1 contradictory. We're not real clear on that behavior.
2 Armored was fairly --
3 MEMBER SIEBER: The kind of armored cable
4 you're talking about is what used to called .
5 MR. NOWLEN: Yes, that is the trade name,
6 yes. Yes, that's a trade jargon for it.
7 MEMBER SIEBER: That's not used very much
8 any more, is it?
9 MR. NOWLEN: Certain plants use it a lot.
10 MEMBER SIEBER: Really?
11 MR. NOWLEN: Yes, certain plants use it a
12 lot.
13 MEMBER WALLIS: Well, the armor is grounded
14 so, I mean, you've got to get there first.
15 MR. NOWLEN: Oh, yes. But again, you've
16 got multiple conductors within the armor.
17 MEMBER WALLIS: Oh, within the armor.
18 MR. NOWLEN: Yes. So the question is,
19 could you get shorts among those conductors or how
20 likely was it to get shorts among those conductors not
21 involved in the armor.
22 We did see some inter-cable and I'm going
23 to use intra-cable and inter-cable. Intra-cable just
24 means within a single multi-conductor. Inter is just
25 between two independent cables. In our case it was

1 typically a multi-conductor and the three single
2 conductors represent the inter-cable behaviors. The
3 inter- cable conductor and conductor shorts were less
4 likely but we did see some, we saw a few cases.
5 In this case the thermo-plastic cables
6 appeared more likely to experience these inter-cable
7 shorts. Again, the melting allowed the conductors
8 from the different cables to come together whereas
9 with the thermo-set cables the charring behaviors
10 seemed to keep them apart more, especially between
11 cables. The cables I the conduits also saw some
12 inter-cable shorting behavior, that is we'd have
13 multiple cables in a single conduit and there were
14 some behaviors there as well. Again, less likely, but
15 it was observed.
16 We did some testing with DC power supplies
17 and AC power supplies and we ended up with some
18 inclusive data here. There were some problems in some
19 of the tests where the data didn't come out quite
20 right due to a flaw in the system that we were using.
21 And so we ended up with some kind of inclusive
22 results. There were some things that seemed to
23 indicate it may not make a difference. Some things
24 seemed to indicate it does. So that's why we still
25 have open --

1 MEMBER KRESS: Why would you think it would
2 make a difference? If you were to ask somebody, me
3 for example, I would say it wouldn't make any
4 difference.
5 MR. NOWLEN: If you asked me beforehand, I
6 said it didn't make a difference, too. We wrote this
7 down as a potential influence factor and said it was
8 likely a weak influence factor. We did not expect to
9 see differences. We have seen some things in the test
10 data that we need to think whether we were right or
11 not. I don't know why and I'm not sure it's correct.
12 It may an artifact, this is just something we --
13 MEMBER WALLIS: It's probably an artifact,
14 because I don't think this cares which way the
15 electrodes are going.
16 MR. NOWLEN: That was my judgment, too.
17 MEMBER POWERS: Once again, the momentum
18 equation rears its ugly head here.
19 MEMBER SIEBER: Other than when you were
20 testing each portion of the cable, there was no power
21 going through the cable, right?
22 MR. NOWLEN: Correct, yes. We would -- for
23 our test, we would energize one conductor at a time.
24 MEMBER SIEBER: Right, and it was at very
25 low current, right, so you aren't heating the case.

1 MR. NOWLEN: Yes, yes. Correct. Let's
2 see, the last point here was another mode of failure
3 would loss of continuity of the conductors
4 themselves, they break. We did not see that in any of
5 these tests. That type of behavior is usually
6 associated with high potential cable, high voltage,
7 high current.
8 MEMBER WALLIS: I have another question,
9 I'm sorry. Talking about this power, these cables are
10 not energized with large currents. It's just a test
11 current, it's a tiny current, isn't it?
12 MR. NOWLEN: Correct, yes.
13 MEMBER SIEBER: For a tiny period of time,
14 too.
15 MEMBER WALLIS: You're not worried about
16 any kind of forces due to currents.
17 MR. NOWLEN: Correct.
18 MEMBER KRESS: Or you're not worried about
19 differences in voltages that might cause sparks and
20 things like that that damage the cables, is that --
21 MR. NOWLEN: Well, we did have substantial
22 voltage differences. You know, these were typically
23 run at 120 volts, AC or DC.
24 MEMBER KRESS: I'm worried about one cable
25 above another one, with different voltages at that

1 port.

2 MR. NOWLEN: Yes. We would energize one

3 conductor at 120 volts and so its potential to the

4 others could have been 120 and there was always at

5 least one that was grounded. So you'd always have one

6 energized, one grounded. The others would kind of

7 in the neutral if they had shorted.

8 MEMBER KRESS: So you did have that.

9 MR. NOWLEN: Yeah, but we did not impose

10 anything in the way of substantial baseline currents.

11 So there is no impacity heating, for example, of these

12 cables.

13 CHAIRMAN ROSEN: No heating of any kind.

14 Would you expect that in a high powered cable that's

15 in a fire, there would different failure modes or

16 failure effects? Did you say anything at all about

17 that?

18 MR. NOWLEN: For high power, yes, and

19 again, it's a thing that may influence timing. These

20 are control cables and for control cables, no, it's

21 not a major issue. The heating rates for control

22 cables are rather low. You know, they're bleeding off

23 tenths of amps, usually one or two conductors carrying

24 a few tenths of an amp. So for control cables it's

25 not a big issue. Power cables, perhaps. Okay.

1 MEMBER SIEBER: If you were carrying a big
2 load, that's where the difference between AC and DC
3 is.
4 MR. NOWLEN: Possibly, yes. Yeah, and
5 again, power cables would the application.
6 MEMBER SIEBER: Right.
7 MR. NOWLEN: So again, in these particular
8 tests, we didn't see any loss of continuity failures.
9 But again, these are behaviors that are associated
10 with things we didn't have in our tests, the real high
11 intensity fires, and high -- the high potential
12 cables. Ours were not that high potential, so again,
13 that wasn't a reals surprise consistent with our
14 understanding.
15 So the second thing that was done under
16 the NRC sponsorship was a surrogate instrument loop
17 and basically what I put up here is a circuit diagram
18 of our system. We had a current to simulate a control
19 signal or, I'm sorry and instrumentation signal coming
20 from a transmitter, say inside containment or
21 wherever. There were fuses to limit any fault
22 currents coming back into our current source. The
23 cable was then run through the fire test cell and back
24 out of the test cell through another pair of fuses to
25 a simulated control room indicator. Basically, there

1 is these resistors, the 10 ohm resistors were intended
2 to simulate a long length of cable between you and the
3 world and then this, the 250 ohm resistor is basically
4 a ballast resistor that will take a 4 to 20 milliamp
5 signal and turn it into a voltage signal that's then
6 read out on in effectively a voltage indicator. So
7 this is a fairly typical simple configuration for an
8 instrument loop, 4 to 20 milliamps and we ran these in
9 several of the later tests.
10 The next slide gives you an indication of
11 two tests, the results. This test was a thermo-
12 plastic cable and this test was a thermo-set cable.
13 The interesting thing that we saw and we saw this
14 consistently, was that the thermo-plastic cables
15 failed very abruptly. You know, you went from
16 basically a good reading and here by the way, what
17 we've done is we've taken and said that our 4 to 20
18 milliamp loop current corresponds to a zero to 100
19 percent process scale reading, whatever that happens
20 to . So in this case because of the baseline load,
21 you know, we're running 69 percent on our process
22 variable.
23 So if the operator were watching this,
24 what he would have seen is this would have dropped off
25 scale low, very abruptly, easily diagnosed as a faulty

1 instrument. In this particular case with the thermo-
2 set cable, the behavior was rather different. We saw
3 this progressive degradation and then ultimately there
4 was an abrupt transition to again off-scale low. The
5 off-scale low indicates the conductors have shorted
6 together and I've completely by-passed my instrument
7 reading in the control room. I'm shunting the current
8 through the short and back to the transmitter.
9 MEMBER SIEBER: Is that enough to blow the
10 little eighth amp fuse?
11 MR. NOWLEN: No, not in our case. The --
12 in this case the eighth amp fuse was there just in
13 case we were to short over to one of those 110 volt
14 control cables that can really give a 4 to 20 milliamp
15 power source fits.
16 MEMBER SIEBER: It would give you a chance
17 to buy another one.
18 MR. NOWLEN: Yes, exactly. And NRC didn't
19 want to pay for another device.
20 MEMBER SIEBER: Now was it typical that the
21 thermo-plastic cable would last longer than the
22 thermo-set cable in this instance?
23 MR. NOWLEN: No, actually, it's just the
24 opposite. Yeah, it's interesting, I didn't even pick
25 up on that. Typically, the thermo-plastic cables

1 failed much sooner in equal environments, the thermo-
2 plastics will go sooner.
3 MEMBER SIEBER: Okay, so this isn't
4 representative of equal environment.
5 MR. NOWLEN: No, no, in fact, this was
6 probably -- I'd have to go back and look again. I
7 just grabbed these sort of at random. This was
8 probably a plume exposure. Or, I'm sorry, this was
9 probably a hot layer exposure and this was probably a
10 plume exposure, so it went more quickly --
11 MEMBER SIEBER: Okay, thank you.
12 MR. NOWLEN: -- especially given the
13 timing there, that's probably a plume exposure.
14 MEMBER SIEBER: Thanks.
15 MEMBER LEITCH: What's that spike on the
16 plastic cable? Is that --
17 MR. NOWLEN: Well, for a second it jumped
18 back. You know, it separated out and came back again.
19 We did see that a few times. But again -- well, let
20 me jump to the -- it's this pronounced behavioral
21 difference between these two types of cables that was
22 interesting here. We had speculated about this in
23 advance of these tests the fact that thermo-plastics
24 melt that we would see more abrupt transitions and in
25 fact, we saw that. So, you know, the idea that with

1 the thermo-plastic there's no real signal degradation,
2 it's either good or it's bad. But with the thermo-
3 set, there's substantial degradation of this signal
4 that the implications would that if we're doing
5 human reliability analysis. You know, the operator
6 probably diagnosis the loss of signal on the therm-
7 plastic with extreme ease, whereas he might misled
8 by the degraded signal that he gets from a thermal set
9 cable. So that was what we saw there.
10 Now, there was a complimentary set of
11 industry tests. Their tests focused on a surrogate
12 MOV circuit. Fred Emerson is going to speak about
13 those, so I'm not going to cover these in any detail
14 at all. We did do an analysis of the data and there
15 is a write-up of that in Appendix D of the draft
16 report we provided you with. This was based largely
17 on my own input as a member of the EPRI panel on
18 spurious actuations. And so that's its basis. The
19 report is currently undergoing review and our findings
20 to date are based on our understanding of data and
21 that analysis.
22 In particular the EPRI expert panel report
23 is out, but the industry test report is not yet out.
24 We haven't seen that yet. We've seen presentations at
25 the NEI forum twice, so we -- you know, we've fed

1 their interpretations into that extent, but this is
2 still subject to some reconsideration.
3 So overall, what did we find? We learned
4 a lot from these tests. These were really very
5 illuminating. Many of our previous findings were, in
6 fact, confirmed. The idea that multi-conductor cables
7 fail conductor-to-conductor with high probability, we
8 had seen that in previous testing. We felt reasonably
9 confident of it and we definitely confirmed that here,
10 80 percent probability or higher.
11 MEMBER POWERS: Steve, let me ask a
12 question about that probability. If I'm setting up my
13 fancy fire PRA, and we've got a fancy one, and by
14 doing some analysis carefully, can I take your 80
15 percent to the bank?
16 MR. NOWLEN: Conductor-to-conductor faults,
17 yes. Now, is that a hot short probability? No,
18 because again a hot short is a specific kind of
19 conductor-to-conductor failure. It's an energized
20 conductor coming into contact with a non-energized
21 conductor that I care about. Is it a spurious
22 actuation likelihood, no, because that's another step.
23 It's a hot short involving the right pair of
24 conductors. So this is a part of the problem. It's
25 the conductor-to-conductor behavior.