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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON FIRE PROTECTION

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WEDNESDAY,

SEPTEMBER 11, 2002

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ROCKVILLE, MARYLAND

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

ACRS MEMBERS PRESENT:

STEPHEN ROSEN	Chairman
GEORGE APOSTOLAKIS	Member
MARIO V. BONACA	Member
THOMAS S. KRESS	Member
GRAHAM M. LEITCH	Member
DANA A. POWERS	Member
JOHN D. SIEBER	Member
GRAHAM B. WALLIS	Member

NRC STAFF PRESENT:

TIMOTHY KOBETZ Cognizant Staff Engineer, Designated Federal Official

SUZANNE BLACK

DOUGLAS COE

MARK CUNNINGHAM

J.S. HYSLOP

MICHAEL JOHNSON

PETER KOLTAY

STEVE NOELEN

MARK REINHART

NATHAN SIU

SEE-MENG-WONG

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

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

(8:31 a.m.)

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

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

The rules for participation in today's meeting were noticed in the Federal Register on August 21st, 2002. A transcript of this meeting is being kept and will be made available as stated in the Federal Register notice. It is requested that speakers first identify themselves, use one of the microphones and speak with sufficient clarity and volume so that they can be readily heard. Chairman Merserve will address the staff at 8:40 a.m. this morning on the tragic events of September 11th, 2001.

I will ask the speakers to pause at the time the Chairman begins to address the staff over the public address system. We have received no request for time to make oral statements or written comments from members of the public regarding today's meeting. We will now proceed with the meeting. I call upon Mr. Mark Cunningham, Chief of the Problemistic Risk Analysis Branch to provide some opening remarks.

MEMBER POWERS: Mr. Chairman, before we start, I would note that we are going to hear several presentations from people from Sandia National Laboratories and they who are associated with that institution, members should apply the appropriate weigh-in factor to any derogatory or replauding comments that I make.

CHAIRMAN ROSEN: We will do so as is our normal practice.

(Laughter)

CHAIRMAN ROSEN: Mr. Cunningham.

MR. CUNNINGHAM: Thank you, sir. With me this morning are Nathan Siu, from the PRA staff and

Office of Research, Steve Nowlen from Sandia National Laboratories, J.S. Hyslop from the PRA staff in the Office of Research. J.S. is going to be the principal speaker this morning with help from the others.

CHAIRMAN ROSEN: Welcome to you all.

MR. CUNNINGHAM: Thank you. For the past several years, we've had a fairly extensive research program underway to improve the methods and tools and guidance that could be used by a number of different types of organizations and staffs to perform fire risk analysis. We believe this is one of the most important areas of needed improvements in PRA methods and tools, so it's been one or two of the high priority items in the group in terms of PRA research.

J.S. will talk today about the plan that we have for that research. We developed this plan originally a couple of years ago, updating it. We're in the process no of updating it again to reflect a look at what we ought to be doing over the next four or five years. J.S. will summarize some of the accomplishments to date, try to explain where we are now in the program. We are very interested in getting the committee's comments on the plan and what we're doing, whether we should be doing it at a different pace, doing some things with a higher priority, doing some things that aren't in the plan at all or perhaps if there's things in the plan that you don't think are important, that we would be interested in hearing all that type of feedback from the committee.

We want to use this event to help us formulate and cement in our plans for the next two or three fiscal years in this program. I think it's a very wide ranging program, going from experimental work all the way over into applications in -- by NRR staff and the significance determination process, potentially by licensees and the NRC staff in terms of doing fire PRA's or supporting and using this in PRA's and risk informed regulation in general.

With that kind of general overview, I turn it over to J.S.

MEMBER POWERS: You mentioned the staff doing fire PRA's. Does the staff have routine tools for doing fire PRA's?

MR. CUNNINGHAM: One of the goals -- we have tools today. We think those tools are in need of improvement to better reflect the current state of technology, if you will, and that's a big part of what the program is; is to include the tools and improve the guidance that goes with that, with those tools.

MEMBER POWERS: If I go out to the regions and ask the senior reactor analysts for the risk of a particular plan on one of the regions with respect to fire, does he have a tool that he uses?

MR. CUNNINGHAM: One of the things we're doing is, improving the tools that are now used in the significance determination process by the regions for inspection purposes and J.S. is extensively and Steve extensively involved in the improvement of that tool, that specific tool, as well as others.

CHAIRMAN ROSEN: One of the things I'm going to be listening for and perhaps you can help me with it as you go along, is what fire protection research is pertinent to advanced reactors. We are writing an advanced reactor research plan, we the committee in general, not just the fire protection subcommittee. We are writing a letter to the Commission on the advanced reactor research plan and clearly part of that plan should include some fire protection research.

Now, you've got a separate fire protection research plan but clearly some or much of what you do can or should be applicable to advanced reactors. So together today, let's think about that and do what we can to discuss and highlight for each other where this all leads in terms of advanced reactors as well.

MR. CUNNINGHAM: Yeah, that would -- you know, from our perspective, we're not very far along in some of the advanced reactor risk analysis considerations at this point, so it's a little vague from our perspective of being very precise about how you would use this information that we're generating in advanced reactor licensing reviews. But you're right, I would agree that a lot of this information should be very useful in that context, but we just haven't -- we don't know enough about the advanced reactors to say a whole lot at this point, but we can certainly --

CHAIRMAN ROSEN: Let's not consider these two things in isolation --

MR. CUNNINGHAM: Agreed.

CHAIRMAN ROSEN: -- fire protection and advanced reactor. They need to be brought together at some point.

MR. CUNNINGHAM: Yes, that's right.

CHAIRMAN ROSEN: And there are, you know, of course, additional challenges with some of the advanced reactor designs that are proposed. For instance, the graphite rim.

MR. CUNNINGHAM: Yes, yes, exactly.

MEMBER WALLIS: You said at the onset to

Dr. Powers, that the inspectors have tools. Are you going to tell us something about what those tools are like during the course of the day.

MR. CUNNINGHAM: We can do that, yes.

MR. HYSLOP: Yeah, we can tell you a little but my understanding is that NOR is on your schedule later today to talk specifically about the SDP revisions, so I would expect that they would provide the detail that you're interested in.

MEMBER WALLIS: Okay, thank you.

MR. HYSLOP: At least the agenda that I saw earlier, I presume that it's still the same.

CHAIRMAN ROSEN: Yeah, NRR will be here at 2:40 -- 2:30 to 2:45.

MR. CUNNINGHAM: Shall we proceed or shall we pause because it's --

CHAIRMAN ROSEN: No, I'm suggesting that we just proceed. We will hear the announcement.

MR. HYSLOP: Thank you.

CHAIRMAN ROSEN: I'm assuming we can hear it. We may have a problem with hearing in here, and so we'll find out and if we can't hear, we will move outside.

MR. HYSLOP: Hello, my name is J.S. Hyslop. I'm a recent addition to the Office of Research. I'm a senior risk and reliability analyst. I've spoken to this subcommittee before with respect to the Fire Protection SDP. This is an interesting program certainly in my mind and I'm coming on board and learning it and I'll be referring to Nathan, who is also listed on this presentation, and Steve, for some areas, some technical details.

CHAIRMAN ROSEN: I believe that's the announcement. We may have to go outside. So let's pause now.

(Off the record.)

MR. CUNNINGHAM: Okay, J.S., please continue.

MR. HYSLOP: The next slide shows the Eight Line (phonetic) of our presentation. First of all, I'll be talking about the status of the program plan. As Mark has told you, it's currently being updated. I'll talk about program objectives.

MEMBER POWERS: What is -- I mean, when you say it's currently being updated, that means that everything we see today will be replaced with something else?

MR. HYSLOP: No, no, in fact, a lot of -- what you see today will remain in the plan. If you'll look further down in my Eight Line you'll see recently initiated task. Those tasks will remain in the plan. We expect good things out of those tasks. I'll get to that in a little bit more. So I'll be talking about recently initiated tasks which will carry us through `03. Plan potential activities, accomplishments, that is the work that we've done in existing tasks, general elements of the plan that we would expect to retain in the update, events since plan development. We've had regulatory related events, activities related to communication of research results, and we've initiated cooperative activities. And last, but not least, I'll provide some concluding remarks.

As I said, the program plan is being updated. The last version was for 01/02 and we're considering a four-year plan for the new version to take us through `06. We'll be providing a lot of detail for the first two years and similar to the previous plan, and less detail for the latter two.

The program objectives -- these objectives are taken from the 01/02 plan and they're as follows; to improve the qualitative and quantitative understanding of risk contribution due to fires in nuclear power plants, to support ongoing or anticipated fire protection activities, including development of the risk informed performance based approaches, and to develop improved fire risk assessment methods and tools. We would expect similar objectives to follow in the new plan.

Now to get to your point, Dana, these are some recently initiated tasks that will certainly stay in the plan. The first task is the fire risk for quantification studies. And when I say "recently initiated", I'm talking about the technical activities. There was much groundwork done before May `02 where we held the kickoff on the requantification studies. We have a detailed presentation on these studies following this overview of the research plan so right now I'll just give you a few high level points about those studies.

First of all, these are joint NRC research EPRI studies. They represent the integration of many tasks in our research plan and again, we'll get to those task in the detailed discussion. We have many objectives including developing new methods, and we certainly expect this to support the ANS fire risk standard which as just gotten underway.

MEMBER WALLIS: A requantification, that means you're now going to be able to calculate things in a different way. That's what requantification -- you're getting a number in some new way.

MR. HYSLOP: In a better way, yeah.

MEMBER WALLIS: Just because the old numbers were lousy or because they were inadequate for the task or too much uncertainty associated with them or what was the problem with the old numbers?

MR. HYSLOP: Well, there was a lot of uncertainty associated with the old numbers. The old numbers were used in the IP EEEs and there was certainly a lot of questions back and forth between the staff and industry. There was -- some issues were resolved for the IP EEEs but that's not clear that that would be good enough to get an absolute value --

MEMBER WALLIS: So they varied a lot between different people in the different -- they were coming out with quite different numbers for apparently the same thing?

MR. HYSLOP: There were various methods used from IP EEE to IP EEE. So there's a lack of standardization.

MEMBER POWERS: Dr. Shaq (phonetic) is not with us but he in fact, has gone through the IP EEE insights document and done a regression analysis looking at the risk estimated by the various methods, really following up what you did in there, your insights document in a quantitative fashion and comes up with a fairly quantitative conclusion that the risk estimates are proportional to the method that is used and that the higher -- the more qualitative the method, the higher the risk. And this is not earth shaking news to you, is that the more qualitative methods tend to be more conservative and I mean, he gets numbers out of these things but this is kind of what we always thought and kind of what your insights appendix or chapter says.

But it's fairly -- it's surprising how clear-cut it is, but the cruder the method, the more conservative it is, at least in that direction and not the other.

DR. KRESS: Did he have a base quantitative -- what quantitative was versus quantitative?

MEMBER POWERS: Well, they categorize them and I forget all the details. It's basically five, augmented five and fire PRA are the three categories they use and then he just looked at the three categories, looked at their estimates, compared sister plants, compared other things.

DR. KRESS: He just looked at the same distance apart on --

MEMBER POWERS: Sure, sure and did an order statistic, you know, non-parametric statistic on it and comes up with a conservatism associated with each one of the methods and well, he wrote it up in an e-mail to me and the upshot of it is that, I mean, what Shaq was asking the question, we come out from the IP EEE saying, the risk from fire is commensurate, I think, was the word we used with risk from normal operations and Shaq was questioning that.

And, in fact, he comes up with a conclusion that when you use a real honest to God fire PRA maybe the risk is not so high and whatnot and that just adds impetus to what they're trying to do here is, is get better measures on this thing because in some sense we are allocating resources, inspection and regulatory resources, according to risk and if that's inappropriate, then not only are you making a mistake but you're probably neglecting something that is very risky.

CHAIRMAN ROSEN: Well, I think there's another conclusion one can come to to supplement what you said then and that is that if you believe that fire risk is comparable to internal events risk, and there's some doubt about that, based on what Dana's just said, but if you did believe that, and you also put that together with the Chairman's and the Commission's expectation that future plants, advance reactors will be safer than the current generation, and that the way that they'll be safer is because they're be mainly passive, a lot of passive features, so that that will mainly effect their internal events PRA numbers, this will mean that the overall CDF for these new plants will be mainly dominated by fire. Is that something that you would conclude as well?

MEMBER POWERS: I'll -- I certainly understand where you're coming from on that and it's a logical conclusion. I know one of the members, people at the table has toyed with, if not explicitly, advanced the concept that if we really are serious about advanced reactors, we ought to be designing them so that fire is no longer a reactor safety risk, that it is strictly a property and life safety risk and that based on some of the insights that have been gained out of the NRC research program, it ought to be possible to do that.

CHAIRMAN ROSEN: It's not apparent to me how one would reach that goal, that fire would not be a risk to an advanced reactor. Any time you have electrical systems, you have fires and it seems to me any time you have people, you have fires, and surely in advanced plants, you'll have both.

MR. NOWLEN: This is Steve Nowlen. This is actually something that I've actually put forward. I think that the goal for advanced reactors or a goal for fire protection would be to try our best at least, to relegate fire back to the domain of life, safety and property protection through appropriate design. You're right, you're never going to get rid of fires. You're still going to have fires.

The objective would be to insure that fires cannot create a nuclear safety challenge. You're still going to have the life safety, property protection issues and that's never going to go away. It's the nuclear part that I think we can attack and hopefully virtually eliminate.

CHAIRMAN ROSEN: All right, let's go on.

MR. HYSLOP: The next task that's been initiated is the fire risk standard. The Office of Research is providing two members of the Writing Committee, Nathan Siu and Steve Nowlen here at Sandia, my understanding is I'll be supporting Nathan. We had a kickoff meeting held recently at the Fire Protection Information Forum in Seattle which I attended a little of. I had to get back over to the Fire Protection Forum.

The next task is the Fire Protection SDP revision. NRR is managing that activity and research is supporting the NRR direction to revise. And I'd say this is a fairly comprehensive review. We're looking at all the elements of the SDP and we've identified issues and identified challenges for those issues.

The last task is something that Steve is supporting plant systems and NRR with and that's to develop risk related guidance to support inspection of fire protection circuit analysis issues. Now, we're going to be giving a lengthy presentation of circuit analysis later and so Steve will be able to give you some insights about -- from the circuit analysis program which he's using in developing this report.

MEMBER POWERS: On the subject of circuit analysis, it's not your research, it's not your domain, but we've not been enforcing findings which were associated to circuit analysis. And that's been going on for what, two years now or something like that, a long time.

MR. HYSLOP: Yeah, John, is it that we haven't been evaluating the findings or that we haven't been inspecting for associated?

MR. HANNON: John Hannon, Plant Systems Chief. Back, I believe it was in November of 2001, we did stop inspecting in the area. We focused our resources into other areas where we had good guidance and the intent was to allow industry initiative to provide better guidance.

MEMBER POWERS: Are we still waiting?

MR. HANNON: Yes, they a have recently revised their guidance package based on staff comments. We're supposed to be getting it in the next couple of weeks.

MEMBER POWERS: So in the meantime we have a problem with -- potentially have problems with the circuitry in the plants.

MR. HANNON: The inspection activities have been halted while the industry initiative was underway to try to define the guidance we could use to inspecting that area. We don't know if we have problems or not because we aren't looking right now. Once we get the guidance settled, we'll resume the inspection activities and that's planned for next year, 2003.

MR. HYSLOP: I'll talk a little bit about the planned activities and then the potential activities that we have for the Fire Risk Research Plan. The first three are planned activities. They're in addition to the bench marking and validation, which we've been doing, we're going to perform some testing. The testing is going to consist of looking at cable tray (phonetic) in a compartment and my understanding from speaking to Monte Day (phonetic) who is leading this task, is we'll be looking at more unique configurations for nuclear power plants also.

The next task has to do with gaseous diffusion.

MEMBER POWERS: Let me ask a question. You say you're going to look at unique configurations for power plants. Why? I mean, why should the NRC do it? Why not just tell the industry, "Show us the experimental data that says this is a good configuration"?

MR. HYSLOP: As far as how does it, I'm not sure of the answer to that.

MEMBER POWERS: But really, the question I'm getting to is how do we decide when the NRC does experiments and when the industry does experiments?

MR. CUNNINGHAM: As you probably know already, there's no clear-cut statement as to how that works. It's a -- tends to be an issue specific type of thing, topic specific. In this case we saw opportunities where we could take advantage of experimental work being done in other industries or other countries.

MEMBER POWERS: Okay, so this is a special circumstance.

MR. CUNNINGHAM: Yeah, and I think in both -- let me back up a bit. The benchmarking work that we're doing and the code validation and experimental work that we're doing in large part, there's a substantial part of it which is inter-governmental with the National Institute of Standards and Technology, NIST, whatever that stands for. NIST is in the building fire business. They have developed very sophisticated models and run experiments to benchmark those models, so we want to take advantage of that. So Dr. Day, that J.S. has eluded to, has been on a part time assignment to NIST to learn how -- to bring their technology in effect, back to NRC and to see how it could be used in safety applications.

MEMBER POWERS: I mean, hey, that's great. In your research plan, you really ought to seriously think about articulating "Here is when we do experiments and here is when we ask them to do experiments and in all cases, when we can piggyback and things like that, we'll do so, but" --

DR. KRESS: Yeah, in the absence of special circumstances, I could just mention it seems to me that the answer to that question lies pretty much in the regulatory analysis area in the sense that here's something where there's research needed and you say, now who's going to do it. Well, do we require ask the licensees to do it or do we do it? Well, it's like a backfit.

So if it fits the backfit rules, then you ask them to do it. If it doesn't, then you have to decide whether it's worth enough of your money and effort for you to do it yourself. It seems to me like that's the answer to Dana's question, but there are special circumstances, like you said, which may override that.

MR. CUNNINGHAM: In cases where we -- in this case we began with it's either inter-governmental or inter-country, if you will. There's extensive work that's being done in terms of fire code development and validation in Europe and we're using -- we're leveraging, if you will, our resources here, fairly modest amount of resources here to get the considerable work that's being done in Europe.

DR. KRESS: I think that's an excellent reason.

MR. CUNNINGHAM: So in a sense, if you think of the reg analysis as part of it, as a cost benefit.

DR. KRESS: As part of this.

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

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

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

MR. HYSLOP: Well --

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

MR. NOWLEN: Well, yeah, I'll jump in. The materials that we're using in the U.S. are reasonably fire resistant. You know, they are thermal plastic type materials. They're actually thermal sets. They're good materials but they do burn if you get them hot enough. So, you know, the problem we still face is, there are other ignition sources besides the cables.

We have the motors and the switch gear and the transformers and all the other stuff and if we get a good enough fire going that exposes the cables, then you can get the cables burning. But as an initiator themselves, they're pretty difficult to get to light off. You can light a small fire but it's very difficult to --

MEMBER WALLIS: So a candle won't do it.

MR. NOWLEN: Well, not against the cable, no.

MEMBER POWERS: How about a welding torch?

MR. NOWLEN: Sustained, sure. Momentary, no, it won't do it. A welding torch won't be enough.

DR. KRESS: I could probably set graphite on fire with that.

MR. NOWLEN: I'm sorry?

DR. KRESS: I could probably set graphite on fire with a welding torch.

MR. NOWLEN: Again, it has to be sustained.

MEMBER POWERS: No you can't. You guys at Oak Ridge showed you couldn't do that.

(Laughter)

MEMBER WALLIS: It depends on the form of the graphite. You can light steel if it's in steel wool.

DR. KRESS: This is two dimensional metal block.

MEMBER WALLIS: Oh, that's very different. You can light a two-by-four if it's dry enough.

MEMBER POWERS: A two-by-four is easy.

MEMBER WALLIS: Not if it's wet.

MEMBER POWERS: I can light a dry two-by-four with a cigarette lighter.

MEMBER WALLIS: Or a match if it's dry enough.

MR. HYSLOP: Okay, the second task is the gaseous diffusion plants task and there the issue is what's combustibility of the liquids used in the process and we also have a task under there looking at guidance of testing of in-service sprinklers.

The next task has to do --

MEMBER POWERS: Let me interrupt here. You have gaseous diffusion plant but I don't see you addressing the MOX fuel fabrication facility and the

MOX fuel fabrication facility is -- or the ACRS subcommittee that looked at that said the only real risk that exists in this fire, I mean, it's fire in the kerosine, it's fire from the fuel cladding. It's fire from the furnaces for the centering. I mean, it's fire, fire, fire raging all about. How come that doesn't show up on your list?

MR. SIU: This item showed up on the list maybe, what is it, a year or two ago based on discussions with staff and NMSS. This was an area that they'd expressed interest. I don't know that we've gone back recently and had any extensive discussion to see if they've updated their views as to what we should be working on. Obviously, that will be part of what we do as we update our --

MEMBER POWERS: Well, I'd sure look at that one because the subcommittee came back with two things. One, the dominant hazard to the facility that could have consequences to the public, okay, where public was -- it's a pecular definition because the facility is located on a government reservation. And the normal public is located 30 miles away but there is an earth stats (phonetic) public which are the workers at the government reservation that are not associated with the facility, per se and there are

25,000 of them, a bunch of them.

And what they also said was not only is there fire risk but there doesn't seem to be a good, well articulated definition of what the design basis should be for fire protection. That is, in nuclear power plants, we have effectively a design basis that says, "Thou shall be able to shut this plant down and keep it shut down even in the event of a fire that damages one of your pathways for shutting down".

Okay, they have an equivalent type of definition, even though that, as far as the committee could see, was the only way you were ever going to effect the public with -- I mean, fire was the only way to get to them.

DR. KRESS: Presumably the models that you're developing would be sufficiently generic that there might be, you know, some adjusting, applicable to the facility like the MOX.

MR. SIU: Yeah, in fact, of course, as J.S. mentioned, the notion of the properties of the liquid combustibles was obviously an input that you would have into your fire model. After that, you run your fire model. Again, what we do in this program includes fire modeling but lots of other things. So we'd have to look at the sprinkler systems as well, and whatever -- as Dana says, whatever defense strategy.

MR. HYSLOP: The next task is fire risk assessment for precursor analysis. There the task indicates that we would need to review existing simplified models and approaches. There's an approach developed by Nathan while at INEEL, a report by Budnitz (phonetic) and Apostolakis, I believe and then the STD us undergoing revision. All of these could be fodder for a precursor analysis method.

The next two bullets are place-holders. We're not actively doing anything with those now, but we would expect the last bullet, advance guidance to come out of the requantification studies.

CHAIRMAN ROSEN: How about the rulemaking support? Clearly, you're going to be doing something about that. The NFD 805 has been certified to the Commission.

MR. HYSLOP: As I said, we're participating in the development of the ANS standard. I've just categorized it differently, but in that sense you know, better techniques, more complete techniques for fire risk analysis, all of those things would eventually come into play to support a PSA analysis which the rulemaking would require -- would allow.

CHAIRMAN ROSEN: We don't have on our agenda today a discussion of rulemaking and the status of the rulemaking. Is there someone that can tell us where that is now or --

MS. BLACK: Yes, Suzanne Black, Deputy Director, DSSA. The Commission paper went to the Commission the 15th, July 15th and so they have it before them for consideration at this time. And when we get an SRM approving it, we'll put it out for public comment.

CHAIRMAN ROSEN: It sound like -- is there any -- we don't want to prejudge the Commission, obviously, but is there any sign that there would be some difficulty with it because I'm thinking that my understanding was that there would, you know, likely be an SRM which would mean that the fire protection people in the agency would have quite a bit of work to do on rulemaking. It would become a significant work load for these guys.

MS. BLACK: Yes, but, no, we don't have any negative indications that they aren't going to approve it.

CHAIRMAN ROSEN: I mean, I think you should be thinking that it's going to be a workload.

MS. BLACK: Right, we're working with them to develop a plan on that.

MR. HYSLOP: Let's talk a little bit about the accomplishments, that is what we've done so far. The first two bullets talk about circuit analysis and fire detection suppression and there are detailed presentations given by Steve Nowlen later, so I'll skip those for now. We have a fire modeling toolbox which we've developed and that includes a collection of references for heat release rates, cable fragilities, ignitability.

The next task is frequency of challenging fires. There we've produced a model for handling the early stages of fire development. It's a mechanistic model. It looks at fire starting, fire spreading, it's a step by step and it relies on expert judgment to provide some of these probabilities.

The next is experience from major fires. Basically, that's been renamed to be risk methods insights. And there we found out that the fire risk analysis framework captures the chain of events observed real fires, with some exceptions, one of which is multiple fires. Those aren't currently analyzed to my knowledge.

CHAIRMAN ROSEN: Before you get off of that multiple fires --

MR. HYSLOP: Yes.

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

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

MR. NOWLEN: Not really, no. If you go back to the event review that we did, we concluded that in a sense you could capture multiple fires under the existing framework of the PRA. That is there's nothing that says you can't postulate damage in multiple locations. The problem that we have is understanding why and when and where multiple fires might occur and being able to do that in a statistical analysis. The knowledge base is very weak in this area and so this is one that's going to take a bit of work. I don't believe we're going to get there in the quantification studies. I don't think we're going to try and tackle multiple fires yet.

CHAIRMAN ROSEN: What troubles me about not putting intellectual horsepower on doing something about this is that there is clearly no way to conclude that what we calculate without it in the analysis is conservative. We have to conclude that whatever we calculate may be non-conservative and that's very troubling because we usually don't do that. We usually do just the reverse.

We usually say, "Well, we know it can't be as bad as this. It feels uncomfortable. We see an analysis that we believe is as bad as it can be is acceptable.

MR. SIU: I guess another example, which was raised yesterday where we've kind of lived knowing that there's an issue that hasn't been addressed is that there's errors of commission in PRA's. We've gone forth saying we know that certain errors have occurred in real events. We have very hard times developing a tool to predict the occurrence of those errors and so we have PRA analysis that don't -- they have boundary conditions if you will. And this is one of the boundary conditions, the multiple fault of fires, I guess the one saving grace is that they don't occur very often.

Out of the many hundreds of events that we've had in the fire data basis, a relatively small number, what, less than five, thereabouts --

CHAIRMAN ROSEN: Five or five percent?

MR. SIU: No, five, five out of the several hundreds of events.

CHAIRMAN ROSEN: So it's a one or two-percent event based on --

MR. SIU: It could be but then, you know, on the risk side you have to say, if I happen to have multiple fires in a certain situation, could that be risk significant, and, you're right, we don't have the answer to that question.

CHAIRMAN ROSEN: Well, I think your response is interesting, that the merits of commission are in the same class of things which could make the circumstances much worse than we anticipated. I'm not sure that they're exactly analogous. I have to think about it.

MR. SIU: It just meant that there are some things that we don't have in our models at this point and we try to be very clear about that but the models aren't perfect.

MR. HYSLOP: The next task for which we have accomplishment is the fire model bench marking validation. There we've compared models versus one another for cable tray fires and find them consistent. And we're looking at turbine hall (phonetic) fires with large oil sources now. Monte's doing this work.

The next task is the integrated model and parameter uncertainty. The following task is significance of smoke effects where we've -- Steve Nowlen's done a review of literature.

MR. NOWLEN: I find that the threshold smoke level for damage for digital circuitry is very high concentration, films protection and then we have some evidence from San Onofre and other events -- or San Onofre anyhow, that the high voltage is vulnerable to smoke arching.

MEMBER POWERS: The question now that is --

occurred to me is in October I have a fire at a facility, smoke goes every which way. In December, I find my contacts on every relay in the plant have been corroded and that impact because you get these smoke particles that transmit everywhere and they're aggressive acidic little puppies. They usually have sulfuric acid, a little HCL associated with them. They get on the contacts, they start doing things in remote parts of the plant, well, removed from the location of the fire that cause me headaches. Do we know anything quantitative about that?

I mean, this is just a presumption on my part that this occurs just because I know the particles are corrosive.

MR. NOWLEN: Yes, the simple answer is, yes. It is observed. We see it in practice. It's a fairly well-known phenomena. There are actually businesses out there that specialize in post-fire recovery. They've developed techniques for cleaning equipment, for identifying what equipment needs to be cleaned. So it's a fairly well, research topic. I think, you know, there are clearly issues there but again, people know how to deal with it.

The other thing that makes me less troubled about this is that in a sense, what you're doing is you're increasing the probability of random failure somewhere down the road, due to environmental insult. That -- you know, if you have a single component that has a random failure some time downstream that's not necessarily risk challenging. The thing that makes the fire challenging is the preponderance of several failures concurrently.

MEMBER POWERS: What I'm driving at is the fire, we take care of it, everybody's happy, that's done. Now, if I'm at San Onofre and I'm running my risk monitor, I got to go in and change all probabilities in my risk monitor for -- on the reliability of various pieces of equipment because some of them lost their reliability and I don't have a clue how to change those.

CHAIRMAN ROSEN: Well, that might be true but if NRR gave -- if research gave NRR some guidance in this area and NRR put in their inspection manuals, wherever an appropriate place of fire, that if a facility, a licensed facility, has a fire with smoke effects that go from different spaces, that part of the inspection job is to make sure the licensee views these services or takes into account the likelihood of remote effects and you know, that's a way of getting some of this knowledge into practice. Can you do that?

MR. NOWLEN: I can't speak for industry practices but I would concur that this is one that's going to be easier to fix than quantify. You know, appropriate post-fire recovery inspection efforts can fix a problem. They know what to look for.

MEMBER POWERS: Steven, suppose the -- again, I'm at South Texas. I've had a fire. I call in the cleaning agencies. They've polished down everything. They conclude, don't I still have to adjust my PRA because there's some probability that they missed the critical thing that is going to mess me up six months down the road?

CHAIRMAN ROSEN: I don't know. I guess it depends upon how much confidence you have in the protocol for cleaning up and testing they can do after that.

MEMBER POWERS: Testing doesn't do anything for me because nothing happens to the electric circuit, to the electric contacts till six months down the road.

CHAIRMAN ROSEN: No, I mean, you do the cleanup efforts and you polish them up and you do everything that's risk significant, and then you do the testing beginning, you know, monthly, to show that there's no effect.

DR. KRESS: I have trouble visualizing going in, cleaning all the relay contacts and all the switches and --

MR. NOWLEN: That's actually true. There are criteria. Some of these things can be cleaned fairly simply, soap and water, if it's amenable to it.

DR. KRESS: Yeah, but there are thousands of them?

MR. NOWLEN: Well, yeah, again, it depends on where your fire is, what got exposed, but there are certainly criteria where --

DR. KRESS: Well, that's one of the issues. If you have a fire, will you know how much smoke got where? How will you know that?

MR. NOWLEN: You usually go by antidotal reports of the people at the scene, you know, was there smoke in this area and if there was, they'll go in and they'll do a survey and --

MEMBER POWERS: You just insult Dr. Kress and his career of work on aerosol because he can calculate these things down to three significant digits.

DR. KRESS: Dr. Powers is reading my mind. Why don't you guys put some aerosol physics in here and we won't worry about smoke.

MR. NOWLEN: Yes, well, it's certainly possible. One of the things that the recovery companies will tell you though is getting it right away, getting it within 24 hours is the ideal and they try to take actions right away so if you let things go for very long, you know, long enough, for example, to do an aerosol calculation, disbursal and whatnot, you may already have lost the battle, and you will be replacing your components. At that point, it's an inspection for what needs to be replaced, not an inspection for what needs to be recovered.

So there is a trade-off, and yes, in a lot of cases in an application like this, you're probably going to see them say, "Hey, look, don't clean it, just replace it. We've got one in the warehouse". And so, again, it's a mater of going in and identifying what those pieces are, what got exposed and what needs to be replaced.

CHAIRMAN ROSEN: Okay, thank you.

MR. HYSLOP: The next task has to do with fire protection STP support which occurred before the revision was undertaken. And there research provided a model for roughly quantifying the effectiveness of actions or remote shut-down and it was basically an order or magnitude estimate based upon looking at combinations of influences.

And then finally there's been 805 development support, name by Nathan. I want to run down the general elements of the plan; objectives, background, you know there, you know, we would think to continue including the initial prioritization of activities by the different offices and certainly continue to relate these activities to our risk informed regulatory improvement plan.

Program outputs and regulatory uses remain important. Relationship with other programs and activities such as HRA, that would be important, technical objectives, task milestones and a communication plan.

MEMBER LEITCH: Could you go back to the previous one for just a moment, the fire protection SDP support? The last bullet talks about a model for quantifying the effectiveness of manual actions with the remote shutdown panel.

MR. HYSLOP: Yes.

MEMBER LEITCH: Just having heard about the human reliability analysis at a meeting yesterday, it seems as though a lot of this is based on simulator performance and I guess my question really is, how is the data for this generated? Many plants don't really have simulators of the remote shut-down panel. How was -- how did you quantify the effectiveness of these manual actions?

MR. SIU: This activity again is just indicated for SDP report and necessarily it was kept at a very simple level. Basically it's an elicitation. You looked at the various factors that could effect the performance of the crew, such as the location of the panel or their distractions and what's the kind of indications are available on the panel. And so you come up with a modification factor to the SDP number.

Just a point of clarification, yesterday we haven't been using simulator data extensively in our work. We plan to go in that direction. We're showing the feasibility of doing that.

MEMBER LEITCH: Yeah, yeah, thanks. Okay.

MEMBER WALLIS: This plan you showed us, you say it's general elements of plan. It looks to me like elements of a general plan no matter what the topic. Is there anything that distinguishes this plan from any other plan that any other organization might put together? It looks like a blueprint for an undergraduate project or something and this is --

MR. CUNNINGHAM: Well, it's the elements of a general plan.

MEMBER WALLIS: Yes, is there anything special about your plan that is worth talking about or is it just the blueprint for a general plan applies to yours and we knew that anyway.

MR. HYSLOP: Well, my next slide talks about that a little bit.

MEMBER WALLIS: It does say something that distinguishes this from other?

MR. HYSLOP: Well, from others. You know, I think these are good elements, you know. Certainly they're common elements but the next slide talks about relationship to regulatory applications. It talks about communication. Why don't we go there?

MEMBER WALLIS: I was just wondering if there are certain outputs which would distinguish it from others.

MR. HYSLOP: Let's go to the next slide and maybe I'll address that. Events since plan development, you're aware of the 805 and the rulemaking plan. There's the plan to revise the fire protection SDP that's been developed. Industry has submitted NEI 00-01 on circuit analysis. We've identified potential needs for non-reactor applications.

MEMBER WALLIS: This circuit analysis that you keep talking about, what circuit are you talking about here?

MR. HYSLOP: We're talking about the circuits that control the equipment in the power plant, MIV circuits.

MEMBER WALLIS: Electrical circuits.

MR. HYSLOP: Yes, yes.

MEMBER WALLIS: Oh, okay.

CHAIRMAN ROSEN: When you say "events since plan development", which plan are you talking about, the 2001/2002 plan?

MR. HYSLOP: I was really talking about since the first plan which was `98. Was it then or was it -- since 2000, oh, okay.

CHAIRMAN ROSEN: The current plan which is the 2001/2002.

MR. HYSLOP: Okay.

CHAIRMAN ROSEN: Which is a fiscal year plan, all right, so this plan ends the end of this month.

MR. HYSLOP: The points that you raised, I think these last two major bullets address your 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 feedback. These folks had a better understanding of what we were working on. We saw progress. Of course, like everyone, they wanted to know, "When are we going to get the answer, what is the answer". And that wasn't there, you know, in many of these, but there was progress so they appreciated it. So I think those two major bullets are unique.

MEMBER LEITCH: A question about the potential needs established for non-reactor applications; do you mean by non-reactor applications decommissioning sites and ISFSF facilities?

MR. HYSLOP: Well, I was thinking of diffusion plants.

MR. CUNNINGHAM: It's other licensed facilities such as gaseous diffusion plants but not reactors.

MEMBER LEITCH: Well, then what about, have you thought or do you intend to think about decommissioning facilities and ISFSF?

MR. HYSLOP: Decommissioning and what?

MEMBER LEITCH: And independent spent fuel storage facilities?

MR. CUNNINGHAM: There is a separate activity looking at the risk associated with dry cast storage of fuel, on site dry cast storage of fuel and part of that, in that we looked at potential for fire effecting those dry casts. That's part of a somewhat different program that overlaps with this.

MEMBER LEITCH: And the status of that work, that work is complete and --

MR. CUNNINGHAM: we have a draft report that's been out that's being reviewed, being peer reviewed and being reviewed by our customers at MNSS. We expect the work to be done by the end of this year.

MEMBER KRESS: It's a pretty big gasoline truck there.

MR. CUNNINGHAM: Or airplanes, yes, accidental impacts from airplanes and things and the fire that would be associated with that, but you're right, the bottom line, if you will, it's very hard to damage those things in any credible way and to get to the point where you would get offsite relations.

MEMBER LEITCH: My question, though, also goes to decommissioning facilities, that is facilities that are in the process of being decommissioned that are may be non-reactor. Maybe the reactor is down the road someplace. Is there -- it seems to me there's a difference then of fire risks associated with that kind of an activity and I just wondered if you've looked at that. It's a destruction environment instead of a construction environment and that brings a whole new set of factors into play.

MEMBER KRESS: Certainly, they've got fire protect people.

MEMBER POWERS: A lot more cutting and welding.

MEMBER KRESS: Probably a lot of transient --

MEMBER WALLIS: Perhaps some impact on fire protection systems.

MR. CUNNINGHAM: That has not been part of it, but that's a good point. We'll put that on the list of things to think about.

MR. NOWLEN: I think there's a point at which you basically delicense a facility. It's no longer a nuclear facility, so once again, you're in practice it kind of relegates things back to the life safety and property protection realm which is less NRC's role here.

MEMBER LEITCH: But I think there's a window of maybe five years until a reactor is finally shut down and gets into the phase that you're speaking to.

MR. CUNNINGHAM: This is before that happens.

MEMBER LEITCH: It's before that delicensing portion.

MR. CUNNINGHAM: Yes.

MEMBER LEITCH: I think there's a lot of variabilities in there because circumstances are constantly changing, staffing is changing, equipment is being impacted, you know, you wonder about power supplies, the fire pumps and fire headers and all that type of thing as the activity proceeds.

MR. CUNNINGHAM: Before you go on, J.S., you went past quickly two acronyms, COOPRA and WGRISK. Just to be clear on that, COOPRA is NRC's international Cooperative Research Program and Risk Analysis. One piece of -- it's a program of about 17 countries. One piece of it is fire, cooperative research on fire. WGRISK is a OECD CSNI international cooperative program that Committee on Safety of Nuclear Installations used to be known as PWG-5. People recognize it as PWG-5 and don't recognize it as WGRISK.

MEMBER KRESS: Is COOPRA a hew name for what used to be called C-Sharp (phonetic) or not?

MR. CUNNINGHAM: It's an analogue to C-Sharp in the PRA.

MEMBER KRESS: Okay.

MR. CUNNINGHAM: Yeah, but it's PRA as opposed to severe active.

MR. HYSLOP: Concluding remarks --

MEMBER POWERS: Another generic slide.

MR. HYSLOP: Yeah, but I thought it was so good. I thought if we met these bullets every year, I might want to put this up every year because I think it's success.

CHAIRMAN ROSEN: Well, the key bullet of the generic slide is more research in needed. Okay, well, unless there are any other comments, we will be in recess until 10:00 o'clock.

(A brief recess was taken.)

CHAIRMAN ROSEN: Now, we have a little problem. This clock says it's 10:01 and this one says it's 9:59, so I'll take the average.

MEMBER POWERS: A PRA guy worries about that kind of error.

CHAIRMAN ROSEN: I worry, I worry. I'm averaging the numbers.

MEMBER POWERS: Getting the right day ought to be good enough for a PRA type.

CHAIRMAN ROSEN: You'll notice that both are palindromic numbers, 9:59 and 10:01.

Now, we'll talk about the Fire Risk

Requantification Studies. Again, we have J.S.

MR. HYSLOP: These are joint NRC/EPRI Fire Risk Requantification Studies and we're working together on these and I'll talk more about that in my presentation. I'm going to be giving this with the assistance of Steve Nowlen and we intend to occupy most of the hour with this presentation since the risk method insights is a brief update.

Background, as I said before the first step towards more formal cooperation between research and EPRI occur with the development of a memorandum of understanding between the two entities. It's a general MOU. It talks about working together, sharing information, and PRA took advantage of this general MOU and developed a fire risk addendum.

The Fire Risk Requantification Studies are one of several technical elements on this addendum. It also identifies cooperation on circuit analysis. Mark Cunningham talked about cooperation we have with the testing that's being done and Steve's going to talk a little bit about that. And then there's fire modeling that's also an item on the addendum.

The objectives that we have for the requantification studies are on the slide; to develop state of the art fire risk estimates with our new improved methods, tools and data, to develop -- determine the qualitative and quantitative impact of these methods, tools and data on predicted fire risk, to develop guidance for conducting FRA, to develop guidance on strength and weakness of these methods, tool and data and implement of technology transfer. At NRC we're certainly interested in transferring our technology to NOR and the Regions and we're also interested in having industry use improved methods of tools and data.

The scope of the studies are full power, including estimates of large early release frequency. This includes low power and shutdown, spent fuel pool accidents, sabotage and Level 3 estimates of consequence.

CHAIRMAN ROSEN: You see, that's a problem to me.

MR. HYSLOP: What is?

CHAIRMAN ROSEN: Those exclusions, especially the low power and shutdown loads exclusion. Not that what you're doing is wrong, I just think it's incomplete and I understand you do, too, but my take on low power and shutdown risk for fire is that it is significant and potentially as significant as fire during operation modes.

MEMBER SIEBER: They're more likely to occur in shutdown.

CHAIRMAN ROSEN: Clearly more likely to occur for a lot of reasons and maybe potentially more hazardous because of things like open containers.

MR. HYSLOP: That's not to say that that wouldn't be a topic for a later requantification studies but this is the current topic.

CHAIRMAN ROSEN: I understand that. My comment is that part of the job is being done. We need to do that whole job at some point, so perhaps in your planning for the 2003 through 2006 prime window you ought to be thinking about this.

MR. HYSLOP: Thank you.

MEMBER LEITCH: I guess my question is, if this is a requantification though, am I current in assuming that there is a current quantification for those low power and shutdown modes and that you're just not requantifying them at this time?

MR. HYSLOP: Well, we're not requantifying them at all. They're out of scope.

MEMBER LEITCH: They're out of scope, okay.

MR. HYSLOP: They're out of scope for these requantification studies, low power and shutdown.

MEMBER LEITCH: Okay.

MEMBER POWERS: But the substantive question, aspect of the question, is there a primary quantification for fire during shutdown?

MR. HYSLOP: We have some examples that were done. I don't remember the plants but NRC did some examples. Do you know that, Nathan?

MR. SIU: Yeah, there was a study done for surrey but for the two particular plants that are being investigated, I'm not sure what the status of that is. Steve?

MR. NOWLEN: Yeah, the two plants that we're dealing with, I don't believe they've looked at low power shutdown fire risk at all. As far as I know they haven't.

MR. HYSLOP: The next slide talks about participants in these requantification studies. NRC and EPRI will be working together to develop improved methods. The pilot plants are Millstone 3 and D.C. Cook and they will utilize the methods to update their FRAs and then there's six non-pilot participating plants. Their function in these studies is to perform a review of methods.

We have a process for resolving differences of view on technical issues and the major points are that it provides a clear process to allow consideration of all parties' views in the development of these methods. We strive for consensus at many points in this process. However, we do recognize that there may be some technical issues where we'll have differences in view and those differences in view will stick and so each party maintains its own point of view if a consensus is not reached.

Products, research will produce NUREGs on insights and methods. EPRI wil produce an updated fire PRA Implementation Guide. They currently have a fire PRA Implementation Guide but they will be updating that with these improved methods and tools that come out of the requantification studies. And the pilot plants will develop updated FRA, Fire Risk Analyses. I wish to add that a new form of review of the Fire PRA guide is planned in this project.

CHAIRMAN ROSEN: Leave that up for a minute.

MR. HYSLOP: Yes.

CHAIRMAN ROSEN: The pilot plants will develop updated FRAs. Now, what will the non-pilot plants do again?

MR. HYSLOP: The non -- there are six non-pilot plants. Their role in the structure of the project is to perform a review of the methods that come out of the EPRI and NRC deliberations. So they will perform a review function of those methods. They're not at the top of the structure. I've got a backup slide if you want to see the full structure but basically there's EPRI and NRC developing methods. The non-pilot participants reviewing methods and then there's an additional level EPRI and NRC in the whole process.

CHAIRMAN ROSEN: I think maybe you ought to show us the slide. I'm having trouble, see if you can pull it out, understanding what the whole structure of this thing is.

MR. NOWLEN: Right, I think a little bit -- the pilot plants have basically paid for a seat at the table. Their seat at the table is being used as a peer review function for the methods development task. That's their opportunity to have input into the process. That is they get to comment on the methods development activities that we're doing, procedures we write to do a specific analysis task. They will review those, provide us with comments and the team will consider their comments.

It was an opportunity we decided to take advantage of basically. These all have boxes around then that you can't necessarily see. What we have is a process --

CHAIRMAN ROSEN: Wait, stop, stop.

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

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

We then go down and depending on whether or not we reach consensus amongst the technical team, EPRI and NRC, we can follow one of two branches. If we don't reach consensus, there is a process here for trying again to reach consensus in which we sort of bring in a higher level of management to mediate the dispute, if you will.

If we do reach consensus, then we run on through the rest of the process. On both of these legs, there's a branch for the peer review panel, which again, are these non-pilot participants to have input into the process of trying to finalize these procedures. If we've reached agreement and we agree as to what the procedure should be, the pilot -- the non-pilot participants still have an opportunity to say, "We have problems with that", and we have agreed to hear and consider all their comments. Same thing on the other side.

We seek consensus and the peer review panel has an opportunity to have input to that process and finally, again, J.S. has mentioned the bottom set of boxes here is that if we've not reached consensus initially but we succeed, then we have a method. If we do not reach consensus, ultimately we agree to disagree, then we drop down. The EPRI people basically have the final say in recommending what the pilot plant should use, these are the plant PRAs after all. They are going to be the owners but we have the opportunity to maintain our opposing position. If we simply disagree with the method, then we have that.

So again, peer review, right here, here and here and that's the non-pilot participants.

CHAIRMAN ROSEN: And they are which plants?

MR. NOWLEN: Do you have the list?

MR. HYSLOP: If you know how to interpret the acronyms. Hold on a second. Yeah, I've got it. Exelon.

MR. NOWLEN: Oh, they're here.

MR. HYSLOP: Yeah, right there.

MR. NOWLEN: Exelon, Southern Cal Edison, gosh these names change so quick, Duke, Florida Power and Light, Nuclear Management Corporation, what's OPG, Ontario Power Group, yes, so that is the six participants there.

I want to note Dennis Henneke from Duke is also involved on the ANS standard, he's leading the writing group for ANS. So there's a lot of cross-ties here. Does that cover it?

CHAIRMAN ROSEN: Yeah, I'm just looking at the slide.

MR. NOWLEN: Yeah, this one is a little bit different. You have basically our management structure. At the top you have the joint managers at NRC and EPRI, Bob Kasawara and J.S. We have the oversight committee --

CHAIRMAN ROSEN: That's all right, you don't need to go through it. I'm asking Tim Kobetz to get me a copy of this slide and the prior one with the issues resolutions?

MR. HYSLOP: We provided you all the program plan that was developed jointly and both of those slides are in there, so you have them.

CHAIRMAN ROSEN: Okay, okay.

MEMBER LEITCH: I'm still trying to understand the process here. What we're trying to do here is to requantify the risks from fire associated with -- I mean, full power risks associated with fire as it effects CDF and LERF (phonetic). Now, suppose in this requantification process we find that our original work was flawed and that the contribution is much higher than we thought originally; now how does that proceed, how does that information impact the industry? What's the process there?

MR. HYSLOP: Well, we're publishing NUREG documents on insights and methods so if there are insights to be found, which we certainly expect there will be, then they will be published.

MEMBER LEITCH: But published for information, not necessarily having any force in regulation?

MR. HYSLOP: Yeah, this is the Office of Research. You know, it's a technical task and we're -- the two pilot plants are requalifying their fire CDF and LERF and we're going to develop insights, technical insights and that's what our role is.

MEMBER LEITCH: Yeah, okay.

MR. HYSLOP: I'll talk about the demonstration studies. These studies are analyses, plant specific analyses performed jointly by NRC and EPRI using case examples from pilot plant fire risk analysis. An example may be circuit analsysis for a significant portion of the control room. The purpose is to demonstrate that the methods can be implemented successfully fire risk analysis, that is we develop a procedure for the methods. We test it in the demonstration studies. If the licensee says, "I don't understand", or, "You missed something", that's important feedback for us.

So then we'll go back and we'll take another shot at the demonstration studies and straighten that out. The other purpose is to implement a technology transfer. You know, the goal certainly is for licensees to do -- to understand and to do this themselves. And the demonstration studies comprise NRC's full direct involvement in the pilot plant FRA. Now, we're going to assist them so they can understand and this may take one study, it may take more than one study but -- and the reason that's important is because the next bullet. NRR retains its independence in review of applications based on this pilot plant FRA, since much of the pilot plant FRA would be done by EPRI in the pilot plants themselves.

CHAIRMAN ROSEN: What do you think is the likelihood that plants will -- other than perhaps the ones involved in the study or the peer review, will actually use the new guidance to revise their fire risk analyses?

MR. HYSLOP: The expectation is that they would use it when they had an application that they wanted to submit and it required better methods, better standards.

MR. SIU: Just a comment along those lines, NEI sent us a letter a little while ago talking about the expectation that a number of plants would adopt the risk informed rule when that's in place, which involve the high risk assessment, high risk assessment methods. One of the important things that we're trying to drive towards, of course, is good guidance and eventually good standards so that we can have methods that we can be comfortable with when the application comes in. And they, of course, don't need to know what the target is, so I think that this is a necessary step in leading towards that conclusion.

But again, our understanding right now is that there are a lot of -- there are folks out there interested in using these tools.

CHAIRMAN ROSEN: Okay, let me check. From my understanding here, when NFP 805 is promulgated ultimately, codified, plants who elect to become 805 plants will do fire modeling, fire risk analysis and they will use the new techniques defined by the requantification process. Is that your expectation? Does that put all of the stuff together that we're talking about?

MR. SIU: Yeah, I'm just not sure about the time scale involved. There are going to be things that will be learned along the way that will feed into the writing of the standards. I'm not sure about whether everything will be wrapped up in time to meet this nice neat orderly process. Right now, the ANS fire standard is scheduled for completion in I believe 2004. That was the time schedule put out by Dennis

Henneke. So depending on the rulemaking schedule, I'm not sure if that's supportive. We've had some initial discussions with NRR but no -- John, do you want to elaborate on that?

MR. HANNON: John Hannon, Plant Systems Branch Chief, it's our current goal to have both of these efforts merge such that sufficient guidance would be available to any utility who wanted to adopt 805 and use the risk informed part of it. Of course, if that didn't happen, they could still adopt 805 and use the performance base techniques until the adequate package was available.

MR. HYSLOP: Okay, we'll talk about the schedule. The first bullet, I omitted and that's that EPRI and NRC develop the joint plan for this program. And that was done in May 2002. We then kicked off the technical work at Millstone shortly afterwards. We have a kickoff or D.C. Cook, the other pilot plant in October after the PS 02 conference and I want to advertise that there is a panel session on the requantification studies where EPRI and NRC will participate that the PS 02 conference.

We plan to complete Millstone in September `03 and Cook in November of `03. EPRI plans to update their guide in December `03 and NRC will produce

NUREGs afterwards. And then we have a workshop which time is to be determined. You know, it's possible that we would do that with EPRI. We just haven't really investigated that yet.

The next slides are Steve Nowlen's and I'll turn the presentation over to him.

MR. NOWLEN: Okay, this is an update of where we are technically. Currently, we're focused on two areas and that is defining a consistent set of analysis steps that we can all agree to and that is what is it -- what's the process of doing the fire risk assessment and then what we're doing is we're writing procedures for each of those steps. Right now we're focused on the early steps.

What we're trying to do is we're trying to break this overall process of a fire risk analysis into manageable pieces, small chunks that we can take and work. That's a bit of a challenge of trying to break a big task into little tasks and yet, keeping all of the tasks self-consistent. So there are some challenges there.

The early task, for example, in past PRA we would typically talk about qualitative screening. That one step has been broken into several steps including plant partitioning, the selection of the critical equipment, the fire PRA equipment list, if you will, selection of critical cables and circuits and this gets you towards the circuit analysis issue, what are the pieces of equipment you need to be concerned with there. And then development of a fire PRA data base to consolidate and collect your PRA information. So again, the idea is that we're breaking this up into small pieces and then we're attacking each piece individually with a sight to the overall thing fitting together when we're done.

MEMBER WALLIS: How good is the technical modeling behind this and if you have a fire somewhere in the room, do you make the gross assumption that everything in that room burns and all the functions are demolished in some way or do you have a more realistic analysis of what happens in that room?

MR. NOWLEN: Well, the fire PRA is a progressive process. You may begin with the assumption, for example, qualitative screening, yes, you will assume that you're going to lose an entire room or a set of rooms, for example, depending on how you've partitioned your plant. And you will assess whether or not that has nuclear safety implications for you. As you work through the process, you eliminate the things that don't matter and retain the things that do matter and in the end, you hopefully have an analysis that quantifies specific fire threats in specific locations, impacting specific equipment sites. So it's a progressive thing.

MEMBER WALLIS: Is that a really predictable sort of technology, where you set a fire in a waste basket in this room and predict what will happen in the room and what will happen to the circuits in the room and so on?

MR. NOWLEN: Yes, we hope so.

MEMBER WALLIS: You hope so or --

MR. NOWLEN: We certainly hope so. If we can't then we're fooling ourselves. I thin, yes, we can.

MEMBER WALLIS: But can you now or is that what you're going to be able to can do in the future?

MR. NOWLEN: Well, I think it's a matter of yes, we can do it now. The question is how far can you go in the refinement before you're beginning to lose resolution and validity? Can I tell you that a trash can in the specific corner over here, you know, 10 hours from now might -- no, you know, I mean, there are certainly limits to what we can and cannot analyze. Certainly we can do it today. The IPEEEs did it.

They did it to a certain level of resolution. We're trying to refine that resolution to improve our confidence in the answers that we get and to reduce the uncertainties associated with those answers.

CHAIRMAN ROSEN: I think a more direct answer to this is, yes. I mean, there is a code that we saw described at the Seattle Fire Protection Information Forum called Magic that the people at Point Beach used to describe a fire, how it progressed, whether it burned. You know they even generated a little video, the computer code generates a little video of how the fire progressed, and it's based on fundamental fire physics.

MR. NOWLEN: Yeah, there are a range of such tools available. Magic happens to be one that was developed on France by the utilities there. EPRI has an agreement to utilize that model. We expect to use Magic in our requantification studies. There are others. NIST has a set of models, you know, from simple zone models that are comparable to Magic to the full-blown 3D fire field model.

CHAIRMAN ROSEN: Dynamics models, I mean, the answer to Graham's question is, yes, it's a complex science.

MEMBER WALLIS: Do we know is it validated by comparison with large scale tests?

MR. NOWLEN: All models are validated to varying extents, yes. And there are a range --

MEMBER BONACA: I had a question on that issue. In the previous presentation, one of the program objectives presented was developed improved high risk assessment methods and tools. Are those methods going to be used for this project? I don't think so because this --

MR. NOWLEN: Oh, yes, absolutely.

MEMBER BONACA: Oh, they are.

MR. HYSLOP: That's what this project is about is developing those methods. I was referring to this project.

MEMBER BONACA: Okay.

MR. SIU: If I can enlarge on two points here; first, as J.S. pointed out, there have been a number of achievements of this program and part of the point of the requantitative is to bring those into the fire PRA state of the art with applications, hence the work on developing the procedures and so forth, make sure that these improvements really can be applied in the field. So there's a full intent to do that. Along the way, of course, they're going to find out that we have still issues to address as they do the studies, so that things will have to be done and that is what J.S. is referring to, developments in the field to actually perform the study.

Regarding the fire modeling, you know, I don't think we should over-simplify the situation. There are models, certainly, you give them input and they'll give you output. There is a certain amount of validation. I think we can probably feel confident with early stages of prediction. We certainly can feel confident with if you prescribe an input, heat generation rate, what's going to happen, how is the surrounding -- how the temperature field develops, how the heat flux field develops and you can predict, of course, the thermal response of a target exposed to this.

Predicting secondary ignitions and subsequent progress of the fire, obviously, starts getting more complicated. You're uncertainties start to magnify and I think that's a challenge that we're trying to address. J.S. referred to in some ways this international fire modeling program which is intended to validate fire models. That's a somewhat long-term effort. Some of the results of that, I think, will feed into the requantification study but certainly not all just because of the time scales involved. So I think there are significant uncertainties in fire modeling. Part of the job of the requantification studies is to make sure we at least try to quantify those uncertainties and their effect on the final results.

MEMBER POWERS: When you analyze these fires, especially when they involve cables, do you try to keep track of the chemical speciation that you're releasing?

MR. NOWLEN: Current fire risk assessments don't typically deal with that, no. Some of the fire models have that capability and it's still an undetermined factor to what extent we'll try and deal with that. I believe for the requantification studies, the extent that we'll be able to extend the current state of the art is probably to tracking smoke as a species and trying to predict where the smoke might go and whether or not that might present problems for exposed equipment and manual firefighting for example. I don't think we're going to get into tracking acid gases for example.

MEMBER POWERS: When you calculate smoke, do you attempt to do it in some sort of mechanistic sense or do you just say that there is so many grams per second of smoke generated?

MR. NOWLEN: It's a little of both. Typically, the way it's handled in the current fire models is you specify a grams per gram of fuel burned for smoke particulate generated and then you treat that as a species that you transport along with the oxygen and all of the other things. So the technology there is a little bit limited. There are some attempts being made to advance the state of the art in being able to do first order, for example, predictions of how much smoke might be predicted under or generated under certain burning conditions but those have not yet matured to the point where we try to apply them in the study.

MEMBER POWERS: And particle size in the smoke is assumed?

MR. NOWLEN: Particle size is generally assumed, yes. You usually assume a distribution for the particle size. And the way that most models treat it, it's actually masked. You're looking at an overall smoke density which you can correlate to, for instance, visible distance in the smoke field, how far you can see. That's about the limit of what we do today. Okay.

One thing to recognize is that the level of advancement that we're attempting to achieve here varies depending on the task that you look at. In part, it's relating to our comfort zone. Some of these things we're reasonably comfortable with the way we do it already. Others are simply related to areas where we feel that there are advancements available that we can take advantage of. At the bottom level, I guess, it would be the consolidation of existing methods and this would apply to things like plant partitioning, the screening process, and documentation.

We have a pretty good idea of what we're comfortable with there. It's a matter of consolidating this and providing some consistent consensus, guidance for how those tasks should be done. The next level up would be what you might think of as in incremental improvement. These are things that we do reasonably well. We're looking to make some advances here. Things like a fire PRA database, this is actually something that EPRI has been working on for some time to try and bring together a consolidation of the information that use in the PRA and the information you'd take away from the PRA.

And I think that's a very good advance. It's not incredibly challenging but I think in terms of having the information accessible and useable it's definitely a good idea. Fire ignition frequencies is another case. The methods of fire ignition frequency are fairly well established. We are attempting to go further towards a compliment based ignition frequency. That is the very earliest methods looked at a room or a building and estimated the fire frequency for that room or that building and then sort of parsed it up around the room by area or whatever.

More recently there's been a drive towards a more component level fire frequency look that I have five pumps in this room and that's my fire shouce, so let's talk about the fire frequency of these five pumps. There are issues with being able to do that, population issues, for example. How many pumps does a typical plant have? If I only have two and that plant has five, does that directly translate to the plant with five pumps having higher frequency, maybe, maybe not. So there are some issues here but we're trying to drive the fire frequency further in this direction of component level.

Uncertainty and sensitivity analysis is another one that I would -- this one is kind of a tough one. The extent to which you would call this an incremental improvement versus substantive, which is my next list I think is still a little bit of a debate. You know there are areas where we know how to do uncertaintivity and sensitivity analysis certainly. The questions are, there are aspects of fire that we haven't typically propagated formally through a fire PRA that we're going to attempt to propagate formally this time and also to gain in some cases where we're not formally propagating uncertainty to at least bring a qualitative view of what the uncertainty associated with some of our tasks is.

In some of the other areas we believe that we're really making significant advancements, the plant fire-induced risk model is one area. In this case, the typical practice has been to grab the internal events model, simplify it a little bit and that's now your fire model. What we're trying to do here is we're trying to bring in a view of fire and its unique challenges in the development of the plant model. There are issues, for example associated with circuit analysis that may not be captured in the internal events models, spurious actuations in particular, human factors or human reliability analysis related issues like instrumentation that may not be captured in the internal events model.

Remote shut-down is another one that we

typically kind of plug into the internal events model, trying to take an explicit look at how we deal with remote shut-down for a specific plant. So, in this case, I think there are a number of things that are going to happen that are going to represent a significant advancement in the way we treat the plant model for fire.

Circuit analysis is another one that is a significant improvement area. The identification of critical cables and circuits, the performance of a detailed circuit analysis and then doing the quantification of the circuit fault load and its impact on risk, these are the elements of the circuit analysis task that we see and in each area there's been a lot of work recently looking at the issue of circuit analysis, the behavior of circuits on fire, on given fire damage, how the cables behave given cable damage, how the circuits behave.

So we've got a lot of new information. We've got to talk later in the day that will cover the insights we gained from the recent testing program and again, in the requantification studies we're going to be consolidating this and putting it into practice.

Detection and suppression is another area. You're going to have a presentation on that coming up later this afternoon, so I don't think I'll spend any time there for now. The HRA work, I believe you heard about that yesterday. We are going to be bringing to bear advanced methods of HRA for the fire PRA. They're developing list of issues specific to fire, for example. What is it that's unique about fire analysis, what are the issues that are needed to be resolve, what do we know, what do we not know, and then also the fire modeling. And in this context, I want you to take a very broad view of fire modeling. Fire modeling incorporates a lot of different things. Fire modeling has to do not only with the application of a code like Magic, it has to do with what you assume for your input parameters, what kind of characteristics are you going to assign to this fire that you've postulated?

How does detection suppression interact with it? How are you going to deal with severity factors and a practice of saying not all fires are severe? How do we reflect that in our fire PRA? There's different levels of fire modeling. You can do very simplistic fire modeling, the sort of thing 5 did, spreadsheets, correlations, back of the envelope kinds of things. What role do those have to play in a modern fire PRA? So this fire modeling task actually rules up a number of things, so I'd ask you to take a very broad view. And I think in many, many areas, we're going to be making some significant advances here.

So that's where we're at. Unless there's any comments, that's the end of the presentation.

CHAIRMAN ROSEN: Well, I'm not really clear about your first bullet on the significant advancement; plant fire-induced risk model, how that differs from what we are doing now.

MR. NOWLEN: Well, again, the current practice is to simply take the internal events risk model. It's typically simplified. Some things are removed. You look at specific initiators, specific accident sequences and you then run with that with fire. And so along with the internal events model come the human liability analysis features of the internal events model. And you may go in and re-examine some of those.

You typically credit the same human actions but you may assign different reliabilities depending on where the fire occurs. So again, basically the current practice is to simply take the internal events model, do some simplification and modification and apply it in fire.

Our concern is that the internal events model does not capture all of the things you would be interested in in the fire context. And the biggest example is this spurious actuation issue. And internal events model will not typically postulate, for example, that a valve will spuriously operate randomly because that's not something that's going to happen just randomly, but fire can do that to you. Fire can cause a valve to reposition, for example. Fire can cause systems to start with no other intervention. So it's bringing those kinds of features into the plant model in a fairly formal way. How do we identify what unique things the fire might to do us, how do we then incorporate those items into the fire risk model in such a way that we can actually quantify the fire risk.

And again, the other example is the human reliability issues. Fire can compromise your indicates and instrumentation in the control room, for example, that may not be captured in the internal events model. For us it may be important to capture those kinds of features when we do the human reliability, human response analysis for our fire situation. Can they rely on their instruments, have they lost instrumentation, have they lost it in such a way that it's going to be obvious that the instrument has been damaged, those sorts of questions.

CHAIRMAN ROSEN: Okay, thank you on that. One of the things that's obvious to me is that during -- in a typical internal events analysis, one credits operator actions in recovery and other things. When you have a fire in the plant where it's in a time period when there is very little support available, late at night or something like that, the -- in many plants, the fire brigade is also the plant -- the operating staff of the control room. So the workload, the task workload on the same people is enormously magnified in the case of fire. Is that something that's going to be thought about in HRA when you talk about fire?

MR. NOWLEN: Yes, absolutely. It's typical practice, there is one member from the operating staff assigned to the fire brigade. Most of the rest of the fire brigade is typically made up from security and maintenance personnel or dedicated personnel who do fire protection for the plant, you know, the people responsible for the maintenance of the systems and whatnot, but yes, clearly there are issues of staffing and communication.

Many plants rely on remote actions, for

example, given certain fires in certain areas, the fall back is to send an operator out to take a manual control action. You know, have they thought adequately about their staffing for those kinds of actions, have they thought about timing communication of those actions?

CHAIRMAN ROSEN: What I'm worried about is we had a human factor subcommittee meeting yesterday and we talked again about things like shaping factors in many of them, including stress and task work load. You know, clearly in a fire there plant damage, trips the plant which is normally what happens in a serious fire or can happen in a serious fire. Well, those things get, you know, impressed on the staff and in addition, some of the key resources for the crew that will be dealing with the shutdown is pulled out to fight the fire or be part of the fire brigade.

So human performance under those circumstances can be very challenging. So who do we look to, to make those -- to get the properly reflected in the PRA and then the fire PRA. I think we really have to start here.

MR. NOWLEN: I agree entirely. There is an explicit task to do improvements in HRA for fire PRA as a part of the requantification studies and again, both NRC and EPRI will be bringing their experts to bear on the problem and we will be addressing this.

MR. SIU: And by the way, these are the same people who are working for us on the other aspects of the HRA projects, so it doesn't sound like we're getting different folks with different views.

CHAIRMAN ROSEN: Okay.

MEMBER LEITCH: Just as an addition to Steve's thought, if there's a serious fire, a lot of times that drives you into an emergency condition where there are certain actions that are necessary, notification of the number of people and so forth and I guess all I'm doing is just reinforcing what Steve says is that this increases the workload on what might be a very limited number of people. They've not only got the operational aspects, the firefighting aspects, but you have the actions that are necessary to support the emergency plan implementation.

MR. HYSLOP: Steve will be presenting our update on the risk methods insights. I believe he's given you a presentation fairly detailed before.

MR. NOWLEN: We did do a presentation on this in October 2000 and in that presentation we covered the objectives approach and resulting insights of this task. At that time, the presentation was based on a public draft that we had issued for comment of the report that we had written on this task.

This is the last slide in the presentation. Just to let you know as an update that we did receive some comments from the public but they did not substantively change any of our conclusions that we had reached. We got comments from within NRC and industry but our conclusions basically remain the same, mostly in the form of editorial changes. The report has been published. It's out as a NUREG CR 6738 so it's available to you. And we've gotten a lot of good feedback on this one. So I hope you all get a chance to read it and that you enjoy it. And that's it.

MEMBER LEITCH: That was, to me at least, one of the more interesting documents. I thought it was very worthwhile reading and I would recommend it to those that perhaps, haven't had a chance to read it yet. There are portions of that that reads like a novel.

MEMBER POWERS: I wish you wouldn't say that. I have to live with this guy. He gets a big head and becomes insufferable.

MEMBER LEITCH: It was interesting though, that a number of these incidents are for turbine building associated and I'm sure you're taking a look at that.

MR. NOWLEN: Yes.

MEMBER LEITCH: We tend to look at just the reactor portion of the plant but a number of these real serious fires started in the turbine building and promulgated to other sections but --

MR. NOWLEN: Yeah, the turbine building is an interesting case. We've -- as fire protection engineers, we've long recognized that the turbine building has some real fire sources up there. You can get real challenging fires there. In the PRA context, we have perhaps tended to dismiss the turbine building a little bit early in the process. So again, tying back to our requantification studies, one of the lessons learned from the event review was to take a more careful look at areas like the turbine building that might present challenges to you that you wouldn't normally expect; in turbine building, at secondary sites, the power generation side, sometimes there's things there that can catch you. So, yeah, again, in requantification we're going to be taking a specific look at turbine buildings for the two plants.

I have no idea what we'll find. I don't know what the turbine buildings these plants have in them but --

MEMBER LEITCH: Well, I just read an interesting one about an event that happened at a power plant within the last month, I guess, and they had a fire in the generator hydrogen dryer and the hydrogen dryer fit in an ordinary sized suitcase. I mean, you're not talking a big piece of equipment. But somehow this thing caught on fire. They got it out without any trouble apparently but you know, when you say hydrogen and fire in the same sentence, it's interesting. That's scary.

MR. NOWLEN: Yeah, you have -- you know a turbine building you have the hydrogen, obviously. You also have large inventories of hot turbine oil, turbine lube oil and there have been -- yeah, there have been a couple of events associated with turbine blade ejections that have led to fairly severe fires, yes. So, yeah, it definitely presents some interesting possibilities. Again, the question is, is it a risk problem or is simply a classic severe fire problem.

MEMBER POWERS: It seems to me that most of it -- it would be an unusual plant where you would have critical systems crossing with the turbine building, wouldn't it?

MR. NOWLEN: Well, I don't know how usual it is. I would relate that in the IPEEE process we had two plants conclude that they found vulnerabilities, both were associated with issues in the turbine locker.

MR. SIU: I'll add to that, that if you look at the rankings of buildings or areas in the IPEEEs, you'll find a surprising number where the turbine building is somewhere up in that list.

MEMBER SIEBER: You have air compressors where the instrument air comes from the turbine, usually service water, compound cooling water, pumps, so there is safety related equipment.

MR. NOWLEN: Well, we also occasionally find switch gear depending on the configuration of the plant, how it's laid out. You can also end up with a lot of cables routed through the turbine building just getting from the control building to the reactors. So those were the situations we ran into in IPEEE. They were both associated with cable routing.

MEMBER LEITCH: One of the very interesting episodes is describe in the NUREG there is the situation where somebody got hydrogen and compressed air mixed up and it led to the incident that we were talking about earlier where you get several fires in different locations. They said, "Well, you had hydrogen in your compressed air system".

MR. NOWLEN: Yeah, that was an interesting one. It was a maintenance error that cross-connected the house compressed air system to the hydrogen system associated with one of the diesels, I believe. And so guys -- it was during a shutdown and guys out in the plant running their air tools suddenly had flames coming out of their air tools. They caught it right away obviously, and but it's one of the multiple fire events as well.

You had the potential for having fires in, you know, virtually anywhere the house air went. So, yeah, that was very interesting.

CHAIRMAN ROSEN: What I thought was particularly interesting about that report was the descriptions of many of the non-domestic fires. And in that light, listening in Seattle to some of the international participants that I remember in particular from China and from Bohia and I guess that's Czech, Czechoslovakia, that made comments that were, I thought, interesting and instructive because they were different, their approaches were somewhat different than the traditional approaches in the U.S. You know, not to say they're better or not as good, I think is not the point. The point is the differences cause you to think about what we're doing.

In one particular case, the fellow from Czechoslovakia talked about training of fire brigade, first responders, and he talked about noise. And that the simulators that they use have the capability of replicating or simulating the noise of the fire which was a new question to me. It's very important to communicate during fires and I know how hard it is to communicate with all of the equipment fire responders put on. We've seen them don their bunker gear for example, and have to tap each other on the glass to get each other's attention and so on.

And that's just in the assembly area. That's not even in the fire. Communications of a team during a fire is very difficult without any noise but the fact of the matter is that it can be very noisy, I assume in a fire --

MR. NOWLEN: Oh, yes, yes.

CHAIRMAN ROSEN: And I never heard of that before, the point being that this particular country's fire responders are trained in a facility that can simulate noise as well, and I thought that was interesting.

MR. NOWLEN: Yeah, I saw that presentation as well. It was interesting. You know, when you go in a plant, there is a lot of noise. There's operating equipment all over. Some areas can be noisy. They're are echo chambers, so, yes, communications is a challenge. In that particular case they were interested in the noise associated with gaseous suppression system discharge, in particular with a CO2 system which is what they were using. When you discharge CO2, you're discharging a lot of CO2 in a very short period of time and the noise can be pretty horrendous and if you've never heard it, the first time you hear it, it's fairly shocking. So, yeah, I thought it was very interesting that they were training their brigades and actually simulating that noise level, so that when they got in the real plant, they wouldn't have that initial, "What the heck is that", sort of response. It was interesting, yes.

MR. NOWLEN: Well, the general comment was that we have a lot to learn from others, not to get insular in thinking about the only fires that we can learn from our fires that occur in domestic nuclear plants.

MR. NOWLEN: Agreed. In the report that we wrote, the international events were very interesting. We saw some very interesting insights from those fires.

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

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

There was one incident in particular that was a rather severe control -- it started in the turbine building, propagated to the control building and caused extensive damage throughout the control building. You know, a number of things that we would not expect to see similar behaviors in the U.S. for that kind of an event. In fact, our cables are less flammable. Our fire barrier penetration seals have received a lot of attention and I think we can give a lot more confidence in those.

And you know, the speed with which the fire propagated through the control building, I think, was something we would not expect in the U.S. So, yes, you have to look at the international events and be careful about trying to extrapolate directly what happened in the U.S. or what might happen in the U.S. Certainly, I think there were still lessons to learn from those events, but we did also try very carefully to call out where we weren't real confident about the direct extrapolation.

MEMBER POWERS: There was a period of time where fire frequency data bases were sprouting across the landscape like mushrooms, international fire frequency and I'm always very suspicious of that because again, I don't think frequencies are transferrable. But I don't see data bases on fire damage sprouting up with the same intensity yet, I think that is transferrable. Where do we stand on data bases that say we have a fire of such and such a nature and it does these kinds of things?

MR. SIU: Let me take a shot at that. J.S.

mentioned that there is a fire modeling tool box. That was one of our early tasks. My understanding there's a double CD-ROM version that's available that has some of that information. That's from, of course, culling information that we've gathered in the course of our work. He also mentioned a WGRISK activity. That activity right now, you may not like to hear, is indeed aimed at developing fire event data bases or a fire event data base. And I guess lacking better information, I can certainly see that for maybe countries with dramatically different practices in terms of maintenance, dramatically different kinds of equipment, you could argue whether that data is transferrable. Certainly, we'll know where they are coming from.

Other countries it may be that the data are indeed much closer to --- or come from situations much closer to what we've got. We -- NCR, as part of this activity pressed the working group to think about exactly what you were talking about, a data base that covers parameters that we use in other out parts of the fire risk modeling effort. The generally feeling initially from the other members of the working group is no, we want to concentrate on fire events. They haven't said that the working group won't address that but right now the focus is indeed on fire events. So that's where we stand.

MEMBER POWERS: The problem I see is it's very easy to take fire events, say Slovenian fire events and say okay, we don't have the data on the frequency of large fires but they had one and so we'll make the probability of fires of a certain size this, and once you've done that, the origin of that fire, the peculiarity of its environment is lost within a probability number that doesn't have all of the appropriate units.

MR. SIU: Which gets back to your point, of course, this is in the data base and we have to make sure that we have the attributes assigned to each entry so that we can indeed do that filtering. I honestly don't expect us to literally take the data there and just simply crunch out averages and use those averages. On the other hand, there have been some jokes today and yesterday perhaps about availability of data for PRA in general and one of the problems we have, which I'm not sure whether we'll get to in this set of presentations, there's been mention of severity factors.

This is a took that is used in fire PRAs to adjust the fire frequency to account for the observation that not all fires that occur have any -- have the potential to cause damage. Some of them are very incidental fires and we really have no expectation that they would lead to anything. The trouble is, of course, how do you translate that concept into practice. How do you actually estimate those severity factors. The fact of the matter is we have a relatively small number of fires in plants that actually have the capability to cause extensive damage.

So the question and I don't know what the answer is, is to what extent can we take information from other sources and use that if we're talking about, for example, switch gear fires. We'll perhaps some of that information is indeed transferable to our situation. Of course eventually you'd like to have something along the lines about what we talked about yesterday, a more fundamental understanding of the whole fire process, from ignition all the way through growth over the initial fuel and then propagation to other fuel objects in the room but we're not real close to that yet, I think.

The initial phase of the fire is a real challenge. J.S. had mentioned that actually we had a study done on that and it's one of his accomplishments. He talked about the frequency of challenging fires and essentially that ended up with a proposed elicitation process for characterizing the initial phase of the fire. I'm not sure if we're going to be able to use that in the requantification study. So again, this is a challenging area for us.

CHAIRMAN ROSEN: Well, I brought up the whole issue of international data and experience and insights and the purpose of bringing it up was to encourage this to continue to build those interfaces and to use that data appropriately of course, with int the caveats that Dr. Powers so eloquently mentioned but that fire us a universal phenomenon and we need to pay attention to what happens elsewhere as well as in the United States.

Okay, we're up to the next presentation on fire detection and suppression analysis.

MR. NOWLEN: Yes, so this is a discussion of the results of a task we've been working on, on detection and suppression modeling. I want to go over the objectives that we had in performing this task, how we approached this and basically this is going to be a description of our task structure and then I'm going to go through the results that we obtained basically by-pass and the provide you with some of the general insights that we came away from this with.

So the objective of this particular task was to provide an improved modeling framework and data for estimating the reliability, including effectiveness to the extent possible of automatic and manual suppression activities. To develop estimates of these conditional probabilities for current operating nuclear power plants and to identify and quantify key uncertainties in these estimates.

The approach and there's a more detailed task structure but at the higher level, we were looking at the modeling framework, that is how do we do detection and suppression modeling, how does it fit into the PRA. We performed a number of information gathering and data analysis sub-tasks, looking at various data sources and the information we could glean from that and then documentation of our results. Again, probably a pretty good master's thesis outline.

With regard to the modeling framework, the first activity was to review current practices and what we saw there is basically there's two primary methods you'll find in current fire PRAs for doing this sort of a detection/suppression analysis and the first method is the direct application of historical event data and this has an advantage in that it inherently captures your experience relating to long duration fires, for example. It has a disadvantage in that it's difficult to tailor the results to a specific application.

That is if I'm at a specific plant and I'm looking at a fire involving a specific piece of equipment, it's difficult to tailor these generic estimates to that particular case. The second method is to estimate the fire brigade response time and this basically assumes that the fire brigade is really your ultimate line of defense for fire suppression and so the focus is placed on the fire brigade and how long it would take the fire brigade to respond to a fire in a particular location. The advantage of that particular approach is that at least nominally it's case specific.

You're looking at a specific fire and specific plant, and specific fire brigade. The disadvantage is that when you put it into practice, you see very, very little variation in the estimates of how long a fire is going to last. It also has the potential to minimize the importance or the potential importance of long duration fires. You may prematurely assume that all your fires are going to be out within 15 minutes, for example, and so you may not consider the 20-minute fire and the 30-minute fire.

MEMBER WALLIS: How do you model the probability of success of the fire brigade in putting out the fire?

MR. NOWLEN: That also varied from application to application. This particular method was the most common one we saw in the IPEEEs. Most of the IPEEEs did it this way.

MEMBER WALLIS: They assume the fire brigade gets there, the fire gets put out?

MR. NOWLEN: That was a common assumption initially. Typically, the questions that we would ask in the review process, which I was also involved with, would be, okay, the guys have arrived but they still have to assess the situation, they have to plan an attack. They have to have a critical number of brigade members before they can execute the attack and then they actually have to actually execute the attack and how did you deal with that in your quantification? The answers we got back would typically say, yeah, we'll do a sensitivity to look at what happens if we extend the fire duration by some period of time and again, for the purposes of the IPEEE, we considered that acceptable.

Again, IPEEE was a vulnerability search.

For the fire requantification studies, we don't consider that to be acceptable going forward. We think we can do much better here.

So our conclusion with regard to past practices was that a more mechanistic approach might capture the advantages of both methods. I mean, each method has its advantages and the idea would be to try and capture that and our conclusion was that a mechanistic approach would be the way to go about that.

The next slide just as an illustrative example, this is a historical data approach kind of look at things. It's a classical statistical modivazian approach but this is basically a plot of the duration of fires from the current EPRI fire data base. This curve captures all of the fires happening within the plant buildings. So this excludes the outdoor fires and the offsite fires and it hasn't tried to parson them out in any way at all. It's just simply all the fires that have occurred within the plant lumped together, all the ones that report a fire duration and plotted up on this --

MEMBER WALLIS: There are not 651 points on the curve.

MR. NOWLEN: No.

MEMBER WALLIS: So the others are presumed beyond 120 minutes?

MR. NOWLEN: No, there's a few beyond 120 minutes. You can see the curve hasn't quite reached 1 yet, for example, but there's also -- you know, you'll have maybe 50 fires that report 5 minutes so there's a bit of adding there.

MEMBER WALLIS: So there's bundling.

MR. NOWLEN: Yeah, there's a lot of bundling here.

CHAIRMAN ROSEN: Let me see if I understand what that's telling me. It says that probability -- if you have a fire that will be -- it's an 80 percent chance it will last less than 20 minutes, is that right?

MR. NOWLEN: Yes, yes, 80 percent of all the fires that have occurred for which I have a duration estimated, were less than 20 minutes and on the other hand, 10 percent or six, seven percent, were over an hour. So yeah, and again, this is a historical approach. You look at this and one way to do it is to simply apply this curve or you can parse it up. You can say, "Well, I don't want 651 events". The data base contains 1300 events total and I have 651 of those which were inside buildings and gave me a fire duration, so about half of the events gave me -- you know fit that category.

Well, I may want to look at battery fires, pick anything. So I could parse this out and come up with a smaller set of events and do the same kind of a duration curve. You can also look at it a different way. I want to look at fires that were manually suppressed. And those are some of the things that we've done in the task here is to parse these out and look at fire durations.

MEMBER KRESS: What would you do with that information?

MR. NOWLEN: Well, you could -- typically, your fire growth and damage analysis --

MEMBER KRESS: Yeah, but there are some sort of concentrates modeling, based on the duration of the fire?

MR. NOWLEN: Yes, exactly. You look at the duration of the fire, you model the fire and you may have damage occurring to different pieces of equipment at different times in the fire. So if for example, I were to lose one important cable in the first 20 minutes, I could say, well, the likelihood that that's my damage state is .8. That's 80 percent of my fires give me that damage state.

MEMBER KRESS: You have some other data base to go with this then.

MR. NOWLEN: There's other modeling results that go along with this, yeah. Yeah, you fold this in along with your modeling results as an estimate of how long the fire lasts because then there might be a second cable that you're interested in but because it's more remote from the fire source, maybe that one takes an hour to damage. So you might say, well, the damage -- the likelihood that I reach that damage state is only six percent. You know, you move out on the curve and you can look at the different damage times and begin to bring in more damage --

MEMBER KRESS: Somehow implicit in durations state the magnitude of the fire, it's sort of implicit in there?

MR. NOWLEN: Yes, there's -- I'm going to cover that in a minute. There's links between how you get your fire frequency, for example, and the duration that you should then assume, so if that's the direction you're headed, I'm going to get there in a minute.

MR. SIU: But I think also a short answer, we don't have real strong mechanistic links right now between the propagation and the suppression phenomena.

This is largely a statistical approach.

MR. NOWLEN: Okay, so again, we're looking for a mechanistic way of dealing with dealing with detection/suppression and if you search the literature, one of the things that will pop up is a Siu and Apostolakis paper from 1983 that proposed a mechanistic model for doing detection/suppression analysis. This is presented as a network model. I should probably use this one.

MEMBER WALLIS: It's covered with these weird Greek symbols.

MR. NOWLEN: Those Bayesian guys.

MEMBER POWERS: The alternative symbol would not be more edifying.

MEMBER KRESS: I know who Siu is but who is this double P, Apostolakis.

MR. NOWLEN: Did I misspell his name, oh, my God. George, I'm sorry, even though you're not here. Apostolakis, is not in my spelling dictionary yet. It will be after this.

MEMBER POWERS: Apologize.

MR. NOWLEN: Yes, I formally apologize to Dr. Apostolakis for misspelling his name.

MEMBER SIEBER: We ought to change his name.

MR. NOWLEN: Okay. I usually catch those kind of things. So anyway the model begins with the ignition of the fire and this postulates the question of whether or not you have an immediate detection. In some cases you do, you know, right away you know you've got a fire and if you do, then you by-pass the other detection paths.

MEMBER KRESS: It's detected immediately because somebody is standing there or for some reason?

MR. NOWLEN: Yeah, or perhaps you heard an explosion in the plant, you saw a flash of light, you had a fire watch there. There happened to be someone in the area, they saw it when it started, a lot of reasons that could happen.

MEMBER KRESS: So that Greek symbol, there's a probability that --

MR. NOWLEN: Yes, that's the likelihood that that occurs and the compliment is the likelihood that you don't detect immediately in which case, you have to go to some other means of detection and in this case, you asked the question whether or not you have automatic detection systems available, yes or no. That's basically a yes, no answer and then if you do have them available, then you've got a possibility of automatic detection, a delayed local detection or a delayed remote detection that if someone happens upon the fire and calls in the fire alarm, this would be for example, the plant operator sees some funny things going on, on their control board and they speculate that there's a fire and they --

MEMBER KRESS: That's not necessarily an automatic system them.

MR. NOWLEN: No, this is --

MEMBER KRESS: That's what confused me coming out of the A.

MR. NOWLEN: Right, well, this asks the question of whether there's an automatic system available or not. If there isn't then all you've got is the delayed local and remote paths. If you have a system available, then you also have the opportunity of detecting automatically but that system has a likelihood that it would fail and there's at time factor here.

MEMBER KRESS: The -- what is the figure at that end?

MR. NOWLEN: Here?

MEMBER KRESS: Yeah, I don't understand what that is.

MR. NOWLEN: In this case, it's basically a yes, no.

MEMBER KRESS: It's just a yes, no, okay.

MR. NOWLEN: Yes, do you have automatic --

MEMBER KRESS: I understand that.

MR. NOWLEN: Yes, yeah. In this case it's a probability.

MR. SIU: Yeah, it's probability. The other -- there are time constants associated with the other processes. So you've got competing processes you can detect in one of three ways on the upper branch. Whichever gets you first is the one that wins.

MR. NOWLEN: Right. So anyway, those take you to detection. You then have various paths to get ultimately to suppression. In this particular case -- by the way, we're going to go through this model in some detail, so we don't have to go through every link here. But --

MEMBER KRESS: Is that also a yes, no, that two coming out of there?

MR. NOWLEN: This one, no, is a probability and this is the probability basically that someone intervenes in the fire manually very quickly. Yeah, in this particular case the way this model was written, this is the manual fire brigade. That the manual fire brigade intervenes promptly and wins the battle and puts out the fire. We've changed that a little bit so I'll come back to it.

If they fail to do that, then you're back to your automatic or fixed systems.

MEMBER KRESS: That's a yes, no.

MR. NOWLEN: This is a yes, no. Yes, that's correct.

MEMBER KRESS: And the -- if there is one there, what's the --

MR. NOWLEN: Transition times.

MEMBER KRESS: Transition times.

MR. NOWLEN: Yes, yeah, the idea is what's the likelihood that you put out a fire within a certain period of time. Following these different paths, you can have multiple answers to that question.

MEMBER KRESS: Okay.

MR. NOWLEN: So given that you have a system available it may or may not actuate and suppress the fire, so if this is basically the fixed suppression failure path, and this is the success path, the final element here is what they refer to as large scale manual suppression which basically was off-site fire brigade arriving to support it. Yeah, a fire truck shows up from off-site.

MEMBER WALLIS: And that includes that it will essentially burn itself out, too.

MR. NOWLEN: Well, we'll talk about that. So that's the model that we started with. Our conclusions; this does have key features that we really like. You know, it's mechanistic. It has the paths that we think are most important to the PRA. So we decided to move forward with this. We did identify some desirable modifications based on our examination of the events that have occurred. In particular -- it looks better on yours than on mine -- add a path for self-extinguished fires. This model basically doesn't have a self-extinguished fire path, so that was something we thought would be important. We definitely see that in fires. I'm going to cover that in a minute as well.

We combined the local and remote manual detection paths. Basically, you're looking at -- well, I've taken it away, but the detection path had two possible ways of delayed detection by personnel, local and remote and what we saw in the data was you couldn't tell which of those paths had been followed in any particular event with very, very few exceptions so you really couldn't support a statistical estimate of what that split might be. We do see both in events. We do see events that report that the control room saw something odd on the control board and concluded there was a fire. So you see it but you can't do it statistically.

CHAIRMAN ROSEN: Is that only something odd on the control board or is it a an annunciation of a fire in a fire area? Plants have fire detection systems with fire zones that annunciate when one of the detectors goes off in one of those zones. It's not odd, they see an alarm. So Fire Zone 21, okay, it's either a real fire or it's a spurious actuation of the fire system but they send somebody down to look.

MR. NOWLEN: But that a separate path. That's the fixed detection path. There's an explicit path to allow for so a fixed detection system picks it up and the operator then takes action. This is other stuff that might lead them to conclude that there was a fire.

Okay, and we also decided to revise or redefine, depending on how you look at it, the manual suppression paths. Again the original model had --

MEMBER KRESS: When you say you have a manual detection path, can I read that to say somebody happens onto the thing?

MR. NOWLEN: That would be the manual local, yes. The delayed local is someone goes by the area and smells smoke.

MEMBER KRESS: But it just means that there is a person that picks it up.

MR. NOWLEN: Picks it up at or near the location of the fire. The remote is the implication that someone picks up the presence of a fire but they're not anywhere near it, they're somewhere else in the plant.

MEMBER POWERS: You may get to this and maybe this is your point, I mean, one of your points, of course, is that Apostolakis and Siu got it wrong and I appreciate that, but --

CHAIRMAN ROSEN: If it's wrong, it's Apostolakis that got it wrong. Siu probably had it right but he couldn't --

MEMBER POWERS: The other question is, the more substantive question is you have a lot of ways to get to the success path here.

MR. NOWLEN: Yes.

MEMBER POWERS: And you don't have a lot of data to support those ways of getting to the success path.

MR. NOWLEN: We're headed there.

MEMBER POWERS: Are you doing one of the more classic things that we see so often in probabilistic risk assessment of breaking down that rare event into a bunch of component events and artificial probabilities down here?

MR. NOWLEN: I hope not. Let's go through the presentation because I'm specifically headed in that direction, and you judge. So again another modification we decided to revise or refine these manual suppression paths. The original model had two that were basically the local fire brigade and the off-site fire brigade. What we saw when we looked at the event data is that you often see off-site fire brigades responding to fires at plants. It's fairly common, they have cooperative agreements. An alarm goes out, they respond.

But from the event data, you can't tell whether that did any good in terms of putting out the fire. So what we did is we changed those to two alternate paths and what we've done is suggested that there's a prompt manual suppression path and there's a delayed manual suppression path. The prompt path would cover things like a fire brigade or I'm sorry, a fire watch that happened to be at the site of the fire. They put the fire out right away or a security person doing their rounds found a fire and put it out right away, grabbed an --- that's that path.

The delayed manual is when the fire brigade gets involved. If a fire brigade is called out and fights the fire, that's the second path. We don't distinguish with whether or not the off-site fire brigade shows up and does any good.

We also added a suppression path for removing power or isolating fuel from a source when that's possible. A lot of electrical fires are put out because they simply trip the breaker, isolate the electrical energy that's supporting the fire and the fire goes out. You see the same kind of thing at hydrogen fires. You close it out and somewhere the hydrogen leak stops and the fire stops, so we added a path for that.

MEMBER WALLIS: Don't these cases, the manual and immediate suppression may put out some of the fire and then the large scale suppression later puts out the rest of it.

MR. NOWLEN: Yes.

MEMBER WALLIS: That is suitably modeled in your -- dealing with these fires. They're not sort of complete success fires. They could be partially success or something.

MR. NOWLEN: Yes, that's correct. Hopefully all fires eventually go out somehow.

MEMBER WALLIS: Well, they don't all eventually go out.

MR. NOWLEN: It's a question of time, yeah, time is a very important factor.

MEMBER WALLIS: In the ground in West Virginia, they go on forever.

MEMBER POWERS: You certainly had one in the Ukraine that went out all right, but 12 days later may not be -- may not fall into your category of promptly going out.

MR. NOWLEN: I agree, time is of the essence.

CHAIRMAN ROSEN: I also heard of a tire fire at a tire disposal that just won't go out.

MR. NOWLEN: There are other applications where fires may burn for years and years and you know, coal seams will start on fire and I don't think we have those --

CHAIRMAN ROSEN: Not treated in the data base.

MEMBER KRESS: You wait till you get a graphite moderator.

MR. NOWLEN: Okay, so again, back to the framework, another thing that we concluded is the fact that they had formatted this as a network model, which is a potential barrier to acceptance, is that people aren't familiar with network models. So what we decided to do is to translate this to an event tree model and that was possible because there's no feedback paths in this model which event trees can't deal with very well, and we were hoping that this might improve the acceptability and the use of the model. So what we've done, the next two slides present a fire detection event tree which is essentially equivalent to what you saw before with the modifications and the added, and again some of these are yes, no questions, some of them would have probabilities and each would have transition times associated with it so that you can follow through this path and you know, assess how you got to detection and each of those paths would have a time associated with it and a probability that that's the path you took.

MEMBER KRESS: And then there would be attached to that some sort of consequence.

MR. NOWLEN: Yes, yes, you're still linking to the same vision of consequence where you're fire modeling and you're looking at how long does it take for critical damage to occur and so I'm trying to weigh what's the likelihood that that occurs versus what's the likelihood that I put the fire out before it occurs. And similarly for the --

MEMBER KRESS: I think this is what Dana was worried about you breaking up the overall probability and a series of probabilities.

MR. NOWLEN: Yeah, I haven't triggered him yet, so that's the next slide, I think. This is the suppression event tree. Again, it basically follows the same model. Some of these are yes, nos, some of those there are transition times associated with each one and we've put in the modified suppression paths so you see the prompt suppression, the self-suppressed fires, manual brigade all of these things and you'll notice that in each of these there is suppression fails outcome and again, that's in the context of a time, you fail to suppress it within a certain time.

MEMBER SIEBER: Why is the self-extinguished in the detection tree instead of the suppression tree?

MR. NOWLEN: Oh, I'm sorry, yes, that's true. We did put the self-extinguished fires in the detection tree and the idea there is that if the fire self-extinguishes, and you don't need to detect it necessarily, it's out. You may, in fact, detect a fire after it occurred. That happens fairly frequently. We see, you know maintenance folks dispatched down to take care of an equipment problem. They get down on the site and find that the components burned itself, but it's out. There is no fire. So yes, that actually was a variation.

We moved that particular suppression path up into the detection group. In a sense this is -- current PRAs will often apply a factor to the fire ignition frequency that says, "Well, you know 10 percent of my fires are self-extinguished and I don't care about those in a risk context, so I'm going to apply a .9 multiplier on my frequency to get rid of those". In a sense, that's a different path. We've allowed for it explicitly to --

MEMBER SIEBER: It matters when they self-distinguish.

MR. NOWLEN: Well, yes, in our definition we would say it would be self-extinguished with no damage beyond the initiating component. That would be the typical kind of criteria you'd use is that if all I lost is the particular item that failed and initiated the fire, then that would be the self-extinguished fire. If it grew beyond that, I -- we didn't run into any case where it grew beyond the initiating component and still self-extinguished. The only exception would be cases where they explicitly allowed a fire to burn out because it wasn't causing any harm and there was a recent hydrogen fire for example, where they simply allowed the hydrogen inventory to bur off so the fire went out on its own, but it was a conscious decision. Beyond that, we wouldn't see any cases like that.

MEMBER SIEBER: You don't care if you do have, for example, manual suppression is unsuccessful. You eventually run out of fuel and it stops on its own.

MR. NOWLEN: Yes.

MEMBER SIEBER: You don't want to make that explicit distinction again?

MR. NOWLEN: Well, again, that becomes a risk question because if --

A VOICE: It's a time question, too.

MR. NOWLEN: Yeah, but if I were doing my screening appropriately, I would tell you that I don't care if that fire burns for 10 years, it's not going to cause you any harm. There's nothing there that I'm worried about in the risk context. So hopefully before we ever got to this level of fire analysis where we're actually doing a detailed fire growth and damage and detection/suppression analysis. We've 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 base out within NRC. We utilize that data base. It covered a period from 1986 to 1999. At the time it was the most recent data base available. That's not really any longer true. There's new versions of the EPRI data base out but --

MEMBER SIEBER: Yeah, and he's working on an update of this.

MR. NOWLEN: Yeah, I've heard that as well. But these particular analyses, this was the data base that we used. So what we did is we went through the data base. We parsed it and then analyzed it. Here we go. So we were looking at things like the method of detection, the manual versus automatic fixed systems, indoor versus outdoor fires, fires for key locations, et cetera. So, you know, basically this is the PRA, cut the problem up into little pieces and analyze each little piece. So here's where if we made the mistake, this is the place.

What we then did is we looked at the fire direction --

MR. SIU: Sorry, Steve, it seems to me that it's a little bit different here in the sense that especially when you're talking about looking at duration times for fires, it's not the question of parsing them and making duration times shorter. What you're doing is if you think of those transition rates on that diagram, you're increasing your uncertainty and your estimates of those -- each of those transition rates as the amount of data you use to estimate them goes down, so if we do this right, then the uncertainties for the scenarios should increase.

Now, there's a point of diminishing returns of course, but if you were to use that global curve you saw at the very beginning, you say I know that curve very well, the historical data, I know it very well, but so what? Should I really apply that to my particular fire in a particular switch, that's the question.

CHAIRMAN ROSEN: One of the things that has been troubling me about all of this is this implicit assumption that the arrival of the fire brigade will always be a good thing. There are cases where the first brigade can make things worse. Does your modeling take that into account at all?

MR. NOWLEN: That's a very difficult question. In general, for PRA, we presume that the arrival of the fire brigade is, indeed, a good thing. There are questions of spurious well or misdirected manual suppression efforts, for example, that might spray the wrong equipment.

CHAIRMAN ROSEN: Yeah, I mean, the guy's got a fire hose in his hand which is basically fairly damaging. I mean, he can damage equipment.

MR. NOWLEN: He can, yes. We look for that in the events. It's one of the things we couldn't find in the events. You know, why we don't find it is certainly open to debate but we did not see events where that was occurring. Now, part of that maybe because we have incomplete reports, you know. We don't get a real good feel for what was damaged in a given fire event and what caused that damage, whether it was a fire or perhaps, you know, flooding or impact by a hose stream. So that particular question is a very thorny one for us and I will admit that, no problem.

It's a very difficult question to answer and I won't say we have real good methods in that area yet.

CHAIRMAN ROSEN: Well, I think you shouldn't neglect it. You should park it some place and make it explicit that you're not treating damaged operable safety equipment that occurs as the result of a fire brigade or other fire equipment actuation.

MR. NOWLEN: Yes, agree.

CHAIRMAN ROSEN: I mean, we've talked about that in a lot of context, one of them other than just a host stream is the actuation of a CO2 system in a cable spreading and in fact, it's so shocking to the equipment operatable or operating safety equipment that it's a factor.

MR. NOWLEN: Right, and we've actually seen a couple of cases of that during pre-operational testing, freezing of relays and things like that. Again, we have to say something about this in requantification. We're not quite sure yet what it is that we're going to say. This task did not bring anything in the way of new insights there.

We tried and it's one of the areas where we didn't succeed. The data won't tell us --

MEMBER WALLIS: There are incidents where activation of a fire suppression system when there was no fire has obviously, led to compromising some safety systems.

MR. NOWLEN: Yes, yes, clearly.

MEMBER WALLIS: Is that model somehow in your analysis?

MR. NOWLEN: Not in this particular one. That's a little bit different question. You're now looking at a suppression system that goes off when 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 CO_2 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.

MEMBER SIEBER: My suspicion is that that wouldn't be reportable, because half the time, even if they do damage something, they don't realize they did.

MR. NOWLEN: That's where --

CHAIRMAN ROSEN: My question, Jack, is not about reportability, it's more about when you're doing modeling --

MEMBER SIEBER: Do you have to have data --

CHAIRMAN ROSEN: -- do you take that into account and I don't see any of that. I don't see ll these things progress out, you know, without ever having a branch that says, fire fighters trip the operable off speed water pump by spraying it when they went in to put fire out, when they went to put the fire out in the adjacent feed water pump that was burning.

MR. NOWLEN: Yes, we agree it's an issue. Again, this particular task didn't give us any new insights there. We tried and didn't -- the data didn't support anything new. So again we have to deal with it in the requantification studies. I can't give you an answer as to where we're headed now. It's certainly on our table.

CHAIRMAN ROSEN: That kind of question, that kind of action is why fire brigades always include an operator and he is in control -- constant communications with the control room because it may very well be that the shift manager would say, "Let the damn thing burn because I'm getting water to the steam generators from the adjacent auxiliary feed water pump and I need that now". It's a very difficult decision for him because he knows that the source of water he's using now is being threatened by the fire, but on the other hand, he doesn't want to make it inoperable but that's the point of having good communication between the brigade and the control room. These decisions are not -- can't be made -- a fire brigade decision isn't made in isolation.

MR. NOWLEN: Yes.

CHAIRMAN ROSEN: I mean, for a lot of reasons, that one I've just described but also the other one, the control room has to say if this is going to be a threatening fire for the life of the fire brigade to fight and whether or not he wants it fought depends upon whether the fire matters to him from the safety related perspective and equipment protection because it just may be that there's nothing safety related in the area, it may be that there's no significant loss of equipment or potential economic damage. It's the decision of the control room. It may very well be to let it burn, self-extinguish.

MR. NOWLEN: Okay, here's where we started to run into our limitations. The data that we had available certainly does have limitations. I think people have heard this before. The kinds of things that we ran into is fire detection times are typically not available or not reported. It's often very difficult to figure out when a fire really, really started. What we typically know is when they figured out they had a fire. What we don't know in most cases is when the fire actually began. There are exceptions, you know, the case of the explosion.

You heard the explosion, you know when it occurred. They tend to be tied up with the ones where you detected it immediately. You can occasionally go back and reconstruct from an event log, for example, that there was a blip in the reporting of something and you can postulate back to that, that that was in fact, the fire starting. That's happened a few times but it's pretty rare. So again, detection times are a real challenge for the fire event data base and that means we need independent means for detection time analysis or we must treat it implicitly, that is we incorporate it into our modeling assumptions.

When we model the fire, we assume that the starting point is -- it's conditioned at detection not the incipient little fire that's been ignited. So you know, there's two ways of going about this. The requantification studies will probably try a little bit of both frankly. We'll look at trying to do some detection time modeling. We'll probably also be looking very closely at out modeling assumptions and trying to update those to the point where we are starting at detection.

MEMBER SIEBER: Why is that important?

MR. NOWLEN: Because again, it's a horse race between damage and suppression. And for a lot of fires detection time could be extended and if I give a fire -- you know, if I begin with a little incipient fire in an electrical component in a panel for example, that's a tiny little fire that isn't going anywhere but if I give it 15 minutes to grow before I know I've got a fire, I could now have a substantial fire. So the detection time is important and when I link that to may model for example, if I assume that my fire starts out as this little candle in the panel and it slowly grows but that I essentially activated my fire brigade immediately, then I would typically assume with high reliability that 15 minute time period, fire brigade is going to put it out in that time. High reliability.

So this link between you know, figuring out that you have a fire and the state of the fire at the point that you realize that you've got one is important. It's a horse race and often it's a pretty tight race. For the critical scenarios, it tends to be a tight race.

MR. SIU: It's a matter of consistency. The fire models need to start with some initial condition and typically some initial size of fire. And so simply speaking, are you going to start with a fire size really as Steve says incipient or are you going to start with that one that was detected and those are two different sizes.

MEMBER SIEBER: Right, I understand that, but it would seem to me you won't know you have a fire until you detect it, okay.

MR. NOWLEN: Yes.

MEMBER SIEBER: Something happens in the plant or you get a fire alarm. And then the appropriate assumption if you're modeling this would be to say every fire I detect because of the nature of the detector, has to be at least this big, right?

MR. NOWLEN: Yeah, but there are --

MEMBER SIEBER: I mean, if you don't know those other things, I mean, you understand they're watching it and waiting -- looking at your watch and seeing when the fire alarm goes off and you say, oh, I'd better extinguish this thing. I think all these protectors have to have a certain size input, fire input for it to actuate, so you already know what those numbers are if you've got a detector.

MR. NOWLEN: Well, the difficulty is that it's very situation specific. For example, one of the conclusions that came out of the control panel fires back in the mid-'80's was that if you have a detector within the control panel it's extremely effective at picking up overheating components basically. You know, you get a component overheated to the point where you're getting a little off gassing, that detector will pick it up right away.

MEMBER WALLIS: Or a detector steam leak, it's not really a fire.

MR. NOWLEN: Yeah, there are issues with that too, false alarms, trusting the alarm that you get, but, you know, the same fire that occurs in a room where there's no detector in the panel but it's on the ceiling, a very different response. If that's now hanging on a pendant below the ceiling it's an entirely different response again. So again, you know, it's a fairly challenging question that has to be tailored to the specific scenario you're postulating. The room, the fire, the fire how big it is, how quickly to grows, all those things link up and in PRA, we want to consistent.

You know, for example, if we're using severity factors, there's another one. I've thrown away all the little fires, so by definition, I'm dealing with bigger fires. Well, that has implications for detection as well and certainly for suppression. My success putting out the little fires is better than my success putting out big fires in a given time period, so lots of links here.

Okay, continuing with our limitations, we had very limited data on fixed suppression system actuation and in particular the timing reliability and effectiveness. When you look at the data base, fixed suppression systems don't come into play in very many events. The vast majority of our events are put out manually and very few have these systems. So it's very hard to then try and gain insights into how effective the systems are, how long does it take before they respond to the fire, and do they fail and why. So that was another area where we really fell flat.

It didn't provide us insights on suppression, success/failure paths. That is, this -- either the network model or the event trees, however you look at it, you can follow different paths. Some things may succeed, some things may fail, and so there's various ways of getting from ignition to suppression. The data base didn't give us a lot of information on that. For example, initial attack with a manual fire extinguisher versus with a follow-up attack from the manual fire brigade with a hose stream. You don't see that. What you typically get reported is that the fire was put out by the fire brigade with a hose stream. So following the path, you know, the success/failures in a given event was very, very difficult, very few cases where we saw an elucidation of a path. It was simply the success -- you know, what was ultimately successful, not the successes and failures.

We also found that we couldn't fine tune our suppression analysis path based on the fact path to detection. Again, this was tied up largely to the lack of good information on detection and as a result, since we didn't know a lot about detection, we couldn't say, you know, having promptly detected a fire, what was -- is there a difference in the likelihood that I now suppress it within a given amount of time.

There was a little bit of exception in that particular case with the prompt detection and the fact that if you have prompt detection, then the likelihood that you get prompt suppression is much, much higher. You're catching the fire at an incipient stage, for example, but other examples, you can't get that information out of events.

So given the limitations we simplified the event tree and we basically collapsed a number of the branches into a single detection/suppression tree. This tree, we believe, can supported by the event data but it doesn't have all of the paths that the other trees had. You know, again, the limitations in the data make those other trees -- I mean, you could quantify them. You can always put numbers on things. You can always put lots of uncertainty in it but in a practical sense, they're not currently quantifiable with confidence.

So this is the event tree we ended up with. We think we can support this one with the data, and so again, what we'll probably doing is in the requantification studies we'll trying to exercise this.

MEMBER WALLIS: Did any of your fires end up in the bottom category, suppression fails?

MR. NOWLEN: Yes, again, you have to look at it's a time question, does suppression fail within a time period.

MEMBER WALLIS: We talked about that before.

MR. NOWLEN: Yes.

MEMBER WALLIS: What if suppression fails here, what happens after that?

MR. NOWLEN: Well, then we've reached our damage state. Then we propagate on through the risk models.

MEMBER WALLIS: So you've got a big enough fire that's actually damaged something which has caused core damage?

MR. NOWLEN: Some upset to the plant.

MEMBER WALLIS: There's risk there.

MR. NOWLEN: Yeah, I've tripped the plant for example, I've lost enough equipment or they've initiated a manual trip. I now have a safe shutdown challenge to meet, so, no, it doesn't mean that you've reached --

MEMBER WALLIS: But the fire is still going on.

MR. NOWLEN: Yes, but again, in the risk context, I am interested in some specific set of components that's exposed to the fire. Once those components have been lost, the fire is less of interest. I'm still interested because I could still, for example, introduce a new set of components through spread to an adjacent area, for example.

CHAIRMAN ROSEN: I would have answered Graham's question by saying at that point when suppression fails, you're right at the start of where we used to with a deterministic analysis. Assuming if you have a fire, that suppression fails that everything in that room of the fire is lost, that's the way that a deterministic analysis --

MEMBER WALLIS: That doesn't mean that everything in the whole building is lost.

CHAIRMAN ROSEN: No, it means everything in the fire area.

MR. NOWLEN: Well, not even necessarily in the fire area. I may postulating that a fire is impacting a particular set of components within that fire area. For example, I may interested in a switch gear fire that's damaging the cables directly overhead but I've found other basis to conclude that the fire won't grow sufficiently to cause sufficiently to cause things on the other side of the room to damaged, for example. So it's again tailored to the specific application. You have to think about you know, what is the damage set that represents success or failure.

If I lose this set of components, that's failure to suppressing and time. That's what suppression fails means here. I have lost the components I'm postulating might lost. Now, again, I might introduce a new scenario that says what happens if the fire spreads to an adjacent area and in a sense -- well, explicitly I develop a new analysis that now focuses on putting out the fire before it spreads to the adjacent area and causes damage there. So you do this for each scenario that you're developing and for each damage set basically. So again, it's all tied to time. It's this race between damage and suppression.

MR. SIU: Personally, I think perhaps the descriptions might a little misleading. I think what you've got essentially is the delineation of different scenarios, each with a characteristic distribution of times to suppression. And so that sort of thing is going to linked in with the fire growth model, then you'll do the growth versus suppression comparison and come out with what's the fraction of time to put out the fire before damage occurs. So there are characteristics associated with each of these scenarios and so he's identified what are the different classes that he has to address.

MEMBER WALLIS: Well, there's a time axis which we don't see in the total.

MR. SIU: That's right.

MR. NOWLEN: That's right, yes, there is a time axis. Okay, so getting down to the insights, again, the limitations of our event data remain an obstacle to more detailed analysis in this case. We did see some interesting things on detection methods. Nearly 25 percent of the fires in the Houghton data base at least reported prompt detection, the fire watch sort of thing, explosions that you hear right away. That's a pretty significant fraction.

Only six percent of the fires in this particular data base, again, all this is tied to the data base you use, so but about only six percent were reportedly picked up by fixed detection suppression -- fixed detection systems. That was a little surprising. We assumed that number would higher. We have --

MEMBER WALLIS: Fixed detection systems you mean automatic detections systems?

MR. NOWLEN: Yes.

MEMBER WALLIS: And the only thing non-fixed detection systems are people who walk around?

MR. NOWLEN: Yes, basically. You can -- yes, you know, fixed and --

MEMBER WALLIS: You mean automatic.

MR. NOWLEN: Well, with suppression systems you usually think about automatic and fixed manual. With detection systems, by definition they're automatic so the trade jargon is usually a fixed detection system. It's simply a matter of trade jargon is all. There's nothing real magical about that.

But again, a relatively low fraction there. What that implies, if you take those two numbers, you're left with the majority of the events. The other paths we have available are delayed manual detection. In the original model it was local and remote. We combined those in our revision but then again, all the events no modifier was detected so --

MEMBER WALLIS: And if you had an advanced reactor you'd would have far fewer people there, there would far fewer of these mobile detection systems, presumably, and you have to have better fixed detection systems.

CHAIRMAN ROSEN: Well, that's right and I think one of the conclusions I drew from the six percent is that we've got the detectors in the wrong place, places.

MR. NOWLEN: Well, careful, careful. We put detectors in the critical places. Now what does this say? That may say that we're doing a very good job of preventing fires in the critical places. I mean, there's an alternate that could good news here. So you can't conclude that necessarily that we're putting them in the wrong places. We're putting them in the places that we know are important from an operational standpoint. We put them in places like the cable spreading room.

We don't have a lot of fires in the cable spreading room, so, you know, maybe this is good news. I don't know.

MEMBER WALLIS: Maybe the people who cause the fires are the same people who detect them.

MR. NOWLEN: That happens a lot. That actually happens a lot. You know, the fire watch is there or the person who started it and again, the prompt detection.

With regard to the suppression methods,

this is just a rough parsing -- two significant figures, I guess not too rough, but again, given the data base, this is how you see the suppression -- the path that was ultimately reported as successful split out. The one that leaps out obviously is manual suppression. Self-extinguished a fairly high fraction there as well, the power removed fuel isolated wasn't a small number either but the fixed systems and here I'm saying fixed automatic and manual systems, only about three percent of the fires report that that's how they were suppressed. Again --

MEMBER SIEBER: What kind of insight do you get with the combination of the fixed detection system at six percent effective and fixed suppression system at three percent effective?

MR. NOWLEN: Well, no, no, no.

MEMBER SIEBER: Does that give you insight --

MR. NOWLEN: You can't use those numbers that way. No, it's not -- this is not an effectiveness number. This is -- given the events, this is how they were reported to have been suppressed.

MEMBER SIEBER: Okay.

MR. NOWLEN: The others may -- again, they may occurring in areas where we don't have fixed systems present. We don't have detection, we don't have suppression. So we put them out in other ways. That's another area where you can't really tell from the event data. It would possible to go back through the events and to try and back out whether or not a fixed detection system was available. For example, you could look at if you know the plant name, if you know where the fire occurred, you could look and see whether that systems available. The fire reports don't always tell you that, so I don't know from the reports whether a fixed suppression system was present and failed to go off, or whether there simply wasn't a system present. So you can't take this as an effectiveness number. That's not what this number is.

CHAIRMAN ROSEN: I also go back to your response to my point was that fixed distance only put out the fires in three percent of the cases because we only put fixed systems where it's very important and in those areas, we're very careful about not having transient combustibles or other sources of ignition.

MEMBER SIEBER: It seems to me that was have a lot of fixed suppression.

MR. NOWLEN: Absolutely, that's probably a factor. I'm sorry?

MEMBER SIEBER: I said it seems to me as I recall in the plants where I worked, there's a lot of fixed suppression because of the insurance companies. The insurance company says you've got to have fixed suppression everywhere.

CHAIRMAN ROSEN: Sprinklers every place, yeah.

MEMBER SIEBER: So well, I can't draw a conclusion either but I was interested in your insight.

MEMBER WALLIS: Yeah, this says something about the extent and duration of the fire, too. The long term fire is probably more likely to put out by a fixed system, so the fires that really matter may actually in this three percent.

MR. NOWLEN: That's possible, yes. Again, this is a statistic that we observed. We haven't --

MEMBER SIEBER: I wouldn't jump to that.

MEMBER WALLIS: No, I'm just saying that it could that these manual suppression ones are relatively trivial fires.

MR. NOWLEN: Right. That is possible. I mean, certainly some of these are trivial fires and many of the ones that are manually suppressed, the prompt manual suppression --

MEMBER WALLIS: If I light a match, I've lit a fire. If I put out the match, I've put it out.

MR. NOWLEN: Yeah, I've put it out, protection prompts suppression. Yes. The point here was again, in fire PRAs we tend to focus on the manual suppression path and from the experience, that may not such a bad thing. It does seem to the dominant path that we find to success for putting out fires, so again, putting a lot of focus on our manual suppression is a good thing, I think for PRA and we've already hashed this one pretty well, you know, why the fixed detection and suppression systems aren't involved in more of these fires does remain an open question and with that I'll conclude.

CHAIRMAN ROSEN: Well, I'd like to congratulate you on a very interesting presentation and you colleagues as well as being right on time.

MR. NOWLEN: It depends on which clock you pick.

CHAIRMAN ROSEN: That's right, well, no I'm averaging the clocks. One is 12:01 and one is --

MEMBER POWERS: Do you realize how difficult you're going to make it for me next week? I mean, couldn't you find something to criticize?

MR. NOWLEN: You'll have to give me a bigger office for my head.

MEMBER WALLIS: I was going to say, you had about as much fire and passion as the human liability folks yesterday.

CHAIRMAN ROSEN: Well, let me just say that we have had an opportunity and I'd like to give you another opportunity if you have anything else or go back to the earlier presentations or any questions on that from the committee members?

MEMBER WALLIS: Well, I think the thing I'd like to know -- this is very interesting work -- it is really solving the problem that needs to solved? How far is it going along the path that we need to go along? I'd like a perspective on that.

MEMBER POWERS: Yeah, it seems to me we're missing a vision of what we want, our risk assessment capabilities to in the area of fire. And in that regard, I mean, I think we genuinely recognize that our abilities to calculate risk due to fire initiators or due to fire as a consequence of other initiators, is not well developed especially the latter one. That is something initiates an event in a plant and that leads to a fire and the combination of the two lead to core damage are not well developed. And I struggle with Graham in understanding where it is that we want to go with that capability.

And one of the areas that continues to perplex and concern me in the overall strategy of fire risk assessment is the tendency to screen fire areas and say, "Okay, here's some areas. There's no ignition source in here, consequently, I don't have to need to worry about the probability of fire in this region", but there are adjacent fire regions that can have fires and there is some non-zero probability that that fire will propagate into the region that you've screened out, but when you've screened it out, it's gone from the analysis in its entirety. And you rely on excellence in the analysis to make sure that kind of situation doesn't arise.

I contrast that with what's then in PRAs in -- for normal operations where I don't think they have such a dedicated screen step in their analysis and maybe they're just not as explicit as the fire risk assessment people. I suspect that's really the case but you have this screening methodologies that are peculiar and especially this guaranteed non-propagation that occurs seems to excite the public a lot.

And this committee has enjoyed several

complaints about fire barrier penetration seals being assumed to 100 percent effective and things like that. That overall strategy, where is it that we want to , what is it going to take us to get there, I think is something that's just really missing here and it's especially missing in the way you get your fire research funded, which tends to a lot of piecemeal activities each well-designed and well-conducted but I don't know that we have an overall scheme that we're working to here that says, okay, I should able to calculate fire risks to some level of confidence and whatnot.

The other aspect of that is who does the calculation. Are we -- are we on a pathway that says, okay, there will always these guys at headquarters that do fire risk analyses for plants or is it technology that we want eventually to give out clear to the level of the inspection staff and let they do that risk analyses or certainly to the senior reactor analysts in the regions and they do that risk analyses, or are they forever to dependent upon headquarters folks doing these things?

And those kinds of questions just aren't answered.

MEMBER WALLIS: To get back to this

screening out areas with no ignition source, it reminds me I was concerned with this thing excluding sabotage. Now, so the disgruntled employee -- this is a traditional thing a disgruntled employee does is to leave oily rags around and things and try to promote fires. I mean, this is one of the traditional sabotage things that happens in industry. And yet, you've sort of left it out and you've start screening out areas and say there's no ignition source, then that's probably a likely place where there might a sabotage.

MR. NOWLEN: Yeah, I'd a little careful about assuming how quickly we throw things away and never revisit. For example, the lack of ignition sources is usually not a sufficient criteria for screening an area out entirely. We always have transients, you know, fire might happen almost anywhere. You can argue about how well we handle that and sabotage is another one that can happen anywhere.

In fact, if you have a smart disgruntled employee, they can pick their spot which is undesirable. We don't do that.

MEMBER WALLIS: Maybe they don't want to do much damage.

MR. NOWLEN: Yeah, possible. The other

point, I think on screening is, when we screen areas, we always do explicitly retain room to room scenarios. Now. Again, you can argue about how well we do the room to room scenarios when we get down to it and what we assume for the reliability of the fire barriers and things like that, but we do retain them. Beyond that, I'll defer to the NRC.

MR. SIU: Yeah, let me get to the sabotage question first and then the overall scheme. Yes, it's really hard to address things like, "Well, gee, I've got a vault with a locked door but somebody motivated could bring something into that room". I don't know quite what we'll do there. I will say that some of the events in the fire data base represent things that you might have been due to somebody's actions intentionally and we haven't left those out.

MEMBER WALLIS: Arson isn't exactly sabotage. The first suspect in arson is the fire suppression guy.

MR. SIU: So we haven't taken those events out but developing the scenario, I think that's what J.S. is referring to in terms of leaving that outside the scope of this particular work. You know, from the NRC standpoint, I think an important objective of this requantification task is to make sure that the tools we've developed, methods we've developed, actually can work out in the field. Making sure that we've addressed every scenario and this gets to the low power and shutdown issue for example, is not has not been the primary objective of our research program.

Obviously, EPRI as well wants to develop guidance that others can use to develop these upgraded fire PRAs. In a way, I think our terminology requantification test perhaps focuses too strongly on the bottom line number that's going to result out of this. We certainly expect the number to reflect the technology we apply to it but also we're applying boundary conditions to that analysis and the operating regime and the issue of sabotage, these are places where we decided given the resources we're throwing at the problem what we can and cannot do.

It doesn't mean that we shouldn't look at this as a down the road issue. That was a good suggestion by the committee that we'll certainly consider.

Regarding the overall scheme for how we've identified tasks, this is something basically where we are is where we were when we presented to the committee in the last few years, how we identified the research efforts. We had gone through some initial effort, this was back in `97, identifying potential issues in fire risk assessment, where improvements were needed and we had a basis for identifying these areas. We prioritized based on our own considerations and discussions with user offices and came up with a list of activities that we felt we had to address and they were across the board, indeed, in fire risk assessment. Every aspect of fire risk assessment we felt that there was something we needed to get us over some major hurdles. Some of the hurdles we saw in the IPEEE reviews.

But so if there is a strategy, it's largely trying to address the issues that we see that we've been faced with and we anticipate when folks come in with risk informed applications using -- if we weren't to do what we're doing now, then we would probably see something close to IPEEE technology when the applications come in and we felt that there were some places, we just had to address, so that's essentially been the principle.

Now, the stopping rule that you asked about is more difficult. Steve has indicated one stopping rule but it's one that we had only after we did the work which was the data just won't support further developments in this area and either we go out and develop physical models, say for detection which is possible and we hadn't really talked very much about that, or we say well, this is what the data supports right now and that's where we have to in the short term but I know that doesn't interest the long-term issue or vision.

CHAIRMAN ROSEN: It doesn't address the advance reactors issue. You don't have any data on advanced reactors, fires in advanced reactors.

MR. SIU: Yes.

CHAIRMAN ROSEN: You have to have a modeling technique that's not dependent on what data it has because when we began PRA work, we didn't have any data either. We used estimates and expert elicitation and then over time, used basically an update to improve the answers.

MR. SIU: I think fire risk assessment as we know it, in general terms the framework of fire risk assessment, how we approach things is probably applicable. There are technical issues that certainly need to addressed and I guess we had thought about forming a view graph and we didn't do that, talking about potential issues with advanced reactors.

We've heard about smoke, for example, and the effects of smoke on equipment. You would have to talk about fiber optics or you don't have to but that's a potential issue that you have to address. And you know, all the work that Steve's going to talk about this afternoon on spurious actuation is clearly dealing with electrical cables and what happens. So you can come up with a list of issues but the -- in may ways, I think dealing with these issues are -- it's part of the framework already that we've got and we're saying now we have to modify the particular tool we've got or the data we've got to address that issue.

CHAIRMAN ROSEN: The two issues I'm thinking about are digitization or digital equipment in advanced plants and the increased vulnerability to different failure modes or multiple common cause or common mode failure due to fire in advanced plants, and the other issue is graphite, graphite dust in all its forms in advance plants, perhaps.

MEMBER SIEBER: You're also going to find a lot of fiber optics in advanced plants, so we need to know what happens to that.

CHAIRMAN ROSEN: But I think the idea that you're enhancing the modeling capability in what you're doing now and getting experience with that will lead to better fire analysis for advanced plants, too. It's applicable. Some of the phenomena will different, some of the things you model and the way you model might different, but clearly what you're doing is good. I mean, I was excited in listening to what you were talking about and thinking about this afternoon also and being in Seattle and seeing the breadth and the interest of tons of people and some of the things that are being done by utilities and consultants and others, I think the state of fire protection research and interest if very good. We need to continue to encourage it because of the importance of fire risk to the overall risk but I'm encouraged by what I see.

MR. HYSLOP: I'd like to make one statement regarding the use. You know, we're certainly interested in transferring this technology to all the users, to the regions as well, eventually. They do analysis, they have inspections, you know that require exacting analyses and you know, the better off they are in performing those analyses, the better off we'll .

CHAIRMAN ROSEN: Yeah, I think so and there is one question or a note that was offered in Seattle. I'm not sure -- I don't remember who exactly said it, but -- no, I do, Najaffee (phonetic). He said that one of the difficulties with fire modeling is that in the hands of -- in a user that really don't know what they're doing, it can misused. And it's a difficult -- you know, it's like thermal hydraulics in a sense.

MEMBER WALLIS: I wondered when that was going to come up.

CHAIRMAN ROSEN: You can create models without momentum equations and think you're getting an answer that's meaningful.

MEMBER POWERS: There are lots and lots of models in this world that do not have a momentum equation in it.

MEMBER WALLIS: And they work very well --

MEMBER POWERS: And they work extremely well.

MEMBER WALLIS: -- for some purposes.

MEMBER POWERS: That's right, you have to know when to do it and when not.

MEMBER WALLIS: That's right.

CHAIRMAN ROSEN: Well, with that, I would say we will conclude for the morning and stand in recess until 1:15. We'll catch up the -- we'll try to end on schedule anyway.

(Whereupon at 12:15 p.m. a luncheon recess was taken.)

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

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

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

I guess before I jump into the heart of the presentation, let's put this in context. This is circuit analysis, so again, this is the question of fires doing odd things to your circuits and systems in the plant. In a PRA we're interested in potentially different modes of circuit faulting. You may have a loss of function, for example. That's the one we typically deal with, you know, the system is simply unavailable to us, it's uncontrollable. It's either -- it's lost its motive power, whatever. For whatever reason, it's just unavailable. But the circuit analysis topic brings in the potential that there are other fault modes that might occur, spurious actuation being the one we always hear about, and the question that we ask is how likely are those things to occur and given that, how important are they to the overall fire risk. So that's the topic that we're talking about here, is how do we deal with circuit analysis in the PRA world?

MEMBER WALLIS: Excuse me. These are the circuits that actually do things like starting and stopping pumps. They're not the circuits that measure things or are they also the circuits --

MR. NOWLEN: It's all the circuits.

MEMBER WALLIS: All of them, all of them, good, thank you.

MR. NOWLEN: Yes, potentially, we'll get into some of that but for example, instrumentation and indication as it impacts human reliability.

MEMBER WALLIS: Okay, thank you.

MR. NOWLEN: Permissive signals, automatic actuations. You're also dealing with the power circuits that provide motive power to equipment and also controller fits, those that do the opening and closing controls. Okay, so that's where we're at.

So again, we have this new set of tests that I want to tell you about. These were initiated by industry, EPRI and NEI in particular. NRC was invited to and did participate in these tests and their participation included every phase of the program from test planning to the execution of the tests and the analysis and interpretation of the data.

It was agreed right up front that we would share all data. So we were given full access to the NEI data. They were given access to our data, so that worked very well, and each party agreed that we would perform our own analyses of the data and our own interpretation of what the data has told us. So what I'm going to do here today is discuss our initial analysis of the test data results and there's two sources listed here, the primary sources and NUREG CR on on the circuit analysis. It's a draft report that's currently under review and I believe you were provided with a copy of that and then there's also a supporting test report that was published by Sandia for NRC on the Sandia portions of it. And I think you got that a little bit late in the process. We decided to send that over as a supporting information.

Okay, so what was done and this is also going to feed into the test that Fred Emerson will present. Fred has agreed or requested the opportunity to present some more detail on the industry portions of these tests, that is the instrumentation and diagnostics that they did. My presentation focuses on the NRC portions of the test, so I have incorporated what we've learned from the NEI portions as well, but it's not the focus of this presentation. So what I'm going to tell you here about the tests applies to both of the presentations you'll see this afternoon.

So what was done is there was a series of 18 tests total, all of them were conducted with a gas burner diffusion flame, a range of fire intensities. The tests were conducted in basically a steel room, it was a steel plate room, 10 feet by 10 feet by eight feet high. All tests conducted with natural ventilation and in fire jargon means it's an open doorway as opposed to a forced ventilation system.

MEMBER POWERS: Let me ask, Steve, in a nuclear power plant, how many free standing steel rooms are there?

MR. NOWLEN: Loaded question, obviously. None, really. The idea here was not an attempt to try and reproduce the conditions in a typical nuclear power plant room. The idea was to construct some fires that would lead to cable damage and then to observe how that cable damage manifested itself. So we were not real focused on trying to create a representative room and in fact, the effect of the steel, the fact that it's a steel room means that the heat losses from the room were much larger than what you would expect in, for example, a concrete room, but it was also a relatively small room. We also don't have a lot of 10 by 10 by eight-foot rooms in nuclear power plants.

So for a lot of reasons the room is not typical and, in fact, a steel room looks a lot bigger in effect than would an equivalent size concrete room, you know, we are losing a lot more heat than we normally would. So, you know, our interpretation here is don't look at these as a typical enclosure. That was not the intent, but we don't think it compromises the validity of the insights relating to cable failure.

MEMBER WALLIS: What you're really looking at is the cables.

MR. NOWLEN: Yes.

MEMBER WALLIS: The cables subjected to a flame.

MR. NOWLEN: To a fire, to heat, hot layer or a plume, yes, exactly, and so the room, you know, again you have to cognizant of the conditions of the room, and we recognize they weren't representative, but that's okay.

MEMBER KRESS: Excuse me, was the fire necessary for this test? Couldn't you just stick them in a heated compartment and --

MR. NOWLEN: Theoretically you --

MEMBER KRESS: -- and control the temperature and --

MR. NOWLEN: Theoretically, you could. The advantage of doing the fires, even though it's a gas burner, it is a diffusion flame that has radiant in and convective properties. It also allows you to have a much larger set of cables. Doing an entire cable tray in an oven in effect, is --

MEMBER KRESS: Yeah, an oven with a radiant heater, it's not --

MR. SIU: Yeah, part of the issue here is the thermal environment is clearly important even though, as we said, the particular room characteristics may not have been all the important, but you're concerned about, for example, exposure to the plume of an actual loaded cable tray, not just a single cable in some sort of idealized environment, so differential heating across the cable, direction, the speed of the gases moving by the cable, all these things we felt that having real fire is important to try to get to those effects.

MEMBER WALLIS: That's the question I had, how do you characterize this flame then? Do you characterize it by temperature and velocity and do you characterize its chemical composition? What would you need to do to characterize a flame?

MR. NOWLEN: Well, again, the way it was characterized for the test was simply a gas flow rate basically, that leads you to a theoretical heat release rate. You can also get information on the flame heights. There were some measurements of temperatures, although again, our focus was not on the fire. Our focus was on the cables.

MEMBER WALLIS: Doesn't it make a -- another question, is the cable tray put on top of the flame?

MR. NOWLEN: In some tests. Yes, we tested both configurations, where the fire was directly below or where the fire was off to the side so that you're getting more of a hot layer exposure.

MEMBER WALLIS: That makes a difference.

That makes a difference when I'm boiling something in the kitchen, whether I put it on the flame or the side. So it's different.

MR. NOWLEN: Yes, and we're jumping ahead a little bit. It certainly makes a difference in time, how long it takes for the damage to occur. The question that we were asking is, does it make a difference to the mode of failure that I observe once it fails. So, you know, again, we can deal with time through our fire models. The question was, should I postulate a different likelihood of a spurious actuation for a plume exposure versus a hot layer exposure. That was the question that we --

MEMBER WALLIS: It depends on the method of degradation the room. Is it a question of oblation?

MR. NOWLEN: Yes.

MEMBER WALLIS: Or does to boil off, does it -- you know, all that kind of stuff.

MR. NOWLEN: Right. So -- and that's where we've been. So if we -- hopefully, I'll answer your question as I go through this.

Okay, again, let's see, there was one cable tray in each test. Some were vertical and some were horizontal trays and some of the tests also had a conduit, so there are cables inside of a conduit.

The test focused primarily on multi-conductor control cables, and these were often typically bundled with single conductor light power cables. So it was typically a bundle and I've got some illustrations of that for you here in a minute.

We looked at both thermal set and thermal plastic cables that this is a characterization. It's a very -- it's sort of the highest level split you make with insulation materials. Thermal plastics melt and will resoliditify. Thermal sets do not melt. So we also looked at armored and unarmored cables.

This is the general layout of the room. You -- the doorway here --

MEMBER WALLIS: Is this looking down on it?

MR. NOWLEN: Looking down on it, yes, this is a plan view. Sorry. Okay, the cable tray was just located along one corner supported on concrete block pillars at each end and there was actually a chain holding it up to the ceiling back in the corner here. The burner was typically either located right in the middle of the room, which would have been our hot layer exposure, or it was moved underneath the corner of the tray back here to give you the plume exposure and varied in intensity.

The doorway was also varied in its height of the opening to vary the conditions of the fire somewhat. That was kind of on an ad hoc basis during the testing. And so --

MEMBER KRESS: Is the room pretty well airtight from the door?

MR. NOWLEN: Reasonably so. The walls and corners were certainly airtight. They were welded together so this is a test room that was available at the facility and now it wasn't welded to the floor or anything but any air gaps that were there would have been trivial compared to the size of the door, so yeah.

MEMBER KRESS: But was the sprinkler head valve just by coincidence?

MR. NOWLEN: No, it was placed there for a purpose. From a testing perspective you like to able to, you know, if the fire gets out of control, you want to have something that you can snuff it with, but it was also there for the purposes of testing and some of the tests, they actuated the sprinkler to see whether or not it had any additional effects on failures. So --

CHAIRMAN ROSEN: It tends to invalidate the results if your fire facility burns down, fire test facility burns down.

MR. NOWLEN: It does.

MR. NOWLEN: People look on that as --

MR. NOWLEN: Yes, well, you've gotten a data point you probably didn't expect to gather.

MEMBER KRESS: I would have had a guy standing up there with a fire extinguisher.

CHAIRMAN ROSEN: You know, it's more likely to effective, the data we saw earlier this morning.

MR. NOWLEN: Okay, again --

MEMBER KRESS: Do you factor that into --

CHAIRMAN ROSEN: I'm going to gavel myself into silence here in a minute.

MR. NOWLEN: There were a number of cable configurations tested during the tests. The most common is the one that you see here, which is a seven-conductor, multi-conductor cable with three single conductor cables bundled with it. That was the predominant one, but there was also an eight-conductor armored cable, there were some five-conductor cables. These two are instrumentation type cables. This is a two conductor with a shield and drain and this was three twisted shielded pairs. There were some three conductor cables and then there was, I believe, on with a 12-conductor cable and three singles, so, again, a range of configurations for the different cables.

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

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

Some of them were again here in the conduit. Here were on top of the bundle, again, on top of the bundle, some of these are against the tray, so just the idea that there's a range of configurations here, trying to explore how these things might impact the failure modes and likelihoods.

The next slide, I don't think I'll go into any detail. This particular system is a set of input and output switching relays that allow us to energize a cable bundle. This is our test bundle over here so in this case we're illustrating, for example, the seven conductor, multi-conductor cable with three single conductor cables and what this whole rig allowed us to do was do insulation resistance measurements for specific conductor pairs.

I could pick, by energizing one conductor on the input side, and connecting another conductor through on the output side, I could measure the insulation resistance between that conductor and the conductor connected down here. By reversing the process and connecting in the opposite set, for example, this one on this side and the other one as the output, I get an independent measurement of that same insulation resistance and what we did is we would go through a switching logic that did these pairs in sequence. And by taking the two as a set, the one/eight and the eight/one for example, we can also identify not only the insulation resistance between these two conductors but also from each conductor to ground.

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

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

Now, what's interesting is you see the cable sort of dancing along here, not a lot of effect, a little bit of degradation in the insulation resistance. Our threshold by the way was about 10 to the fifth ohms. Anything above that we really couldn't sense so in reality the cable starts probably up in this range, but our sensitivity just wasn't that high. As the fire progresses you eventually see these two come into play with Number 1. Well, you jump up here and that's Number 7 and this one is Number 6. So what we saw in this particular case, Number 1 happens to the center conductor. Okay, if you remember the seven-conductor cable has six around the outer ring and one in the middle. Well, Number 1 happens to the center conductor and 6 and 7 are two of them next -- right adjacent to each other in the outer ring.

So in this particular case, the first fault that we saw, the first failure of the cable was a short that formed between conductors 1, 6 and 7. This is stuff we didn't have before. We didn't have this kind of data on the behavior of cables and you can progress through here and see when the other cables begin to fall into these shorting groups.

CHAIRMAN ROSEN: Hold on for a minute. Let's focus on that for a minute. You said the first fault was between Conductor 1 and 6?

MR. NOWLEN: One, 6 and 7 shorted together.

CHAIRMAN ROSEN: One, 6 and 7, it's three different cables, right?

MR. NOWLEN: Yes. No, three different conductors in the same cable.

CHAIRMAN ROSEN: Three different conductors in the same cable. Those three cables all simultaneously shorted together?

MR. NOWLEN: Yes, that was the first thing that happened.

CHAIRMAN ROSEN: I would thought that most likely it would the two cables would short together rather than three.

MR. NOWLEN: Yes, well, sometimes intuition -- well, we'll get to that.

MEMBER SIEBER: Let's careful, sometimes his intuition.

MR. NOWLEN: Okay, this is this bundle right here. This was a test like this. Number 1 was -- and again, this is a seven-conductor, multi-conductor control cable, okay? These are three individual single conductor cables bundled along with that one. Number 1 is this conductor right here. Six and 7, you know, were a pair of them next to each other on this outer ring and may have been this pair or this pair, it doesn't matter, but so what we had was these three conductors formed a short together. That was the first failure mode right there.

MEMBER WALLIS: What if 6 and 7 shorted out together first and then one of them went to 1?

MR. NOWLEN: Well, I can -- in this particular case, I pulled the one that had the -- that -- well, in this particular case, they shorted together. One, 6 and 7 went at the same time. Now --

A VOICE: What's the difference between the measurements?

MR. NOWLEN: That's where I was just headed. The time frame here is on the order of a few seconds. You know, a few seconds of time in this particular case is for all intents, simultaneous in our analysis. Because of the switching cycle, it takes a little time to get through that switching cycle and so these -- for the purposes of our measurement to our resolution, it was essentially simultaneous.

MEMBER SIEBER: Was that the thermo plastic or thermo set?

MR. NOWLEN: Test Number 3, I don't recall.

MEMBER SIEBER: That would make a difference, wouldn't it?

MR. NOWLEN: It does make a difference and I'm going to get into that. I just pulled this one to illustrate the nature of the data that we're gathering. I don't recall the exact conditions on 3. I'd have to look it up. So again, what we have is we have these kinds of plots for every one of these conductors, so I've got the same plot for conductor 2 and for conductors 9, so there's a set of 10 of these for every test. Taking them all together and looking at the times, we can distinguish when these different shorts occurred in which combinations and what sort of transitions they made. So given all of that --

MEMBER SIEBER: Now, this, if it were an actual cable in a plant, that would give you a spurious actuation?

MR. NOWLEN: Maybe, maybe not. Yeah, it --

MEMBER SIEBER: Or a trip.

MR. NOWLEN: Well, and again, this is where the NEI portions of the test were a great compliment to what we're doing here. When I look at a pair of conductors, I'm taking it out of the context of the circuit. Certain combinations of conductors in a particular circuit can lead to a spurious operation.

MEMBER SIEBER: Right.

MR. NOWLEN: I've divorced that part of the problem here. I'm looking at the cable as a system.

MEMBER SIEBER: Well, sooner or later in the process of cooking this cable, they all short together, right?

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

MEMBER SIEBER: Sooner or later.

MR. NOWLEN: Sooner or later, as the fire keeps going, they all short to ground, in fact.

MEMBER SIEBER: That would better.

MR. NOWLEN: From a hot short perspective, sure. Yeah, because that trips control power typically, yeah. So, yeah, again, you have to take this and put it in the context of a specific circuit and a specific cable. Some circuits have certain combinations that will lead to actuation. You know, other circuits have their own combinations.

What we were looking at are things like this. In the trays, what we saw is that 80 percent or more of the faults, the initial failures of these multi-conductor cables were conductor to conductor shorts. Okay, well, that tells you something. Now, again, a conductor to conductor short does not necessarily mean you're going to get a spurious actuation, but it does say that that particular event, conductors shorting to each other is a high probability event.

Conductor to conductor shorting groups vary. We had some fairly complex behavior in this case.

MEMBER WALLIS: They short by touching each other or does the insulation break down into some conducting component?

MR. NOWLEN: It's a little bit of each but given the low insulation resistance here, I mean, we're talking 100 ohms, that's basically contact between the conductors. There was some speculation going into the test that the charring of the insulation might leave substantial insulation resistance and so you might have, you know, high resistance, you know, low quality faults, shorts.

What we saw were the behavior with the fairly abrupt transition backing up to here, these abrupt transitions where we went from on the order of 1 to 10,000 ohms down to 10 to 100 ohms, every test that's what we saw. If it failed, this is the way it failed. It degraded to a certain point and then boom, down it went. So we believe that this indicates that there's contact. And in fact, when you do the post-mortems, you can see that when you take the cables apart. The thermo plastic cables in particular --

MEMBER WALLIS: Did you observe anything else of the physical condition at this point where this collapse occurred?

MR. NOWLEN: No, this is an ongoing test that continued to burn for some time, so, you know, we didn't stop the test at this point and run in to see what it looked like or anything like that. This -- it just continued, so the condition that we would see would out here when we went in and did a post-mortem on the test.

MEMBER SIEBER: Now, that time, I take it, would very important from the standpoint of modeling what goes on.

MR. NOWLEN: Yes, but again --

MEMBER SIEBER: That's like 45 minutes, right?

MR. NOWLEN: Yes, yeah, many of these, and I'll make that observation in a minute, a lot of these were extended damage times.

MEMBER SIEBER: Yeah.

MEMBER WALLIS: I'd like to know whether I'm paralyzing the cables or boiling them or whether I'm actually burning them off or what's happening in there.

MR. NOWLEN: Well, okay. The termo plastic cables were melted. They melt.

MEMBER WALLIS: So they melt and then they slope into it somehow?

MR. NOWLEN: Yes, a little bit. The insulation would soften and the way cables are manufactured, they twist as they go down through the manufacturing, so there's a little bit of residual tension there, okay. And we think what happens is that as the material softens that residual tension brings the conductors together. There's also the gravity effect. I've got a single conductor next to it and gravity can kind of draw that down through the softened insulation and create contacts.

Now, the thermo set materials which actually are more common in U.S. practice today, the newer cables are almost all thermo sets, they don't melt. They burn and char. And but again, I believe it's this twisting and the residual tension that draws the conductors together and we get shorts, that combined with the gravity effects. Some of the cables had cables on top of them pressing down. So there is various things that draw these things together.

MEMBER SIEBER: These cable trays did not have covers.

MR. NOWLEN: Correct, that's correct. Again, the one thing -- or another thing that we saw was that these conductor shorting groups were very complex in some cases and they were transient. You don't see two conductors short together and stay that way forever. The groups would two or three or four. You might have another group of two over here and then they go -- now you've got six and now you've got eight, now you've got 10 and then they all go to ground. You know, there were these complex transitions among these conductors. So it's not a simple behavior at all.

We generally saw that the outer ring of conductor, the multi-conductor would short first and there was some speculation as to whether that would observed, whether we would see the rather intimate involvement of the center conductor with the rest of the conductors creating more likelihood of shorts to that center conductor. Well, what we learned is that it's the outer conductors that tend to fail first. They're getting the worst thermo exposure. It takes time for the heat to conduct in and that was the dominant effect there.

We also saw in the shorts generally observing nearest neighbors like the case that I showed was 1, 6 and 7, those were all right next to each other. We didn't see shorts jumping all the way across the cable as an initial fault mode. That would happen later in some cases.

MEMBER WALLIS: Now, because of thermal expansion does the cable itself bulge or -- it doesn't just stay straight and it isn't just a question of the twist. There's also significant thermal expansion, isn't there, during this?

MR. NOWLEN: There are, yeah. I don't know how big a role that played. You often see bubbling of the jackets, for example, and you'll see off-gassing.

MEMBER WALLIS: I mean, the metal itself. They get longer, then you know, whether or not they're pushed together is going to an influence.

MR. NOWLEN: Good point. Yeah. I hadn't thought about that one myself, actually.

MEMBER SIEBER: I think if you look at some of the thermo set cables after they've been fried, and I never saw them coming out of the fire, but I've seen where they were partially aged and overheated so much, they failed and what you see is the thermoset insulation breaks apart which I think comes from the expansion of the metal conductor and you see these gaps and little pieces of spaghetti with openings in it and I've seen a fair number of cables that looked like that.

MR. NOWLEN: Yeah, I've seen that as well in the aging context with, you know, as the material has aged they oxidize and become more brittle and, yeah.

MEMBER SIEBER: Just a very extremely hot place underneath the generator and it wasn't shielded in any way. It was an old generator.

MEMBER KRESS: Did they have thermo-couples stuck around in these trays anywhere?

MR. NOWLEN: Yes, I don't know how deep Fred's planning to get into that but there were thermo-couples in the room in general, in the tray. Where were some attached to the cables themselves, so along with all of this stuff, there is a whole rash of thermo-data that we've even scratched the surface of. So, Fred can talk further to that, I think.

MEMBER WALLIS: But they're free cables at the end, so they can expand, they can just grow lengthwise or are they tied down at the end?

MR. NOWLEN: They -- well, they were not tied down at the end. The ends were quite long and they were run out of the room to give us electrical access.

MEMBER WALLIS: So they probably could expand some, then they could grow. If they're held at the end, then they do all kinds of stuff.

MR. NOWLEN: Yeah. In this case, again,

the tray itself was --

MEMBER WALLIS: That expands, too.

MR. NOWLEN: -- about 12 feet long, is that right, Fred, total length, roughly 12 feet.

MEMBER WALLIS: And that expands, too.

MR. NOWLEN: Yeah, everything is going to expanding, so in that sense, it was probably fairly representative of what we'd really see in a plant, a local exposure on a long length of cable.

Okay, this was a point that was raised before. If the cables failed during a test, all the conductors eventually shorted to ground. We had persistent fires. We didn't put the fire out when we saw failures. So again, with the continuing fire, they did all go to ground eventually. And the transition times ranged from seconds, you know, a few seconds, to several minutes. In some cases, the shorts would last longer than others.

MEMBER SIEBER: By going to ground, you mean shorting out to the cable tray?

MR. NOWLEN: Correct, yes, the ground plain in this case was the tray. And it was -- yeah, it was grounded. And we saw a number of factors that influenced the cable failure mode behavior and, again, this is not timing. This is given that the cable fails, how does it fail.

MEMBER WALLIS: Did you get -- out of all this, did you get something quantitative like calories (phonetic) per gram added is enough to melt and do something to it?

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

MEMBER WALLIS: Were you quantitative about it instead of just looking and seeing it?

MR. NOWLEN: Not for these tests, no. There's certainly a potential to look at the heat transfer behavior between the fire environment and the cables from these tests but that hasn't been done.

MEMBER WALLIS: I would think that would the key thing.

MR. NOWLEN: Well, again, from a timing standpoint, yes, it's -- you know how you deliver heat to the cable and cause it to fail is a key question for timing. The focus here again was not timing. The focus here was given that we are going to induce failure, how does that failure manifest itself? Do in our context, we would perhaps call that an influence factor. If I heat it up quickly versus I heat it up slowly, that may change the manner of failure, the mode that I fail.

MEMBER WALLIS: Well, in an hour, it would take 3,000 seconds for this to happen? That suggests that there is some kind of diffusion process. It's a rather slow process going on.

MR. NOWLEN: Yes. Well, and in particular, you know, that's fairly consistent with our past understanding of cable failures. In a lot of these test, the temperature that the cables were exposed to hovered right at where we expect the failure to . You know, 400 degrees, centigrade for example, we were hovering right in that range for a cable that we expect to fail at about 400 degrees centigrade, so these extended times are consistent with that behavior. If you emerse it right at its threshold, it takes a long time for it to heat and respond.

MEMBER WALLIS: It's firelizing (phonetic) whatever the word is, and then sort of the gases are diffusing out and all that.

MR. NOWLEN: Right, and the heat is --

MEMBER WALLIS: Don't you have a model like that?

MR. NOWLEN: There are models.

MEMBER WALLIS: What happens to cable insulation.

MR. NOWLEN: There are models of that, yes. Again, it was not the focus of these particular tests.

Okay, let's see factors. One of the things we saw was that the routing in the conduits appears to increase the likelihood of shorts to ground. This would at the expense, for example, of spurious actuations. A short to ground doesn't typically give you that. There are some specific configurations where multiple shorts to ground might get you there, but this -- again, there was some speculation as to whether the prevalent ground plain that the conduit itself represents would tend to drive things to ground or whether the nice uniform even support that a conduit provides the cable might actually make it more likely that you'd see internal shorting.

It seems that the ground plain won out on that battle. There's a little bit of contradictory information there that we're still trying to short out but in general we saw fewer interactions.

MEMBER SIEBER: Did the cable last longer before failure in the conduit or armor than in an open tray?

MR. NOWLEN: No, not especially.

MEMBER SIEBER: So that didn't do anything for it.

MR. NOWLEN: It's not a fire barrier, no. No, not at all.

MEMBER WALLIS: Is this time to failure very variable between tests?

MR. NOWLEN: Yes.

MEMBER WALLIS: Very variable.

MR. NOWLEN: Very variable. Some happen quickly, some lasted well over an hour.

MEMBER WALLIS: Order of magnitude?

MR. NOWLEN: Yes. And again, it was tied to the exposure mode and the fire intensity. The ones with high intensity fires directly under the raceway failed very quickly. The ones with a lower intensity fire or even some of the fairly high intensity fires off to the side where it's a hot layer exposure, took well over an hour. I think Fred will probably get int that a lot more, too.

MEMBER SIEBER: Did the flame ever touch the cable itself?

MR. NOWLEN: We avoided that. I don't remember -- I think one of the early tests that happened but in general, we were not interested in the direct flame exposure mode. We chose not to focus on that one.

MEMBER KRESS: Could you correlate the failures with the temperature rather than time and --

MR. NOWLEN: Yes, we've made some initial attempts at that. Again, it wasn't really our objective here but we've already done some of that. If you look at the test report that we published, in conjunction with each of the failure diagrams, there's also a temperature plot.

MEMBER KRESS: A temperature/time chart.

MR. NOWLEN: Yeah, and I think, in fact, Fred has -- the NEI effort has taken a deeper look at the temperature behavior than we have.

MEMBER KRESS: You might able to rationalize the time out.

MR. NOWLEN: Oh, I think you certainly can, yes. Yes. Again, I don't see these -- you know, the time to failure here, given the exposure temperature, they're consistent with what I would have expected. In some cases, I think they lasted longer than I might have guessed but looking at the temperature data on the back side, I'm not that surprised.

Okay, we also --

MEMBER WALLIS: You keep saying that something was not the focus of the tests. Presumably, this was rather a try it and see type test where you said let's make some sort of typical cable trays and put a fire somewhere and see what happens. It was not -- so you didn't have a hypothesis to test or a mechanism to test.

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

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

MEMBER WALLIS: That was a pretty bold statement.

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

MEMBER SIEBER: They eventually do.

MEMBER POWERS: I mean, it was true but the implication was that that would not happen otherwise. And an argument presented that this was a result of a careful experiment and on so in many respects this test stands as a counterpoint to that previous presentation to us.

MR. SIU: If I could just add to that, Steve eluded to an earlier presentation. Some of the work we did under this task was to identify factors that might effect the failure mode of the cable and so the experimental design actually explored those factors. What we don't have in this program is a physical model of the cable or the cable tray and we haven't been aiming at development of a mechanistic model of the failure mode given the cable damage.

In PRA, fire PRAs typically the likelihood of a hot short spurious actuation has been teating using a probability number and it's estimated and so what we're trying to do is come up with a better basis for that the probabilities were assigned based on physical characteristics of this.

MEMBER WALLIS: This morning we were saying that besides there trees, there's a very important time element here.

MR. SIU: That's correct.

MEMBER WALLIS: There seems to a very important time element here, too, and if the fire is put out before the cables failed --

MR. SIU: That's right. The probability

number I'm referring to is that conditional probability of the hot short and spurious actuation given cable damage. We say cable damage has occurred. We have other models that tell us what's the likelihood of cable damage and that's exactly what you're referring to, the competition between the growth and suppression.

MEMBER WALLIS: So you can predict this time to failure that's evident in this --

MR. SIU: That's how we treat it in the models now and now so there's this additional element, how does the cable fail given that it has failed.

MR. NOWLEN: Right, and so that's the part we were attacking here. So again, another factor we saw as important is the armored cables. The behavior here was similar to conduits. The armored cable typically has a spiral wound metal sheath over the insulated conductors that often then has an outer jacket over that but that spiral sheath seemed to again, a very prevalent ground plain. They're typically a grounded practice. And so we saw predominantly shorts to the armor rather than conductor to conductor shorts. I think in this case the armored actually was a little more pronounced than the conduit. The conduit is still a little contradictory. We're not real clear on that behavior. Armored was fairly --

MEMBER SIEBER: The kind of armored cable you're talking about is what used to called .

MR. NOWLEN: Yes, that is the trade name, yes. Yes, that's a trade jargon for it.

MEMBER SIEBER: That's not used very much any more, is it?

MR. NOWLEN: Certain plants use it a lot.

MEMBER SIEBER: Really?

MR. NOWLEN: Yes, certain plants use it a lot.

MEMBER WALLIS: Well, the armor is grounded so, I mean, you've got to get there first.

MR. NOWLEN: Oh, yes. But again, you've got multiple conductors within the armor.

MEMBER WALLIS: Oh, within the armor.

MR. NOWLEN: Yes. So the question is, could you get shorts among those conductors or how likely was it to get shorts among those conductors not involved in the armor.

We did see some inter-cable and I'm going to use intra-cable and inter-cable. Intra-cable just means within a single multi-conductor. Inter is just between two independent cables. In our case it was typically a multi-conductor and the three single conductors represent the inter-cable behaviors. The inter- cable conductor and conductor shorts were less likely but we did see some, we saw a few cases.

In this case the thermo-plastic cables appeared more likely to experience these inter-cable shorts. Again, the melting allowed the conductors from the different cables to come together whereas with the thermo-set cables the charring behaviors seemed to keep them apart more, especially between cables. The cables I the conduits also saw some inter-cable shorting behavior, that is we'd have multiple cables in a single conduit and there were some behaviors there as well. Again, less likely, but it was observed.

We did some testing with DC power supplies and AC power supplies and we ended up with some inclusive data here. There were some problems in some of the tests where the data didn't come out quite right due to a flaw in the system that we were using. And so we ended up with some kind of inclusive results. There were some things that seemed to indicate it may not make a difference. Some things seemed to indicate it does. So that's why we still have open --

MEMBER KRESS: Why would you think it would make a difference? If you were to ask somebody, me for example, I would say it wouldn't make any difference.

MR. NOWLEN: If you asked me beforehand, I said it didn't make a difference, too. We wrote this down as a potential influence factor and said it was likely a weak influence factor. We did not expect to see differences. We have seen some things in the test data that we need to think whether we were right or not. I don't know why and I'm not sure it's correct. It may an artifact, this is just something we --

MEMBER WALLIS: It's probably an artifact, because I don't think this cares which way the electrodes are going.

MR. NOWLEN: That was my judgment, too.

MEMBER POWERS: Once again, the momentum equation rears its ugly head here.

MEMBER SIEBER: Other than when you were testing each portion of the cable, there was no power going through the cable, right?

MR. NOWLEN: Correct, yes. We would -- for our test, we would energize one conductor at a time.

MEMBER SIEBER: Right, and it was at very low current, right, so you aren't heating the case.

MR. NOWLEN: Yes, yes. Correct. Let's see, the last point here was another mode of failure would loss of continuity of the conductors themselves, they break. We did not see that in any of these tests. That type of behavior is usually associated with high potential cable, high voltage, high current.

MEMBER WALLIS: I have another question, I'm sorry. Talking about this power, these cables are not energized with large currents. It's just a test current, it's a tiny current, isn't it?

MR. NOWLEN: Correct, yes.

MEMBER SIEBER: For a tiny period of time, too.

MEMBER WALLIS: You're not worried about any kind of forces due to currents.

MR. NOWLEN: Correct.

MEMBER KRESS: Or you're not worried about differences in voltages that might cause sparks and things like that that damage the cables, is that --

MR. NOWLEN: Well, we did have substantial voltage differences. You know, these were typically run at 120 volts, AC or DC.

MEMBER KRESS: I'm worried about one cable above another one, with different voltages at that port.

MR. NOWLEN: Yes. We would energize one conductor at 120 volts and so its potential to the others could have been 120 and there was always at least one that was grounded. So you'd always have one energized, one grounded. The others would kind of in the neutral if they had shorted.

MEMBER KRESS: So you did have that.

MR. NOWLEN: Yeah, but we did not impose anything in the way of substantial baseline currents. So there is no impacity heating, for example, of these cables.

CHAIRMAN ROSEN: No heating of any kind. Would you expect that in a high powered cable that's in a fire, there would different failure modes or failure effects? Did you say anything at all about that?

MR. NOWLEN: For high power, yes, and again, it's a thing that may influence timing. These are control cables and for control cables, no, it's not a major issue. The heating rates for control cables are rather low. You know, they're bleeding off tenths of amps, usually one or two conductors carrying a few tenths of an amp. So for control cables it's not a big issue. Power cables, perhaps. Okay.

MEMBER SIEBER: If you were carrying a big load, that's where the difference between AC and DC is.

MR. NOWLEN: Possibly, yes. Yeah, and again, power cables would the application.

MEMBER SIEBER: Right.

MR. NOWLEN: So again, in these particular tests, we didn't see any loss of continuity failures. But again, these are behaviors that are associated with things we didn't have in our tests, the real high intensity fires, and high -- the high potential cables. Ours were not that high potential, so again, that wasn't a reals surprise consistent with our understanding.

So the second thing that was done under the NRC sponsorship was a surrogate instrument loop and basically what I put up here is a circuit diagram of our system. We had a current to simulate a control signal or, I'm sorry and instrumentation signal coming from a transmitter, say inside containment or wherever. There were fuses to limit any fault currents coming back into our current source. The cable was then run through the fire test cell and back out of the test cell through another pair of fuses to a simulated control room indicator. Basically, there is these resistors, the 10 ohm resistors were intended to simulate a long length of cable between you and the world and then this, the 250 ohm resistor is basically a ballast resistor that will take a 4 to 20 milliamp signal and turn it into a voltage signal that's then read out on in effectively a voltage indicator. So this is a fairly typical simple configuration for an instrument loop, 4 to 20 milliamps and we ran these in several of the later tests.

The next slide gives you an indication of two tests, the results. This test was a thermo-plastic cable and this test was a thermo-set cable. The interesting thing that we saw and we saw this consistently, was that the thermo-plastic cables failed very abruptly. You know, you went from basically a good reading and here by the way, what we've done is we've taken and said that our 4 to 20 milliamp loop current corresponds to a zero to 100 percent process scale reading, whatever that happens to . So in this case because of the baseline load, you know, we're running 69 percent on our process variable.

So if the operator were watching this, what he would have seen is this would have dropped off scale low, very abruptly, easily diagnosed as a faulty instrument. In this particular case with the thermo-set cable, the behavior was rather different. We saw this progressive degradation and then ultimately there was an abrupt transition to again off-scale low. The off-scale low indicates the conductors have shorted together and I've completely by-passed my instrument reading in the control room. I'm shunting the current through the short and back to the transmitter.

MEMBER SIEBER: Is that enough to blow the little eighth amp fuse?

MR. NOWLEN: No, not in our case. The -- in this case the eighth amp fuse was there just in case we were to short over to one of those 110 volt control cables that can really give a 4 to 20 milliamp power source fits.

MEMBER SIEBER: It would give you a chance to buy another one.

MR. NOWLEN: Yes, exactly. And NRC didn't want to pay for another device.

MEMBER SIEBER: Now was it typical that the thermo-plastic cable would last longer than the thermo-set cable in this instance?

MR. NOWLEN: No, actually, it's just the opposite. Yeah, it's interesting, I didn't even pick up on that. Typically, the thermo-plastic cables failed much sooner in equal environments, the thermo-plastics will go sooner.

MEMBER SIEBER: Okay, so this isn't representative of equal environment.

MR. NOWLEN: No, no, in fact, this was probably -- I'd have to go back and look again. I just grabbed these sort of at random. This was probably a plume exposure. Or, I'm sorry, this was probably a hot layer exposure and this was probably a plume exposure, so it went more quickly --

MEMBER SIEBER: Okay, thank you.

MR. NOWLEN: -- especially given the timing there, that's probably a plume exposure.

MEMBER SIEBER: Thanks.

MEMBER LEITCH: What's that spike on the plastic cable? Is that --

MR. NOWLEN: Well, for a second it jumped back. You know, it separated out and came back again. We did see that a few times. But again -- well, let me jump to the -- it's this pronounced behavioral difference between these two types of cables that was interesting here. We had speculated about this in advance of these tests the fact that thermo-plastics melt that we would see more abrupt transitions and in fact, we saw that. So, you know, the idea that with the thermo-plastic there's no real signal degradation, it's either good or it's bad. But with the thermo-set, there's substantial degradation of this signal that the implications would that if we're doing human reliability analysis. You know, the operator probably diagnosis the loss of signal on the therm-plastic with extreme ease, whereas he might misled by the degraded signal that he gets from a thermal set cable. So that was what we saw there.

Now, there was a complimentary set of industry tests. Their tests focused on a surrogate MOV circuit. Fred Emerson is going to speak about those, so I'm not going to cover these in any detail at all. We did do an analysis of the data and there is a write-up of that in Appendix D of the draft report we provided you with. This was based largely on my own input as a member of the EPRI panel on spurious actuations. And so that's its basis. The report is currently undergoing review and our findings to date are based on our understanding of data and that analysis.

In particular the EPRI expert panel report is out, but the industry test report is not yet out. We haven't seen that yet. We've seen presentations at the NEI forum twice, so we -- you know, we've fed their interpretations into that extent, but this is still subject to some reconsideration.

So overall, what did we find? We learned a lot from these tests. These were really very illuminating. Many of our previous findings were, in fact, confirmed. The idea that multi-conductor cables fail conductor-to-conductor with high probability, we had seen that in previous testing. We felt reasonably confident of it and we definitely confirmed that here, 80 percent probability or higher.

MEMBER POWERS: Steve, let me ask a question about that probability. If I'm setting up my fancy fire PRA, and we've got a fancy one, and by doing some analysis carefully, can I take your 80 percent to the bank?

MR. NOWLEN: Conductor-to-conductor faults, yes. Now, is that a hot short probability? No, because again a hot short is a specific kind of conductor-to-conductor failure. It's an energized conductor coming into contact with a non-energized conductor that I care about. Is it a spurious actuation likelihood, no, because that's another step. It's a hot short involving the right pair of conductors. So this is a part of the problem. It's the conductor-to-conductor behavior.

MEMBER POWERS: I guess what I'm really worried about is, we've done, I don't know 17 tests something like that.

MR. NOWLEN: This set was 18, yes.

MEMBER POWERS: And you've got quite a few phases here. But a fairly limited set of experimental conditions, a fairly limited number, that I have a problem with the tests. It's very difficult for me to extrapolate them to the specific conditions of fire I'm likely to have in a nuclear power plant. And so I'm sitting here saying, gee, can I take that, use that 80 percent, should I correct it, should I fiddle with it, should I spread it out a little to account for all the problems I have in using the test data correctly?

What I'm asking for is, what are the caveats I put on this 80 percent before it becomes a number carved in stone?

MR. NOWLEN: Again, the caveats are that this is a mechanistic view of the way the cables themselves fail. It does not tie you to the circuits. It doesn't tell you whether you've got a spurious actuation yet or not. Now beyond that, you know, the issues of the test limitations of the data that we have, I place high confidence in this number as a indicator of the mechanistic mode of cable failure.

MEMBER WALLIS: I think it would very different if you had an external fire like yours or if you have a branch type fire where the fire was in the cables themselves.

MR. NOWLEN: I'm not so sure. I think it's -- I think you're still going to see this same behavior. We saw it -- you know, again, we did a review of that existing literature that was a number of tests that had explored this behavior in not quite as clear a manner but we saw very consistent numbers coming out of it on the order of 80 percent or more of these faults were always occurring conductor-to-conductor and some of those were, in fact, multi-tray tests. The one set that we had that was most complete was four tray tests where the fire was ignited in one tray and spread to 2, 3, 4 and those saw the same type of behavior, again 80 percent of --

MEMBER WALLIS: I guess failure to the tray is most likely for some reason the tray gets very hot not the -- it's not so hot -- I think it's from the tray rather than -- that would rather different to me than a fire from above that heats the cables first and not the tray.

MR. NOWLEN: Well, these were fires from

below and the tray and cables heat together really. I mean, they're an intimate system. The only way I could think of that is some how inducing inductive heating in the tray or something like that.

MEMBER WALLIS: A radiation fire to the tray rather than an inductive fire or some --

MR. NOWLEN: Yeah, that --

MEMBER WALLIS: That might make a difference, I don't know. It's speculative.

MR. NOWLEN: It might, yes. I suspect that you will still see in this mechanistic view of the cables failing, I think you're still going to see this number, take it to the bank and put it in your account. I think this is the right number.

MEMBER WALLIS: Was the tray perforated or was it solid?

MR. NOWLEN: This was a ladder. Yeah, it's a ladder. Yeah, it's like an aluminum ladder.

MEMBER WALLIS: An open tray?

MR. NOWLEN: Yes, that's the predominant configuration.

MEMBER WALLIS: That must make a difference.

MR. NOWLEN: It might, it might.

MEMBER SIEBER: It's like just being out in the air.

MR. NOWLEN: It's like -- well, except that you have the rungs supporting -- you know, the cables are resting on the rungs and that's a pressure point.

MEMBER SIEBER: That's the grounding.

MR. NOWLEN: That's where the ground path is, yeah.

MEMBER KRESS: Yeah, but that may a cooler spot, too.

MR. NOWLEN: It's possible, yes.

MEMBER KRESS: I think what's happening is you're heating up in between.

MR. NOWLEN: Okay, let's see.

MEMBER POWERS: Well, I mean, here's the -- we're talking about the research program here and you've gone and you've got a gee-whiz test and you've got some fuel for the modes of containing -- of conductive failures but I don't have a physical model for the cable here. So, I can't take an arbitrary fire and apply those results, whether it's blow torch over the top of the cable, whatever, some other fire and so I ask the question, why isn't the research program developing this mechanistic cable model, the whole shebang.

MR. NOWLEN: Can I defer an answer --

MEMBER POWERS: Is that the question that's on your mind, Graham?

MEMBER WALLIS: It's been on my mind for a long time, yes. This seems to very much the gee-whiz try it and see what happens type research.

MR. NOWLEN: Okay, let me defer that to my last slide.

MEMBER WALLIS: Generalizing it to some other situation and it becomes different.

MR. NOWLEN: Yes, I agree. Let me defer my answer to the last slide. Okay, let's see, the incidents factor as we saw, some of these that we thought to important proved to important. I think we've covered those. There was one new one that popped up. We had identified the circuit details and a general influence factor. But specifically in the NEI tests, the MOV circuits, these control power transformers turned out to a very important effect here. We hadn't picked up on that specifically. We had identified general configuration as a factor and I believe Fred will cover that, so I'm not going to get into detail there.

We did see a broad consistency between the IR and the MOV results that Fred's going to tell you about. The idea that the embedded conductors fail later. The conductors shorting to nearest neighbors, short complex behaviors, durations of the hot shorts and spurious actuations that were observed and the fact that all of the cables eventually shorted to ground, all those were consistent between the two sets.

MEMBER WALLIS: I'm curious about what happens if you turn on the sprinkler before the cables fail. Is it more likely to lead to failure, early failure?

MR. NOWLEN: That's a question we didn't answer. The sprinklers were turned on in a number of the tests but usually it was after the cables had all failed and fuses had blown. There was one case -- there was one -- no, okay, I'm going to let Fred answer that one then, because Fred knows the details of that.

MEMBER KRESS: On your second sub-bullet on that slide there, I would hard-pressed to see how conductor could short to something which wasn't as near as many.

MR. NOWLEN: We agree. Well, again, you know, these were things that we thought we knew and, you know, we've confirmed it. We've said that. These tests clearly give us definitive, yes, that's what happens.

CHAIRMAN ROSEN: This question about what would happen if the sprinkler turned on is that same question I asked this morning about damage to operable safety system equipment in the event of actuation of fire suppression equipment, either automatic or manual. We were talking about it in the context of a fire brigade but I was really thinking about this situation, too.

MR. NOWLEN: Yeah, yeah.

CHAIRMAN ROSEN: You said you didn't handle that in the modeling. You were talking about modeling.

MEMBER SIEBER: The other thing, as long as we're talking about things that bother us, one of the things that bothers me is not all cables in nuclear power plants are installed horizontal. Somehow they go up too, and down. So we don't have any tests of what happens when the cables are --

A VOICE: Some of these tests --

MR. NOWLEN: Yeah, some of them were vertical trays as well.

CHAIRMAN ROSEN: Oh, were they?

MR. NOWLEN: Yes.

CHAIRMAN ROSEN: And did you see any

difference in failure modes, anything different about that?

MR. NOWLEN: It wasn't a very strong influence factor. There were some differences. It wasn't very strong.

CHAIRMAN ROSEN: Because you showed us a plan view and it all looked like it was all at one level.

MR. NOWLEN: Yeah, I didn't show you the one with the vertical tray.

MEMBER SIEBER: I would think that the vertical tray would deteriorate faster because, you know, there's more space for combustion. On the other hand, gravity is not pulling cables into ground. They're tied in there with tie wraps.

MR. NOWLEN: That's right, that's the point is they are tied in with tie wraps, so it's not like they're sort of hanging out in air. That we didn't do. We didn't do the air drop configuration and --

MEMBER KRESS: But, you're not actually burning this insulation.

MR. NOWLEN: Not explicitly. In some sense there was some burning of the cables, but not --

MEMBER KRESS: It wasn't part of the test.

MR. NOWLEN: No, that wasn't part of the

test.

MEMBER KRESS: You're just heating it up and then --

MR. NOWLEN: Yeah, these were intended to exposures.

MEMBER WALLIS: Suppose I do a one-dimensional analysis? You have a round conductor and you have this stuff, and I instantaneously impose a temperature of x degrees on the circumference and it would seem not too difficult to develop some idea of what happens as a transient, chemically, thermally, diffusing and so on, one dimensional radial transport phenomenon. This must have been done by somebody?

MR. NOWLEN: Yes, it's --

MEMBER KRESS: I don't even think you need that. I think what you've got is radiant heating and conductive heating of the gases go through --

MEMBER WALLIS: Whatever you want to put on for your outside --

MEMBER KRESS: -- going through a --

MEMBER WALLIS: I'm trying to make the problem simple.

MEMBER KRESS: Well, this is --

MEMBER WALLIS: No, it's not because I've got a uniform temperature. I think it's an easier problem radiant than a convective flow.

MEMBER KRESS: Well, all I'm trying to do is find out when the given cable reaches a given temperature at a given spot. That's pretty simple.

MEMBER WALLIS: Well, I'm trying to figure out what's the given mechanism and it appears it has to some sort of diffusion of charred products through the char or something like that.

MEMBER KRESS: I think it's just the mapping of the cable.

MR. NOWLEN: Yeah, it's primarily a diffusion of heat into the cable.

MEMBER WALLIS: But that seems to me is much too quick. It seems to me --

MEMBER KRESS: I think when you get it up to the melting temperature or some other magic temperature, it fails. And I think you can correlate the temperature --

MEMBER WALLIS: That's too quick, that's too quick.

MR. NOWLEN: Well, keep in mind though --

MEMBER WALLIS: I think an order of magnitude, for heaven sake. Well, this is somewhat transient. What is the thermo relaxation time of this installation? It must very short.

MR. NOWLEN: Well, it's a very large mass of cables. It's not very --

MEMBER WALLIS: It's a very large mass?

MR. NOWLEN: It's a mass of cables, yes. It's big with lots of copper and lots of thermo mass.

MEMBER WALLIS: This is a lots of argument rather than a quantitative one? You're going to go back to freshman class here.

MR. NOWLEN: It's a semi-quantity. It was a --

MEMBER WALLIS: But I would encourage somebody to do some of these simple -- relatively simple calculations that we think it's thermo-mass, gee, whiz when we work out the numbers we get 10 seconds that are at 3,000 so we'd better change our minds or whatever.

MR. NOWLEN: I agree, and as I mentioned up front, we have barely scratched the surface of this data set. We've looked at it in this context, but there are many other contexts in which this data is interesting and important.

MEMBER WALLIS: I just can't see how you could resist doing at least one homework problem on this.

MR. NOWLEN: You haven't seen my work

schedule. Okay. Quickly, two more slides; we did see some unique things from the MOV tests, certainly. I think it's worthy of noting that in most of the tests here cables did fail, at least one device in the MOV circuits did actuate.

MEMBER WALLIS: Can I ask -- I'm sorry to keep on asking questions. Would you give me, please, the dimensions and properties of the stuff so that I could do a homework problem? Would that an unreasonable request?

MR. NOWLEN: No, sure.

MEMBER WALLIS: Maybe after a break or during a break.

A VOICE: I think it's in the report.

MEMBER WALLIS: Well, I don't think I have the report. I'm not sure I'm in the right pipeline here.

MR. NOWLEN: Yeah, we can get it to you. I don't have that information with me, but I certainly have it at home.

MEMBER WALLIS: Maybe someone has the report here I can look at. Okay, thanks.

MR. NOWLEN: The one you need is the test report, the published NUREG CR, not the draft.

Okay, the MOV tests, we did see in several tests there was more than one device actuation. In one test the -- there was one test where again, there was four MOVs typically in each test and there was one test where all four of the MOVs saw at least one spurious actuation hit. So, I think that was very interesting and it's important information for us. The device actuations due to intra-cable hot shorts were the most common but there were a number -- a small number of interactions due to inter-cable.

MEMBER POWERS: Then spurious actuation did occur.

MR. NOWLEN: It tells me that these are not incredibly low probability events.

MEMBER POWERS: Yeah, I mean, that's all it tells you, right?

MR. NOWLEN: Well, I think that's an important insight. I think there's been a lot of argument about what the likelihood of these is. I think we have a much better feel for what these likelihoods are today than we did two years ago.

CHAIRMAN ROSEN: These were originally thought to once in a lifetime, once in a million kind of events and in fact, they're not. These probable events in a serious fire. That's the conclusion I take away. You have a serious fire with a lot of electrical cables involved, you're going to have -- you'll probably have a hot short.

MR. NOWLEN: I tend to agree, yes.

MEMBER POWERS: I mean, I'm not sure how to interpret that exactly. It would probably operate from the frame of mind that say, I always thought actuations would occur.

CHAIRMAN ROSEN: Well, you know, I've always thought they wouldn't and, you know, now I think these tests say to me that they probably will. They're not all going to -- not every cable that's involved is going to show a hot short, but if you have a lot of cables involved and a persistent hot fire, you're probably going to have one.

MEMBER POWERS: What I struggle with a little bit is right now I have deterministic kind of analyses that say though shall hypothesize by shorts, possibility of spurious actuation and you do it for every conceivable configuration that you've got. Okay, so now I say, well, I'd really like to put this on a more probabilistic frame and do this in a less demanding fashion. And I'm not sure I can use this to these results, do that.

And so I'm asking is there -- am I wrong about that? Has my life changed? I mean, I want to do a sophisticated job. Can I use these results to change my life and I'm not sure I can but see my next question is, can I do a test in which I do change my life. And then my third question is, should we do a test to change my life. I eventually get back to you, David.

MEMBER WALLIS: The thing is can we devise a test which will change your life?

CHAIRMAN ROSEN: Have you ever changed your mind about anything is the question? Let me take control here for a minute and tell you what's going to happen. We've got 20 minutes more till we break and four more minutes of that time is up for you and the rest is reserved for Fred.

MR. NOWLEN: Well, we still have Fred as well.

CHAIRMAN ROSEN: That's right. He's got -- after you get done messing with the four minutes you've got, he gets the next 15.

MEMBER POWERS: Well, I thought he got the break?

CHAIRMAN ROSEN: What?

MEMBER POWERS: I thought he got the break.

CHAIRMAN ROSEN: No.

MR. NOWLEN: Okay, the last slide. There

are challenges that -- and areas of uncertainty, clearly that we have not yet resolved. The first one gets to the point that was raised earlier, the combinatorial models, this mechanistic connection between the behavior of these cables and the behavior of some circuit that I'm specifically worried about in my plant. There have been some proposals made in this area, in particular Dan Funk, one of the industry folks, has proposed a model. We haven't really had a chance to explore that fully to see how well it works. I think we're -- you know, we're working that direction. We're not quite there yet.

The DC versus AC we talked about, still some uncertainty there. We're not quite sure why. There's a little uncertainty on the conduits, not quite so bad. The influence factors, we didn't look at all the influence factors and some of them have been bandied about here, the things that we didn't look at. So we need to understand those better or at least understand which ones are going to make a difference to us. Quantification for a specific case still requires some expert judgment.

And this is just the last point, can you use this? Yes, absolutely. I argue this is the best stuff you've got. Now, can you just take the number and apply it in your analysis? No. It still takes some expert judgment to make the connection between the behaviors we observed in these tests and your circuit and your cable. That still has to happen and we're still partly expert judgment here.

MEMBER POWERS: This is the problem I have when you tell me use expert judgment to transfer the results from these tests to the real accident, without experimental data, how do I have expert judgment in this thing?

MR. NOWLEN: I understand. It's a challenging problem.

MEMBER WALLIS: By expert judgment, he means guesswork and --

MEMBER POWERS: Hope and prayer it looks to me like all you've got going for you right now. I mean, it's -- the only way I can make this transition is to have a mechanistic mental model of the fire both the accident fire and the test fire, and a mechanistic mental model of the way the cable behaves. Now the trouble with that is that it's my mental model and I don't give the opportunity for Graham to criticize my momentum equation in there because I don't write the damn thing down.

MEMBER WALLIS: I don't think the momentum equation is all that important in this --

MEMBER POWERS: Well, it's never very important.

MEMBER WALLIS: It isn't going to go very far very fast.

MEMBER POWERS: But I also don't let you criticize my chemical kinetic model because you don't ever get to see it here.

MEMBER WALLIS: I don't think you have one.

MEMBER POWERS: Oh, I always have a chemical kinetic model, you can go to the bank on that one.

CHAIRMAN ROSEN: You're using up his four minutes.

MR. NOWLEN: Yes.

MEMBER POWERS: I'm using my four minutes here. So the question we come back to is the one you deferred, is why aren't we producing these mechanistic models?

MEMBER SIEBER: The better question, a forerunner to that is, do you think you have enough data to validate --

CHAIRMAN ROSEN: Not from these tests.

MEMBER SIEBER: This gives good insight but it's not a validated model.

A VOICE: This is the way you develop a model.

MR. SIU: I think we are well beyond where we were, as Steve indicated, two years ago. I think we actually do have some valid test data which certainly doesn't cover all possible conditions. I'll certainly grant that. I guess one of the reasons that we haven't thought about the mechanistic model, maybe that's something we'll need to address as we update our research plan.

When we think about the application of that mechanistic model in the real world PRA, start thinking about the data demands of such a model, I get a little worried. It's my similar fears about computational fluid dynamics. Yes, I know I can do very nice jobs -- a very nice job using those models but I have to develop the model actually to employ that. I have to put the cables in there, I have to put in the supports, I have to do a lot of things that take a lot of time and effort and maybe I don't need to do that.

You asked that question, what's good enough? I'm not sure -- let me back up a little bit. Some of the factors Steve has mentioned before in, I think, a previous talk, we talked about where the cable is in the cable tray. Is it on top, is it on the bottom, because the effect of the weight on top of that cable could make a difference. How are the wires hooked up, which one is the power wire, which one is not? These are things that if you get into a very sophisticated model, which is quite possible, I think it's quite feasible to develop this, you're going to have to do a lot, so this is -- I'm not saying that we're not going to do this. I'm simply saying that this -- in the past, this is some of the thinking that's gone behind where we are now.

We've put a lot of our resources in this whole program, into this effort and has continued and continued, kind of like Topsy.

CHAIRMAN ROSEN: I'm going to let you finish and then I'm going to let Graham Wallis have a word.

MR. SIU: So I'm just -- and maybe it's a rationalization of why we're not -- we haven't done it to date and again, we're listening and we welcome your input on that.

MEMBER WALLIS: I'm usually very impassioned but now you're giving the standard student excuse that I don't want to do any analysis because I'd have to analyze everything and it would too difficult. I think you can go quite a long way with some relatively simple analysis to figure out what matters and what doesn't matter, what might different about your test and the nuclear plant test and so on. You've got to do that. I don't think it's that difficult.

You cannot say, it's difficult because the model is going to have to too complicated. You haven't even tried it seems to me the simple one.

MR. SIU: Well, I'm sorry, maybe I gave the wrong impression. I'm sure we can come up with a reasonable explanation of what's going on, what's the mechanism driving this. I'm going the next step and saying, how do I apply this in the PRA and that's where I'm -- I have certain expectations of what I think is going to important and therefore, what I'm going to have to model. And if I have to start modeling in this mechanistic, completely mechanistic view where exactly the cable is, sometimes it's on top, sometimes it's on the bottom, sometimes the fire is off to one side, sometimes it's directly underneath, I'm wondering if I'm at a point of diminishing returns.

MEMBER WALLIS: But it's simply time to melt, and you simply --

MR. SIU: Well, no, the time to melt again, that's the problem. I don't -- we know how to model it and we are modeling that. It's this competition between the specific locations of the melt point if you will that's telling me do I connect these two conductors first or these two and if these two conductors are connected first, I might just go directly to ground and I don't have a problem or my trips match actuation device. I'm sorry.

CHAIRMAN ROSEN: All right, thank you very much.

MR. NOWLEN: I will leave my last bullet unstated because that's another hot -- you know, there's another aspect of this that we're not dealing with very well yet and that's the transient behavior and this gets you to some of the regulatory issues of simultaneous, concurrent, sequential, how do I deal with it. And again, that's another challenge that we have. So with that --

CHAIRMAN ROSEN: NEI, it's your 15 minutes.

A VOICE: Surely you can more generous than that.

CHAIRMAN ROSEN: Generosity is not the issue. Wait for Christmas and you'll see generosity.

MR. EMERSON: Thank you. Given the

discussion that has taken place over the last hour and 15 minutes, I've concluded that there is absolutely no way I can do justice to these slides in 15 minutes. Take me time?

CHAIRMAN ROSEN: No, take your 11 minutes.

MR. EMERSON: So I will take my 11 minutes.

CHAIRMAN ROSEN: I'll give you the full 15, but go ahead.

MR. EMERSON: Okay. First I'd like to start by -- you're going to probably have to review the slides to get a lot of the data that I'm going to present but let me just try to summarize briefly what the differences are between what Steve presented and what we presented. Steve was looking for IR results, insulation resistance breakdown. We were looking more for circuit effects in circuits that reasonably approximate what you would see in an actual nuclear plant. Take fire phenomena and determine what would happen to reasonably, accurately portrayed circuits for control cables, for -- which is where you expect the bulk of consequences to with spurious actuations and that was really our goal.

So with that, I'm going to skip the first couple of slides. Now, what I have in my presentation is a quick summary of an EPRI test report that Steve indicated is still -- the report is 400 some odd pages long, covers a great deal of ground and as I say, I'm not going to try to do justice to it. And the last two slides in the presentation are a couple of the more important results of the EPRI expert panel that was convened to determine what the probabilities of spurious actuations are from the results of these and other tests.

Steve gave a pretty good summary of what the tests included. What we will include in the test report, we'll reporting on the test arrangement parameters, electrical results and temperature results and melding those together. The -- you'll see them for all of the 18 tests, you'll see key observations and conclusions and you'll see implications for the NEI guidance document that's being developed to guide the industry in the resolution of circuit failure issues.

Steve presented some profiles or presented one example profile from the IR measurements that he did. I'd like to show one typical example of what you will see in the EPRI report for one of the tests. Now, you can see what this represents, that's one bundle of seven conductor and single conductor cables, 350 kilowatt heat release rate and with the bundle located in the bottom of the tray and the laboratory power supply as opposed to a CPT.

MEMBER WALLIS: What do you mean by the 350 kilowatt heat release rate, that's in a fire of some sort somewhere?

MR. EMERSON: Yeah, that's the heat release rate associated with the fire for this particular test.

MEMBER KRESS: That's basically the rate of gas flow.

MR. EMERSON: Yeah, it's based on the rate of gas flow. That's correct.

MEMBER WALLIS: But you still don't know the heating weight of the cable itself.

MR. EMERSON: That's correct, this was based on the parameters of the fire itself, not of the cable.

MEMBER KRESS: Now, when you talk about a bundle, cables?

MR. EMERSON: Yeah, the bundle is the --

MEMBER KRESS: Are they just strapped together or is there something that --

MR. EMERSON: The bundle is the seven conductors surrounded by three single conductor cable configuration that Steve showed.

MEMBER KRESS: Yeah, my question is, what holds the bundle together?

MR. EMERSON: They are strapped together loosely so that they won't --

MEMBER KRESS: Okay.

MEMBER SIEBER: But the seven has a single jacket, right?

MR. EMERSON: Yes.

MEMBER SIEBER: And the three are on the outside.

MR. EMERSON: Right.

MEMBER KRESS: It has a jacket of what?

MEMBER SIEBER: Some kind of a thermo-plastic material.

MR. EMERSON: It's either thermo-set or thermo-plastic material.

MEMBER SIEBER: Usually the jacket is thermo-plastic even though the insulation may thermo-set.

MEMBER KRESS: Okay, so it's completely closed to the gas flow.

MEMBER SIEBER: That's right. And then the three extra cables are tie wrapped to the outside.

MR. EMERSON: Basically.

MEMBER SIEBER: That's what it looked like in the drawing.

MR. EMERSON: That's correct.

MEMBER KRESS: Okay.

MEMBER BONACA: Which means the outside cables are not --

MEMBER SIEBER: They're not inside the jacket.

MR. EMERSON: Well, they could but we tried to keep them as equally spaced as we could and there were four such bundles in each test in addition to the IR bundle that Steve talked about.

Now, this is a typical temperature profile from the test that shows not only the average and maximum temperatures and when I say that, I mean, these are the temperatures that were -- we had thermo-couples attached to bundles that were adjacent to the test bundle. We didn't want to attach them directly to the test bundle itself because when the jacket goes, then you get some interference between the measurement and the cable itself in terms of sorting. So we put them on the adjacent ones.

MEMBER WALLIS: What's the temperature of the flame?

MR. EMERSON: The temperature of the flame? I'm sorry, was that your question?

MEMBER WALLIS: Yes, the temperature of the flame.

MR. EMERSON: We did not measure the flame temperature directly. We measured the temperatures on the tray and adjacent to the cable bundles and we had two thermo-couples trees that measured temperatures in the hot gas layer and the plume of the fire.

MEMBER KRESS: What kind of gas are you using?

MR. EMERSON: I think it was propane but I'm not --

MEMBER WALLIS: This is just a heat-up of cable. You'd expect a simple RC type transient expediential. It looks a little bit like an expediential to me. No one has tried to model that? You --

MR. EMERSON: No one has tried to model it.

MEMBER WALLIS: Okay. Like an RC, right.

MR. EMERSON: What we've tried to portray with this temperature measurement in addition is there's a line for the -- let's see if I've got this right, for the onset of failure which was basically the point at which you started getting leakage currents and the time when you got full failure which is either a hot short or a short to ground, depending on the particular failure.

This one is a little harder to read and in your package you should have a full size slide. I'm not going to try to describe what all of the curves mean. This particular one indicates when you start off with a zero voltage and then it spikes up, that's where you had a hot short.

MEMBER KRESS: What's the voltage on the top?

MR. EMERSON: This is 120 volts and the nominal voltage that we ran in the conductors that we had powered.

MEMBER KRESS: Okay, so that's the potential difference.

MR. EMERSON: That's the potential difference is 120 AC. So in a case like this, it would start off with zero volts. There would an interaction with a 120 volt cable and it would spike up and you would get a hot short in that case. Whether or not you got a spurious actuation depends on the current and we found pretty much throughout the test that it required a current of about a quarter of an amp to actually get it. When you had a spurious actuation it as associated with a current of about a quarter of an amp.

MEMBER KRESS: That's for a particular MOV or something?

MR. EMERSON: This is for -- the type of MOV we tested, it wasn't actually an MOV, it was a motor started for one and this is a relatively small one.

MEMBER SIEBER: This is a relay in effect.

MR. EMERSON: Yeah, it was a relay, the kind you would find on the typical small valve, small MOV. But below 25 milli-amps you would get -- I'm sorry, before 250 milli-amps, you would get a hot short but not necessarily a spurious actuation.

MEMBER SIEBER: Right.

MR. EMERSON: In a case like this, this shows where you have a short to ground that's going along a 120 AC and then bingo, it falls off when you shorted it out.

MEMBER SIEBER: One point, when you get the short, it's a high resistance short, then there's this relay coil attached to it, it wouldn't go all the way up to 120 volts, would it?

MR. EMERSON: Not all cases did it, but typically you wouldn't get it. The lower threshold was probably about 80 or 90 volts.

MEMBER SIEBER: Okay, so that's the reason why the relay didn't pull in --

MR. EMERSON: Right.

MEMBER SIEBER: -- because you didn't get enough voltage to it.

MR. EMERSON: Right.

MEMBER SIEBER: It's not a current thing.

MR. EMERSON: Okay, I'd like to talk briefly about the summary of the types of failure modes. Now I'd like to emphasize that this slide and the next one are covering hot shorts and then after that we'll talk about spurious actuations and as Steve indicated the two phenomena are not identical with each other.

Okay, in this case what we were trying to do is to illustrate the -- by cable type what generally you got in terms of ground faults or faults to ground versus hot shorts as a percentage of total failures. And we did that, we broke that down for armored, thermo-set and thermo-plastic cable and totaled them. Now, recognize this covers a wide range of fire conditions so this is not -- this is just a very broad indication of the overall results.

What you can take home from this slide is that generally the percentage of ground faults is a percentage of total faults is roughly the same for thermo-set or thermo-plastic cable. The phenomena are different when you go to spurious actuations but for the basic faulting modes that's what we saw. For armored it's a little bit different. There was a higher percentage of ground faults and from what Steve said, you might expect that given the grounded -- the fact that the armor is grounded.

MEMBER SIEBER: A question on that before you move on.

MR. EMERSON: Sure.

MEMBER SIEBER: I take it that some of the hot shorts show up in these numbers covert themselves to ground faults?

MR. EMERSON: Yes, all of them do eventually.

CHAIRMAN ROSEN: But I think this --

MR. EMERSON: I'll talk about duration later.

CHAIRMAN ROSEN: This is the slide where it says that originally we would have argued or some of us or I would have argued that that 31.6 percent is an order of magnitude too high. Now, we see a third of the faults are going to hot shorts.

MEMBER SIEBER: And these are hot shorts that are solid enough to able to actuate the starter coil.

MR. EMERSON: No, these are hot shorts, not spurious actuations.

MEMBER SIEBER: Okay.

MR. EMERSON: This is where we saw evidence of shorting between the conductors and I should indicate that although -- we were measuring two different things. One was actually what happened to a typical circuit, but we were also taking fairly detailed voltage and current measurements to correlate the electrical behavior with what happened in the circuit, so we can see what was actually going on in the circuit at the time of the spurious actuation.

Okay, the next slide has a somewhat different view of this data and rather than looking at it by cable type, we were looking at it as to whether a seven conductor or a single conductor cable. As you see for the seven conductor cable, the percentage -- and again, this is brushing across both thermo-set and thermo-plastic, there's a lot of ways you could slice and dice the data but we chose this one. The percentage of down faults and hot shorts for seven conductor cables is about the same. In fact, it's exactly the same based on the data that we took.

For single conductor cable, you're more

likely to get ground faults. And that's really to expected also because there are more opportunities for hot shorts in a seven-conductor cable. And the next slide I'm going to talking about the spurious actuations rather than the hot shorts and what we saw there. And the first two lines show spurious actuations as a percentage of the total devices where you could have had spurious actuations and the tests that we ran. You can see that there's a much higher percentage for thermo-plastic cable and thermo-set cable. So you can see that although the percentage of hot shorts versus ground faults is the same -- is about the same for the two cable types. The percentage of spurious actuations is different.

And again, given the less robust nature of thermo-plastic cable, that was to expected. Armored is lower because, again, the inherently more rugged construction of the armored cable. The next two lines show spurious actuations as a percentage of the total cable failures and as you can see here, for armored cable, given the two tests that we ran there, this -- you could argue that this wasn't a very complete data set but we -- I'm presenting it for illustration that the percentage of spurious actuations to total cable failures is about 30 percent. For thermo-set it's about 40 percent and thermo-plastic it's about 50 percent.

The last two lines show the average time to failure and as you can see, the lowest average was about 26 minutes for thermo-plastic, 36 minutes for armored and 46 minutes for thermo-set cable, again brushing across a wide range of temperature conditions, heat release rates and so forth.

MEMBER SIEBER: Fred, do you have any data that you could tell us about that shows what percentage of hot shorts converts to a spurious actuation? It looks like it's about half.

MR. EMERSON: I think you can probably derive that from the figures that I've presented.

MEMBER SIEBER: Yeah, it looks like I would guess about half.

MR. EMERSON: Which would show you -- again, illustrates the point that not all hot shorts turn into spurious actuations. And the last line has to do with duration. The durations ranged from very short, just a few seconds, to as much as 10 minutes. The average was in the range of one to two minutes.

MEMBER POWERS: Let me ask you a question that there is, of course, no answer to.

CHAIRMAN ROSEN: If there was an answer

you'd know it and you wouldn't have to ask.

MEMBER POWERS: If I sat down and did this whole data set all over again, how would those numbers change?

MR. EMERSON: I'm sorry, if you did it all over again?

MEMBER POWERS: Yeah, did the whole data -- did the whole test sequence over again.

MR. EMERSON: Oh, okay, you're rerunning the tests.

MEMBER POWERS: As closely to identical as you did them in the original, how much would the numbers change? I mean, you've got 20.6 percent there.

MR. EMERSON: What you're asking is how repeatable are the tests.

MEMBER POWERS: Yes, that's right.

MR. EMERSON: Well, if you ran them in the same test chamber and you ran them with the same release rates as identical, same types of cables, same everything, I'm sure there would some variability.

R. KRESS: Did you run a couple of tests like that?

MR. EMERSON: We didn't run two tests exactly the same. Because a sequence of 18 tests, you're trying to get as much bang for the buck as possible and vary the parameters in an intelligent way to get useful information. So we did not repeat tests, no.

MEMBER KRESS: But that's useful information.

MR. EMERSON: Yes. It would useful information.

MEMBER SIEBER: It tells you something about the uncertainties.

MR. EMERSON: We didn't have --

MEMBER POWERS: There is at least one person at the table that believes that in a short sequence of expensive tests that it's absolutely essentially to run --

CHAIRMAN ROSEN: You mean there are two?

MEMBER POWERS: Two of us.

MR. EMERSON: As I recall, you gave us some input on the test plan before we actually ran the tests and we did take your advice as much as we could.

MEMBER POWERS: But you didn't run her up.

MR. EMERSON: We did not run her up. Okay, moving along, I want to go through the general observations, in fact, the rest of the presentation as quickly as I can. Steve mentioned this as an observation. We would certainly concur. Proximity is a strongly determining factor. One could argue on the second bullet that we didn't have enough data to support sweeping conclusions and I would agree with that but we think that given what we saw and while we didn't repeat any tests, we saw a lot of common phenomena in what happened when we tested the same types of cable under different conditions that we can achieve some statistical characterization and predict on a broad sampling of cables a certain fraction of failures as we did in the earlier data.

We have a better understanding of what were the main influence factors. Obviously, we could do more to beef that information up. What we can't do is to look at an individual circuit and predict how it's going to fail. We can't say this particular thermo-set cable in this particular room and under these particular conditions, we can't say you will have a short to ground here or you will have a hot short. We can't do that because, as Steve indicated, the short phenomena are pretty complex and very hard to predict on a microscopic level.

MEMBER SIEBER: But it's good enough to give you some sense of the probability.

MR. EMERSON: We think so, yeah, and the --

MEMBER SIEBER: And the distribution?

MR. EMERSON: And the expert panel felt that way, too.

MEMBER WALLIS: Now, you said the phenomena are hard to predict so you didn't do it.

MR. EMERSON: Well, on a microscopic level.

MEMBER WALLIS: Well, are they hard to predict on any level?

MR. EMERSON: We think if you look at a broad sampling -- if you look at say, I'm a plant guy and I have all thermo-set cables in my plant, and I have some knowledge of what fires I can expect in a certain area, yeah, I think I can say with some confidence that I can expect something to happen or something not to happen and from a spurious actuation standpoint. That doesn't mean I can't ignore --

MEMBER WALLIS: But if I knew that really was happening, it was simply heating up the cable till it reaches a temperature and then it fails, and this is a transient heat-up problem, all you need to know is get the integrated heat transferred to the cable from the fire, then we're learning that the uncertainty and prediction is in characterizing the fire.

MEMBER KRESS: That's right.

MEMBER WALLIS: And it's in relationship to the cable.

MR. EMERSON: Yeah, you need to --

MEMBER WALLIS: If we knew that, that would help us because we would stop worrying about some other uncertainties.

MEMBER KRESS: Maybe we could find that out.

MEMBER WALLIS: You might able to find that out by rather simple calculations.

MEMBER KRESS: Run a test --

MEMBER WALLIS: Right.

MEMBER KRESS: Yeah, I think you're right. I think the thermo-set probably tells --

MEMBER WALLIS: Just by heating it up.

MEMBER KRESS: -- the product time and temperature and the thermo-plastic fails when it reaches melting.

MEMBER WALLIS: Whatever.

MR. EMERSON: These are the influence factors that we thought were -- based on the test results that we thought were important. Cable type, obviously, we think thermo-set is more robust than thermo-plastic in terms of its resistance. Tray fill, the more tray fill you have the less exposure you have of individual cables in the middle of the fill. You have a greater thermo-mass and we saw some pronounced effects when we ran a similar test with one row instead of four rows. The conductor connection pattern had some influence. We varied the connection of the conductors to the circuits so that some conductors where you had a power cable against -- right against an unpower cable or you had other cases where the power cable was in the middle and some of the target cables were on the outside, there was some influence of the connection pattern and as Steve indicated, the power source characteristics seemed to play a major difference, too, in terms of whether you had current limiting devices on your circuit or you were just using a regular power supply.

MEMBER WALLIS: You always had the same fire and the tray was in the same place? I forget now. I would think the biggest influence would where the fire is relative to the tray.

MR. EMERSON: As Steve indicated, we varied the location of the -- when we were looking for plum effects, we had the flame right under the corner of the tray and --

MEMBER WALLIS: So wasn't that the biggest effect, how close the fire is to the cable?

MR. EMERSON: Well, plume effects are certainly more pronounced than hot gas.

MEMBER WALLIS: I think that's the first thing my wife would tell me. Isn't that the biggest effect? I mean, you're saying influence factors, but really the biggest effect in all of this is where's the fire relative to the cable? How big is the fire? Isn't that the biggest thing?

MR. EMERSON: I think what we're talking about is --

MEMBER WALLIS: I think if you knew that you'd throw out all the other uncertainties as being relatively unimportant compared with that uncertainty.

MR. EMERSON: Yes, the location of the fire is certainly an important factor. If you're looking at influence factors for hot shorts versus spurious actuations, the location of the fire is less important than the temperature it gets to.

Some secondary influence factors and I'm not going to try and get into these in any detail, the orientation exposure type, we did run two vertical tests. We did run plume versus hot gas layer. To address the water spray issue that we touched no during Steve's presentation, the -- what we tried to do is to spray just before the end of the test when there was still some unfailed circuits to see whether those additional failures would take place just based solely on the water spray. And of the 18 tests we ran, only once did that happen. So there was some effect but it wasn't a major one.

MEMBER POWERS: Let me ask you a question, on the brute force you say five percent of the time the water spray caused failure, just strictly from --

MR. EMERSON: Yes, uh-huh.

MEMBER POWERS: Okay, but maybe I should do that. Maybe I should just say the result of the test is that indeed sprays can cause actuations.

MR. EMERSON: They can, that is true.

MEMBER POWERS: Okay, I mean, which conclusion am I sounder to take?

MR. EMERSON: Well, the reason we -- I'm sorry. The reason we ran the test was to see if it was a pronounced effect, whether you could get circuit failures like this from any time you sprayed it and if so, that would tell us we need to think about how we fight fires in areas that have this potential problem.

MEMBER SIEBER: But that alternative is to not fight the fire. And it would seem to me that it would better trying to put the fire out than worrying about whether something is going to --

MR. EMERSON: I don't know if it's a question of whether you put the fire out or not. It's what additional precautions you might want to take to deactivate the circuits before you fight the fire.

MEMBER SIEBER: That's true, you would want to do that regardless of whether you sprayed or not.

MR. EMERSON: You would think so but it would give you an idea of how much time you had.

MEMBER SIEBER: That's true.

MEMBER POWERS: The trouble is it's just not clear to me that the answer I come out of this is don't worry about it, it's only a five percent effect. It seems to me I come to the second conclusion, yeah, worry about it, because it does occur.

MEMBER WALLIS: I would worry about how I sprayed it. I mean, if I sprayed it with a jet which had momentum, I might create forces which would push the conductors together.

MEMBER SIEBER: Cable tray fires are usually fought with fog.

MEMBER WALLIS: Yeah, well, that's quite different.

MEMBER SIEBER: Yeah, it sort of diffuses out there and gets everything soaking wet.

MEMBER KRESS: What causes it to create a short then?

MEMBER SIEBER: Pardon?

MEMBER KRESS: What causes the -- what is the cause of --

MEMBER SIEBER: Water sprayed up.

MEMBER KRESS: It's a conductor, is that the problem you're stating?

MEMBER POWERS: I think that's right.

MEMBER WALLIS: I would think it cause brittle failure by thermo-shock.

MEMBER KRESS: That's what I would think.

MR. EMERSON: Well, by the time we sprayed the cables, the insulation was pretty well gone anyway, so it wasn't -- we weren't losing insulation. Okay, in looking at some of the observations we can make about internal versus external hot shorts and what you're seeing here is conclusions without seeing a lot of the data that went into it. Mr. Chairman, feel free to bang the gavel whenever you feel like it.

CHAIRMAN ROSEN: Well, I feel completely free, but you're making what appear to be unsupported assertions which is our stock and trade. Go ahead.

MR. EMERSON: It's the result of turning a 50-slide presentation into one with far fewer slides.

You have to cut the slides somewhere. When you read our 417-page test result, I think you'll have much better support for the conclusions. The external hot shorts do occur but we've -- the data tell us that they're less likely than internal hot shorts and you might empirically guess that anyway from the proximity of the internal shorts and the existence of jacket material between the conductors as opposed to the extra layer that you would get between two cables shorting externally.

One thing that was interesting was the second bullet it indicates that we did get external hot shorts but they've now resulted in spurious actuations. Does that mean we're going to say you cannot possibly get -- no, we're not going to say that but it was an interesting result of the data. And as we saw from the data table, thermo-plastic cable has a higher propensity for spurious actuations from external shorts than thermo-set cable does.

Now, if I were -- this first bullet was one as a true blue industry person, that I would least likely have wanted to see as a result of this test but it says that if you get a hot short in a multi-conductor cable it's pretty likely that you're going to see multiple hot shorts. And so we're going to factor that into the methods we have for addressing -- for doing -- for analyzing cable failures. These are what we would call and what the expert panel would call dependent hot shorts within the same multi-conductor cable.

You can have multiple independent hot shorts but it happens with less frequency than for a single multi-conductor cable. The next slide shows for all 47 spurious actuations that we observed it's just a bar chart of the time it took to get them and you can see some very, very long time frames and you can see some very short time frames.

MEMBER WALLIS: There's something odd about the two minute --

MR. EMERSON: That was the thermo-plastic cable in a plume which --

MEMBER WALLIS: Right above the fire.

MR. EMERSON: Right above the fire. It shows that spread over all of the tests a large majority of them were over 20 minutes, about two-thirds of them were over 30 minutes and about one-third of them were over 40 minutes. So what that tells us is that in many cases you'll have time to interdict the fire before you get a spurious actuation.

MEMBER WALLIS: Do you have a room like the one that Sandia has?

MR. EMERSON: A room?

MEMBER WALLIS: Yes, a steel room where the fire --

A VOICE: It's the same room.

MR. EMERSON: It's the same room.

MEMBER WALLIS: It's the same room.

A VOICE: It's the same test.

MEMBER KRESS: The same test.

MEMBER SIEBER: The same test.

MEMBER WALLIS: If the room is an oven, how long does it take to heat up to temperature? Does it take something like 60 minutes or something?

MR. EMERSON: Well, you could see from the earlier slide what the temperature profile is at the cable.

MEMBER WALLIS: I did. I noticed that. I thought that was very interesting.

MR. EMERSON: It was not a really quick rise. Obviously the --

MEMBER WALLIS: I was discussing with my neighbor here whether or not it's characteristic of the cable or of the room.

MR. EMERSON: It was some of both, I think.

MEMBER WALLIS: Ah, some of both.

MEMBER KRESS: I bet you could depending on how fast you heat up the room.

MR. EMERSON: Actually, I don't think that's true, especially in the case of the vertical test. Radiation heat transfer was -- might have been the predominant mechanism that was saw but I'm not an expert in that area.

MEMBER WALLIS: Especially if it's coming from the walls of the room rather than directly from the flame.

MR. EMERSON: This slide, I've pretty much covered before. It just gives a little more information about the durations, the shortest, longest average and standard deviations for each of the three cables.

MEMBER WALLIS: How hot does the room get, the wall of the room get?

MR. EMERSON: How hot?

MEMBER WALLIS: Yeah.

MR. EMERSON: We did not have the instrumented, but I guarantee you it was too hot to touch. It was not insulated.

MEMBER SIEBER: Fred, now these times here don't really make any difference if the fault causes the contact to close for an instant.

MR. EMERSON: The implication of this slide is that for most MOVs once you get an instantaneous fault you're locked in.

MEMBER SIEBER: You are locked in.

MR. EMERSON: For some AOV's it could make a difference.

CHAIRMAN ROSEN: Get to your key conclusions.

MEMBER SIEBER: You're talking about AOV's that are operative.

MR. EMERSON: I don't claim enough expertise to answer your question.

MEMBER SIEBER: For them to close, it takes an instantaneous signal. For them to open you've got to hold it.

MR. EMERSON: Okay, moving on to the key conclusions, given cable damage, you can certainly get spurious actuation singly or multiply. You can get external cable hot shorts but we didn't see any of those for thermo-set cables result in various actuations and overall, as Steve said, the likelihood of spurious actuations is higher than we thought using fairly elderly NUREG 258.

We think there exists thresholds below

which you do not get cable failures and this was a conclusion that the expert panel reached also in coming up with probabilities. The time --

MEMBER WALLIS: And of course that must true.

MR. EMERSON: Yes.

MEMBER SIEBER: Or they'd failing now.

MR. EMERSON: The fact, the time for failure was fairly significant, in many cases meant that in many cases people will have an opportunity to interdict the fires before you have the effect of a spurious actuation. And we've talked about the effect of current limiting devices like CPTs and such.

There are implications both for the deterministic analysis and the risk informed methods and I'm not going to go into detail on those. It will impact the way we think about both of those and those impacts will addressed as we finish this document in the next few weeks. Now, just quickly two slides on the expert panel results, these results are taken directly from the EPRI report which is currently available.

There are a number of cases from therm-set tray, conduit, thermo-plastic tray and armor tray that the expert panel and I'm not even going to begin to describe the process.

MEMBER WALLIS: The probability of this happening in a fire?

MR. EMERSON: This is the probability of spurious actuations based primarily but not exclusively on the test results that I just presented or that will available in more detail.

MEMBER WALLIS: But there must have been the real situation. The only thing that matters is the probability, I think, hot enough, close enough to damage the cable.

MR. EMERSON: And therein is a key point because this presents a probability given cable damage but there's also a probability associated with getting to the point where you have cable damage and that is reflected in the NEI document as a total risk treatment of likelihood of --

MEMBER WALLIS: I don't understand that because if you have cable damage and it lasts long enough or the fire continues after that point, you're eventually going to get short, aren't you?

MR. EMERSON: Yes, but --

MEMBER WALLIS: What is the probability really saying then? Eventually, if you wait long enough you always get a short.

MR. EMERSON: But if you have a hot short that results in a spurious -- an initial hot short for most MOVs, it doesn't make any difference how long it lasts if you get the initial voltage and current. It's locked in, you have the spurious actuation and --

MEMBER WALLIS: So these are probabilities of spurious actuation.

MR. EMERSON: That's correct, that's correct.

MEMBER WALLIS: Ah, okay.

MR. EMERSON: Given cable damage.

MEMBER KRESS: It seems to me like you need a model for what causes spurious actuation. That model involves getting up to a particular voltage to actuate the -- the question is how do you get that voltage? It seems to me there's a missing element here.

MEMBER WALLIS: It must depend on the relay, the voltage. The relay needs to --

MR. EMERSON: It depends on the characteristics of the relay or whatever the electrical --

MEMBER WALLIS: How can they make any estimate at all if they haven't done an electrical analysis of the relay? It's just a blind guess.

MR. EMERSON: Well, this is taking --

MEMBER WALLIS: For this particular relay that was used in this particular test.

MR. EMERSON: That's correct.

MEMBER WALLIS: Okay.

MR. EMERSON: Not intended to generalize to all types of relays.

MEMBER WALLIS: Okay.

MEMBER SIEBER: That's really not a bad value, 80 volts or so.

MR. EMERSON: And last but not least --

MEMBER WALLIS: But someone would take it out of context and apply it to any relay in any test.

MR. EMERSON: The other primary product of the expert panel was fragility curves which plotted the probability of any cable damage versus the temperature at the cable. This curve is for thermo-set, thermo-plastic cable. This one is for armored, this one is for thermo-set. And there were zero values if you will, below which probability was essentially zero. But now, I urge you to read the EPRI report which provides --

MEMBER WALLIS: Why does everything kink at .5?

MR. EMERSON: Well, that's an artifact of the way these were plotted. There were actually three values given. Basically, it was .05, .5 and .95.

MEMBER WALLIS: Oh, two straight lines, yeah.

MR. EMERSON: And it was just two straight lines.

CHAIRMAN ROSEN: Well, with that, I'll ask if there are any other brief questions. If not, we'll take a 15-minute break. Try to back at 3:25 and we'll try to make up some time. We've already lost control of the meeting. We will resume at 3:25.

(A brief recess was taken.)

CHAIRMAN ROSEN: It is definition 3:25. Please, Mark and See-Meng, you have the floor.

MR. REINHART: Thank you. I'm Mark Reinhart, the Chief of the Licensing Section of the Probalistic Safety Assessment Branch in NRR. Our purpose today is to discuss the fire protection significance determination process, a product we've been working on for about two and a half to three years. We've -- at our desire and the desire of the industry, we've been working at refining the tool we have.

Around April of this year we took some efforts in the staff to focus on the product, on what needed to worked upon. Then in July we brought the industry and other stakeholders into the discussion and today See-Meng is going to give us a presentation that will show where we are with the fire protection SDP and where we hope to go.

MEMBER WALLIS: And who are the other stakeholders?

MR. REINHART: It was a public meeting. Whoever showed up at the public meeting we had. It was NEI and licensees.

MEMBER WALLIS: That was all?

MR. REINHART: That was all that showed up.

MR. WONG: Some of the public meetings -- the public attendees as well. Thank you, Mark. Good afternoon. I'm See-Meng Wong in the PRA branch and as Mark has stated, we have been -- our branch has been involved in developing the fire protection SDP that is currently that exists in the inspection manual Chapter 06098 and is described as Appendix F. The original developer of this SDP is J.S. Hyslop who has moved onto the office of research and has been presenting a lot of the research work this morning to you.

As I look at it, it is more difficult to developing a tool and for me to involved in trying to improve it, I think it should an easier task.

Anyway the fire protection SDP is one of the many SDP tools that used in the direct oversight process. It is designed to assess the significance of degradations in fire protection defense and death elements, mainly fire prevention, fire detection and suppression and protection of the SSE's important to safety against fire damage to accomplish land safe shutdown.

And this fire protection SDPs those are designed to support the risk informed focus of the tri-level fire protection inspections that are going on. Just very briefly, as a background, go onto to summarize this actually what is in the two-phased methodology. The first phase methodology is essentially a qualitative screening process that screens the fire protection findings that are related to operational or functional fire protection future conditions, that means it will ask questions, is the fire protection system, whether there is a fixed suppression system or is a fire barrier, is it degraded and if it is, then it screens into the Phase 2 process.

The Phase 2 methodologies also by design is a screening methodology and it is more of a quantitative approach to try to assess the significance of the collective impact of the findings on the fire protection defense in-depth elements. This Phase 2 methodology is a nine-step process, okay, and within this nine-step process it uses a simplified fire risk equation which attempts to provide an integrated assessment of the fire ignition frequency with the degraded fire protection defense in-depth elements.

Fire protection defense in-depth elements are fire barrier effectiveness, automatic suppression effectiveness, and manual suppression effectiveness and also the term that try to come for common cause contributions.

MEMBER SIEBER: Before you leave this slide, when you screen using Phase 1, if it's of no safety significance, it goes away, right? If it has some significance in Phase 1, you come out with a color (phonetic) and then you go to Phase 2 and my question is, how often does the color decrease in significance between the Phase 1 screen and Phase 2?

MR. WONG: Okay.

MEMBER SIEBER: Do you see what I mean? Do you understand my question?

MR. WONG: Okay, right. The short answer is very briefly, okay, the Phase 1 screening process is that we want to screen findings that is of significance, so it is by design, conservative in nature. So most of the findings that we have --

MEMBER SIEBER: I understand that.

MR. WONG: -- may not string to green and most of the time, our top -- this is actually one of the issues that we're trying to find guidance (phonetic) and most of the time the findings has gone right through to the Phase 2 methodology. Then the Phase 2 methodology, because of some of the problems that we have experienced, that is why we are trying to come up with better guidance on each of the issues that I will discuss a little later.

MR. REINHART: Maybe I could add a thought. The Phase 1 screening needed work, so one of the efforts that we think we've made progress on to date is to get a better Phase 1 screening. Like See-Meng said, almost all of them right now have just ended up as Phase 2.

MEMBER SIEBER: And that's because Phase 1 determined significance, risk significance.

MR. REINHART: What Phase 1 would do, it would say it's either green or greater than green. If it's green, one of licensee's corrective action program. If it was greater than green, it would go beyond.

CHAIRMAN ROSEN: So you said almost all Phase 1 findings would greater than green, did I understand what you're saying?

MR. REINHART: What I've said so far is that the Phase 1 screening questions that were there, we saw a need to improve to make them more effective. Consequently, almost all of the performance deficiencies in the fire protection area were Phase 2 or Phase 3 efforts.

MEMBER SIEBER: That means that they were greater than green in Phase 1.

MR. REINHART: In essence it means that --

MR. WONG: Yes.

MEMBER SIEBER: Okay, now, let me ask the second part again. When you get to Phase 2, how many of the greater than green from Phase 1 turned into green in Phase 2, percentage-wise, roughly?

MR. JOHNSON: While they're -- this is Mike Johnson. While they're thinking about the answer to that, let me talk about Phase 1 one more time.

MEMBER SIEBER: Okay.

MR. JOHNSON: In Phase 1 what you're trying to do is to set aside those issues that are clearly green but certainly no more than green. So if you go

-- you pass the threshold where we've talked about you've got a performance deficiency that is significant enough to documenting. You go to Phase 1. If something doesn't screen beyond Phase 1, it's a green. If it goes beyond Phase 1, that doesn't necessarily mean that it will more than a green, but because it could potentially go to Phase 2 and then you decide that it's a green. It's just that simple screen that we have in Phase 1 can't make the determination.

MEMBER SIEBER: Well, I think it's fair to conservative in your screen. On the other hand, you may making yourself extra work because now you've got to do an additional phase of evaluation because it's too conservative. So my question is, how conservative is it really?

MR. JOHNSON: I understand.

MR. REINHART: If you go to slide 4, what it shows is there is 73 findings --

MEMBER SIEBER: Yeah, I read that, that's what prompted my question.

MR. REINHART: -- and 19 or 52 of those 73 ended up as green. Now, I follow up on both what you and Michael said, the -- my belief is that once we get our improved Phase 1 screening effective and as of our last meeting, I think the staff had some thoughts, the industry had some thoughts, and the industry is going to combine those and propose to us a method. If that's successful, that should do exactly what you said and screen out more of these so we don't have to go to Phase 2 analysis.

MEMBER SIEBER: Thank you.

MR. WONG: Well, I think we jumped ahead a little bit.

MEMBER SIEBER: Yeah, I know. I asked the question because I was looking at your later slides.

MR. WONG: Okay, then I'll just go very quickly to state that --

MEMBER WALLIS: Well, I'm curious about the first slide of Phase 2. You have this simplified fire risk equation. And if I were going to improve the fidelity, I would think that one way to improve it would to improve the equation. Is that part of the scope?

MR. WONG: Yes, yes, I will get to it when I talk about Phase 2 issues. In fact, I think that's probably central to the improvement initiative. This next slide is based on the information that we had from the inspection program branch. To date, since April 2000 there has been 50 tried fire protection inspection completed and out of this there as been 73 fire protection inspection findings. And out of this 73, 39 issues are related to safe shutdown and alternate safe shutdowns. For example, those issues are the associated circuits that are effected and which we have the moratorium on inspection until we resolve this issue.

And 17 of these 73 are fire protection system issues and this related to problems with suppression systems and detection systems.

MEMBER SIEBER: You mean inoperable.

MR. WONG: Inoperable, degraded, depending on the observation from the inspectors. Then there are 13 fire barrier issues. These are related to again degradations observed in three out of five barriers, problems with, you know, fire domes (phonetic). And then there are four procedural adherence issues. These are problems related to not taking appropriate corrective actions to correct some of the problems.

MEMBER SIEBER: Is anybody still using thermal lag?

MR. WONG: Yes, there is one issue.

MEMBER SIEBER: As a three-hour barrier or --

MR. WONG: As a three-hour barrier. In

fact --

MEMBER SIEBER: When do you think that one will disappear? I mean, when will they take it out?

MR. WONG: That question, I think, is the fire protection branch would probably have a better answer for you.

MEMBER SIEBER: Okay, so I take it some of these 13 in the fire barrier issues are thermal lag issues or are they?

MR. WONG: Well, some of this is related to the use of the hammock (phonetic) fire wrap issues and that again, is a generic issue. It's awaiting resolution but if you look at the SDP characterization, one of the issues that we finalize as a white finding is actually related to a degraded three-hour thermal lag fire barrier issue at one of the sites.

MEMBER SIEBER: Okay.

MR. WONG: And the other finalized white findings relate to an inadequate smoke detectors in the cable spraying room that was not installed in accordance with NAPA codes.

MEMBER SIEBER: Okay, thank you.

MR. WONG: Right, but what is of challenge to us is that there are a pool of 19 findings that are of significance that needs to determined and there is, therefore, the impetus for us to try to improve the tools that we have currently in place as soon as we can and we have -- as I will elaborate a little bit further, we have an aggressive schedule to try to accomplish this by next year.

MEMBER SIEBER: Now, is this a backlog that's being worked off, these 19 or are they just sitting there --

MR. WONG: These 19 are --

MEMBER SIEBER: -- waiting for you to come out with your guide.

MR. WONG: Yes, most of those 19 are sitting there and waiting, for example, the resolution. A lot of these 19 findings are the associated circuits and the use of the hammock wrap fire barrier issues. That's the pool of them.

MEMBER SIEBER: And they're sitting there because we're still working on associated circuits, right?

MR. WONG: Yes.

MEMBER SIEBER: So this could take some time.

MR. WONG: Yeah.

MR. REINHART: It could. I believe it's

waiting on the resolution of some generic issues. They're in the region. They haven't come to us, like as a Phase 3. But they are -- there's some generic issues also involved.

MEMBER POWERS: As I understood the resolution of the associated circuits, the NEI came forward with their proposal, right.

MEMBER SIEBER: That's true. On the other hand, I take it we're still not doing inspections on associated circuits, right?

MR. WONG: Yeah, my understanding.

MR. REINHART: That's our understanding.

MEMBER SIEBER: Okay, thank you.

MR. WONG: Okay? My next slide is to summarize the major issues related to the fire protection SDP as we have today, okay. And one of the first issue is a determination of the performance deficiency that is related to the fire protection finding. This came about actually from an experience that we have in trying to resolve one of the issues related to the Halon system concentration that did not meet the NAPA code but the point here is that --

MEMBER SIEBER: Is Halon -- there was some question as to whether that would allowed or not, right?

MR. WONG: Yeah.

MEMBER SIEBER: I don't think they even make Halon any more, do they?

MR. WONG: No.

MEMBER SIEBER: Isn't that an environmental concern?

MR. REINHART: They don't make any more but there are plants that have it stockpiled.

MEMBER SIEBER: Okay.

MR. REINHART: And it becomes very expensive because of that stockpile.

MEMBER SIEBER: Well, if you can't reach the concentration when it discharges, that means you don't put out the fire.

MR. REINHART: Right.

MR. WONG: Yes. The point I'm trying to make here is that in the determination of performance deficiency the question was did the licensee meet the licensing basis.

MEMBER SIEBER: Okay.

MR. WONG: And so this is one of the areas which probably await much broader generic resolution. So currently there is, in the fire protection SPD that we have today there is no clear guidance that asked inspectors how to deal with it.

MEMBER SIEBER: How to deal with it.

MR. WONG: So that's an area that we have to look at. The second bullet in this slide is the issues related to Phase 1 screening process and we have briefly touched on that. One of the things is related definition of the SDP entry conditions. The guidance that we had, we did not provide the verbiage to direct say the inspectors to go through what we call whether the observation is -- or the finding is more than minor through the criteria that is described in the inspection manual Chapter 0612. And then from there where does it go.

So there's kind of a linkage or direction but it's not clear how -- when do they go to the Phase 1 and then from Phase 1 how they go to the Phase 2 as the finding is being processed. So that's an area in which we think we need to provide better guidance.

But the main --

MEMBER SIEBER: But that's not why these 19 are sitting there, right?

MR. WONG: No, that's not why the 19 is -- the 19 is sitting there for other issues.

The four main issues that we have identified for the Phase 2 screening methodologies is, one area is the use of the fire ignition frequencies, okay. You've heard discussion on you know, whether we use a room frequency versus a component ignition frequency, whether we use the pre-data base as, you know, reflective of you know, the events data base that we should looking at to derive the fire ignition frequencies because this is always a point of contention when we try to process it, are we looking at the right fire ignition frequencies.

And this is an area which one of these solutions is that we might try to use the EPRI data base as, you know, one of the standards to try to derive fire ignition frequencies and then provide a table of fire ignition frequencies that as a guide for the inspectors when they use this Phase 2 screening process.

MEMBER SIEBER: Are you going to use the Houghton (phonetic) study?

MR. WONG: I've looked at the Houghton study and in fact, from my experience when I tried to process one of the findings looking at his -- his data base is limited to a certain time window, I think 1986 to --

MEMBER SIEBER: It ends at 1999 but he's on 2000 and 2001 right now.

MR. WONG: Right.

MEMBER SIEBER: But --

MR. REINHART: Well, we talked about this in one of our meetings. I believe if I remember the number right, there's maybe seven different data bases you could look at.

MEMBER SIEBER: Yes, there are.

MR. REINHART: And we --

MEMBER SIEBER: But this one is yours.

MR. REINHART: Right. Our long term goal would to get Jim Houghton's data base up to date and formatted in a way that we could go into it and come out of it simply and have everyone agree that that's the appropriate data base for the appropriate situation. If we can do that, we're miles ahead and we're working on that.

MEMBER SIEBER: Okay.

MR. WONG: So this is one of the areas.

MEMBER SIEBER: Okay.

MR. WONG: The second area is related to the degradation ratings for the --

MEMBER POWERS: Why is there a resistance to using for instance, the EPRI data base?

MR. REINHART: I don't think there's a resistance to it. I think we -- from time to time it gets used. What happens is in a given situation, somebody likes the EPRI, somebody likes something else and so we're in a discussion. What we want to able to do is say what's the appropriate place to go for category A, B or C to get the right answer.

MEMBER POWERS: If I'm a member of the public and I want to look at the data base that you've used to assess one of these things, can I get to the EPRI data base?

MR. REINHART: I don't know the answer to that question.

MEMBER POWERS: If I can't get to the EPRI data base, then I ipso facto can't use it?

MR. REINHART: The big picture, we want to make sure the data base that we agree with or data bases that we agree with are in the public arena. If the information is not, at least we'll able to show the information that we had that we used to make the decision. That would public. But whether the EPRI data base per se, in its entirety is public right now, I don't know the answer to.

MR. JOHNSON: And, of course, I guess, it goes without saying, the major challenge that we face on all of these issues is to make sure that we have an acceptable agreed upon methodology, in this case, an acceptable agreed upon frequency and then we've always tried in the SDP to make sure that whatever we use then in terms of the tool is available so that people outside of the agency can see what we've done so that the process is predictable.

So your question is a good one. We just haven't -- we've got to seize upon what is the right source of data, what is the right data base for fire ignition frequency and then we need to make it available to people can see what it is we used.

MEMBER POWERS: I can think of nothing that would -- I mean the peculiarity of fire is that it's one that everybody thinks they know everything about because, I mean, it's a hazard, it's a nuclear hazard. It's not like a neutronic hazard and nobody can calculate except some guy at Brookhaven or something with a fancy computer group. And so fire is of interest to people.

I mean, they know that this is a hazard and when you go through a significance determination process in a fairly mechanistic thing kind of that somebody can understand fire, fire ignition frequency, times the degradation factor, that I just love because I can never figure out what it is, but you go through these steps, you know, if I remember the public, you know, the first thing I'm going to do is say, gee, how would I get there. And I'm going to sit down.

And if I can't get to the data base, I'm going to irritated. I'm going to irked. And then, you know, you'd say, well, this is an agreed upon process. Yeah, you and somebody else agreed to it, I didn't agree to it.

MR. REINHART: I understand.

MR. WONG: Okay, let me go to the next major issue that we have through our discussions. The second major issue that we have identified has to do with degradation ratings for the defense in-depth elements, okay. The defense in-depth elements are -- that is currently we are -- that is in the SDP guidance document is the fire barriers, okay, the automatic suppression and also the manual suppression. And we have degradation ratings of whether that fire barrier is highly degraded or moderately degraded or whether it is in the normal operating state.

And this is an area in which there has been subjectivity and this is an area in which we're trying to get the I call the fire protection world to come to grips to provide us, you know, a good set of criteria what is really highly degraded, you know, description, what is moderately degraded? Is it nearer to scale of a highly degraded or is it more to the nominally operating --

MEMBER POWERS: Just what the hell do you mean?

MR. WONG: Yes.

MEMBER POWERS: You know, since this thing has been founded, I've been railing about, I don't know what -- how to evaluate that number.

MR. WONG: Right, so this is one of the big problem areas and this is actually -- a lot of these issues is causing us to get, you know, two hours or three hours of magnitude away from what we think is the, you know, the reasonable significance. And so this is a problem area which is part of the improvement initiative we're having for fire protection folks, and engaging or so the NEI industry to at least come to some consensus agreements like Dana, what you said is what does it really mean. Is it moderately degraded, versus a highly degraded description and the basis that go with it.

MR. REINHART: In fact, what you're questioning there is the question we have to ourselves for each factor. We want each one to scrutable, and understandable, why do we have it, what does it mean, when do we use it and where do we enter this table, chart, et cetera and how do we know we're right?

MEMBER SIEBER: What would nice is if you took five independent analysts and they all got the same factors.

MR. REINHART: Right.

MR. WONG: Well, that's one of --

MEMBER SIEBER: Because it's not clear to me that that's happening, right?

MEMBER POWERS: It's probably not clear it will ever happen but if you could have some categories and antidotes and examples and say, okay, this is what we mean by moderate, this is what we mean by severe and this is what we mean by close enough to normal operation, I mean, enough of them so that people could look at them and say, okay, since I will never have exactly that situation in any other plant at any other time, but I kind of know what pot to put it in --

MEMBER SIEBER: Right,

MEMBER POWERS: -- that's about the best you're going to ever have on that very subjective factor.

MEMBER SIEBER: Right.

MEMBER POWERS: I mean, that one is just really subjective.

MR. WONG: Yes.

MEMBER POWERS: Well, there's another one and that's the degradation of the fire brigade.

MR. WONG: Yes, that's another area which we're --

MEMBER POWERS: The guy's five pounds overweight, does that mean he's moderately degraded or badly degraded or what?

MEMBER SIEBER: That's easy. I've gone through all of those phases.

MR. WONG: Okay, the third issue is the use of the fire severity factors and right now in the current guidance document, we don't use it but when we do a Phase 3 analysis, we use it and the fire severity factors that I have used in Phase 3 analysis is from the -- what is provided in the five document, the EPRI five document.

Again, here it is, you know, how -- how do we -- you know, and when do we use it, you know, to adjust the fire ignition frequencies or the population of the fire because this is tied to when we develop the five scenario we're looking at, you know, a big challenging fire or do we, you know, screen away the smaller fires and try to establish the significance of that. So this one you know, it's one of those things that we have to come to have some agreement.

MEMBER POWERS: You're doing this radically differently than the analyses for Phase 2 significance determination processes for the really classic operational event analysis. I mean, they do Phase 1 by walking through a worksheet based on some PRA analyses and then in Phase 2 they actually run the SPAR (phonetic) codes and things like that.

MR. WONG: Right.

MEMBER POWERS: Why don't you just beat up research and say give me a good fire analysis tool and I can do Phase 2 by a risk assessment methodology the way the guys in Ops do? Make my life easy for me.

MR. WONG: They are part of the team.

MEMBER POWERS: Tell them it will make their life easy for them.

MR. REINHART: Our Phase 2 actually, it's a notebook that we run through and the SPAR would get involved in the Phase 3. Whether it's us running a software, a licensee running a software, comparing results, there's --

MEMBER POWERS: You're just determined to make Phase 2 difficult and make Phase 2 automatic.

CHAIRMAN ROSEN: What you're saying is they ought to get away from the subjective scales and get to analysis technique that provides some relevant answer. And to me, you know, as much as I hate to admit it, I think I agree with you. You know, trying to interpret these subjective scales, you know, look at a fire barrier, is that moderately degraded, minor --- degraded in a minor way or severely degraded, you know. It shouldn't matter. The question really is, is what is an analysis say.

It may turn out that the fire that you postulate doesn't require a fire barrier within that area. And so I think we'll never get done, we'll here in 10 years arguing about fire barriers and as a matter of fact, now that I say that, I think it was one of the NRC staff people who said we had a decade of arguing ahead of us. If -- and so, you know, I kind of agree with Dana's comment, that maybe rather than starting this six months into that decade, rather than do that, we ought to step back and say, let's figure out a way to avoid a decade of arguing, which might fire modeling.

MR. REINHART: We're aware of the sentiment and I think there's a spectrum of sentiments that are out there from going to a fully automatic analysis to a semi-automatic analysis, to the notebook check sheet type of an approach. We appreciate that.

MR. WONG: Okay, the last sub-bullet is the development of the fire scenario and here the issue is, you know, trying to develop a credible fire scenario or a fire modeling that is needed, you know, to support the SDP process. Basically, you know, the guidance that we have to identify the ignition sources, the likely ignition sources, the fire modeling, you know, from fire initiation to fire growth, the example, some of the switch gear room scenarios is what are the heat release rates that we will using to model the fire -- you know, to get the time line of when the fire will go to an extended damage cables that is overhead.

And we have again, argument as to, you know, which is the right heat release rates that we will   using? Is it 200 kilowatt or is it 300 kilowatt or 400 kilowatt and that's an area which, you know, we want to take advantage of what the work that the fire protection folks have done in trying to develop a spreadsheet, you know, fire dynamic spreadsheet, you know. We want to see how we can take advantage of that and use that. This again, is an area that we need improvement and especially, you know, develop, you know, kind of a time line that we need to look at in order to say whether there's a credible fire scenario or not.

These are just the major issues. That's

not to say that there are other issues as well in the Phase 2 that we have identified and we're going forth to try to find you know, agreement and resolution for fixes for some of these issues. The Phase 2 objectives and the goals, this one is sort of a general issue and one of the things we're striving for in the objective of the Phase 2 screening methodology is you may have heard the word simplicity, transparency, repeatability and reasonableness. Okay. This is a list that we're trying to use as a measure to try to improve the SDP.

But really one of the desired goals is to see if we can come up with a methodology that we have like one order of magnitude so and see if we can strive to that, but recognize that the fire PRA methodology that we're using, we have been using the traditional fire PRA method and technique and so that's a achievable goal but that's something that we have to look at because from our past experience, we have, you know, been getting two orders and three orders of magnitude from the Commission's desires is that in the SDP to consistent with the overall RFP process the goals is to try to see in the Phase 2 what order of magnitude, so that if we proceed to a Phase 3 analysis, then all we have to do is to look at, you know, what are the findings and assumptions that we need to make to bring it back to that order of magnitude that we're looking for.

The second bullet is related to quantification approach and this was asked earlier. We have a simplified formula that is in the current Appendix F. And as I stated, it is this simplified formula that one, we tried to get what we call the fire mitigation frequency, okay, trying to integrate the assessment of the fire ignition frequency that we've calculated and used and what are the effectiveness of the defense in-depth elements. Okay, all those four put together.

What we see is that the problem is that it does not link some of the dependencies between one factor from the other and like you mentioned earlier, you may have a degraded fire barrier but if your ignition source or your combustible loading is very small, you know, it's how significant is this highly degraded fire barrier in the context of the SDP? Or you know, and there's also the -- when we model the fire scenarios, the competing factors of, you know, manual suppression when you postulate if there's a big fire growing, you know, if there's good suppression does this degraded, you know, fire barrier, does it come into play? So those dependencies are not there right now and so one approach which we're going to try out is to the same as like what we did in the safety SDP, try to develop an event tree and come up with, you know, some sequences and try to capture this dependencies and make this a better tool.

That's all that we can think at this point in time. The other issues is how do we credit for compensatory measures that has not -- to date has not been vigorously addressed in fire PRA methodology?

MEMBER SIEBER: You mean like fire watches and those --

MR. WONG: Yeah, fire watches, closed circuit TV, roving watches and so on and so forth. I understand that Sandia or Steve Nowlen is doing it and they have done some study looking at, you know, the net impact of, you know, compensatory measures. So this is an area in which we probably would take, you know, some of the insights and try to improve the guidance I this area.

Critical human actions and the treatment of safe shutdown actions, this again, we are trying to come up with a better, you know, basis and you know, common, you know, rules of how we credit the human actions and HEPs for, you know, manual shutdown and remote shutdown actions. So there's work that has been done and we'll take advantage of those insights from research work.

Treatment of Appendix R exemptions, this area is right now is not in the guidance and we need to take a look at how do we evaluate the risk changes due to a deficiency in the approved exemption and where against the baseline the approved exemption.

MEMBER SIEBER: What was the basis for the Appendix R exemptions in the past before risk consideration were predominant?

MR. WONG: That, I think --

MEMBER SIEBER: You know, there were some exemptions because of Appendix R came after some plants were designed and built and so you might have ended up, you know, I know of one plant where all the ox feed pumps were in one room and you're supposed to have redundancy. Even though they put in a fourth pump in a different room, it wasn't safety grade. And so there was an exemption there and but there's been a fair number of Appendix R exemptions in the past.

MEMBER POWERS: Didn't the agency go through and look at these for the previous chairman and come back and say that there were none of the exemptions whose risk wasn't adequately addressed by compensatory measures that they imposed? I mean, very few of these exemptions were given willy nilly.

MEMBER SIEBER: That's true, that's true. We had to do something for every one of them.

MEMBER POWERS: I think it cost you more to get the exemption than what it would without but I mean, haven't we looked at that once before?

MR. WONG: I think --

MS. BLACK: Yeah, this is Suzanne Black. We looked at that. I've seen a study that showed certain plants we had to go back and do some more. We did a screening study at first and then looked at a couple of plants for these specific exemptions and determined that the total of them was not really significant.

MEMBER POWERS: That's right, and so maybe we're recognizing too much of the risk exemptions here.

MS. BLACK: I hate to say that but the criteria we used, the 5109 criteria for exemptions, you know, to show that the alternative was as safe or almost.

MR. REINHART: And I think the thought here is whatever was done, is it appropriate or maybe not appropriate to consider that in the SDP. We just want to make sure, is this something we should give credit for, should we --

MEMBER SIEBER: I would think so. The exemption is out there and it's been audited and it's legitimate.

MR. WONG: J.S. has a comment.

MR. HYSLOP: There was one thing, as I recall this and I'm not sure we're getting at it, it was for a room or an area with an exemption, should the a part of the baseline from which you calculate departures for the risk significance associated with your finding. That's how I recall it coming out, or do you look at the case of compliance as your baseline and I think that was the thrust behind the statement treatment of Appendix R exemptions for purposes of impact on the SDP. I don't know if that's what everyone was getting at or not.

MEMBER POWERS: I doubt it.

MR. HYSLOP: Okay, okay.

MEMBER SIEBER: Well, I do understand it but it seems to me including whatever exemptions have been granted, if they were granted and it's true, then they weren't really significant. And that, I would think, becomes the licensing basis and a baseline to start for SDP. That's my opinion, personally.

MEMBER POWERS: Well, the headache in all of this stuff is that you end up with every SDP now becomes absolutely plant specific.

MEMBER SIEBER: That's right, absolutely.

MEMBER POWERS: And there's no generic guidance here whatsoever.

MR. REINHART: And we have to go back to that issue of the licensing basis, what is the licensing basis.

MEMBER SIEBER: That's right.

MR. REINHART: How things were written in the `80's and how people are looking at the words today, a different set of folks looking at those words. There's questions coming up, old issues coming up.

MEMBER SIEBER: Well;, and then you've got the added complication that different plants are under different sets of rules.

MR. REINHART: That's right.

MEMBER SIEBER: Some are Appendix R, some are not, some are branch technical positions.

CHAIRMAN ROSEN: And there are different people at the plants, too. It's not just on the regulatory side.

MR. REINHART: That's right.

CHAIRMAN ROSEN: There's knowledge transfers.

MEMBER POWERS: And to cap it all off, we don't know what the licensing basis is anyway.

MEMBER SIEBER: Well, somebody ought to and it may take awhile to find out but just the fact that there's different sets of regulations for different plants, every SDP is going to plant specific. So we might as well just make matters worse and add a new wrinkle to it.

MEMBER POWERS: I'm glad I don't have your job.

MR. WONG: Well, I want to make a closing statement. The next one is very easy. This is a summary of the -- all the actions completed to date that we started to embark on this implement initiative. This is essentially we do need a request to research.

CHAIRMAN ROSEN: You don't have to read it to us.

MR. WONG: Okay.

CHAIRMAN ROSEN: Go ahead to the next one.

MR. WONG: Go ahead to the next one? Okay. The next one is essentially the future activities, okay, what we plan ahead for us. And one of the things that we plan in the imminent future is to have a public workshop some time in the early or in early November to go through each one of these Phase 2 SDP issues and engage the external stakeholders and internal NRC stakeholders, meaning, the people, the -- from the regional offices, the inspectors, the SRA's to work through each one of these issues and reach, you know, a general consensus agreement. That's my goal on each one of these issues because at the end of the day and the bottom line is that I don't want to have to go to a regulatory conference and then have to in a contentious argument with the licensee on some of these issues which we can resolve it, you know, generically beforehand.

MEMBER SIEBER: I think you have your work cut out for you.

MR. WONG: Yes.

CHAIRMAN ROSEN: You have a busy year coming.

MR. REINHART: And hopefully, and to get back to your question, your comment, a goal is to have an SDP that is generic.

MEMBER SIEBER: But flexible enough to accommodate all these differences.

MR. REINHART: Right, and that's -- a

challenge is going to getting our arms around that licensing basis, how to address it up front and then what to give credit and not give credit for as we go through it.

MEMBER SIEBER: Do you folks know what the licensing basis is for each plant or would you rely on the licensee who may not know either?

MR. REINHART: That's an issue that is out there and the goal is to have the staff and the licensee able to understand what the licensing basis is.

MEMBER SIEBER: See, without knowing for sure what it is, I'm not sure how you can inspect the plant.

MR. REINHART: I understand the dilemma.

CHAIRMAN ROSEN: All right, it's quarter after 4:00. Thank you very much and we will --

MEMBER WALLIS: Can I ask a naive question?

CHAIRMAN ROSEN: -- move onto the --

MEMBER WALLIS: Can I ask a naive question?

CHAIRMAN ROSEN: Oh, you're asking them a question?

MEMBER WALLIS: Yeah, I wondered if I could. I mean, I'm just puzzled about what all this has to do with what we heard the rest of the day. I cant' make the connection.

CHAIRMAN ROSEN: It's just another fire protection issue. I mean, it's in the area of --

MEMBER WALLIS: Yeah, but I thought we were going to hear something about how the research being done served the needs of NRR.

MEMBER POWERS: Well, I mean, there were several points where the speaker said that they were going to look at what came from research. I think the research that we've heard about is well beyond this. I mean, I think he's looking at stuff that was done in the past.

MEMBER WALLIS: In the past, that's right.

MR. REINHART: Maybe a clarifying point, the person that did a lot of the initial work for us, as See-Meng mentioned, was J.S. Hyslop.

MEMBER WALLIS: Right, who presented this morning.

MR. REINHART: But now he went to research.

MEMBER WALLIS: That's right.

MR. REINHART: So he's supporting us along with his contractors are supporting our refinement.

CHAIRMAN ROSEN: Mark, one of the questions that was asked earlier today was about vision and it was about what is your vision for this fire protection area and maybe more specifically about fire protection research. Can you tell us what -- you know, we asked a few vision questions. You're asking really what would you like your future to like?

MR. REINHART: Well, I have to address the SDP, that's the part that I own, and my vision would , as I said, that we have a way to understand, first of all, what's a finding and what's not a finding, what's a performance deficiency, what's not a performance deficiency, get our arms around the licensing basis, then take that and most of those issues as in the other SDPs, are screened out through those ineffective Phase 1 screening.

The next part would the Phase 2, it could scrutable, repeatable, that we can quickly move through, move that and I know we talked about can the inspector do that, do we need a fire protection excellence group, somehow have a group that can quickly give us the significance so we can put it in its proper place and move on.

MEMBER POWERS: I guess the issue that I hear most from the licensees in connection with fire protection boils down to asking what do you mean by quickly, what would your target from going from a -- you've had a Phase 1 determination that something is greater than green, so it's gone to Phase 2. What kind of turnaround time would you like in Phase 2.

MR. REINHART: I'm trying to --

MEMBER POWERS: I'm not going to hold you to it. I'm just trying to understand.

MR. REINHART: Ideally, if an individual had everything at hand, he ought to able to sit down that week and come up with an answer that another person could sit down with the next week and come up with the same answer and depending upon the complication, it's going to longer than a week or shorter than a week.

MEMBER POWERS: Yeah, I would caution you against having as an aspiration that somebody else would come up with the same answer. I think my aspiration would somebody else could understand why he came up with the answer he did.

MR. REINHART: And they would hopefully agree that it's within the decade of green or yellow or white.

MEMBER POWERS: I understand. That's what I was looking for. Next year I will not say why you got eight days and you said a week.

CHAIRMAN ROSEN: I think you've annunciated a pretty useful vision. What I think -- what I would like you to do is to write it all down in one or two paragraphs. That would helpful. What is the vision and then you've annunciated and here's how I'd like my future to look. I mean, you could create --

MR. REINHART: That's a good suggestion. Maybe we could do that going into our workshop so that everybody can see --

CHAIRMAN ROSEN: You know, it ought to exceed your grasp, your vision. Man's reach ought to exceed his grasp but write down the way you'd like to and you might find a lot of people agree with you and that will a good basis to work together.

MEMBER POWERS: I think based on our interactions with the licensees, if they just understood that that's what we were trying to invoke, it would a great comfort to them. They just see us going in the other direction and taking longer and longer and longer to do these things.

CHAIRMAN ROSEN: Thank you. Mr. Coe, welcome back.

MR. COE: Good afternoon, Mr. Chairman. I'm always glad to come back.

CHAIRMAN ROSEN: One of the two greatest lies, right?

MR. COE: Even though I'm the anchor man.

CHAIRMAN ROSEN: The check is in the mail.

MR. COE: Not always the best position to in is the anchor man. So I've prepared a very brief presentation.

CHAIRMAN ROSEN: Well, I compliment you on the positioning of the staples in your package, something that's been giving people trouble with all day. You can see what the tenor of the debate has been.

MR. COE: I was asked to prepare a brief presentation on the type of inspection findings that we've had in our program since its inception. The ROP program that is. What you heard at the last presentation was a categorization I think and some -- of the inspection findings that came out of the tri-annual inspection procedure. We also have a monthly and a quarterly inspection procedures that is conducted by the resident inspection staff on site and what I'm going to give you here today is a little bit more expansive set of numbers. These are the numbers that have come from the reactor oversight program since its inception.

There's 156 fire protection findings that we've classified as fire protection findings. They fall into these four categories, which are the same categories that you just saw a moment ago. There is a little bit of overlap and there's maybe some findings that could fall into one or the other and we've made some choices here. But in general, you can see out of 156 findings, we've had two white issues and although I wasn't here for all of the last presentation, I understood that both of these particular issues may have been touched upon.

In each of these categories, all I'm going to do now is show you a set of -- or some examples of some of the findings in each of these categories. Okay, the first category is the safe shutdown/alternate safe shutdown. And here we're talking about as an example, the first bullet, inadequate protection of safe shutdown components, this might typically a safe shutdown path for a given fire area has not been protected in accordance with the Appendix R requirements.

CHAIRMAN ROSEN: What does that mean, the thermal lag isn't adequate?

MR. COE: Either the thermal lag isn't adequate or the separation isn't there or there's -- or maybe there's deficiencies in being able to complete the function that's intended by that safe shutdown path, path meaning a series of actions taken to provide a particular reactor safety function.

Okay, emergency lighting deficiencies for performing manual actions for the alternative safe shutdown path, shutdown outside the control room where the procedure itself could not performed as written under the circumstances that the procedure assumed or finally inadequate procedure for implementing alternate safe shutdown for fire in the main control room, just the procedure itself inadequate in some other aspect other than it couldn't performed or perhaps it would, you know a little bit confusing or it would lead you astray in some manner.

Okay, so these are findings and again, out of 157, you'll find -- we found most of these to of green significance. Fire protection issues, this really has to do with detection and suppression issues, smoke detectors inadequate, maybe they were misplaced, they weren't in the proper position. Perhaps they were inoperable, they wouldn't work for various reasons, inadequate testing with sprinkler system, inadequate Halon system, failure to maintain full area detector coverage, smoke detector or flame or fire detector, fire brigade problems. Okay, these we classified under this broad category of fire protection issues.

The third category is barrier issues. There are your typical barrier degradation issues, holes in barrier walls, lagging or a thermal lag that was not -- found not to rated at its required rating, fire doors that had been left open, compensatory measures that have not been maintained and adequacy -- questions, continuing questions of adequacy of thermal barriers.

And finally, failure to follow procedures is outside of the other category that we looked at, at the first. That was the alternate safe shutdown category also had some procedural problems in there, but other than that, other failures to follow procedures might involving transient combustibles, fire damper surveillance tests or surveillance tests in general, failing to follow those tests in accordance with the written requirements, equipment control, and failing to follow a procedure which actually resulted in a fire.

Okay, and finally, we have a category of findings that we send directly to traditional enforcement. I think we may have touched on this when I spoke on Monday. Impeding the regulatory process is one of three specific cases that we send directly to traditional enforcement regardless if there was an impact that could measured in using and SDP process. This, of course, would invoke escalated enforcement and civil penalties and those sorts of sanctions.

In this particular case, impeding the regulatory process may involve failure to obtain NRC approval when it was required, failure to provide the NRC with complete and accurate information if we -- if the approval was being sought, failure to complete -- failure to complete monthly inspections of extinguishers. That doesn't sound like it's in the right category. I don't think that's correct. I'm sorry, I guess it is an error. I apologize.

And the final point here is or the final example is failure to perform a safety evaluation and submit it again. It's just the general nature of these findings is that we should have been part of a decision that the licensee made and we were not provided that opportunity.

That completes my presentation.

CHAIRMAN ROSEN: Fantastic, Doug.

MEMBER POWERS: Doug, if I wanted to locate and follow up on the details of these, is there a summary written some place?

MR. COE: Yes, the way that we conducted these examples is we looked in our inspection data base procedure or our findings data base and if you wanted to look at more detail, we can provide that to either basically a high level line item description or we can gather further detail from our plant issues matrix.

MEMBER POWERS: I guess, why don't we start w with the highest, the next --

MR. COE: The next level down.

MEMBER POWERS: If I wanted to follow it up more than that, I can get in touch with you.

MR. COE: Sure. In fact, do we have a copy of that here with us? We do. We'll provide that to you right away.

MEMBER POWERS: Thanks. Let me ask a question. How do your inspectors feel about inspecting for fire protection nowadays.

MR. COE: How do they feel about inspecting for fire protection nowadays.

MEMBER POWERS: You know, the last time we talked they felt like they were --

MR. COE: I'm going to ask Peter Koltay to address that question. Peter is on my staff and is actively engaged in participating in the SDP process that you just heard about and the improvement process there. He also attends fire protection meetings that are held out in the field, in the regions and in various industry forums. So, I'll let --

MEMBER POWERS: Did he go to the Seattle meeting?

MR. COE: Yes.

MR. KOLTAY: Pardon me?

MEMBER POWERS: I asked if you went to the Seattle meeting.

MR. KOLTAY: Yes, I did. I missed you. I didn't see you there.

MEMBER POWERS: I know, I couldn't go this time and I was crying in my beer ever since.

MR. KOLTAY: I don't know if I need further clarification on your question, but the inspections are done at several levels. One is designated team leaders, each region has, and there's a -- I mean, some team leaders are better trained in fire inspection than others. So we get fewer phone calls from the ones that are trained and have more experience and have quite a few phone calls -- no longer directed to us because we refer them to the technical group, Eric Weiss' (phonetic) group for technical questions.

As far as the SDP goes, though, I would say that there's a good percentage of inspectors out there who do not dislike the existing SDP.

MEMBER POWERS: Do not what?

MR. KOLTAY: Do not -- they got used to it and after a year or so, they -- some of them actually feel that it works for them. Don't forget, not every issue comes into headquarters and not every issue is as complicated as the ones we constantly discuss. There are hundreds of issues out there handled in the region by the inspectors and the SRAs and they don't come to us because it works for them and probably because they screen them to green and they're comfortable with the outcome. So you know, it's not a total failure at that level.

MEMBER POWERS: You're giving me the sense that I'm looking for is that -- I mean, I think what you're telling me is that you have a growing and they're growing up comfortable with this whole thing.

MR. KOLTAY: I believe so, until we get down to the real PRA risk informed technical detail on what they should pick for an ignition frequency or they get confused just how to grade it or barriers or what do to with the fire brigade not performing properly and they don't even know how to enter it into the inspection report right now. So you know, those questions come up regularly but at some level, most findings are handled at the regional level by the inspectors.

CHAIRMAN ROSEN: Why don't you let them enter fire brigade performance into an inspection report? I don't understand that or I never knew that.

MR. KOLTAY: It's -- I'm not sure how we got where we are with this. Right now, we give instructions to the inspectors to inspect the fire brigade or observe fire brigade drills at least once a year and spend so many hours doing this. But there's no real -- there's not an SDP to assess the brigade performance, and their observations or any comments they would like to make about the fire brigade right now, manual Chapter 0612 on documentation, basically tells you, well, if it's a minor violation or just an observation, you can't really enter it here. So it's sort of a Catch 22 for them. We didn't provide them the right vehicle at this point and I think the technical people are looking at that and we should coming up with some kind of solution to that.

CHAIRMAN ROSEN: That's alarming, I think. I think because we count so much on suppression, and very much of that is the fire brigade, it would seem to me a fairly --

MR. KOLTAY: It's not totally lost --

CHAIRMAN ROSEN: -- not trivial but certainly possible to define two things that you wish fire brigades didn't do or maybe better what they do do, you know, that they look at the pre-plan before they go and fight the fire, that way they understand that and communicate each other to it, that their bunker gear is in good shape and that they don it properly and timely. I mean, it's the obvious things.

MR. KOLTAY: There is one source for that and that's really the licensee's drill critique. They're supposed to and they do critique their own drills and that's recorded and it's available to us.

CHAIRMAN ROSEN: Right.

MR. KOLTAY: But it would nice if they had a more independent assessment, like the NRC assessment.

CHAIRMAN ROSEN: So why don't you have your resident inspectors watch their drills?

MR. KOLTAY: They do. They do.

CHAIRMAN ROSEN: And write down what they see.

MR. KOLTAY: And they do and right now it's sort of information that they provide to the tri-annual team but it's not found necessarily in an inspection report like you would expect it to , I would expect it to .

CHAIRMAN ROSEN: Right, I didn't know you weren't doing that and that, to me, is -- that's alarming.

MR. COE: There is a threshold above which an inspector will write a fire brigade finding and I've given you one example that we drew from the data base of findings that we use to prepare this presentation. The specific case that I held up was a fire brigade that receives a failing grade during drill or the failure to use a self-contained breathing apparatus during a drill when they should have.

I think that the problem that Peter is relating to you is in many ways the standards that should applied to fire brigade performance are very unclear and subjective. And so I think it's difficult in some cases for inspectors to generate a finding when the standards are so subjective, but there is a threshold, as I've shown here, that clearly we will document.

MEMBER WALLIS: Can I ask my question again? Maybe I'm just perplexed because I have the wrong concept of what the meeting is about. I thought that part of our real purpose today was to look at the research program and see how it met the needs of NRR and I just don't see the connect. I mean, we hear this list of findings, it tells me nothing about whether the research program is adequate or not. Maybe I've got completely the wrong idea of what's going on.

CHAIRMAN ROSEN: Well, I think you did. I think our meeting was to look at the research plan but there were other objectives as well.

MEMBER WALLIS: So these are separate items all together.

CHAIRMAN ROSEN: Yes.

MEMBER WALLIS: They don't fit some overall objective.

CHAIRMAN ROSEN: Right. The meeting became a hodge-podge after.

MEMBER WALLIS: Okay.

CHAIRMAN ROSEN: Yes, there were some other issues besides the research plan.

MEMBER WALLIS: Okay, I was under some misunderstanding then.

MEMBER POWERS: One of the reasons these last two topics came up explicitly is some of the feedback we got during our various plant visits and to the regions and we got an earful on these things.

CHAIRMAN ROSEN: Doug, let me get back to your --

MEMBER POWERS: On the SDP, the fire SDP got hit more than any other single thing that I heard and it addressed all the issues that the speaker brought up. I mean, he got them all, so I suspect he's gotten an earful.

CHAIRMAN ROSEN: On this slide where you listed all the findings, you have URI there's 29 unresolved issues.

MR. COE: Yes.

CHAIRMAN ROSEN: Those are things that are tied up in these barriers, like 10 of them are in barriers.

MR. COE: Yes, yes, and typically they're either going to an unresolved item because we haven't decided if a deficiency exists and some of that, of course, goes to the question of the clarity of the design basis or the licensing basis and otherwise an unresolved item may that an issue has entered an SDP process and the report was simply not delayed for the completion of that process and so the report was issued as an unresolved item.

CHAIRMAN ROSEN: Well, it's 4:35 and we are finished except for what should we do with what we've heard. Thank you, Doug.

MR. COE: Thank you.

CHAIRMAN ROSEN: I have been taking notes of some questions that the committee has asked and what the committee seemed to interested in with respect to these speakers and I can go through that but I would prefer maybe before I did that or in lieu of doing that, perhaps give me some guidance to what we say, what I say on your behalf to the full committee on, I think it's Friday or maybe Friday and Saturday.

CHAIRMAN ROSEN: Yeah, that's why I asked the -- oh, I thought it was Mark Reinhart. Oh, well, okay. Let's -- we've got about, I don't know a really short time on the agenda, I think only a half an hour to summarize the subcommittee's deliberations today for Friday and what I was going to propose was that I just tell the full committee what we heard in terms of you know, just going through the agenda and then spend some time on everything you questioned and talked about but trying to hit some what I think are the high points of what the committee was interested in by extrapolation from the questions and comments. Dana, did you have any other ideas on that?

Okay, let me go through it. On initial

briefing, on fire risk research plan, the committee was interested in what the mission for fire protection research was and we didn't hear that and what future was desired. The committee was interested in what the likelihood of multiple fires was, what the cleanup from smoke effects of fires and the fire risks in non-reactor facilities, including facilities being decommissioned.

MEMBER SIEBER: That's a serious issue.

CHAIRMAN ROSEN: Stock side fuel fabrication.

A VOICE: Well, that's the only thing -- we looked at the risks. We spent some time looking at criticality but criticality effects people at the site itself. It's not going to go much beyond that. And we worry some about safeguarding the material but that's somewhat outside of the risk domain. When you get into the risk domain, the only place that we came up with anything that was really significant as far as the public was concerned was it's fire and it's fire over and over and over again. Every time you turn around in that facility, you got fire. And in the processing facility, you've got fire with kerosine. In the cindering facility you've got fire with the furnaces and in the fuel assembly area, you've got fire with clad.

A VOICE: Yeah, but you're grinding an oxide. You got a little aerosol problem there, you know, hook the filters and take care of it. But fire is -- fire is the biggy in this facility.

CHAIRMAN ROSEN: Okay, I've added that to the list. In the area of fire risk requantification activities that we heard about, the committee asked questions in the area of the scope and schedule and process and participants, who is involved. We note that fire risk requantification during shutdown is important and that it's excluded from the current studies. We noted that the techniques that are being developed in the requantification studies would used ultimately by plants that adopt NFP 805 so the whole issue of whether 805 will ever used by anybody, it's critically determined, I think, by how one ends up on risk requantification, whether that technique is amenable to use.

MEMBER SIEBER: I need somebody to refresh my memory. Was it ever decided whether licensees would allowed to partially adopt 805?

CHAIRMAN ROSEN: Yes, and it was decided and the answer is, yes, they can.

MEMBER SIEBER: Boy that turns things into another little bit of a mess as far as being able to inspect and establish what the licensing base is, I think.

CHAIRMAN ROSEN: Maybe.

MEMBER SIEBER: You know, they'll cherry pick whatever the --

CHAIRMAN ROSEN: Well, the issue is whether the staff should let them cherry pick and I think that the decision is based on that it was the desire not to place another barrier --

MEMBER SIEBER: Well, the argument to allow them to partially adopt is the fact that they would probably never adopt if they to do it totally all at once.

CHAIRMAN ROSEN: Right.

MEMBER SIEBER: On the other hand, I can picture the cherry picking.

CHAIRMAN ROSEN: Is there any --

MEMBER SIEBER: That's okay if it's okay with the staff.

MS. BLACK: We had a lot of discussion about that and what actually it means to cherry pick because in 805 you don't have to reanalyze all of your rooms and so I think our position is that when you decide to adopt it, you should do all the up front work that you need to do which is not that much to get into the process and then area by area you can decide to analyze an area once you run into a problem, but you don't have to analyze the whole plant. So that's what we would call cherry picking.

MEMBER SIEBER: So it's built into the process.

MS. BLACK: So it's built into the process. So you would an 805 plant but with your old licensing basis, you probably wouldn't pick it up unless you have one problem area that you wanted to analyze but you would 805 in the plant with your old deterministic licensing basis in most of the fire areas.

MEMBER SIEBER: Okay, thank you.

CHAIRMAN ROSEN: One other protocol question, I think that at this stage of the meeting we typically go off the record, just to -- am I correct about that?

So I'll adjourn the meeting for the purposes of the record.

(Whereupon, at 4:41 p.m. the meeting in the above entitled matter concluded.)