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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

536TH MEETING

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THURSDAY, OCTOBER 5, 2006

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VOLUME II

The meeting was held in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., Dr. Graham B. Wallis, Chairman, presiding.

MEMBERS PRESENT:

GRAHAM B. WALLIS	Chairman
WILLIAM J. SHACK	Vice-Chairman
SAID ABDEL-KHALIK	Member
GEORGE APOSTOLAKIS	Member
J. SAM ARMIJO	Member
MARIO BONACA	Member
MICHAEL CORRADINI	Member
THOMAS S. KRESS	Member
OTTO L. MAYNARD	Member
DANA A. POWERS	Member
JOHN D. SIEBER	Member-At-Large

ALSO PRESENT:

SAM DURISWAMI, Designated Federal Officer
MARY DROUIN
JOHN MONNINGER
GARETH PARRY
BIFF BRADLEY
MARK SALLEY
PATRICK BARONOWSKI
ANTHONY HAMINS
KEVIN McGRATTAN
RAY GALLUCCI
FRANCISCO JOGLAR
JASON DRIESBACH
SUNIL WEERAKODY

C O N T E N T S

P R O C E E D I N G S

(8:32 a.m.)

CHAIRMAN WALLIS: Good morning. The meeting will now come to order.

This is the second day of the 536th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting the committee will consider the following:

Proposed Revision 1 to Reg. Guide 1.200, an approach for determining the technical adequacy of probabilistic risk assessment results for risk informed activities;

Verification and validation of selected fire models;

Preparation for meeting with the NRC Commissioners;

Future ACRS activities;

The report of the Planning and Procedures Subcommittee;

Reconciliation of ACRS comments and recommendations;

And the preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Sam Duriswami is the Designated

Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions.

A transcript of portions of the meeting is being kept, and it is requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

I would like to welcome Brandy Hamilton. She's on the three-month rotational assignment to the Operations Support Branch, ACRS, ACNW. She is a contract management specialist in the Division of Contracts, in the Office of Administration. She is in the Nuclear Safety Professional Development Program, graduating with the class of 2008.

She has a B.S. degree in biology from Bennett College. She is working towards an M.S. degree in environmental management at the University of Maryland.

Please welcome Brandy.

(Applause.)

CHAIRMAN WALLIS: I'd like to move ahead with our schedule today. The first item on the agenda is this revision to Reg. Guide 1.200. I invite my colleague, esteemed professor, George Apostolakis, to lead us through this one.

MEMBER APOSTOLAKIS: Thank you, Mr. Chairman.

The purpose of this session is to review and comment on the draft final version of Regulatory Guide 1.200, an approach for determining the technical adequacy of PRA results for recent performed activities and the associated standard review plan Section 19.1.

We reviewed the original version of this regulatory guide in September of 2003 and issued a letter, and the guide was issued for trial use in February of 2004.

Since then the staff and the industry have conducted five pilot applications of the guide and have incorporated those lessons into Revision 1 that we have in our hands.

There have been several changes both in the guide and the SRP that I'm sure the staff will talk about. I was particularly please to see in one place definitions of core damage frequency and large early release frequency.

And the staff is requesting a letter from us, which we will issue at this meeting. So without further ado, I will turn it over to Ms. Mary Drouin, an old friend.

MS. DROUIN: I like the "friend" part.

(Laughter.)

MS. DROUIN: I'm Mary Drouin with the Office of Research, and with me at the table is Gareth Parry from NRR.

Before I get started I'd like to turn over to my manager, John Monninger, to see if he wanted to make some comments.

MR. MONNINGER: Good morning. I'm John Monninger. I'm the Deputy Director for Probabilistic Risk in Applications from the NRC's Office of Nuclear Regulatory Research.

I'm very pleased to be here today discussing this revision to our Reg. Guide 1.200 and the SRP with the ACRS. One of the things I'd like to note broad picture-wise, this is part of the agency's phased approach to achieving PRA quality.

Several year ago -- I'm sure Mary may go into it -- the staff issues a commission paper describing that phased approach. Rev. 0 of this reg. guide was the start of this. This is Rev. 1, and in the future we have additional revisions to this reg.

guide planned to reflect other aspects of PRA for low power shutdown, external events, fire, et cetera.

One of the things I will note, we had the meeting with ACRS yesterday on reg. guides. This was on the list of reg. guides, but of particular note, this is a little bit different. The majority or I would say all of the reg. guides on the list yesterday with the exception of this one were meant for new reactors.

Reg. Guide 1.200 is for new reactors and operating reactors, but really within the near term its focused is actually more on operating reactors. So that is one nuance or distinction out there.

But other than that I just wanted to thank you very much, and we look forward to a good meeting.

CHAIRMAN WALLIS: Well, I have a question, Mary. Why did you censor one line on every slide with a big black bar? What is it you cut out?

(Laughter.)

MS. DROUIN: The big, black bar.

MEMBER SIEBER: Right there. It's on the screen under reactor safeguard.

MS. DROUIN: Oh, that big, black bar?

CHAIRMAN WALLIS: It looks as if you cut out a line. It's inappropriate or something. You cut it out.

MS. DROUIN: No, this is the -- I'm just going blank on the word -- you know, when you pick your different templates, this is the template that came with this one.

CHAIRMAN WALLIS: Oh, you're not raising the bar in any way, are you?

(Laughter.)

VICE CHAIRMAN SHACK: After this meeting, they'll probably belly-up to the bar.

(Laughter.)

CHAIRMAN WALLIS: Can we go on with the meeting now? Okay.

MS. DROUIN: Okay. The purpose of today's meeting, as George said, we're here to discuss the revisions that we've made to Rev. 0 when it was issued for trial use. We're wanting now to issue Rev. 1 for use, not for trial use anymore, for use.

So we're here today requesting a letter approving the issuance of Rev. 1 for use.

Several things I'm going to go through just quickly, you know, the history and background of how we got here, you know, the status, what's the purpose behind both the reg. guide and the SRP, the revisions that we made.

We had a public meeting in July where we went through the changes that we have made to the document, and we have received comments from that public meeting. The public review and comment period is open until October the 14th, and I will get to that later, and then ultimately what our schedule is.

In looking at the history, ASME starting back in April of 2002 issued Rev. 0 to their standard. Subsequently, since then they came out with Addendum A and Addendum B. Revision 0 to Reg. Guide 1.200 is on Addendum A. This now talks to the changes that are in the standard in Addendum B. A lot of those changes, you know, were a result of the five pilots and to address the staff comments are objections that are in Rev. 0.

NEI has also provided a self-assessment process. The self-assessment process looks and tells the licensees what they may need to do or should do where there is a discrepancy between the criteria that was used in the peer review and what's in the standard.

And what I mean by discrepancy is that there's something in the standard that wasn't addressed by the peer review, and then what they need to do for that difference.

We did publish 1.200 in February of 2004, and that also included SRP 19.1. Since then, you know, we've done, you know, the five pilots and, again, there's Addendum A and the self-assessment to Rev. 1 of the NEI 002 on the self-assessment process.

So right now where we are is looking at Addendum B. It's important to note that Addendum B only looked at and made changes to Chapter 4 of the standard, which deals with the technical requirements. It also made some changes to Chapter 2 where the definitions are.

But Chapter 3 of the standard which gives the application process, which is a very important part of the standard, the application process goes through and gives the requirements of what technical requirements to need to meet for what application. It gives that criteria because depending on the application you may not need to meet everything that's in the standard. So this gives the requirements for that process.

That was not changed in Addendum B. Section 5 of the standard gives the requirements for configuration control of your PRA, and that's intended so that over time your PRA represents the current, as built, as operated plant, and then Chapter 6 of the standard gives the peer review process, and that part of the standard was not changed.

So what's important to note here is that our objections for those chapters did not change for Rev. 0 to Rev. 1.

NEI-02, Revision 1, it updated the self-assessment process. It did not update the other parts of NEI 00-02. So, again, where we had objections on the other part of NEI 00-02, they still remain at this point.

Okay. The status, as I said, you know, there were the five pilots. If you were interested in knowing what the lessons learned by the pilots, those are documented, and I've given you the ADAMS number.

CHAIRMAN WALLIS: This green color is not a good color.

MS. DROUIN: Well, see, that's not the color on the screen here, and it's not the color on the template. That's something wrong with your machine.

MEMBER MAYNARD: Well, put.

(Laughter.)

MEMBER POWERS: No, no. It's wrong with him personally.

MS. DROUIN: I'm sorry?

MEMBER POWERS: Wrong with him personally.

MEMBER KRESS: Don't ask. I don't see green.

MEMBER POWERS: What green?

MS. DROUIN: I mean, if you want me I could just probably very quickly in like 30 seconds just delete the background if it's really bothersome.

VICE CHAIRMAN SHACK: We've got them in front of us, Mary. Charge ahead.

MEMBER KRESS: That's fine.

MS. DROUIN: Well, maybe this is good. You all will focus on that, and we can just go through real fast.

MEMBER BONACA: It's just we like to complain.

MEMBER POWERS: Just get through it quickly because I've got a question for you.

MS. DROUIN: I'm sorry?

MEMBER POWERS: Get through it quickly so I can ask you a question.

MS. DROUIN: On this slide or the whole presentation?

MEMBER POWERS: On the whole philosophy of things.

MS. DROUIN: Okay.

MEMBER KRESS: Fair warning.

MS. DROUIN: One of the things that John said that was very important is that right now, you know, the real focus of this reg. guide is to support operating reactors, but we did make a change. It's not a huge change, but it's an important, subtle change that was in the reg. guide because this is now also to support new reactors, and there's DG-1145, which is the reg. guide to support Part 52, and there is parts in there that talk to PRA quality, and we made changes in there, and if you look at DG-1145, it now references Reg. Guide 1.200, and we'll get into that.

As I said, we had a public meeting in July. We went through in detail all of the changes we've made to both the reg. guide and the appendices to get an early reaction so that we wouldn't have to wait completely on the formal review and comment period and to try and resolve some of them prior to going out for public review and comment, which I think we did.

And it is out for public review. It is due October 14th, and it's noted as DG-1161.

Okay. The purposes of the regulatory guide, going back in history it has always been there, is to provide, you know, the technical adequacy for your PRA, for your risk informed decision making; that if you implement this reg. guide, we would have the confidence in the PRA quality of the base PRA, not the application, but the base, and that's a very important point, that the base PRA is technically adequate.

CHAIRMAN WALLIS: All right. This applies to all levels of PRA or this is a Level 1 PRA or what is it?

MS. DROUIN: Okay. Right now, Reg. Guide 1.200 is just written to Level 1 and LERF, all initiating events, both internal and external, and all operating modes, full power, low power, and shutdown. It does not address a full Level 2 or a Level 3.

Now, ANS is working on standards with that. So we will ultimately update that main body of the reg. guide that goes through the attributes and characteristics and add that in for Level 2 and Level 3, but that's going to be down the road in a future revision.

MEMBER CORRADINI: Well, later on will you explain if it applies to LERF or it defines it and then works through that where it's deficient in Level 2 sot hat I understand? Because you said it isn't Level 2 but it does address LERF. So it's --

MS. DROUIN: It only addresses large, early release frequency, what you need to do to calculate a large, early release frequency. So it doesn't get into -- and I mean, I wasn't going to go through that, but it won't get into late releases.

MEMBER CORRADINI: Okay. Thank you.

MEMBER APOSTOLAKIS: It doesn't get into the amount of release.

MS. DROUIN: Right.

MEMBER APOSTOLAKIS: Level 2 would tell you this is how much you are releasing. This one just says this is the frequency of releasing large amounts early.

MS. DROUIN: Right.

MEMBER APOSTOLAKIS: Without specifying.

MS. DROUIN: Right, and that was purposely done, as you know, to align with Reg. Guide 1.174, which uses, you know, the risk characterization in terms of just core damage frequency in LERF. So we did not go beyond Reg. Guide 1.174.

MEMBER KRESS: Now, while we're on that subject of LERF, let me ask you another question. Generally it's the early part of the large early, is to find before you can have effective evacuation. It seems to me like effective evacuation is a site specific attribute, and how can you define a LERF without having a site and talking about Level 3 type stuff?

Mean, I don't quite understand how you can divorce LERF from site characteristics. Would you explain that one for me, please?

MS. DROUIN: No.

MEMBER CORRADINI: I'm sorry. This kind of relates to why I'm curious, is that it seems that either there must be something as some standard location or standard set of downstream characteristics for somebody to compute this. Otherwise you get a result that --

MEMBER KRESS: Maybe your answer to my question --

MEMBER APOSTOLAKIS: Why don't we look at the definition of LERF? Do you have the definition on a slides?

MS. DROUIN: Yes. We'll get there in a minute, but I guess my question is back to the committee. You know, this is a discussion to me that is more appropriate for like Reg. Guide 1.174. It's not something that this reg. guide deals with. That's really outside the scope.

I'm not debating the validity of your

question.

MEMBER KRESS: Yeah, you know, I'm concerned. You know, we're talking about the quality of the PRA with respect to its ability to calculate LERF, and then the calculation of LERF has to have somebody saying what's meant by early and what's meant by large and what's meant by unmitigated release in their definitions.

And the one that strikes me is -- the one of those that bothers me is the early because it is a site specific characteristic, and without having a site all you have is a PRA with a reactor. I can see if you have a site you might be able to do a site related calculation, but --

MEMBER APOSTOLAKIS: There is no precise definition of anything. Core damage frequency is not precisely defined either. There is a certain amount of fuzziness in these definitions, and it depends, you know, on the consensus of the analysts that are doing the analysis.

As a rule of thumb, although it's not really a rigid rule, releases before three hours, if you release within three hours of the core damage, then that's considered early.

MEMBER KRESS: Yeah, what's the technical basis for that?

MEMBER APOSTOLAKIS: The technical basis is within three hours you don't have much time to evacuate the people. There is no technical basis. It's an argument.

Now, there are some sequences, you know that are much sorter than that, you know. The time is longer and so on, but roughly three hours is considered a time that, you know, you really don't have much time to do it.

MEMBER KRESS: What if I have a sequence that ends up being 3.2 hours? Is that counted as LERF?

MEMBER APOSTOLAKIS: Oh, yeah, it's like everything else. I mean, they will decide probably to include it.

MEMBER KRESS: A lot of this is left to the judgment of the analysts.

MEMBER APOSTOLAKIS: Yes, yes, but again, if you look at the core damage definition, there is a lot of fuzziness there, too.

MEMBER KRESS: Is the three hours spelled out anywhere?

MEMBER APOSTOLAKIS: No.

MS. DROUIN: No, it is not.

MR. PARRY: And remember this is going to be applied on a plant specific basis. So I think that there are arguments that for some plants you cannot evacuate even in three hours. So it is going to be, as George says, it's somewhat subjective, and we recognize that.

CHAIRMAN WALLIS: Is there fuzziness a factor of two or ten or how big is the fuzziness? How big is the fuzziness? I'm puzzled by this.

MEMBER APOSTOLAKIS: I think it's what Gareth said. It depends very much on the application.

CHAIRMAN WALLIS: Yeah, but you said depended on the analyst. Well, that means I don't like this person, this sort of influence thing.

MEMBER APOSTOLAKIS: Because you can't really give.

CHAIRMAN WALLIS: Some people may be trying to make it small. Others are trying to make it big.

MEMBER APOSTOLAKIS: Well, that's why you have reviews.

MR. PARRY: And that's why we have peer review as part of this, and that's also why we exercise the right to review the application.

CHAIRMAN WALLIS: I didn't realize that it was so fuzzy thought. I thought things were more precise, more academic.

MEMBER APOSTOLAKIS: Well, it's the price you pay for not having a Level 3 PRA. It's a tradeoff. But so far I haven't really heard any major disagreements in any of the PRAs that people disagree as to whether a sequence should be part of early release or not.

MS. DROUIN: Correct, and when you go through the standard where it gives the requirements for what you need to deal with in calculating your LERF, we have not taken any exceptions in Appendix A to that part of the standard. We were quite happy with what's in the standard for the calculation of LERF.

MEMBER KRESS: You're getting an automatic update to your software.

MR. PARRY: I think one of the areas where it may come into play occasionally is in the STP, but then I think we get into some arguments about evacuation.

MEMBER KRESS: That would be a place. You're right.

MR. PARRY: But in typical licensing applications, I don't think it's as big an issue.

MS. DROUIN: Okay.

MEMBER POWERS: Maybe I can ask a question, and you'll probably give me a similar answer. You indicate that you want an approach for determining the technical adequacy of the PRA is sufficient to support risk informed decision making, and what you focus on is CDF and LERF, and these are dominated by accident initiators and the plant responds to those initiators.

Yet what I see before this committee is a lot of people requesting to run their plants at higher power. I don't so much see it in front of this committee, but it's true that they're running fuel at a much higher burn-up. So they're changing the inventory of radioactive material available for release, and they surely must change the risk.

But it cannot possibly be reflected in CDF and LERF. Does that make this -- is any PRA focusing on CDF and LERF technically adequate to support risk informed decision making at plants that are running at higher power and higher burn-up?

MS. DROUIN: I think that the quick answer is probably a no. This reg. guide is strictly focused for the base PRA, and when you go through the reg. guide, you know, we've tried to put the caveat in there that when it comes to the application and you're looking at the delta change in risk, that that application reg. guide and its associated SRP is going to give the guidance in terms of PRA for that.

So if there's something that you need to do in the PRA for that delta, you're going to have to go to that application specific reg. guide. There is no way that this reg. guide and this standard could cover all of those kinds of I don't want to say subtleties, but situations.

So it was deliberately -- the standard and this reg. guide was deliberate for the base PRA, not things that you were going to change. And we've tried to make that clear up front in the regulatory guide.

MEMBER POWERS: What I question is whether you've given adequate guidance to the user, be he staff or licensee, to say when you're talking about changes that affect the inventory of fission products, you're not going to see those risk consequences or those changes reflected when you use this reg. guide.

MR. PARRY: I don't think that's the purpose of this reg. guide. This reg. guide is not a reg. guide that addresses how you assess changes in risk. This, as Mary said, this reg. guide addresses the technical adequacy of a base PRA. So I think both you and Dr. Kress are taking this out beyond the scope of this reg. guide into more Reg. Guide 1.174 scope.

And I think that's a more appropriate place to discuss these issues than this particular reg. guide.

CHAIRMAN WALLIS: You got in trouble because of your first bullet. I mean, if you were one of my students and put up the first bullet, I'd first ask, well, what are the attributes and features needed in order to make risk informed decision making. What kind of decisions do you wish to make? What kind of information do you need?

MEMBER APOSTOLAKIS: This is what --

CHAIRMAN WALLIS: Tell me that.

MS. DROUIN: But again, that's another guide.

MEMBER APOSTOLAKIS: This is a little misleading.

CHAIRMAN WALLIS: That's why you're in trouble, because of the first bullet.

MS. DROUIN: Okay. You know, this is a viewgraph. If you want me, I'll come in and I'll quote the actual word from the regulatory guide, not to be sarcastic.

MEMBER APOSTOLAKIS: No, but you are

really proposing an approach for determining the technical adequacy of the evaluation of CDF and LERF.

MS. DROUIN: That's right, for the base PRA.

CHAIRMAN WALLIS: The first bullet is dangerous.

MEMBER APOSTOLAKIS: Yeah. You are not doing that. That's why you're --

CHAIRMAN WALLIS: No, you're not doing the first bullet, right.

MS. DROUIN: Right, but this is to help me, you know, give my presentation. These are not the literal words that are in the regulatory guide.

CHAIRMAN WALLIS: But you see, every time you put something up on a slide, you can be asked questions about it. It's dangerous.

MEMBER APOSTOLAKIS: But it is the title of the guide though, is it not?

MS. DROUIN: Okay. I'll do blank slides next time.

MEMBER ABDEL-KHALIK: Back to Dr. Power's question though, I mean the argument is being made that if you go through a power up rate, you're essentially increasing the inventory of fission products, but at the same time you're also increasing decay heat, and therefore, for the same hardware you are increasing the core damage frequency.

CHAIRMAN WALLIS: Not the way it's calculated.

MEMBER KRESS: Not the way it's calculated.

MEMBER ABDEL-KHALIK: But, you know, aside from the way it's calculated, in reality.

MEMBER APOSTOLAKIS: Unless the success criteria change, you're not going to see any difference.

CHAIRMAN WALLIS: You've still got enough margin.

MR. PARRY: Think of station blackout.

MEMBER APOSTOLAKIS: Station blackout, how will that be effective?

MR. PARRY: Well, because you've got to recover power in the shorter time, which means it's a higher probability of failure to do so. So I think you do get changes in CDF.

MEMBER CORRADINI: But like I say, if we could just stay with it because Said's point, I think, is well said, is that physically if I run the plant ten percent higher power or I have burn-up that's 50 percent larger, either the inventory is going to go up or something is going to happen. So it goes back to the fuzziness question of Graham, which is in theory you should be able to see a difference, but given the calculation is fuzzy, you won't currently.

MEMBER KRESS: It's insensitive to that.

MEMBER CORRADINI: It's insensitive to something that we know ought to be its -- that it ought to be sensitive to. I think that's what I get the impression that Dana's worried about.

VICE CHAIRMAN SHACK: Well, no, I think it's more there are changes in delta CDF. They're just small.

MEMBER KRESS: They're small.

VICE CHAIRMAN SHACK: The change in the release is 20 percent.

MEMBER APOSTOLAKIS: The CDF is not the problem here. I think it's the LERF, the release.

VICE CHAIRMAN SHACK: Well, yeah, between your CDF and your LERF, either both of those changes are small, but your changes in release --

MEMBER APOSTOLAKIS: I guess what Mary is going to do is tell us how to calculate CDF and LERF with all of their faults, and we're not going to discuss the --

MEMBER APOSTOLAKIS: Maybe you guys should think about --

MS. DROUIN: Well, I'll be honest. I wasn't going to go through that because we went through that when we first issued this regulatory guide, and you all approved it. You know, so are we going back to -- to be quite honest, are we going back to day zero or are we just going to focus on the changes?

MEMBER APOSTOLAKIS: No. I don't think so, but I think the source of trouble here is the title of the guide. You are not really evaluating the technical adequacy of PRA. You are evaluating methods for getting to CDF and LERF. If you had put that up there, you wouldn't have gotten any of these questions.

MEMBER KRESS: That's right.

CHAIRMAN WALLIS: That's right.

MS. DROUIN: Well, you know, I didn't get these questions two years ago from your, Tom.

MEMBER APOSTOLAKIS: Well, the committee gets wiser and wiser.

MEMBER KRESS: We never forget.

MS. DROUIN: That's one way to look at it.

CHAIRMAN WALLIS: Well, if you took down this and moved on to the next slide, you wouldn't have to be answering this question.

MS. DROUIN: Well, I'm trying to.

MEMBER APOSTOLAKIS: You make it clear somewhere. Maybe the title is too late to change, but this is really what you're doing with this guide, looking up CDF and LERF? I know you're defining --

MS. DROUIN: We can make that clearer.

MEMBER APOSTOLAKIS: Somewhere up front.

MS. DROUIN: Yes.

MEMBER APOSTOLAKIS: The purpose of this guide is to do this. Now, it's implied because you give the definitions, but somebody will have to stop and think about it.

MS. DROUIN: Well, I'm going to jump over to --

MEMBER APOSTOLAKIS: Heaven forbid.

CHAIRMAN WALLIS: The next slide gives you the same problem. So you had better jump over that one.

MS. DROUIN: Yeah, I just jumped over. I jumped to Slide --

VICE CHAIRMAN SHACK: Actually whether you believe in knowing CDF and LERF is enough for risk informed decision making.

MS. DROUIN: You have to understand --

CHAIRMAN WALLIS: That's not this part.

MS. DROUIN: -- when we talk, when we use the term "PRA," and I do think it's explained in the regulatory guide, we are always talking about the base PRA. We are not talking about the delta change and how that PRA had to be changed to support an application. This is talking about the base PRA that you started from, and that's all we're talking about, and that's the sole scope of this regulatory guide.

So when we provided the regulatory guide --

CHAIRMAN WALLIS: Now you're in trouble again, I think, because you -- I don't think you list functional requirements. I think you relist features of the PRA itself, but what it's going to do in terms of its functional requirements is not addressed in this guide.

MS. DROUIN: I'm sorry?

CHAIRMAN WALLIS: I think you're in trouble again using this word "functional requirements." Function requirements, I would start with a list of specs. My PRA must have an accuracy of so much. It must have this, this, you know, and that's not what you're doing.

MS. DROUIN: I disagree.

CHAIRMAN WALLIS: Must be useful for power upgrades. You know that's what I mean by functional requirements.

MS. DROUIN: No, no, no, no, no, no. This is the functional requirements --

MEMBER BONACA: I think it has to be a proper model, and here we're talking about the reflection of the plant, a good description of the plant, an adequate -- I mean, you know, otherwise you are forcing other requirements on it. You know, if you're talking about the base PRA, to me that's the message I'm getting, the representation of the plant.

MR. PARRY: Yes, and the functional requirements in another sense are that it's capable of evaluating core damage frequency and large early release frequency, however fuzzy those decisions may be.

CHAIRMAN WALLIS: But you can't do that without looking at the use to which it is put. So I think you need to jump to Slide 11 and then you'll be all right.

Why does he keep doing that? Maybe he's trying to update the guide, not the software.

MEMBER APOSTOLAKIS: Okay. Let's go on.

MS. DROUIN: Okay.

MEMBER APOSTOLAKIS: Where are we now, 11?

MS. DROUIN: Slide 11. We're walking through the main body of the reg. guide.

Section C11 of the reg. guide talks what the scope of the PRA needs to be. This is your base PRA again. The scope may not be adequate for certain applications, but we're talking about the scope of the PRA as it's going to calculate CDF and LERF. So we added definitions on CDF and LERF there.

MEMBER CORRADINI: May I ask a question here just so I understand? So these look like common definitions. Is there anything different here than what somebody walking in would have assumed?

I'm trying to determine the subtlety here, any subtleties that I might be missing.

MS. DROUIN: This is consistent with what is in the standard. The standard is a consensus agreement. So we're completely consistent here. So I would tend to say an answer to that is yes, if you believe in the consensus process, which is, you know, put together by the various stakeholdres on the committee, and then it goes out for public review, I mean, through the whole consensus process, you know, when a society like ASME puts it together. So --

MEMBER APOSTOLAKIS: Are these the

definitions in the standard?

MS. DROUIN: Yes.

MEMBER APOSTOLAKIS: The ASME standard?

MS. DROUIN: Yes.

CHAIRMAN WALLIS: How long is the definition of CDF?

MS. DROUIN: I'm sorry?

CHAIRMAN WALLIS: Is it a one sentence definition --

MEMBER APOSTOLAKIS: No.

CHAIRMAN WALLIS: -- or is it ten pages?

MEMBER APOSTOLAKIS: We don't do things in one sentence, Graham.

PARTICIPANT: It's on page something or other here.

MEMBER KRESS: Seven.

MS. DROUIN: It's in the reg. guide that we sent you.

CHAIRMAN WALLIS: Oh, it's prolonged oxidation, severe fuel damage, a large fraction of the core. Ah, okay. So --

MEMBER KRESS: But it's interesting the way you calculate CDF in the PRA is to see whether or not you meet the success criteria for ECCS.

CHAIRMAN WALLIS: So all of these terms

are --

MEMBER KRESS: Why isn't it defined in terms of ECCS --

CHAIRMAN WALLIS: All of these terms are very, very vague, aren't they? Is it one fuel element, ten, 20, 50?

PARTICIPANT: No, but, Graham, I think what Tom just said is important.

MEMBER POWERS: To answer your question, Tom, to answer Tom's question is when you do the analysis on success criteria, you go in and you look at how extensive the damage to the core is and typically when we have done those things, we recognize somewhere imbedded in the regulations plants are actually allowed to operate with about one percent damaged fuel.

See, core damage has to be more than one percent, and roughly people take -- it depends a little bit on the analyst, between five and ten percent fuel damage.

MEMBER KRESS: That might be a better definition in my mind, five to ten percent..

MEMBER POWERS: Well, it's done on whether you successfully mitigated the accident or not. With interrupted operation, you know, degraded operation in the safety system, has the degradation been so great that you can -- clad ballooning does not count. Clad ballooning is okay. You have to go somewhat beyond that, and if you go beyond that in more than about five to ten percent of the core, then you typically say, well, that is not a successful operation of a degraded safety system.

MEMBER KRESS: I would have looked at that though and said those sequences that end up right there on that level, five to ten percent of the core, don't meet this criteria as core damage.

MEMBER POWERS: Well, the results are --

MEMBER SIEBER: --already calculate any of this.

MEMBER POWERS: No, PRA does not do this. This is when you set your success criteria.

MEMBER SIEBER: That's right. You either make it or you don't.

MEMBER POWERS: When you go through these exercises, I can think of no situation in which I've been hanging around this edge. Usually I'm either well below it--

MEMBER KRESS: Or well above it.

MEMBER POWERS: -- or I go screaming through the limit so fast and I get up to --

MEMBER KRESS: I agree. It's almost like a delta function.

MEMBER POWERS: Yeah, it's very close to a delta function. Now, some of this actually is going through an evolution on the phenomenological level, and I don't even begin to expect the reg. guides to reflect this because it's like all things on the frontiers of research in this area. It could well change tomorrow, but what we are seeing is much more localized initial core degradation, much cooler cores, longer periods of degradation.

So timing, things like timing on what do you mean by large early release, you know, within three hours? Well, sometimes the three hours is just barely getting to cooking the core, and it goes on for long periods of time, much longer than what you're used to from like the 1150 series, and it gets your releasable inventories way the hell up, and this is all on the front of accident analysis can't possibly, ought not be reflected in current regulations because, like I say, these interpretations have a way of changing dramatically from month to month.

MEMBER KRESS: But these definitions wouldn't apply to some of the new reactor concepts. You'd have to redefine the CDF and LERF.

MEMBER POWERS: Well, you always have to consider what your success criteria are based on the actual plant design, and what always stuns me is from plant to plant they change quite significantly. I mean, it's a nontrivial change. I mean, it's one of these peculiarities of you think, you know, all PWRs are alike. Well, they aren't.

MEMBER CORRADINI: If I could just make sure. I was listening to you guys go back and forth. Just for my own benefit, if it were rephrased, just for the sake of discussion, if it was rephrased that results in significant fuel damage, "significant" left vague, it's a reverse of saying you haven't met for a light water reactor the ECCS criteria.

Is that not the same thing though, Dana? Because since it is a cliff --

MEMBER POWERS: You're not helping yourself at all because --

MEMBER CORRADINI: So you're not making it clear. You're just living it at a different sort of state.

MEMBER POWERS: Yeah, sooner or later you get down to a subjective decision. Is what I've done to the fuel damage or not?

CHAIRMAN WALLIS: Well, I think the

problem is the definition is not functional in that it's not calculated by the PRA. The PRA doesn't calculate prolonged oxidation. Core damage frequency is defined by the PRA success criteria because those are the things you calculate. That should be in the definition. Then it's a usable definition.

MEMBER KRESS: That's what I was saying.

CHAIRMAN WALLIS: Core damage frequency is defined by a certain success criteria. These other things are bad because you can argue about them forever, and they're not defined, and they're not usable. They're not calculated by the PRA. So there is a problem there.

MS. DROUIN: It's not calculated by the PRA. That's --

CHAIRMAN WALLIS: Maybe you could say that the purpose of this is to define success criteria which, you know --

MR. PARRY: I think though if you were to look at the way people define these in practical terms in PRAs, I'm pretty sure you'd find out that the way they were implemented was very conservative with respect to these definitions.

And while I've got your attention, I'm going to point you to LEC 1, which is one of the requirements of the ASME standard, which I believe does allow you to address LERF and even for power up rates because what it says is justify any generic or plant specific calculations or references used to categorize releases as non-LERF contributors based on release magnitude or timing.

So I think I would argue that this standard does allow you to even do a base PRA at an increased power level. That's the hook, I think, into the magnitude of the source term release, and all the other issues related to timing would be captured in the CDF criteria. So I don't think it's as bleak as you think it is.

MEMBER APOSTOLAKIS: I guess the logical sequence that would take care of these concerns would be to list this definition and then say based on that success criteria defined which of them the input to the PRA. That's really what you do.

MS. DROUIN: I mean, that's totally accurate. This is where you start, and then the PRA, the analyst does an engineering calculation looking at that to determine, you know, what GPN you need, and then you go in and say this is the GPN. Here are the systems that can provide that. But core damage is not defined by your success criteria. Your success criteria are defined by how you define core damage now.

Yes, this is vague, and Gareth was absolutely correct when he said usually you do it very conservative and you'll come in and you'll say in your PRA as a surrogate definition for perhaps a boiling water reactor, I'm going to say that's two feet above the bottom of the reactor fuel, and then I'll do my MELCOR run or my MAP run, whatever code you choose, and that will tell you, you know, what coolant you need so that your inventory stays above that two feet, and then you go look at what systems are available, and then that tells you your success criteria.

But your CDF is nondefined by -- the success criteria does not define your CDF.

CHAIRMAN WALLIS: What happens if I have one foot?

MEMBER APOSTOLAKIS: They have to draw the line somewhere.

CHAIRMAN WALLIS: We have to move on.

MS. DROUIN: You make an engineering judgment.

CHAIRMAN WALLIS: Well, about such an important thing?

MS. DROUIN: And that's based on a lot of calculations that have been done.

MR. PARRY: I think, again, I'd defer you back to one of the supporting requirements in the ASME standard, which is specifically SCA-2, which you don't have in front of you, but that addresses the issue of which plant parameters you use to define core damage.

MEMBER APOSTOLAKIS: And that's not the only place there is fuzziness, by the way. I mean, how do you define failure? What does it mean the valve has failed to open? What does it mean the pump has failed?

CHAIRMAN WALLIS: Or maybe half opened or three quarters?

MEMBER APOSTOLAKIS: All of these partial successes are not there. So you make judgments all the time, and that's why at the end you are risk informing rather than basing.

MS. DROUIN: That's right.

MR. PARRY: And I think we tend to be somewhat conservative in defining failures.

MEMBER APOSTOLAKIS: I think so. I think so.

CHAIRMAN WALLIS: Maybe you need to say that somewhere then.

MEMBER APOSTOLAKIS: Yeah, but the

sequence though, you're right, should have been this is the definition. These are the success criteria, and then the PRA guys do their own thing.

CHAIRMAN WALLIS: Okay.

MS. DROUIN: Okay. Moving on maybe --

CHAIRMAN WALLIS: You put it up on the slide and we can ask you questions about it. So what's the next one?

MS. DROUIN: The next one is C-12, which gives the technical elements of a PRA. We added clarification that the PRA results are addressed in an integrated manner, and we added definitions on key sources of uncertainty and assumptions.

CHAIRMAN WALLIS: I don't know what you mean by addressed in an integrated manner. I'd better not ask, but I don't know what it means.

MEMBER APOSTOLAKIS: What is it that matters to you, Graham?

CHAIRMAN WALLIS: I don't know what it means.

MEMBER POWERS: You take no racial prejudices when you --

MEMBER APOSTOLAKIS: Which part is it?

CHAIRMAN WALLIS: I don't know what it means, but it doesn't matter. Just leave it.

MEMBER ABDEL-KHALIK: Well, if you have clarified C-12, could you please remove the double negative?

MEMBER APOSTOLAKIS: Where?

MEMBER ABDEL-KHALIK: On page 9.

MEMBER APOSTOLAKIS: Page 9? Oh, ride (phonetic) itself?

MEMBER ABDEL-KHALIK: Right. Under quantification.

MEMBER APOSTOLAKIS: What does it say?

MEMBER ABDEL-KHALIK: Here it is. "If truncation of accident sequences and cut (inaudible) is applied, truncation limits are set so that the overall model results are not impacted in such a way that significant accident sequences or contributors are not eliminated."

MEMBER APOSTOLAKIS: It's a test of the --

MR. PARRY: I think the second "not" should probably not be there.

MEMBER APOSTOLAKIS: -- already boring assignments.

MEMBER ABDEL-KHALIK: That's exactly correct.

MS. DROUIN: Thank you.

CHAIRMAN WALLIS: I thought PRA results

were CDF and LERF. I didn't quite know how to integrate them, but I just said go ahead.

MS. DROUIN: I'll make a promise here, Graham. I'll talk to you off line.

CHAIRMAN WALLIS: Okay. Obviously if you put something up there people look at it and say, "What does it mean? What is she trying to tell me?"

MS. DROUIN: All this is trying to tell you is that when you look across the contributors -- sorry -- the CDFs that you calculate from internal events, external events, you can add them up.

CHAIRMAN WALLIS: Ah, that's what it means. Okay.

MS. DROUIN: That's one way to address the overall.

CHAIRMAN WALLIS: Okay. Thank you.

MS. DROUIN: So it was just no more complicated than that.

Okay. Attributes and characteristics. We've just added some words because this will be used also for new plants, recognizing that a new plant, it's not operating yet. The ASME standard and this reg. guide in Rev. 1 -- I'm sorry -- Rev. 0 was originally written for operating plants that have, you know, years of history.

So we just wanted to recognize that in using this for new plants you're not going to be able to go to the same level of detail.

CHAIRMAN WALLIS: What does different plant stages mean? Different ages or different stages in the --

MS. DROUIN: It means like the design stage.

CHAIRMAN WALLIS: The fuel cycle?

MS. DROUIN: It means like the design stage, the construction stage, the operating stage.

CHAIRMAN WALLIS: That's where it is. Okay.

MS. DROUIN: And that's explained in more words in the regulatory guide.

Probably the biggest thing that we added to the main body of the regulatory guide was the next one, and that was to provide more guidance and be real clear. When we talk about the as operated, as built plant, what we meant by that and what sources of information that you should be using to insure that the PRA really is representing the as built and as operated plant, that that was a critical item.

So we added more guidance to clarify that.

Section C-2 of the reg. guide gets into

that, you know, you can use a standard to demonstrate that you met the attributes and characteristics that are talked about in C-1 for each of the technical elements of your PRA.

In doing that, we recognized in the reg. guide that you had capability categories, and what those capability categories mean.

We added a global --

MEMBER APOSTOLAKIS: Let me ask a question here, Mary.

MS. DROUIN: Sure.

MEMBER APOSTOLAKIS: Which is not, again, related to this, but the capability categories in the ASME standard were put there because people didn't have complete PRAs and this and this and that; is that true?

To give different -- you know, if everybody had a Level 3 PRA, you wouldn't need all of that.

MS. DROUIN: No, no. The capability categories recognized that on any given particular requirement or technical element, that you don't do it necessarily to the same level of detail.

MEMBER APOSTOLAKIS: Right. And what I'm saying is if everyone had a Level 3, full scope PRA, you know --

MS. DROUIN: No, no, no.

MEMBER APOSTOLAKIS: -- technically correct and so on.

MS. DROUIN: That's -- no.

MR. PARRY: You'd still have capability.

MS. DROUIN: You'd still have capability.

MEMBER APOSTOLAKIS: Why? Why?

MS. DROUIN: Because the capability category -- let me use systems analysis as an example. You don't create -- even if you had a Level 3 PRA, you would not develop every fault tree to the same level of detail. You might -- for one system you might just have a black box. For another system you might go to excruciating detail and the development of that logic model.

Initiating events, for example, regardless of the capability category, you have to identify all of your initiators, but in some cases you may do a more gross grouping of the initiators. In another PRA you may do a more finer grouping of that.

MEMBER APOSTOLAKIS: But if you had the PRAs at the phased approach and visions as Phase 4 or whatever it is, the latest state of the art, then all of this stuff would be taken care of. If I don't want to use the data that I have there, I don't use it, but I have it.

So the point, the whole point was, and in fact, I think when you move from one category to another you're allowed to use generic information here; there you have to use plant specific information. The whole point, I think, was to face the reality that we didn't have those perfect PRAs, that utilities had PRAs of various degrees of fidelity and sophistication and so on.

And I'm wondering whether this now will be permanent. I mean until when are we going to tolerate this?

MS. DROUIN: Well --

MEMBER APOSTOLAKIS: It's irrelevant to your effort, by the way. I preempt you. I realize what you're doing here, but I'm just wondering about that. I mean, it has been now what, eight years since the first Regulatory Guide 1.174.

MR. PARRY: More than that.

MEMBER APOSTOLAKIS: '98 I think it was.

MR. PARRY: Well, maybe.

MEMBER APOSTOLAKIS: Yeah.

MS. DROUIN: The standard was first started in January of '98.

MEMBER APOSTOLAKIS: Yeah, yeah. So anyway, again, that's probably for some other discussion, but I mean, let's --

MR. PARRY: I think if you lock in some of the guidance that's out there like NEI 00-04, which is the 5069 guidance, it actually recommends that people should migrated to capability Category 2. So in principal --

MEMBER APOSTOLAKIS: Which is, you know, pretty good.

MR. PARRY: -- which is -- well, that's industry good practice.

So I think if eventually we migrate there, yeah, these other categories may become redundant.

MEMBER APOSTOLAKIS: What I'm saying is that we really went out of our way back in '96, '97 when we were preparing the regulatory guide, the basic one, to accommodate the situation at that time and encourage people to become more risk informed.

But what is happening in the intervening years now is that we are taking that as a boundary condition that this is the way it will be forever, and I'm wondering. As you know, one of our members here has been pushing the idea of Level 3 PRA. So --

MEMBER KRESS: Who is that, George?

MEMBER APOSTOLAKIS: I don't know, Tom. I don't know.

MEMBER POWERS: I keep wondering how he's going to do one.

MEMBER APOSTOLAKIS: Let's not open that issue. But we should revisit these attitudes of the past, I think, at some point. Not today. It's not your problem. I realize that, but I'm just putting it into the record.

MS. DROUIN: I mean, I'll give you a personal answer.

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: I do think that having the different capability categories has added a lot of I personally feel unnecessary complication to the standard --

MEMBER APOSTOLAKIS: That's my impression, too, Mary.

MS. DROUIN: -- and the regulatory guide.

MEMBER APOSTOLAKIS: I agree with you.

MS. DROUIN: I don't think it has been as helpful as it was meant to be. I personally would like to see it dropped, but this is not a question so much for us. It's really a question back to the standards organization who are writing the standards with the different capability categories.

MEMBER APOSTOLAKIS: We should give them some time to use these standards as they are now, but at some point we have to question again the wisdom of having these distinctions..

MS. DROUIN: I agree.

MEMBER APOSTOLAKIS: Very good.

MS. DROUIN: Okay. The one thing that we did add, we added what I'd call this global exception to the references there. When you look at the standards, and this is probably rally more so for the external event standard than the Level 1 ASME standard where there are incredible amounts of references that are cited. The external event standard has a lot of commentary which is not requirements. It's commentary.

So we did not want to have people because we did not take exception, for people to think that then, therefore, those references are completely acceptable.

MEMBER APOSTOLAKIS: But how do you put it, Mary? I remember vaguely. What is the sentence you use, that the staff does not endorse?

MS. DROUIN: Unless there was a requirement that we took no objection to, if there is a reference in that requirement and we didn't take objection to it, then we accept that reference, but if we took an objection or were silent on it, then we are not endorsing the references.

MEMBER APOSTOLAKIS: I guess that language is important here because you may or may not endorse. Maybe you didn't review it.

MS. DROUIN: That's right, and so all we're saying is that we're not --

MEMBER APOSTOLAKIS: Do you make it clear that that's what -- because if you say we do not endorse, people might think, boy, you really don't like it.

MS. DROUIN: No, we just say we don't have a staff position.

MEMBER APOSTOLAKIS: That's good.

MS. DROUIN: We don't have a staff position.

We added clarification in this body of what is meant by requirements because when you look at the standards, you know, they use the word, you know, called a high level requirement versus the supporting requirement and what does that mean.

In terms of the peer review, we do acknowledge in the regulatory guide that --

MEMBER APOSTOLAKIS: That was a point of contention, wasn't it?

MS. DROUIN: Well, I'll get to that. NEI 00-02, which provides a peer review process and a self-assessment process, is referenced in the standard as an acceptable peer review process, and I underline "process" here because that is the area where I think we have an area of disagreement.

The peer review, we do provide a clarification that when you do a peer review, we want you to do the peer review against established standards, and if not, then to demonstrate that whatever criteria you use is consistent with the NRC endorsed standard.

MEMBER APOSTOLAKIS: Now, I read somewhere -- I think it was in the guide -- that you're trying to explain who is a peer; is that correct? And you give some ideas about experience and --

MS. DROUIN: Right, your peer review team.

MEMBER APOSTOLAKIS: Yeah.

MS. DROUIN: Right. We didn't change any of that from Rev. 0 to Rev. 1.

MEMBER APOSTOLAKIS: It seems to me one can have ten years' experience and be consistently wrong for ten years.

(Laughter.)

MEMBER APOSTOLAKIS: Don't you think?

MS. DROUIN: Yes.

MEMBER APOSTOLAKIS: It's kind of hard to define who a PRA is.

MS. DROUIN: It was very hard.

MEMBER APOSTOLAKIS: Maybe you can -- you don't need to explain it. Anything you say, somebody will say the opposite. You know, a guy has published 150 papers, and all of them are useless. I mean, what -- is he a peer? It's very difficult. I mean, it's much more difficult than defining core damage.

VICE CHAIRMAN SHACK: If you knew that was the case, George, it would be easy to decide whether he was a peer.

MEMBER APOSTOLAKIS: What's that again?

VICE CHAIRMAN SHACK: If you knew he published 100 references and they were all wrong, no.

MEMBER APOSTOLAKIS: No, they may be wrong.

VICE CHAIRMAN SHACK: That's a more difficult question.

MS. DROUIN: So you know, I agree. It was difficult, but we did the best we could.

MEMBER APOSTOLAKIS: It was difficult. I

mean, there are many practitioners, and some of them are better than others.

MS. DROUIN: We recognize that.

MEMBER APOSTOLAKIS: And we all know who they are.

(Laughter.)

MEMBER APOSTOLAKIS: Do they know? If I ask you, Gareth, to create a peer review team, or Mary, now for a PRA, you can do it in two minutes if you had the freedom of selecting anybody you wanted.

MS. DROUIN: Absolutely.

MEMBER APOSTOLAKIS: Yeah.

MS. DROUIN: But that doesn't mean, for example, you would agree with my choice.

MEMBER APOSTOLAKIS: I probably would. I always agree with you, Mary. That's the problem, the tragedy.

You know, another point though for future presentations. The slides are way too descriptive. We did this; we did that. You should give specific examples, it seems to me. When you say what is meant by capability categories, this is what we did. Do you see what I'm saying?

Now, you are telling us at the high level what you did without really going into any detail.

MS. DROUIN: Well, because we only had an hour and a half.

MEMBER APOSTOLAKIS: Well --

CHAIRMAN WALLIS: And it is being eaten up pretty quickly.

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: For a subcommittee, we would have done something like that.

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: Been very detailed.

CHAIRMAN WALLIS: Are you going to move to the next slide or are you --

MS. DROUIN: Yes.

(Laughter.)

MS. DROUIN: The last two parts of the --

CHAIRMAN WALLIS: This is one I had a question on, Mary. I'm sorry. Technical adequacy is, I think, one of the key things about PRAs. If you are, say, dealing with a BWR that's asking for a containment over pressure, can this be in the PRA? Are they required to model leaks in the containment probabilities? Probability of the cooling water temperature having certain values and so on. Are there some success criteria involved in the PRA that can be used to decide whether or not one should grant containment over pressure?

This isn't a regulatory application. Can the PRA be expanded to take care of this sort of thing? Should it be? Should it be required that it be able to take care of all regulatory applications?

MR. PARRY: I think you have to decide that on an application by application basis. I mean, that's part of Chapter 3 of the standard, is to determine whether the PRA does, in fact, have the right requirements to address the application, but you have to start from the application.

MEMBER APOSTOLAKIS: But that means that there's quite a few things that it's not capable of supporting; is that right?

MR. PARRY: Probably there are, yeah.

MEMBER APOSTOLAKIS: Okay. So it cannot be always expanded to deal with any technical issue which is --

MS. DROUIN: That's correct.

MR. PARRY: That's correct.

MEMBER APOSTOLAKIS: Although there may be risks and obviously there are risks involved with the granting or not granting containment over pressure, say, but you can't evaluate it in the PRA or you have to go to great lengths to evaluate it or something?

MR. PARRY: I'm not going to answer that specific question, although I think a couple of people in the audience --

MEMBER APOSTOLAKIS: I was just wondering because I think it's a very, very useful tool, and I'd like to use it when making decisions about things like that, and maybe I can.

MR. PARRY: Well, I think you have to determine whether what you want to do with it is capable of being supported within the PRA framework, and that's, in fact, what we say in Reg. Guide 1.174. It's what the PSA applications out of EPRI says. If you can't do it, then you aren't able to use these models to estimate the risk. You have to find some other way of dealing with it.

MS. DROUIN: And, again, if you go back to Chapter 3 of the standard, it goes through a process.

CHAIRMAN WALLIS: Well, I think this is a problem because the ACRS has recommended the agency risk inform the sump strainer problem, and if you can't do it in the PRA, how can you risk inform it?

MS. DROUIN: I don't think -- and I'm probably going to deviate us off here -- being risk informed does not necessarily mean that you always have to have this quantitative PRA model. There is a lot of risk insights that you can bring to bear from a qualitative perspective into your decision making.

CHAIRMAN WALLIS: From the qualitative? Did you say qualitative?

MS. DROUIN: Qualitative.

MEMBER APOSTOLAKIS: Yes, she made that mistake.

MS. DROUIN: What?

MEMBER APOSTOLAKIS: You shouldn't use the word "qualitative."

MS. DROUIN: Qualitative.

MEMBER POWERS: But what she says is absolutely true. I mean, what she said is absolutely true, and we do it all the time.

MS. DROUIN: Yes. Thank you.

MEMBER APOSTOLAKIS: Absolutely. But there are some times when you can't do it qualitatively, I think. If you've got a technical question --

MS. DROUIN: Well, I'm not saying you can do it every single time. I'm just saying that risk informed does not always require a quantitative analysis. That's all I'm saying.

CHAIRMAN WALLIS: Well, I don't understand that because I think all it means, it means calculating CDF. I don't know how you do that qualitatively, but that's another question.

MEMBER POWERS: That's where you make a mistake, Graham, because much of the value in the PRA comes in in saying what are the critical systems involved, and we do that all the time.

CHAIRMAN WALLIS: That's not what risk -- that's using a broader definition of risk. I thought you were talking only about CDF and LERF in this.

MEMBER APOSTOLAKIS: And the sequences.

CHAIRMAN WALLIS: Okay. So I think sometimes it may not be possible to risk inform if the technical features are very difficult to put into the PRA.

MEMBER APOSTOLAKIS: It's impossible sometimes to find the quantitative estimate of that particular phenomenon.

CHAIRMAN WALLIS: And sometimes the qualitative things may be misleading, too, where you can't --

MEMBER APOSTOLAKIS: No, but you can do, what I think Mary meant was you can still have the context within which that phenomenon takes place. The accident, the frequency of the accident, you know, these kinds of things.

CHAIRMAN WALLIS: Well, then you calculate the CDF and it hasn't changed.

MEMBER APOSTOLAKIS: No, no, no. Then you don't rely on that estimate of the CDF because you have missed something that's important in the C --

CHAIRMAN WALLIS: Okay. I think we realize that. That's why I'm asking though because this, I think, is an important area, especially if you're looking for a comprehensive PRA.

MEMBER POWERS: Only Tom looks for comprehensive PRAs.

CHAIRMAN WALLIS: Only Tom? He's got to get some allies.

MEMBER KRESS: My first name is "Only." My middle name is "Tom."

MEMBER APOSTOLAKIS: When we switch to a risk based --

MEMBER POWERS: Lonely Tom.

MEMBER APOSTOLAKIS: -- all of these questions will be extremely relevant.

MS. DROUIN: That's right.

MEMBER APOSTOLAKIS: None of us will be here on this committee at that time.

MS. DROUIN: Okay. The main body of the regulatory guide gives, you know, the staff guidance or position in the various things, and then the appendices are now giving the staff positions on the standards. Appendix A addresses the ASME Level 1 LERF standard for full power, internal events, excluding internal fire, whether it's giving a position on that standard or in Appendix B, which is the NEI 00-02 on the peer review in the self-assessment process, we do one of three things. We either have no objection. We have what we call objection with clarification.

What that means is that we don't have a technical disagreement with what was written, but we think that there's enough confusion or ambiguity in the way it was written that we think there's a high likelihood that it could be misinterpreted.

So we take an objection with clarification, and then we provide we think what the needed clarification is for us, the NRC, to find it acceptable or we give an objection with qualification. In that case, we do have a technical disagreement and we provide the necessary words that would have to be changed for us, the NRC, to find it acceptable.

Addendum B, as I said earlier, only addressed changes to the standard in Chapter 4, which are the technical requirements in some of the definitions in Chapter 2. So in updating the regulatory guide on Appendix A, we did not change any of our objections that were in Chapters 1, 3, 5 and 6 because nothing was changed in the standard. So our objections still remain.

The majority of the objections that we had in Revision 0 of Appendix A were addressed in Addendum B, and so most of our objections have been removed. Appendix A is now much, much shorter in this revision than it was in Revision 0, and we only have four qualifications that have remained, and they deal with requirements on data and internal flood.

When we look at Appendix B, the revisions that were made to NEI 00-02 primarily addressed the staff objections on the self-assessment process, and then they were also updating that to Addendum B of the standard. The Revision 0 to the self-assessment was to Addendum A. So they also made their comparable changes to address Addendum B and to address our objections. And so you see an update to Appendices D-1 and D-2 in NEI 00-02.

The staff objections in the main body of that document, Appendices A, B, and C, still remain because that part of that document did not change. The majority of our objections that we had in Appendix B were removed as it dealt with Appendices D-1 and D-

2.

The one thing that NEI did add to D-1 was a reference to NEI 05-04. When we had originally done our update to Appendix B, we did not give a staff position on this. As a result of the public meeting, we were asked, you know, to give a staff position. So we have now provided that in Appendix B.

MEMBER APOSTOLAKIS: Self-assessment process is where they create the PRA review team from other utilities, right?

MR. PARRY: No.

MS. DROUIN: No. The self-assessment looks at here's what the criteria that we used in the peer review because remember the peer reviews on these were done prior to the standard. So it identifies where they're different.

MEMBER APOSTOLAKIS: I see.

MS. DROUIN: And what needs to be done. So the licensee does their own self-assessment. This document tells the licensee how he needs to self-assess it.

MR. PARRY: It's a gap analysis really between the original criteria and ASME.

MS. DROUIN: We don't have that many objections that remain at this point. The ones that do remain dealt with HRA data and the quantification.

CHAIRMAN WALLIS: How do you deal with HRA? There seem to be lots of conflicting models for HRA. Which ones are going to be acceptable?

MR. PARRY: Any one that meets the requirement of the standard is the simple answer.

MS. DROUIN: Yeah.

CHAIRMAN WALLIS: So there's definite filters on these HRA models which are endorsed by all peers?

MR. PARRY: No.

MS. DROUIN: No.

CHAIRMAN WALLIS: I don't see how they can be.

MEMBER APOSTOLAKIS: I think we should set our house in order first before we state objections to what other people are doing, and we have at least three models that I can think of right now that different groups in the agency are using.

CHAIRMAN WALLIS: So there is a problem with it.

MEMBER APOSTOLAKIS: There is a problem.

MR. PARRY: All developed by the agency.

MEMBER APOSTOLAKIS: All developed by the agency, yes.

MS. DROUIN: And, again, the standards are written to, you know, what needs to be in your PRA, not how to go about doing it, and that was deliberately done and then added to the standard because the technical requirements are written to the "what" and not the "how to." In order to meet the standard you have to do a PRA. So you can't just meet the standard just by implementing the technical requirement of PR. Peer review has to be done, and we're relying on the peer review to look into that the "whats" were properly or adequately addressed.

Okay. NEI 05-04, we didn't have very many objections to this document, and mainly what this document does is that it gives the process of how to do the peer review on the upgrades.

One of the things that they had was on the sub-elements can be and generally are performed a different level of detail. So to give an overall grade would be inappropriate.

And also, any follow-on peer review, for that peer review to be acceptable, it needs to take into account the regulatory position. If we can --

CHAIRMAN WALLIS: The grading process is pass or fail?

MS. DROUIN: I'm sorry?

CHAIRMAN WALLIS: The grade pass or fail?

MR. PARRY: No.

MS. DROUIN: No.

MR. PARRY: It's a one, two --

CHAIRMAN WALLIS: I was just wondering how you actually implement the grading process.

MR. PARRY: It would be -- actually maybe Biff could help us out here -- it's either the original grades in the NEI process or it will be --

CHAIRMAN WALLIS: But someone has to make a decision is it acceptable or not. It seems to me it's a pass-fail grade eventually.

MR. PARRY: Well, if it doesn't meet any of the grades, it's a fail.

MS. DROUIN: It's a fail.

MR. PARRY: Biff may have some comments on that.

CHAIRMAN WALLIS: You can partly fail then?

MR. PARRY: No.

MEMBER APOSTOLAKIS: Biff Bradley will --

MS. DROUIN: I mean it's like when you grade a paper. It might be A, B, C or D.

CHAIRMAN WALLIS: It has to pass every -- no, a regulatory decision is is it adequate or not.

It's a black and white decision.

MEMBER APOSTOLAKIS: Biff? Let's give Biff a few minutes.

MR. BRADLEY: I think Gareth had it essentially correctly. So grade one, two, three, or four. You can also have a conditional grade based on something being resolved, but that's essentially --

MEMBER APOSTOLAKIS: Ultimately the staff reviews the request, and the staff has to convince itself that it's good enough.

MR. PARRY: If it's a grade one, we would have to -- if an element comes out to be a grade one, we would have to accept the fact that a grade one was adequate for the application that was being considered. I mean, that's the way the grades work. You have to meet a certain minimal standard to get a grade, and it goes up as you go up through the grades.

MR. BRADLEY: To take credit for meeting the equivalent requirement in the ASME standard, you have to have a grade level of three minimum according to 1.200.

CHAIRMAN WALLIS: Well, there is a pass. Eventually there is a pass although you have these other things. It's just yes-no.

MS. DROUIN: Okay. Oh, wow, Gareth gets

to do this one.

MR. PARRY: Yeah, just to remind you, the SRP Chapter 19.1 is the guidance to the staff on how to interpret what's been done according to Reg. Guide 1.200. So it relies heavily on Reg. Guide 1.200, and really the SRP hasn't changed very much since the last version other than the fact that during the pilot studies we felt we ought to have some criteria on when we should instigate an audit, and what we've done is we've come up with five different examples of cases where we might consider performing an audit of the base PRA.

MEMBER CORRADINI: Can I ask? So this is working on the assumption there is something out there, and due to some sort of review or analysis, you might want to audit their standing PRA. Is that what you --

MR. PARRY: Let me explain it. What will happen is when the licensee submits an application, they have to document that their PRA is adequate to support that documentation, that application. Thank you.

MEMBER CORRADINI: So would it be a number of things?

MR. PARRY: Well, what they will do

hopefully is they will apply Reg. Guide 1.200, and they will document that their PRA is consistent with the position taken in Reg. Guide 1.200, and the intent was that if that happens, then we would not need to review the base PRA.

Part of this, when John mentioned earlier that this is an essential part to the phased approach to PRA quality, to be efficient we do not want to be going out and reviewing the base PRA for every application that comes in.

MEMBER CORRADINI: New application. I'm sorry. When you --

MR. PARRY: Any application that is submitted to the NRC for review. So it might be, for example, a 50-69 application. Okay. A license --

MEMBER CORRADINI: And what that is? I'm sorry.

MR. PARRY: That's the special treatment. That's the revision of the special treatment provisions for components.

MEMBER CORRADINI: Okay.

MR. PARRY: Based on their risk classification. So we would still review the changes to the PRA that were being made to implement an application, but the idea was that we would not need to review the base PRA.

MEMBER CORRADINI: Okay.

MR. PARRY: But under certain circumstances we have always said that we would reserve the right to audit that PRA if we feel that there is reason to do so.

So what we added in Chapter 19.1 of the SRP was some indicators of when we might consider that audit.

MEMBER CORRADINI: Thank you.

MR. PARRY: And that's what these five bullets are, and I don't think there's really a need for me to read them, unless you have a question on them.

Let's slip over to the --

MS. DROUIN: Okay. As I said, we had a public meeting at the end of July where we went over in detail the changes we had made to the reg. guide and the appendices, and we did have one area of disagreement, and that's when you look at NEI 00-02, you know, we talked about the self-assessment process, but there's the third part of it, which is the peer review process, and what's important is that the peer review process that is provided in NEI 00-02 is referenced in the standard as an acceptable process to be used for performing a peer review.

So we have read that, and we have taken some objections to some of the stuff that is in the peer review process, part of NEI 00-02.

The comment that we got was that they felt that the peer review process part is an historical document. These peer reviews on the Level 1s have already been done and they don't plan to update this part of the document, and we should remove our objections.

Our position is that as long as that is listed in the standard as an acceptable process to be used, that means it can be used in the future. There may be, you know, a new plant. Maybe somebody in Europe uses it. It may be used -- I mean, I can't say who's going to use it, but you know, it's there in the standard as an acceptable process to be used, and it can be used. So since it's there, we feel that our objections should not be removed, that it's not an historical document in that regard.

So we plan to leave our objections in Appendix B.

Okay. Where we are --

MEMBER MAYNARD: Let me make sure I understand. So the industry is contending that if they've already done the peer review and everything that meets the current requirements, they should be able to utilize that.

And the staff's position is that if that was done before this standard came out, that they can't take credit for any of the past peer review. They have to go through the process in --

MS. DROUIN: No, no, no, no, no.

MR. PARRY: That's been sort of grandfathered in the sense that the self-assessment process is to address any discrepancies between the previous peer review and what we would expect a peer review to be done according to the ASME standard.

Biff has a comment.

MR. BRADLEY: If I could comment on this, I don't consider this a --

MEMBER APOSTOLAKIS: Would you identify yourself, please?

MR. BRADLEY: I'm Biff Bradley, NEI.

This isn't a major issue, but we do believe these peer reviews have all been complete, and NRC has said you can take credit for these for meeting the ASME standard for the equivalent parts if you go through the self-assessment process. So it doesn't seem logical to be taking regulatory exceptions to something that you've said is acceptable and also has already been done. You know, we can't go back and I don't know what we're supposed to do with those. The process is complete. All plants have been through it.

And just to speak to one other point, I still don't believe we're going to be using the base 00-02 in the future. We're developing a new document for internal fire PRA peer review, primarily develop that off of 05-04, not 00-02. So I think it's just going to create confusion out in the licensing world, you know, when NRC is taking a bunch of objections to something that has already been done and at the same time they're telling us it is acceptable for use.

That's all.

MS. DROUIN: Right. I mean, we appreciate their concern, but the issue is the fact that this is a standard that is out there for use. What's been done is a Level 1. This does not preclude -- I mean, the standard doesn't caveat, does not provide a caveat that, okay, this has already been done on these and it will never be used in the future. We cannot predict that someone may not use this, and since it is in the standard as saying this is an acceptable peer review process, it's a difficult -- but I do agree with Biff. It's not a major issue, but you know, if someone elects to use that standard and says, "Okay. I'm now going to use this peer review process in the future," yes, we've grandfathered the ones that have already been done.

But this is in the future if someone does elect to use the standard and says, "Okay. I'm going to use this process because the standard says it's an acceptable process," by not having our objections --

MEMBER MAYNARD: If it's not important to either one, I don't want to belabor it too much. I'm just trying to understand what does the licensee have to do different because of this staff position or this --

MS. DROUIN: In terms of the ones that have already been peer reviewed, nothing. These are for plants that have not been peer reviewed.

VICE CHAIRMAN SHACK: But suppose you had a major upgrade that was internal events PRA. He would presumably have it peer reviewed again, and he could choose to use this process then presumably.

PARTICIPANT: That would be 05-04.

MS. DROUIN: That would be 05-04. This is for a plant that's never done any peer review.

VICE CHAIRMAN SHACK: For a plant in the U.S. -- and I can't speak to what someone worldwide might do, although I don't think that would be in the purview of NRC -- but for a plant in the U.S., I can't imagine any plant going back and using 00-02 to do a peer review of their internal events PRA at this point. I mean, we're past that point.

This is something that was done before we even started writing standards or discussing PRA standards, and industry took this initiative on their own to develop this process.

MS. DROUIN: Right. I mean to me the resolution is for ASME to remove it out of the standard as of --

CHAIRMAN WALLIS: It's never going to be used. It doesn't really matter what you do, does it?

MS. DROUIN: I don't know that it's not going to be used.

CHAIRMAN WALLIS: Well, why don't they just agree with what you proposed then if it's never going to be used? It seems that what you do is reasonable. What's the problem?

MR. BRADLEY: As I said, this isn't a major issue. It's just for clarity, I think there's a dichotomy with NRC saying it's acceptable for use and at the same time taking exceptions to it, and then you know, just out in the licensing world it will create confusion that we don't really need to deal with.

MEMBER POWERS: We do that all the time with standards. Yeah, I mean it's hard to think of a standard that will do the whole thing, comes along and says this is acceptable with the following exceptions. Sometimes they're trivial. Sometimes they are whole blocks, you know, taken out.

MEMBER MAYNARD: I just don't see where it makes any difference either way. I'm not sure I understand why the NRC feels obligated to do it, and I'm not sure what it hurts by it being there either. So I just don't know.

MS. DROUIN: Okay. The reg. guide is out for public review and comment. The public review comment period does end October the 14th. We don't anticipate any new significant comments. As I said, we had a public meeting. We went over in detail, you know, the changes we've made.

We do plan on notifying the ACRS if we receive a significant comment that's different than what we have sent you and what we've talked about today.

CHAIRMAN WALLIS: What do you expect us to do with it? What do you expect us to do? Do you expect us to meet with you again or something and write another letter?

MS. DROUIN: At this point --

PARTICIPANT: -- do whatever we want to do.

CHAIRMAN WALLIS: Well, are you expecting that we will just be informed, but we won't do anything? Is that your expectation?

MS. DROUIN: You're going to have to make that decision.

CHAIRMAN WALLIS: Have an opportunity to make a decision to revisit if we want to.

MS. DROUIN: Absolutely, depending on what the comment is.

CHAIRMAN WALLIS: Okay. That's all I wanted to establish, that it's possible.

MS. DROUIN: Oh.

CHAIRMAN WALLIS: Right. Because it looks as if we're signing off on this at this meeting, and then we won't get another chance. But we will.

MS. DROUIN: But you will get another chance.

CHAIRMAN WALLIS: If something really shows up, we'll get another chance.

MS. DROUIN: But we don't, we honestly

don't anticipate anything than what you've seen.

CHAIRMAN WALLIS: Okay.

MR. PARRY: Yeah, and I mean the reason we don't is that the standard has been out for a long time, and so has the Reg. Guide 1.200, the original version, and there haven't been major issues with it up to now.

CHAIRMAN WALLIS: So in spite of all the questions we asked you, it still seems to be a useful, functional document.

MR. PARRY: We think it is.

CHAIRMAN WALLIS: And so does everybody else apparently. So that's good.

MS. DROUIN: Yes, thank you.

We are really wanting to issue it for use this year, and we're on the track to meet that date. So we are requesting, you know, an ACRS letter approving is to issue Reg. Guide 1.200, Rev. 1, for use.

And I emphasize the "use" because we want to take off "for trial use," off the title.

CHAIRMAN WALLIS: What about some of the questions raised today? Is there some other forum where we can raise them? Because there may be some way to improve this whole PRA picture. Is that when we're looking at 1.174?

MS. DROUIN: I think it's more appropriate under that venue than for this one.

MR. PARRY: Although I think I would argue that maybe Reg. Guide 1.174 is not the right place to introduce new metrics if that's what you want because those are going to be policy decisions.

And we've been having discussions on this internally, and we have even a position paper that we've agreed between RES and NRR that discusses this issue.

CHAIRMAN WALLIS: Do you want to bring that to us?

MR. PARRY: I don't know. You'll have to ask RES, I think.

CHAIRMAN WALLIS: What's the risk of bringing it to us?

(Laughter.)

MS. DROUIN: Do you want the mean value or do you want the 95th percent?

MEMBER APOSTOLAKIS: Are there any other questions on this particular regulatory guide?

Hearing none, I'll turn it over to the Chairman again.

MS. DROUIN: Can I ask a question?

MEMBER APOSTOLAKIS: Sure, sure.

MS. DROUIN: And maybe it's premature, but I guess I would like feedback from the committee of what we can anticipate in terms of a letter.

CHAIRMAN WALLIS: What?

MS. DROUIN: What you're going to say in your letter.

CHAIRMAN WALLIS: You can come this afternoon when we'll discuss it.

MEMBER KRESS: Come this afternoon and you'll find out.

CHAIRMAN WALLIS: Then there will be a discussion.

MEMBER KRESS: That's something that is a committee discussion and no individual here can tell you.

MEMBER SIEBER: Not a single person.

MEMBER POWERS: Well, I'm sure that we'll express the joy and thrill we always get when Mary appears before us.

MEMBER KRESS: Oh, that's for sure. The letter will start out and says, "We're so glad" --

MEMBER APOSTOLAKIS: This afternoon at 3:15 we start deliberating on the letters.

CHAIRMAN WALLIS: Or maybe before because we may get some other business out of the way, but we don't deliberate here.

We're going to take a break, and we're going to take a break until 10:30, I think it is, because we can't do anything until then.

MS. DROUIN: Thank you very much.

CHAIRMAN WALLIS: Thank you, Mary.

MS. DROUIN: A pleasure, as always.

MEMBER KRESS: Always a pleasure, Mary.

(Whereupon, the foregoing matter went off the record at 10:00 a.m. and went back on the record at 10:33 a.m.)

CHAIRMAN WALLIS: Please come back into session.

The next topic on the agency had to do with verification and validation of selected fire models, and again I turn to our nobel academic, George Apostolakis.

MEMBER APOSTOLAKIS: Thank you, Mr. Chairman.

CHAIRMAN WALLIS: To lead us through this one.

MEMBER APOSTOLAKIS: The Subcommittee, the Reliability and PRA Subcommittee, met with the staff and representatives of EPRI and National Institute for

Science and Technology on September 21st, and we went over this effort, and we raised a few questions that we hope the staff will address today.

This is a very important project. As you know, we've been dealing with fires since way back there, Brown's Ferry fire, with Appendix R, and then the PRAs came out and showed that the fire initiated sequences are usually among the significant sequences in the plant, accident sequences.

And, of course, having mechanistic models that attempt to predict the thermal environment in a compartment when you have a fire is very important and not just when you do a risk informed analysis, but also in the deterministic space. So this is a very important project.

And a lot of it has to do with thermal hydraulics actually. I don't know why the PRA Subcommittee had to review it.

MEMBER POWERS: Because we wanted to make progress on the subject?

MEMBER APOSTOLAKIS: We had strong representation. Said and Sanjoy were there. So we did have that input.

So I will turn it over to the staff and walk us through this presentation.

MR. SALLEY: Good morning, Chairman, members of the ACRS Committee. My name is Mark Salley. I'm the team leader for the Fire Research Team in the NRC Office of Research.

This is an important project as George has stated, and I have assembled a number of folks today to talk to us, and let me just give a quick overview of who all is here.

From Research I have myself and Jason Driesbach. We have the people we did the work for, NRR, Sunil Weerakody, Ray Gallucci, and Naeem Iqbal. We're hopefully going to show you why this is important and how it's going to be used by NRR.

We also have our partners, representing IRPI is Francisco Joglar. This was a tailored or -- excuse me -- this was a collaborative project, much like CR-6850 on fire PRA which you saw a year ago. This also was a joint NRC Office of Research-IPRI project.

We had a lot of support from the experts at NIST, and they will be here to talk about the first models. Dr. Anthony Hamins, Dr. Kevin McGrattan and Rick Peacock will be here from NIST to specifically answer some of the questions that came up in the subcommittee.

So that's the people we've assembled for this.

Next slide.

MEMBER APOSTOLAKIS: You have almost as many people as the ACRS members.

MR. SALLEY: Well, we figured one to one if it goes down to hand combat, George.

Let's take an overview of what this project is. The reason we're here is we're requesting a letter from the ACRS to move forward with this document and would like your endorsement to go forward with it. It's important to understand that this is a part of the bigger picture of fire modeling. This is one critical pieces, one element that fits into the big picture of fire modeling, which I'll give you a brief overview on.

Also, our goal in research is to support the offices that are actually doing the work, in this case NRR. So hopefully we've built a product, a tool that they can do their jobs better with. That was our intent.

We will cover in specifics some of the details of the V&V Program for mathematical, deterministic mathematical fire models. We will try to focus specifically on the questions that came out of the subcommittee, and we're also going to give you a broad overview for the members who weren't at the subcommittee meeting. So this all kind of makes some sense for you.

And hopefully when we get to the end of this we have some examples with NRR that will show you how this could possibly be used in regulatory applications.

Next slide.

A brief overview of fire modeling at the NRC. It started back really in the late '90s. We needed -- we saw the risk informed performance based was the wave of the future, and that's where we were moving toward, and we started with the inspectors. And we had to rethink how we do fire protection. Rather than the deterministic, is this a three hour barrier? Is this a UL rated fire door? Is this a good sprinkler system? The classic fire protection items.

We had to start talking about fire and understanding fire dynamics. We worked for about four years with quarterly workshops with the inspectors, and we started to teach the language of fire dynamics, if you will. Naeem Iqbal and myself when I was in NRR, we put all of our lessons plans together, and then after that we said we didn't want to lose this work. So we put it together in the form of a NUREG which had gone before this committee, NUREG 1805.

And if you think about it, it's basically an introduction to fire dynamics. Now, that's important for fire modeling because you have to have a basic understanding of the fire dynamics to really make sense to what the fire models are telling you.

So that was the first big piece we put into place. Today we're going to talk about the second piece that we're trying to put in place, and that's the V&V. It basically had two parts. Okay? The verification and the validation.

CHAIRMAN WALLIS: Could I ask you about that? I'm sorry to do this, but no model is ever correct, and I don't see any verification in your report.

I do see a very useful comparison of various more or less adequate models which have been put together in a reasonable way with experiment. That's all there is in there. There's nothing in there that says this model is complete or adequate, and what's in the report contains a whole lot of incomplete models that's missing. There's nothing that shows me that they're complete and can be used.

I can't use the models in the report because there's not enough information.

So it's a useful report, but I think your description here is not the right one of what's in it.

MR. SALLEY: Okay. I apologize if I've got some incorrect --

CHAIRMAN WALLIS: No one verified anything in this report. There's no check that equation 3-1 is usable over certain ranges, that the parameters in it are adequately defined, and so on. So it's okay, but what you say you're doing is not what you did, as far as I can see.

MR. SALLEY: Verification and validation --

CHAIRMAN WALLIS: What's verified in there?

MR. SALLEY: Yes, the majority of our work is on the validation. Our mission was to see how well these models would predict for the environment we're looking for, and --

CHAIRMAN WALLIS: Okay. Then the words are wrong here. Okay.

MR. SALLEY: Yes.

CHAIRMAN WALLIS: How well did they work is the question.

MR. SALLEY: Our major effort was on the validation.

CHAIRMAN WALLIS: Agree with that. I agree with that, but otherwise --

MR. SALLEY: I'd like to speak a minute to the verification. True, we didn't go through a huge, rigorous, verification process. When we got to the models, we found that the models were mature. You know, for the most part, CFAST has been around for years. FDS, they've been used; they've been around for years.

One thing we find, it was the developers of the codes had spent a fair amount of time doing the verification. If you take CFAST, for example, you'll see that they have a whole documented report. We reviewed that report, and we found it to be pretty rigorous, and we documented in our Chapter 4 or 5, I believe, where we reference you to those reports that were done by the developers.

It's interesting to note, too, though as verified and as comfortable as we were with that, when we really started exercising the models, four of the five models that we did we actually found bugs in. They were small; they were minor, but nevertheless we did find them, and the developers went back and corrected them.

So we kind of stopped and restarted the process. So, Graham, I agree with you. We really didn't go through a huge, rigorous verification. We built a lot upon what was done before us.

CHAIRMAN WALLIS: At least we could approve the report as being useful.

MR. SALLEY: Yes.

CHAIRMAN WALLIS: But I can't really approve it as verifying the models because it's not in there. I think we'll find a way to give you the right letter, but --

MR. SALLEY: Okay, and I can let the guys from NIST who have first-hand experience talk to that a little more if you'd like to.

CHAIRMAN WALLIS: And then there are some errors in here, but I guess it's not the place to introduce them now in this discussion, but the first item on Table 2-4, for instance, but don't worry about that.

MR. SALLEY: You're reading ahead of me.

CHAIRMAN WALLIS: Yeah. Okay. Go ahead, please.

MR. SALLEY: Again, our key was validation. The end of the day question was if we're going to use these models in a nuclear power plant environment, are we getting reasonable answers. How accurate are we?

That was here we focused most of our effort. An important point I'd like to just drop in here, too, is that I feel and I think the team feels that this report reaches on beyond nuclear power. when we started this effort, we looked around and did somebody else do this? Did they do a V&V for the petrochemical industry or for some other industry?

We couldn't find a good, rigorous V&V. So we had to break a lot of new ground, and I think a lot of people watched us, and I think this report will actually be used beyond nuclear power as kind of an aside.

Getting back to the big picture, again, this project is a part of the overall scheme. We've looked at the thermal hydraulics work. We've tried to talk with the folks and get an understanding of how they're doing their models, and let's learn from their experience.

One of the things we discovered was in fire modeling we couldn't find anyone who has ever done a PIRT for fire modeling. Now, that seems to be real basic when you talk to the thermal hydraulics people. They've all done PIRTs. We're going to attempt to do one here in the next year on fire modeling, and also a request from the user office NRR is we want to go with the user's guide as a follow-on.

MEMBER APOSTOLAKIS: Let me -- go ahead.

MEMBER CORRADINI: No, I'm sorry.

MEMBER APOSTOLAKIS: Why are you doing a PIRT?

MEMBER CORRADINI: Good. Thank you. That was my question.

MEMBER APOSTOLAKIS: I mean, you already have five models.

MR. SALLEY: Yes.

MEMBER CORRADINI: What does it buy you?

MEMBER APOSTOLAKIS: Yeah, what does it buy you? Exactly.

MEMBER APOSTOLAKIS: It buys us a number of things. From my standpoint, when I do research, and I'm going to go do some experiments, when we looked at -- and Anthony Hamins is going to give you an excellent discussion on the experiments that were done -- is there really isn't a road map for those experiments. Someone had a question somewhere for some application, and they decided to do an experiment and gather data.

And we see a lot of repetitive or very similar type experiments that were done. We feel the PIRT will help us put a road map together of looking at the phenomena of fire. What things did we want to research harder versus what things do we think we know pretty well, that we don't want to keep doing the same experiments over and over?

We're hoping the PIRT helps guide us with that.

MEMBER CORRADINI: So can I ask a question here? Because this is to me, this is maybe -- maybe it's not -- but to me this is unique in the sense that you've identified you actually went through a big effort and you have essentially a document that tries to talk about what you understand to be the modeling of the dynamics.

Then you referenced something in NIST that I want to get the reference, the NIST reference, that supposedly lists out the models and writes out at least the approximate mathematical formulation, and they potentially verify. And now this one supposedly mainly validates.

And so when I participate in these PIRTs, there's a lot of hand waving and grunting and nodding because a lot of physics isn't known or it's too complicated to be known precisely. So is this PIRT going to be done differently? You're not going to get a bunch of people in the room and ask them to prognosticated.

Do you see where I'm going with this? How are you going to do this differently since there's so much. It seems to me like a wealth of physical and mathematical information you could use.

MR. SALLEY: Do you want to take that Jason?

MEMBER CORRADINI: What I'm trying to get at is -- here's where I'm going -- what I'm trying to get at is Professor Wallis asked something relative to verification. If you're going to do this and if it buys you anything, I thought you were going to say it buys you the answer to his question.

Do you see where I'm going with this? It essentially closes the loop. Otherwise I don't see what it buys you.

MR. DRIESBACH: One of the differences that this PIRT might be and your experiences were going to focus on the users of the codes; so the people that will sit around the table with us will be the people that actually use the codes, the consultants, the people that run the codes.

To bridge the gap between what's actually out there and what needs to be modeled and how the user can model it so that it will be sort of more of a complement to a user guide and our verification and validation document versus the strictly more or less academic exercise, which is more of what's been done before.

MEMBER APOSTOLAKIS: If you have the users though, you are biasing your experts, aren't you? I mean, can you see a guy from NIST who participated in the development of CFAST come to you and say that there is an important phenomenon that is not in CFAST?

Because the question is: why isn't it?

I mean I don't understand the --

MEMBER POWERS: The guys that know the most about what's not in their codes.

MEMBER APOSTOLAKIS: No, but I mean, these codes have been used, as Mark said. It's not something that was developed yesterday. I mean it has been used, I assume, internationally.

CHAIRMAN WALLIS: I think you're wrong to say you need -- the users say what they want for use, and the phenomena identification and ranking is sort of what's the physics --

MEMBER APOSTOLAKIS: Exactly --

CHAIRMAN WALLIS: -- the chemistry you need to put in. It is at the academic level. It has to address itself to the user, but it also has to say what needs to be into these codes in order to represent what happened.

MEMBER APOSTOLAKIS: I'm not saying they should be excluded, but they should not be the only thing present.

But I thought you were doing PIRTs before you developed codes.

MR. SALLEY: Yeah, the cart before the horse. I guess that we are putting the cart before the horse with the PIRT. Like I said, the fire modeling community developed different than the thermal hydraulics. Nevertheless, we want to look at the thermal hydraulics people to see what they learned and how they did it and learn from that. We thought that a PIRT would help us, and like I said, I look at it from a selfish standpoint.

If I'm going to invest some research and some time to improve the codes, what portion of the codes? If I'm looking at the hot gas layer, for example, our validation shows that we have pretty good agreement, and the codes do a reasonably good job there.

If I look at radiation heat transfer, if I look to the heat transfer to the walls, again, the codes do a pretty good job there. But if I look at the near field, targets that are up close to the flame, we see that it's not that good. The phenomena, we don't have it that tight.

What we were looking to come out of this PIRT was kind of a road map to help guide our future research.

CHAIRMAN WALLIS: In radiation you have smokiness, which seems to be one of these things which is rather difficult to predict, when you get more carbon particles, you get more radiation, but you also get more absorption and so on. All of that stuff seems to be somewhat vague.

So the PIRT will say we've got to have a better model for carbon particles in the flame inside this thing. It identifies the phenomena.

MR. SALLEY: And that's what I wanted to do.

CHAIRMAN WALLIS: That's what you want to do, right.

MR. SALLEY: Yes, and it will help me, guide me for future work to be done. It will help guide the co-developers as to where we want to add rigor or improve the codes, if you will.

MEMBER APOSTOLAKIS: Are you limiting yourself to the space of these five codes that you have evaluated? In other words --

MR. SALLEY: No.

MEMBER APOSTOLAKIS: -- there are phenomena for which I'm not sure we have any models or codes, like fire propagation in cable trays (phonetic).

MR. SALLEY: Exactly.

MEMBER APOSTOLAKIS: Is that part of the PIRT exercise?

MR. SALLEY: Yes. Again, we are just learning the PIRT process. We come from the fire modeling background. So this is new for us.

MEMBER CORRADINI: That may not be bad. Sorry.

MR. SALLEY: It may not be bad, but I tend to come up with ideas and when I talk to the guys who are experienced in PIRT, sometimes I get out of the bounds, and they have to bring me back in.

MEMBER CORRADINI: Here's where I'm coming from and then I'll stop. I had to give a talk in front of an audience, and unfortunately I was on a panel with Banerjee and Katton, and Professor Katton very politely and diplomatically told me how wrong I was, and all I'm reflecting --

MEMBER APOSTOLAKIS: He did that?

MEMBER CORRADINI: No, but he was less than diplomatic and less than polite, but the point that he made which was correct was if you really do have the mathematical formulation, you could kill potentially two birds with one stone. You can go back to the verification and actually look at the physical models, and if the mathematical representations are truly representative in some regimes, you can actually drive mathematically where you are potentially in error and where you have to improve.

And then in the areas where there's no model, you can at least try to represent with some starting mathematics. My point is you could use this in a different beneficial way, and I wouldn't let the PIRT people lead you down a path that is not appropriate. You could go down an inappropriate path is what worries me.

MEMBER APOSTOLAKIS: Are you planning to come to us when you design this PIRT exercise? I mean this is not today's subject, right?

MR. SALLEY: Right.

MEMBER APOSTOLAKIS: Obviously the

committee is very much interested in this. Do you have any plans of coming here before you actually jump into it and invest a lot of effort?

MR. SALLEY: Pat?

MEMBER APOSTOLAKIS: What is this 1207, by the was? The end, the --

MR. SALLEY: That's when we're looking at having it done.

MR. BARONOWSKI: To address Dr. Apostolakis' question, I'm Patrick Baronowski, Deputy Director in Division of Risk Analysis and Special Projects.

Yes, I think we've been a little bit remiss in not having maybe some regular ACRS subcommittee meeting on the fire program, and as Mark has pointed out, we're sort of filling in some blanks that we realize we should have done maybe beforehand to have a more systematic and comprehensive program.

And so I would propose that we do have a couple of subcommittee meetings as we go along instead of coming in at the end and saying, "Look at this great invention we have."

MEMBER APOSTOLAKIS: I think that's a great idea. It really is a great idea.

MR. SALLEY: And we'll be happy to do

that. Again, this process is just starting up. We're trying to get our contracts in place. The question you brought up, George, about the users, you know, one of the early things that we saw was we didn't want the PIRT panel to be made up from the guys who did the models. We felt that would bias it.

MEMBER APOSTOLAKIS: You need to mix, Mark.

MR. SALLEY: Exactly, and that's what we're developing now, is that mix.

MEMBER APOSTOLAKIS: But it's everything, but I think the committee is very much interested in this PIRT business. So before you guys invest too much effort and time into it, it would be nice to have a meeting, you know.

MR. SALLEY: When we get it framed up before we do it, we'd be happy to come before you.

CHAIRMAN WALLIS: Let me interject that PIRT is really part of a circular loop process. You have a PIRT, and the experts say, "This is what we think should be in a model."

Then someone develops a model and the code. Then you validate it, and when it doesn't work on certain things, you say, "Ah-ha, we missed something in our PIRT," and you go back and do it again. It's an iterative process.

MEMBER APOSTOLAKIS: Let's not forget though --

CHAIRMAN WALLIS: It's part of the validation really. It's part of the validation.

MEMBER APOSTOLAKIS: This is not what we're reviewing today.

CHAIRMAN WALLIS: It can be part of the validation is the point. It does tied in with the validation.

MEMBER APOSTOLAKIS: Validation is not what we are reviewing. So be careful, Mark. Don't mention anything that's not part of today's --

(Laughter.)

MR. SALLEY: I'm just trying to give you your money's worth, George, and the whole big picture.

MEMBER APOSTOLAKIS: You aren't going to go in ten different directions here.

CHAIRMAN WALLIS: Don't put anything up on the screen which we can't question.

MEMBER APOSTOLAKIS: That's right.

MR. SALLEY: Okay.

MEMBER SIEBER: I'm sorry you put that slide up.

MR. SALLEY: Getting back to the

validation, again, the thing today and an important point, too, is with the end product here that we're hoping to deliver this year, it's a transparent product, and what I'm saying is that all of our work, the calculations we've done, the actual models where we can't, other than the proprietary ones from IPRI, will be a part of this. So anyone can go back, look at how we constructed this, look at the calculations that were done, and reproduce it.

So we're looking to get a fully transparent product out.

Next slide, please. I never thought that one would end.

MEMBER APOSTOLAKIS: Let's ask a broader question here.

MR. SALLEY: Ut-oh. You just told me you weren't going there, George.

MEMBER APOSTOLAKIS: The previous slide. So what is the ultimate -- I mean, when will you say, "Now I'm happy"? What kind of methodology would you like to have? You know, that's why you're validating models. You're doing PIRTs, doing other things.

When will we say, "Gee, we are in pretty good shape now"? When we have what? A methodology for doing a fire risk analysis, for example? Other kinds of things in the --

MR. SALLEY: George, that's just a loaded question. I mean, when I was happy when I was six years old, I had different values than I do when I'm 30 years old versus when I'm 48. I'm happy this changes.

CHAIRMAN WALLIS: I'll give you the answer, George.

MEMBER APOSTOLAKIS: You don't have to do it today, but next time you're giving us an overview, maybe you can tell us ultimately this is where we want to be.

CHAIRMAN WALLIS: George, I'll give you the answer. When you can put it in a fire PRA and it tells you what the risk is.

MEMBER APOSTOLAKIS: -- fire PRA and Professor Wallis does not object to anything he sees. Then we're happy.

CHAIRMAN WALLIS: No, no, no, no, no. When it's adequate for a fire PRA. You can make predictions that you can use to evaluate risk.

MEMBER SIEBER: All of this work is deterministic work.

MR. SALLEY: Yes.

MEMBER SIEBER: It's not based on

distributions or anything like that.

MR. SALLEY: Yes. These are deterministic mathematical fire models.

CHAIRMAN WALLIS: Its use is a nuclear regulation, and what tools is it going to support in a nuclear regulation? That's when you're happy.

MEMBER SIEBER: It tells you how many sprinklers you need.

CHAIRMAN WALLIS: Yeah, that's when you're going to make decisions, right.

MEMBER APOSTOLAKIS: I mean, it seems to me that when we have overviews like this or maybe in a future meeting we ought to ask ourselves why are we doing all of this. What holes are we trying to fill and where are we going?

MR. SALLEY: Yes. I don't know that we ever will be happy. I think there's always going to be something else we'll want to know.

MEMBER APOSTOLAKIS: It's in our nature.

MR. SALLEY: And some other question will come up.

CHAIRMAN WALLIS: Happiness is irrelevant. What use is it to the agency is the question. How are they going to use it, and that's what we were asking this morning.

MEMBER APOSTOLAKIS: By definition, we are happy --

CHAIRMAN WALLIS: The same thing we were asking the last --

MEMBER APOSTOLAKIS: -- when the agency's needs are met.

CHAIRMAN WALLIS: Yes.

MR. SALLEY: Okay.

MEMBER APOSTOLAKIS: Let's move on to Slide 4. It took us 20 minutes to get there.

MR. SALLEY: I want Slide 3 or -- excuse me -- 4, Slide 4, and I will step back and let Sunil up here.

MR. WEERAKODY: Sunil Weerakody. I'm the Grand Chief of Fire Protection, NRR, the user of the products that Mark develops.

As always, you know, it's a pleasure to come to the committee.

I still don't know why I have a hard time sleeping, George, the day before the ACRS meeting. I know it's nothing to do with you, but --

MEMBER POWERS: The members have no trouble sleeping in the meeting.

MR. WEERAKODY: I don't think I had anything to do with that.

CHAIRMAN WALLIS: What happens after the ACRS meeting?

MEMBER APOSTOLAKIS: He sleeps like a baby.

MR. WEERAKODY: I didn't.

MEMBER POWERS: Secure in the knowledge that --

CHAIRMAN WALLIS: Guys, we only have until 12 o'clock.

MR. WEERAKODY: All right. I'm going to make some statements and get out of here and Dr. Gallucci is sitting back there. He's going to defend what I say. Okay?

CHAIRMAN WALLIS: That's what the Grand Chief does.

MR. WEERAKODY: Yeah. He's my senior fire PRA. So my job is to make statements. His job is to defend me.

CHAIRMAN WALLIS: Very good.

MR. WEERAKODY: With that, let me go to the first bullet. Verification and validation of fire models required by NFPA 805. Dr. Apostolakis mentioned this. We have 41 units adopting NFPA 805. What the rule says is there should be acceptable methods and models. Okay?

It's slightly different from how it is worded here, but I very precisely. So really as far as NRI is concerned, we look at what Research do alerts and make a determination whether the model is acceptable for 805.

Then the second bullet, it is going to minimize unnecessary conservatisms or apply appropriate conservatisms in the proper areas. If I think of an analogy, think of like an onion that we peel out in terms of how we would use fire modeling in our regulatory decisions. The better the tool is, the more sharpening of the pencil we can do or the more peels we can take off in making that decision, that regulatory decision in terms of, you know, implementing and enforcing our regulations.

Support regulatory decision making to insure that our decisions provide reasonable assurance that the health and safety of the public will not be endangered.

MEMBER APOSTOLAKIS: Wait a minute. Let's go back to this. In the second bullet there is sort of an implication that all we have in these models are conservatisms, and it seems to me that we may have non-conservatisms, too.

MR. WEERAKODY: No, that --

MEMBER APOSTOLAKIS: In fact, some of your predictions in the report of the models are under predicted, right?

MR. WEERAKODY: No, that's not what I was trying to --

MEMBER APOSTOLAKIS: Yellow minus?

MR. WEERAKODY: No. I'm not saying that everything in the model is conservative.

MEMBER APOSTOLAKIS: But it's implied, Sunil.

MEMBER BONACA: Well, it says "or apply appropriate conservatism."

CHAIRMAN WALLIS: Right. It's both sides of the coin.

MR. WEERAKODY: No, no, I think -- let me clarify that.

MEMBER APOSTOLAKIS: You are very much used in this business to talk about conservatisms we use. Sometimes we are not conservative, not deliberately, but let's face it. Some of these models are not always conservative.

I know what you mean though, anyway.

MR. WEERAKODY: Okay.

MEMBER MAYNARD: I think the second bullet says that though, either way.

CHAIRMAN WALLIS: Well, we're not going to debate Bullet 3. We're going to move on from that one.

MEMBER APOSTOLAKIS: It doesn't necessarily apply approximate conservatism.

MR. WEERAKODY: What I'd like to -- I'm sorry.

MEMBER APOSTOLAKIS: Go ahead.

MR. WEERAKODY: What I'd like to do is elaborate Bullet 3 with three statements. Point one, you know, 20 years ago we ran comp. burn in support of IPEEE. Okay? And then some of you know how high quality that is. Okay?

Over the last four or five years, we have made some regulatory decisions using the fire modeling. We didn't have 1824. We had 1805, and I have two of my staff members. Naeem Iqbal, he's going to go through an example of how we made some decisions in the, you know, inspection finding area using the state of the art that was present at that time.

And what I would say is without any hesitation, is 1824 will take is a significant step up in the quality of those decisions because we made regulatory decisions using what I would say are point estimates. We didn't have a whole lot of, you know, high level of grass pond (phonetic), the accuracy that 1824 brings in.

So one of the reasons we are really speaking for NRR is appealing to this community and those 1824 is going to enable as to not perfect, not be perfect, but make a significant step up.

In fact, I could say with reasonable assurance that 1824 is world class in terms of the state of the art because I haven't seen anything that's of higher quality in fire modeling, but again, I haven't seen a whole lot out there. So, you know, that's why I'm saying it's reasonable assurance.

And one other final point that I want to convey to this committee is in terms of making regulatory decisions, if I'm reviewing a license amendment where I'm sharpening the tool like this too much to decide whether a particular amendment should be granted or not, we wouldn't grant it. I mean, we would just deny it.

I don't have examples in fire modeling per se, but I have an example in CO_2. A licensee came in, and they basically said, I don't have 50 percent. I have 27 percent, and they showed some calculation as to why that may be just enough.

We denied that amendment because we said, "Look. You know, that doesn't give us the reasonable assurance."

So my parallel is if somebody takes a model and relies on it too much for the bottom line and then sharpens that tool too much, we would say no. Okay, and because that's not the right way to manage safety of plants.

Then finally my other bullet. We do support in addition to 805; we have been supporting without 1824 some of our other issues like fire protection is DP (phonetic), and both licensees, fire protections deviation and exemption request.

So I think I'm done with this slide, and this is my only slide, right, Mark?

I just again reiterate the purpose of, you know, at least our presence here is to appeal to this committee to endorse this document so that we can improve the quality of our decision making.

Thanks.

MR. SALLEY: That was our commercial message brought by the sponsor of this program.

MEMBER POWERS: Happy customer.

MR. SALLEY: Hopefully happy customer.

Next slide, Jason.

Okay. I want to start focusing in on the exact project here and tightening it up a bit.

Fire modeling is nothing new. Fire modeling has been around for a while. If you guys were all getting older, I guess, if we remember back to the 1980s after the Brown's Ferry fire when Appendix R was first being framed up, there was an argument from a number of the utilities, especially up in the New England area that wanted to go with a "design basis fire," and they said, "Hey, there are these tools called fire models, and we can tell you what the design basis fire was."

And that movement was starting. Of course, at the time when it was looked at, fire modeling was in its infancy, and there wasn't a lot of confidence in it yet. The Commission decided in 1980, if you read the Federal Register, to go with a deterministic Appendix R.

We've come 20-plus years since then and there has been a lot of advancements in fire modeling. A big program that really introduced it to the industry was Generic Letter 88-20, Supplement 4, when we looked at the vulnerabilities beyond the design basis. Tools like FIVE were developed by EPRI, and we started to bring in this world of fire dynamics in how the fire model was used, and it was a big step if you think about it.

If you think about fire hazard analysis before that, everybody was quite content counting up all of the BTUs of all the combustibles, dividing it over the sure footage of the room and trying to back it into the ASTM E-119 curve.

So the IPEEE really took us a step further in thinking that's not how thing burn. You need to use these physical models. So that was a big step.

MEMBER APOSTOLAKIS: That was the first time this happened, was the fire in Indian Point PRAs, wasn't it?

MR. SALLEY: Yes. I've got to give you credit for that one, George. Yes.

MEMBER APOSTOLAKIS: There was the fire in Indian Point in 1981.

MR. SALLEY: I guess what I bring with the IPEEE, George, is we went across the industry, and every plant had to do something, some type of fire analysis which led to fire modeling comp. earn (phonetic) or the FIVE method.

A couple of years ago the Commission decided to move forward still and they passed 10 CFR 5048(c). Sunil talked about this. This, of course, is the performance based (pause) --

MEMBER APOSTOLAKIS: On this slide though, since you are having --

MR. SALLEY: Oh, I'm sorry.

MEMBER APOSTOLAKIS: On this slide, you know, a point of disagreement, I guess, at the subcommittee meeting, and I'm sure they will address it, is how do you answer the question how accurate something is, and the subcommittee took the position that you do that using probability distributions, and you guys used colors.

So we will address this at some point?

MR. SALLEY: We are going to address that, and we've changed, George based on your comment. So later on in the presentation, some of the experts from NIST will talk about that, Kevin in particular.

You forced us to change, George.

MEMBER APOSTOLAKIS: Every time we make a comment, you agree with us. This is not fun.

MR. SALLEY: I'm sorry. I skipped a slide there.

But, again, we're looking at the accuracy of the fire models, and another thing that rolls out of this is when you have the five models, you will see that some do things better than others. So it will help you in the selection of the models.

Let's get to the slide that I inadvertently jumped to.

Again, the Commission has moved forward. We've revised the regulation. There is now 5048(c), which allows the licensee -- Sunil spoke to this, and we have over 40 licensees that have signed up to go this day. So this is the wave of the future.

In starting this project, we found a document. It's actually an international standard put out by ASTM, 1355, and it gives us a road map or an amount of guidance on how to do this project.

This standard has been around for a while, but it has not been exercised much. We learned a lot about it, and we're going to have a lot of feedback to the ASTM committee about using this standard.

In the big picture, this was a collaborative project. We worked with IPRI. We worked with NIST. Actually IPRI brought in EDF with their fire model MAGIC. So we had a lot of smart people working on this project.

To V&V a model or to evaluate a model is a job. We did five, five models. That made this project much more complex and much harder. It made it better, but it was a lot of hard work.

Now, when Sunil and NRR came over with

their request, they didn't request to give me a fire model. Their request was much more. They wanted a series or a suite of fire models, and the idea was that for the folks who were moving especially toward the 805, is that they would have a tool box. Okay? If they needed a simple calculation where they were looking for something like a hot gas layer and you knew the fragility of a cable was 400 degrees Fahrenheit, you were getting calculations in the thousands of degrees, it didn't make sense to run detailed computer models for three, four days when you could do a simple hand calculation.

So the first two models that we evaluated was 1805, which s the one the NRC produced, and FIVE Rev. 1. So the first two tools in the tool box are those simple hand correlations that are done on spreadsheets.

If you want to, as Sunil says, sharpen the pencil, look at it a little harder, we move to the next tier, the next level of fire modeling.

MEMBER CORRADINI: Is this the second one you said, 1805 N?

MR. SALLEY: FIVE, F-I-V-E, Rev. 1, the EPRI model.

The second tier is to go to the two zone layer. We all know that when the fires burn, we tend to get nice two zone arrangements where you have the upper hot gas layer and the cooler layer. There's models that do that, and we refer to them as the two zone models or the zone models.

CHAIRMAN WALLIS: So you don't have a well mixed containment.

MR. SALLEY: No.

CHAIRMAN WALLIS: This is a reference to the earlier.

(Laughter.)

MR. SALLEY: I'm going to get right back on track on that, Graham.

The zone models, CFAST is put out by NIST. It's available. It has been around for a while. It's pretty rigorous code. Also, EDF through EPRI has a code called MAGIC that they use. It is another classical two zone model. So those are two more tools in the box.

Finally, if you really want to work this out and get into it, we get into the world of fluid dynamics. The model that we chose was Fire Dynamics Simulator. It's put out by NIST, and it's the CFD classical code.

So we've got five fire models.

CHAIRMAN WALLIS: That's the model of the future, isn't it? That's the real McCoy, that one.

MR. SALLEY: It's the Ferrari of the bunch. You know, I was doing the Model A Ford for the common folks.

MEMBER POWERS: Somehow calling --

MEMBER APOSTOLAKIS: You don't need a Ferrari to go from --

MEMBER POWERS: Calling FDS a Ferrari implies a speed that doesn't exist.

MR. SALLEY: So we've got a suite, if you will, of five fire models. In those models we looked at the first and said, "What are we interested in fire?"

And we basically came up with 13 different physical parameters that we thought we could get a handle on to do this evaluation. So we had five models looking at 13 different parameters.

Now, hot all of the models could do all of the parameters, and again, that is something valuable that we shook through.

MEMBER CORRADINI: Can you give me some examples? So these are like dependent variables that are key figures of merit to look at?

MR. SALLEY: Exactly, exactly. When we

have a fire, the fire will burn and we'll have a plume. So one thing is how hot is that plume.

It makes a hot gas layer. Well, what's the average temperature of that hot gas layer? Heat transfers radiation to a target. So those are the figures of merit in PIRT-speak or key parameters in fire modeling-speak.

MEMBER SIEBER: This is really a miniature PIRT that you've done.

MR. SALLEY: I put the cart before the horse, Jack, and I'm sorry, but yeah.

MEMBER SIEBER: Okay.

CHAIRMAN WALLIS: To a point, yeah, this is going to really help us in the PIRT.

MEMBER SIEBER: Sure. All you have to do is copy what you did here.

MR. SALLEY: Yes.

MEMBER APOSTOLAKIS: Well, this is not really PIRT.

CHAIRMAN WALLIS: No, it isn't.

MEMBER APOSTOLAKIS: What you need, the information you need to do a fire analysis. That really deals with modeling.

MEMBER SIEBER: -- things that that aren't listed there.

MR. SALLEY: And then we looked at 26 experiments. Now, if you start seeing this matrix in your mind, you've got five fire models, 13 parameters, and 26 experiments. You can see that there's a lot of calculation going on here. There's going to be a lot of analysis work.

It's also very --

CHAIRMAN WALLIS: Can I talk about the experiments there? Maybe one result of your study ought to be to point the way to more comprehensive experiments. I look at, say, RCJ over H, which is the distance along the ceiling divided by the height of the fire. The range of the experiments is extraordinarily small. It's 1.2 to 1.7. There must be rooms where you're concerned about a much bigger range of things along the ceiling.

MR. SALLEY: And I have speakers that are going to come after me, Kevin and Anthony, who are going to speak to those parameters and how we went about it.

CHAIRMAN WALLIS: Because I think that you may have a lot better analyses than you have in the range of experiments for some of these things.

MR. SALLEY: They will address that, and I will be getting out of my league.

CHAIRMAN WALLIS: Thank you.

MR. SALLEY: I'm dealing with you guys.

MEMBER SIEBER: And the tools are not particularly good at those full ranges.

MR. SALLEY: I will let the experts answer that.

MEMBER SIEBER: Okay.

MEMBER POWERS: I'm struggling to think of an accident analysis code where that's not the case, Graham. The code can cover a bigger range than the experiments ever will.

CHAIRMAN WALLIS: Yeah, but this is for a narrow range of experiments. That's why I said that. I can't imagine it's only making measurement for one point in the ceiling.

MEMBER POWERS: Again, I struggle to think of an accident analysis code where that's not the case.

CHAIRMAN WALLIS: Okay. You don't need more information?

MEMBER POWERS: Oh, you're love to have it, but practicality gets in the way.

CHAIRMAN WALLIS: Okay.

MR. SALLEY: So you can see the matrix layout, five models, 13 parameters, 26 experiments.

Another very valuable thing that came out of doing the five fire models was that they all come from the same baseline of experiments.

Now, that's important because if I have a code and George has a code, and he goes and validates his, he picks ten experiments and he does his. I pick ten different ones and do mine. We both validated it, but we came from different bases.

Here we came from the solid baseline, and this looks toward the future. Someone else comes up. Graham develops -- you know, him and George get together, and they come up with the ultimate fire model, and this is going to be the ultimate fire model. Because we've done a transparent process here, you can go back and look at our experiments and take, you know, Graham's ultimate fire model and run it and see how well it does against us.

So we've established a foothold here, a baseline of how we move forward with that, and that's a very important point of this project.

This project also went through a 60-day public comment period. We had a number of comments from around the world. It's amazing who reads our stuff and sends us comments. Hopefully we've resolved those.

IPRI has sponsored a peer review. We had three excellent peer reviewers, Dr. Quintere from Maryland, as well as Phil Dineno and Dr. Beyler from Hughes Associates that we went through a rigorous peer review in December, and we think it's prime time for this document to move forward.

So with that I've more than covered the introduction. I would like to turn this over to Jason Driesbach, and he's going to give you the last big picture and we're going to dive into your comments then, George.

MR. DRIESBACH: As Mark mentioned, my name is Jason Driesbach. I was the project manager for this project for the last stage of it. I'm going to provide -- this next slide is basically providing a high level overview of the process. Mark talked a little bit about some of the things we went through, but this is for the benefit of the folks that weren't at the subcommittee meeting so that we can get through just the process.

I'm not going to go into any detail in the various boxes here. I just want to provide the process and explain how we did what we did, more or less, not the details necessarily, but why they're important to do it this way.

So the first part, as Mark has mentioned, we've identified fire modeling tools with the help of our partners, as well as NRR. NRR was instrumental in identifying the fact that we want more than one. Five is what we went with, and a variety of types of codes.

And we want to evaluate, identify, and select the fire experiments. This was another really extensive task. We'll talk a little bit about it later.

We also identified the scenarios and the important five modeling parameters to identify. Those, as Mark mentioned, are like hog gas layer temperature, heat flux, oxygen concentration, smoke concentration, all the way down to target temperatures and those kinds of things, that are fire model outputs.

The important part is these parameters are fire model outputs and can be compared with experiments. The experiments do measure these fire modeling parameters. So we have the ability to directly compare it with the model outputs.

During the process we identified a problem relating to the applicability of our results. We realized that while the experiments were all full scale experiments that we chose, they weren't performed in real nuclear power plants obviously. We didn't have any U.S. data as far as experiments performed in nuclear power plants themselves.

So the experiments are obviously not going to match exactly with the real scenarios. So the --

CHAIRMAN WALLIS: Well, excuse me. Were most of the experiments based on burning a liquid fuel in sort of a dish or something like that rather than burning other things?

MR. DRIESBACH: For the most part they were liquid fuels. There were spray fires as well.

CHAIRMAN WALLIS: Rather well defined fire.

MR. DRIESBACH: Exactly. That was a key parameter. Anthony will talk about that. Anthony Hamins from NIST will talk about that later when we go into the experiment part.

So we resolved the problem through the use of what we call scaling parameters common in the fire science community, and we provide guidance for the users in how to evaluate their particular scenarios using these parameters to be able to compare with the results that we've got.

Then as listed next in the figure is the verification part. We talked a little bit about that before. We relied mostly on the developers for this. We reviewed their processes and determined the quality and documented them. It was more of a reference to the developer's technical documentation versus us going through and evaluating the mathematics or the numerics behind the codes.

Again, our focus was on the validation work. As I mentioned here, the majority of our effort was the comparison between the model and the experiments, which we term as the validation. We document hundreds of model predictions along with comparisons with the experiments.

We document the differences between the models and the experiments, and in an attempt to quantify those differences in the next step, which is the model accuracy step. And here we determine the range of model predictions over the range of experiments. This is going to be discussed a little bit further, and it came out from our subcommittee meeting earlier.

And then finally, we're reporting the V&V results in the seven volumes. It's about 1,000 pages worth of information, as well as hundreds and hundreds of graphs, time histories.

The boxes highlighted in red on this chart indicate areas where the ACRS subcommittee had questions, and the next part of the presentation will attempt to address each of these questions as we go through them.

One comment that was made is that perhaps you should make it explicit that you are dealing with compartment fire models. So when you say fire modeling tours or when the title of the report is verification and validation of selected fire models, I think if you insert the word "compartment" there you will be much more accurate, and the people will know what you're talking about.

MR. DRIESBACH: Okay. So the first box highlighted in red is the fire experiments, and the question that the ACRS subcommittee raised was how were the experiments selected, and Anthony Hamins from NIST will explain a little bit more in detail about the selection of the experiments.

Anthony.

MR. HAMINS: Good morning. My name is Anthony Hamins, and I'm the leader of the Analysis and Prediction Group at the Building and Fire Research Lab at NIST in Gaithersburg, Maryland.

I'm an experimentalist. I have about 25 years of combustion and fire measurement experience.

My remarks are focused on the question how were the experiments selected, but I'll be happy to answer any of the other questions regarding the experiments.

There were 26 tests from six experimental configurations that were selected for evaluation. The emphasis was on using high quality data and let me explain what that means.

All of the experiments were realistic in scale to assure direct applicability to nuclear power plant applications, avoiding hidden scaling effects that might otherwise affect model accuracy. So these were directly applicable to nuclear power plant applications in terms that will be described by two speakers following me in terms of scaling parameters.

The fire heat release rate controls the thermal environment in a compartment fire. So in this study the heat release rate was not calculated. It was controlled and in the models it was specified, and it was based on measurements.

CHAIRMAN WALLIS: When we have a fire in a nuclear plant, how well can we predict this fire heat release rate?

MR. HAMINS: At this point we don't do a very good job of predicting fire spread and growth in an arbitrary configuration. the evaluation was based on understanding the heat release rate, running the models, and comparing them to experiments where the heat release rate was well understood.

CHAIRMAN WALLIS: This seems to be one of the inputs you have to put into your model in the fire.

MR. HAMINS: Because it's the input. That's correct.

MEMBER CORRADINI: So a specified source.

MR. HAMINS: Exactly, yes. The fires themselves were gaseous or liquid fuels which were well controlled. Either the burning rate was measured or the supply rate was measured, and the uncertainty was understood in that measure.

CHAIRMAN WALLIS: And there was no secondary combustion. There was no flashover to something else. It was just a very -- just one fire and no --

MR. HAMINS: Yes.

CHAIRMAN WALLIS: Okay.

MR. HAMINS: All right. The other --

CHAIRMAN WALLIS: And English language fire. That's interesting.

MR. HAMINS: Well, it wasn't an English

language fire. However, there are experiments that have taken place in other countries, but unless they were well documented in a language that we understood, we did not consider them for selection.

MEMBER CORRADINI: Can I ask one question I'm kind of curious about? So you had a known source term. All of the source terms were either gaseous fuel or liquid fuel. So you didn't have a solid fuel, and if I understand correctly, you did not look at what I would call an oscillatory phenomena where I would have a source. I would grow. I would essentially increase the fuel source to watch it do this and do this. So I wouldn't see an oscillatory or frequency based phenomena.

MR. HAMINS: Well, let me explain a little bit more to clarify the answer to your question. There were a number of different scenarios that were selected for study, and in a pool fire, for example, steady burning is achieved after several minutes. So there's a ramp-up that occurs as the heat feedback process warms up the fuel and it starts to burn faster and faster.

So typically measures were made using load cells, for example, how fast the fuel will burn. So we did look at the ramp-up. With gaseous fuels we also had -- we could control the rate of delivery of the fuel. So in those experiments sometimes the fuel was ramped up, and it was maintained at a steady value, and then it was ramped down.

So we did look at transient changes of fuel burning rate as part of the study.

MEMBER CORRADINI: And then just one last question just for understanding for source term. So since I'm not a fire type person, some people were talking as smoke. I call it soot. Is the fact you use a gaseous fuel or a liquid fuel create a character of soot that could be fundamentally different than what you'd see from a solid agent or a solid fuel?

MR. HAMINS: Yeah, the most important aspect in the production of smoke is the fuel type, and the compartment conditions. For example, when a fire is small and starts to burn in this room, for example, on this table top, these pieces of paper, it's what's called well ventilated. There's enough oxygen to burn this to near completion.

However, once half of this room is burning, the amount of oxygen in the room is depleted and the combustion chemistry is completely different, and so what's difficult to model, and none of the models have chemistry in them, none of them have detailed chemistry.

MEMBER CORRADINI: Really?

MR. HAMINS: That's absolutely right. None of them have detailed chemistry. Detailed chemistry can be done in a combustion situation.

MEMBER POWERS: Be absolute precise. The models that you tested don't have chemistry.

MR. HAMINS: That's correct.

MEMBER POWERS: There are models out there that have chemistry in them.

MR. HAMINS: That's right.

MR. HAMINS: There are combustion models that have chemistry. The fire models at this point have very limited amounts of chemistry.

MEMBER POWERS: I point to thinks like Wollken and there's another one that have actually a fairly elaborate soot formation models in them, and there are fire progression models.

CHAIRMAN WALLIS: Maybe this is why they seem to do poorly on smoke and almost all of the models do poorly on smoke.

MR. HAMINS: the models at this point are tracking smoke, the models that we test.

MEMBER CORRADINI: Okay. Thank you.

MR. HAMINS: The other criteria that I'd

like to mention are complete documentation of the experimental apparatus instrumentation procedures. Well documented experiments are important to assure that the experiments could be repeated and that the model boundary conditions were well specified.

Experimental uncertainty --

CHAIRMAN WALLIS: Well, these were designed to look like something that might occur in a nuclear plan. The Factory Mutual people have been doing experiments for decades with grids of timbers and all sorts of stuff, but that is of no use to you?

MR. HAMINS: Well, we actually did use a Factory Mutual set of data for this evaluation, yes.

CHAIRMAN WALLIS: But not that much. You maybe selected some that was most relevant or something.

MR. HAMINS: Yes. We were looking for relevant data that was comprehensive. It could not be reduced scale. Many of their experiments were in reduced scale, nd many of them weren't focused on the types of measurements, the parameters that we were interested in.

So experimental uncertainty I mentioned is emphasized in our study. For example, the uncertainty in the heat release rate is a very important parameter, and it allows us to estimate model sensitivity to the uncertainty in that parameter, which drives the thermal environment in a fire.

So the experiments were selected based on these criteria after an extensive review of the fire literature, and we found that there's a scarcity of well documented, high quality, real scale department fire test data that is available for validation.

For this reason, many of the experiments were specially funded by the NRC and an international group of fire scientists funded by their home governments to work on fire model validation for nuclear power plant applications. This is called the ICFMP group. NRC is a member of the ICFMP and is leading that group.

VICE CHAIRMAN SHACK: Wouldn't it have been worthwhile to include some reduced scale experiments just so you get some experience with scaling and the validity of the scaling?

MR. HAMINS: That's something that we considered, but we did not do at this time. There are a tremendous amount of reduce scale experiments that one could have considered, but we were concerned about hidden scaling effects.

VICE CHAIRMAN SHACK: Well, I mean, I can understand why you want to emphasize the full scale test, but it would seem to me that including some small scale data would have been very valuable to get a notion of how well you can scale.

MEMBER CORRADINI: Well, I mean, to ask the question differently, do the scaling laws that you were using to make judgments dictate or indicate that there was such significant distortion that you wouldn't want the -- that's what I'm trying to -- the logic that you threw these guys out --

MR. HAMINS: No, no, no.

MEMBER CORRADINI: -- was based on scaling law distortion or what?

MR. HAMINS: No. We were concerned that there were hidden artifacts that we wouldn't fully understand, as was the case in all of the experiments that we looked at. There were unspecified boundary conditions or some other thing that wouldn't allow us to do a good job.

MEMBER CORRADINI: Okay, all right.

MR. HAMINS: So let me go on. The NRC sponsored two of the experiments we considered of the six configurations and data from two of the others were provided by this international group, this ICFMP group.

So over the last five years the NRC and the international community has spent millions of dollars on experiments to --

CHAIRMAN WALLIS: Well, I'm going to go back to the factory mutual. I think Heskestat was there, wasn't he? And he's got two of the correlations you used. Presumably his coalition fit his data for some reason, and you just look at how well they fit your data. I mean, if they fit his data very well and they didn't fit some of your data well, there's some reason for that. Maybe you could --

MR. HAMINS: We used -- for example, the Heskestat correlation is very important in the development of some of the zone fire model flame high correlation and in certainly the hand calculations. All of that sort of work went into develop these models, and they were usually focused not necessarily on comprehensive compartment fire experimentation, but they were focused on one aspect, for example, flame height in an open burning room.

So most of the studies at Factory Mutual were very focused, and we tried to select comprehensive data sets, and that was our criteria. Over the last five years the NRC and the international community has spent millions of dollars because there is a lack of well documented, high quality, real scale compartment fire test data. For example, there have been few industrially sponsored compartment fire experiments in the open literature. Tests sponsored by industry are typically proprietary and are typically focused on specific fire scenarios, often in reduced scale and not necessarily relevant to nuclear power plant scenarios.

Many experiments considered in this selection process were discarded, including those by the Navy in which the ventilation systems and their interaction were complex and not particularly well documented.

In addition, steel surfaces and confined compartments are not accurate representations of nuclear power plants.

So in summary, there was an extensive review of the literature. It showed that there was a scarcity of relevant high quality fire compartment test data. Many data sets were discarded because they did not meet the selection criteria, and the data considered here was carefully selected.

The experiments that were selected represent a range of fire conditions in terms of heat release rate and compartment geometry, and a useful way to characterize the experiments is in terms of key scaling parameters, which enable an understanding of the applicability of the experiments in nuclear power plant scenarios, and this will be discussed next.

MR. DRIESBACH: As Anthony said, the next question that was posed by the ACRS Subcommittee had to do with the technical basis for the scaling parameters, and kevin McGrattan from NIST is here and explained more about these parameters and how they come to pass.

MR. McGRATTAN: Thank you. My name is Kevin McGrattan. I'm a mathematician at NIST, and I've been asked to explain the history of fire research in about three minutes. So here it is in one slide.

We'll start around the mid-1800s with the Navier Stokes equations. Obviously this speaks mostly to me as a mathematician, but I also point out how experimentals look at the world.

D-star, Q-star, these terms have been bandied about in these sessions, and there was some confusion last time about what these actually mean. so I thought I could quickly explain a little bit about what D-star and Q-star are.

If you take the energy transport equation that I'm showing here in this slide and you were to nondimensionalize it a fairly straightforward way and set the fraud number equal to one, if you choose this length scale that I have up there, the Q dot, which is the total heat release rate, over some of the ambient conditions, density, temperature, and so forth, what you will do is when you integrate that energy source term, the Q, dot, triple prime, that's the heat release rate per unit volume. Essentially that's the fire in the equations. When you integrate that over the volume of the fire, you will get unity.

Okay. So you've essentially scaled your equations with the heat release rate of the fire.

MEMBER CORRADINI: Say it again. I'm sorry. Slower.

MR. McGRATTAN: I told you I had three minutes, and we're still in the 1800s. So --

CHAIRMAN WALLIS: We'll give you more.

MR. McGRATTAN: You'll give me more time?

CHAIRMAN WALLIS: That's okay, but the food number is wrong though.

MR. McGRATTAN: The food number is wrong.

CHAIRMAN WALLIS: The food number, B should be multiplied by the density difference. What's driving this is the intensity difference between the hot and the cold gas, and then you should have a density ratio.

The velocity is government by rho V squared, which is the actual density. So you need a density ratio in there. Food number should always have a density ratio, a density difference and a density. It should never be expressed this way.

MEMBER CORRADINI: but other than that it's okay.

CHAIRMAN WALLIS: No, unless you have two different densities, you don't have a food number, right?

MEMBER APOSTOLAKIS: It would be easier if some value point is closer to the screen when you're talking. You can use a cursor here to do that.

MR. McGRATTAN: Okay. Here's the pointer.

MEMBER APOSTOLAKIS: Here's a pointer.

MR. McGRATTAN: What I'm merely pointing out here is the correspondence between the velocity and the length scale. Okay? I'm going to choose a length scale. I'm going to call that D-star. Okay? And by choosing that particular expression on the screen -- do I have a pointer here? Okay. It's better in the write-up -- but when I choose this as my characteristic length scale, okay, feed it back into the energy equation, integrate the source term. My source term essentially becomes one.

To me as a model and now I solve this nondimensionalized set of equations numerically, and when I rescale my results, I'm essentially getting a plume from a fire that would be as big as your coffee cup filled with gasoline to maybe an oil tank farm. Okay? That's the beauty of this type of scaling. I can apply it from about six inches to 60 meters or even more. We probably don't even have test data to figure it out.

MEMBER ABDEL-KHALIK: This equation doesn't even have a radiation heat transfer term.

MR. McGRATTAN: Right, right. Right now we're not considering radiation in this scaling. This is just purely the transport of smoke and heat from the fire. The smoke plume is our most important driver of the smoke and the heat.

MEMBER ABDEL-KHALIK: But isn't that an important parameter? You know, one of your --

MR. McGRATTAN: It is, and the scaling that I'm describing here is not the only way to scale the equations, but for our tests which focus mainly on the transport of smoke and heat from the fire, the D-star or the Q-star, these types of the parameters were our more important.

CHAIRMAN WALLIS: Now, Q-star is good, but I think in your table it's wrong. I says the neat release rate and the flame height. It's actually a flame diameter that defines Q-star, not the flame height.

Now, that's okay. You can fix that. What I found, I deduced these things, and what I found the most important thing was delta T over T. I mean, it's the temperature difference between the hot and cold divided by the absolute temperature, which is the same as the density ratio. So it appears in all of these things, and it's hidden in them. You don't have it, but it's sort of hidden in all of them.

MR. McGRATTAN: No. In fire research our most important quantity is the heat release rate.

CHAIRMAN WALLIS: But if there's no density difference, nothing ever happens. So you've got to have a density difference somewhere. Nothing ever happens in a fire, and this is a density difference.

MR. McGRATTAN: The density difference is in the momentum equation where the source term of the velocity is. Here we're focusing on the energy equation, and what I'm trying to explain is that we scale these equations --

CHAIRMAN WALLIS: Energy equation causes a temperature difference though. Without a temperature difference, there's no energy effect.

So anyway, I don't want to quibble with you. I think these are perfectly good, normalized parameters.

MEMBER CORRADINI: So since he's okay with them, just I want to make sure. Where did you -- you mentioned Q-star. Where is Q-star defined? I didn't read the reports. So I apologize.

MR. McGRATTAN: And I apologize, too, because in putting this slide together it was hard to put everything on.

MEMBER CORRADINI: That's fine. So it's somewhere. I should find it.

MR. McGRATTAN: But basically I'll explain where Q-star comes from. If you look at the plot on the right-hand side, okay, if you look at center line temperatures and velocity from smoke plumes of different size fires, you'll see that they collapse according to the scaling I've just described with D-star.

What McCaffrey observed in the mid-1970s was that the flame length scaled with D-star, right, and D-star has an actual dimension, okay. So we know the flame length scales with D-star. What Heskestat did at Factory Mutual is he went on to note that the flame length divided by the actual diameter of the fire could be correlated with this parameter called Q-star to the two-fifths power.

CHAIRMAN WALLIS: Could I give you an explanation? A Q-star is the energy that's delivered by the flame divided by the amount of stuff which is stirred up by the flame, by gravity and so on, and Q-star roughly gives you delta T over T, the temperature difference created divided by the temperature of the ambient stuff by a very simple model, and that's what I think you show here.

But it's the heat release divided by the amount of air that gets involved, and so it gives you a measure of the temperature change, right, roughly speaking?

MEMBER ABDEL-KHALIK: But back to the question of radiation transport. Is the implication of this entire process that you're focusing on fires where soot formation and the radiative heat transfer is not an important part of the process?

MR. McGRATTAN: Certain radiation is important, and it's one of the key parameters that we looked at. However, when we look at the overall set of experiments, what we have is a specified fire of a known size that we get from the experiment, and what the models are being asked to do is predict the transport of this heat and energy from the fire throughout a space.

Now, what Francisco will discuss next is when people ask us where are your experiments applicable and where are they not applicable, we chose to look at these parameters I've described, the D-star, the Q-star, in order to describe the relationship between the fire and the geometry of the space.

The most important dimension is the height. So, for example, when we look at the height of the room compared to the characteristic length of the fire, we want to make sure that anyone applying our validation work to their own use does not go beyond the range that we validated.

MEMBER ABDEL-KHALIK: But doesn't that by sort of definition exclude a large number of fires that a person interested in determining the consequences of a fire or a hypothetical fire in a nuclear plant would be interested in?

MR. McGRATTAN: The particular scaling

that we're looking at here doesn't exclude anything.

MEMBER ABDEL-KHALIK: No. I'm looking at fires where you have relatively large concentrations of smoke and, therefore, radiation transport becomes relatively important,a nd if you're not addressing that at all in your scaling, that means that you can't, you know, regardless of what you do with the model predict something that you're not accounting for.

MR. McGRATTAN: Well, first of all, there's a whole suite of models that we're looking at from hand calcs to the CFD model. The CFD model actually will account for a lot of the phenomena you're talking about.

The simple hand calcs actually don't, and you'll notice when you look at the final charts that there's only a handful of quantities that these simple models can actually predict, and it's because of what you're saying, that these models have been calibrated to work in a certain range.

All of the fires we're looking at typically speaking radiate roughly one-third of their energy. So two-thirds of the energy from these fires goes up into the smoke plume and one-third of the energy radiates to the side, and that's actually a very useful result that fire protection engineers use all the time.

If you don't know what the details of the chemistry are from any given fire, the one-third rule is not a bad one to apply, and a lot of the correlations that you see in the literature actually apply this rule indirectly.

MEMBER ABDEL-KHALIK: So if I'm burning cables, I can still use this one-third rule?

MR. McGRATTAN: Yes.

MEMBER ABDEL-KHALIK: Is that correct?

MR. McGRATTAN: Yes.

MEMBER ABDEL-KHALIK: Regardless.

MR. McGRATTAN: Yes. However, if your room flashes over --

MEMBER ABDEL-KHALIK: If your room what?

MR. McGRATTAN: If your room flashes over, in other words, you've got a small compartment and you're fully engulfed, all bets are off.

MEMBER APOSTOLAKIS: Is that not a little strange though that you would apply the same rule to cable fires?

MEMBER ABDEL-KHALIK: I mean, intuitively I just somehow think that they're --

MEMBER APOSTOLAKIS: Expect more radiative heat transfer from pools of liquids.

MR. McGRATTAN: If you look at most fires that produce smoke, and I'm excluding clean things like methanol and methane and that sort of thing which actually do have less radiative output because they don't produce as much smoke, but most common items that you'd find in an accidental fire are radiating roughly one-third of their energy.

MEMBER ABDEL-KHALIK: So if I burn acetylene versus heptane, I can still use the one-third rule.

MR. McGRATTAN: That one-third rule is pretty good.

MEMBER ABDEL-KHALIK: For both.

MR. McGRATTAN: Right, right. In fact, people have always asked me why don't you predict the radiative output from these fire, and that's a hard prediction to make because you have all of the chemistry to consider, the soot properties and so forth. I have found over the years that just using that one-third rule actually gives me more accurate predictions even with the CFD model than trying to predict outright.

Would I like to predict outright the radiative flux? You bet you, and eventually I think

I will, but for the moment, the one-third rule works pretty well.

MEMBER ABDEL-KHALIK: but that's sort of counterintuitive.

MR. McGRATTAN: A lot of fire is counterintuitive.

I think I'm going to wrap up this discussion.

MEMBER APOSTOLAKIS: Have you guys discussed the figures?

MR. McGRATTAN: I think I have, yes.

CHAIRMAN WALLIS: There's a very good basis for these numbers, George. I don't think you need to be worried about these similarity parameters.

MR. McGRATTAN: The way we use them is going to be discussed next by Francisco.

MR. DRIESBACH: Okay. The third question that was posed by the ACRS was what is the applicable range. This goes back to the experiments and how it relates to what might actually be in the real world, and I have Francisco Joglar from SAIC representing EPRI explaining this a little bit more completely.

MR. JOGLAR: Hi. My name is Francisco Joglar. I supported EPRI in this joint project.

And I'm going to talk in practical terms, what Kevin just discussed in theory, and the first point I want to make is that as we start doing this project, we notice that if you go and analyze different fire scenarios in the plants, there are many of them, and they may be different than, of course, the ones we tested with the experiments we have.

And also, the fire models have different capabilities. So there is a mismatch with these three elements, and we have to come up with a way of helping users of this method determine if our V&V results or the results of this document are applicable for the case they're analyzing.

So we are using these dimensionless parameters to basically define that range of applicability, and two of them that I have here as an example. The first is H over D, the one that just Kevin explained, the height of the room over D-star, and if you see this conceptual plug we have, the red dashed lines would basically identify the range of applicability of our results.

So let's say a small fire in a very large room, a cigarette in a turbine building would be out of our validation range. And similarly, a very large fire in a very small room would also be. so we are trying to present all of these documents --

CHAIRMAN WALLIS: You don't mean Q-star there, do you?

MR. JOGLAR: Not in this.

CHAIRMAN WALLIS: No, I mean your plot is H over D-star versus D-star and Q-star.

MEMBER CORRADINI: Versus H. No, it's H versus D.

CHAIRMAN WALLIS: Yeah, but the stuff on the left says Q-star.

MR. JOGLAR: On the left?

CHAIRMAN WALLIS: The stuff that says Q-star.

MR. JOGLAR: Oh, this would be a second dimensionless parameter. We have --

CHAIRMAN WALLIS: The Q-star is the measure of the strength of the fire in terms of the energy put in. I don't think -- it seems a little bit odd. But anyway, go ahead. I mean it just seems to be in the wrong place there.

MEMBER APOSTOLAKIS: I don't understand. What is wrong?

CHAIRMAN WALLIS: I don't understand. It says Q-star is the length flame length. I don't see what that has got to do with the picture here.

MR. JOGLAR: No, it doesn't.

MEMBER CORRADINI: It doesn't.

CHAIRMAN WALLIS: It doesn't?

MEMBER CORRADINI: It's just another way of thinking on it.

MR. JOGLAR: And I should also add that these are not the only two parameters we have because for different fires in other plants we may or may not care about room geometry. I mean, some of these scenarios have localized fire damage --

CHAIRMAN WALLIS: That's --

MR. JOGLAR: -- close to the flames, and we don't care about what happens away from it.

CHAIRMAN WALLIS: Q-star is the measure of the intensity of the fire in terms of the energy put in. It's a dimensionless form of Q.

MR. JOGLAR: Yes.

CHAIRMAN WALLIS: Okay.

MR. JOGLAR: So these are just two examples, and the diagram, the picture I have is just for the first one, but we want to -- what we're trying to say is that for all of them we have defined this range of applicability that you could see if we have results, V&V results, for a specific application.

With that, that's all I have. So let's go to --

MEMBER APOSTOLAKIS: But this is the result of your experiments, right? The result of your efforts is the dashed lines.

CHAIRMAN WALLIS: I understand the connection. D-star is Q-star to the two-fifths or something like that.

MR. JOGLAR: No.

CHAIRMAN WALLIS: Or it is something one with it. It's something done with it. Okay. It doesn't matter. It doesn't matter. It doesn't matter. It doesn't matter. It doesn't matter.

MEMBER CORRADINI: Say it again. You said it.

MEMBER APOSTOLAKIS: You have to come to --

CHAIRMAN WALLIS: Q-star over D.

MR. McGRATTAN: Yeah, Kevin McGrattan again.

Q-star is D-star over D to the five-halves power.

CHAIRMAN WALLIS: The diameter of the fire, it's the diameter of the fire divided by some characteristic diameter of the flame or something. Okay.

PARTICIPANT: If you have the report, it's on page --

CHAIRMAN WALLIS: I understand it. Don't worry about it.

PARTICIPANT: -- 26.

CHAIRMAN WALLIS: I understand it.

MEMBER APOSTOLAKIS: Okay. So the dashed red lines come from the effort of this project.

MR. JOGLAR: Yes.

MEMBER APOSTOLAKIS: One question that was raised at the subcommittee meeting is what is the range of typical fires and compartments in nuclear plants and how much do they overlap with this.

MR. JOGLAR: Well, the range, it's as I said a wide range. If you're asking me in kilowatts terms fire sizes, they can range 50 kilowatts to two megawatts, five, ten, depending on the size of --

MEMBER APOSTOLAKIS: No, I'm looking at this figure.

MR. JOGLAR: yes.

MEMBER APOSTOLAKIS: So it says dashed lines from the validation effort. Now, I have a range of heights in nuclear compartments, and I presumably have a range of D-stars, right?

MR. JOGLAR: Yes.

MEMBER APOSTOLAKIS: So if I draw lines

that cover those two ranges for nuclear facilities, what am I going to see? Am I going to see that there is minimal overlap, there is significant overlap?

MEMBER CORRADINI: Do you see where he's going with?

MR. JOGLAR: Oh, yes.

MEMBER APOSTOLAKIS: How useful is this going to be, in other words. I mean, you are giving me your results.

MR. JOGLAR: Yes.

MEMBER APOSTOLAKIS: And I have a compartment to analyze, and I'll do what you're suggesting. I'll calculate H and D-star and see whether I fall there.

But can you tell me in advance what kind of range you expect to see in nuclear applications?

MR. JOGLAR: I don't have a specific percentage of our results that would apply to the universe of fire scenarios. My impression is that it would cover a fair amount of them because this --

MEMBER APOSTOLAKIS: How difficult would it be to produce that? It wouldn't be difficult. I know you haven't done it, but how difficult would it be? It seems to me it would --

MR. SALLEY: If I can interrupt, I hear

what you're saying, George. Remember what I talked about a few minutes ago with the application guide?

In some of that stuff I think we're going to develop further on when we start getting into the application guide an the user guide, is where we'll actually fully develop these concepts for the people to use it.

I mean that's what our big plan is. This is to lay the ground work. That application guide, users guide is to really shake it through.

MEMBER APOSTOLAKIS: This is the guide that you mentioned would be --

MR. SALLEY: 2008.

CHAIRMAN WALLIS: There's no scale on this figure? I mean, the whole -- it's just a qualitative figure. It's just a qualitative figure.

MR. JOGLAR: It's a qualitative figure, yes.

MEMBER APOSTOLAKIS: Qualitative?

MR. JOGLAR: This one is.

MEMBER APOSTOLAKIS: This is quantitative.

MR. JOGLAR: No, no, no.

CHAIRMAN WALLIS: There's no scale on it.

MR. JOGLAR: It's just an illustration.

MEMBER APOSTOLAKIS: This particular.

CHAIRMAN WALLIS: No scale.

MEMBER APOSTOLAKIS: But in the report you have quantitative.

MR. JOGLAR: Yes, yes, yes.

CHAIRMAN WALLIS: But in most nuclear plants does the fire go up to the ceiling?

MR. JOGLAR: Sorry?

CHAIRMAN WALLIS: In most nuclear plants did the fire go up to the ceiling? Because you actually talk about hot gas layer on the top. So presumably these fires are big enough to affect the ceiling significantly. So you don't have small fires in a large room very often, or do you?

MR. JOGLAR: Yeah. I mean --

CHAIRMAN WALLIS: You do. Okay. In the turbine hole, for instance.

MR. JOGLAR: Yeah, and another scenario would be let's say a cabinet that has very important cable close by.

CHAIRMAN WALLIS: Okay.

MR. JOGLAR: It may not be a large room, but in terms of the scenario of interest, it's a small -- small --

CHAIRMAN WALLIS: Sure.

MEMBER CORRADINI: Can I ask a question?

We were mumbling over here. So for Brown's Ferry, did anything you did help us?

I'm a hard nosed, old fashioned engineer. I had Brown's Ferry in 1980-something. Did anything we did in all of this work help us understand better a Brown's Ferry sort of fire? Yes, no?

MR. JOGLAR: Mark is the expert on Brown's Ferry.

CHAIRMAN WALLIS: Because it started off as a small fire in a large room, and then it --

PARTICIPANT: Well?

MEMBER CORRADINI: I'm just kind of curious.

MR. WEERAKODY: I can answer.

MEMBER CORRADINI: I'm not a fire expert. This would be --

MR. WEERAKODY: Well, I'm not a fire expert either.

MEMBER POWERS: The answer is no.

MR. WEERAKODY: Right.

MEMBER APOSTOLAKIS: The answer is no, yes.

MR. WEERAKODY: We don't build the plants to analyze, but I will tell you at two different levels how it helps. New reactors, okay; that's part of the program that we are managing at the present time.

One thing we learned is we design the plant separate, be done with it. You know, two cranes. Some of the new designs have four cranes.

Then going to the next level like, you know, things like Brown's Ferry fire, which happened in '75 really --

MEMBER CORRADINI: Sorry.

MR. WEERAKODY: That's fine. I forget, too, but there is a lessons learned report out of that, and the lessons learned basically said, you know, start separating stuff, and I know Dr. Bonaca and I, you know, we worked and Dr. Brown was the Director; we worked at Harronick (phonetic) and how that plant spent millions of dollars to keep separating stuff.

So really this analysis is not going to help Brown's Ferry at all. What we are looking at these things is in the context of if today, a particular plant that adopts 805 comes to a situation where as opposed to wrapping up a cable they are deciding, well, can I live with this situation. This tells them, this figure tells them the kind of fire that they need to consider and the kind of concerns they need to have in that decision.

So it's helpful going forward in terms of applications.

MEMBER CORRADINI: Okay. So where I'm leading with this is back to George's question, which is not here, but I'm still trying to understand. So I have two sub-questions.

One question is: is this the graph that one would put your range of data on relative to some H versus D-star, or are there other ways to characterize your 26 experiments that would determine a range of interest versus a range of applicability?

In other words, I'll take this. so let's say this is the only graph that says, okay, here's 26 experiments and here's where they lay, and then George asks, okay, so where would one postulate fires that would overlay with that to know that given this range of experiments and comparison to models and what we guesstimate is where we have to worry about fires, these are regions where I've got some information that I can use and these are the regions where I don't have information and I may have to do more experiments.

MR. JOGLAR: Yes, you have to go to your scenario which has some geometric characteristics and fire size. You specify that in your analysis, and you would come to this type of graph and way, "Okay. My room height is this high and I would have this D-star, given my inputs to what I am analyzing."

And you check if you're within there.

MEMBER APOSTOLAKIS: But you see, that's where I --

MEMBER CORRADINI: That's where I'm --

MEMBER POWERS: Mr. Chairman, a point of order.

CHAIRMAN WALLIS: Yes.

MEMBER POWERS: I note that it is now five minutes to 12. The members who by their own admission who have not read the documents are leading us well astray of the thrust of this presentation and dealing with some of the context for the presentation and not getting into the meat of it.

I wonder if this is a wise expenditure of either the members' or the speakers' time.

MEMBER CORRADINI: I'll be quiet.

CHAIRMAN WALLIS: I think we should move on, yes. Most definitely we should move on.

MEMBER APOSTOLAKIS: Well, actually I wanted to raise the issue, too. I mean, this is an important project. We are running out of time, and there are good questions from the members. I propose that we extend the time.

CHAIRMAN WALLIS: Do you want to go for half an hour and then have lunch?

MEMBER APOSTOLAKIS: I would say so.

CHAIRMAN WALLIS: Well, let's cut to the chase.

MEMBER APOSTOLAKIS: Because the afternoon is all committee business.

CHAIRMAN WALLIS: Let's cut to the chase where we've got something, some real information on it.

MEMBER APOSTOLAKIS: Yeah, yeah. That's what I'm saying, because it's an important letter we're going to write.

CHAIRMAN WALLIS: Thank you, Dana.

MEMBER POWERS: One wonders what the virtue of having a subcommittee meeting is if we're going to work on the context and not let the speakers get to the point.

MR. DRIESBACH: So just to follow up with the final question, if you look back to the box, the final red box was model accuracy, and this was raised most directly by the ACRS subcommittee members, and the main question that we're getting at again is how accurate are the model predictions.

And the following slides we're going to present something new as a result of this question. We took that question back with us and reevaluated our results in light of this question. So we had a process. That's what's documented in the reports you have.

Where we defined the colors, green, yellow, and red, to represent predictive capabilities.

CHAIRMAN WALLIS: Do you ever award a red?

MR. DRIESBACH: No, we do not.

To assign the color for each model and each parameter, we based those color decisions on comparing the difference between the model and experiments and the experimental uncertainty as Anthony was alluding to earlier. We evaluated experimental uncertainty, and we then compared the model difference and the experimental uncertainty and made a judgment as far as the color goes because we only have the three colors.

So we realized it's a semi-qualitative type of approach, and it was pointed out at the subcommittee that that's what that process was. It's not giving you necessarily hard numbers types of results.

So we took that back and now we've got a new process. We've come up with this new process based on the comments from the subcommittee where we're using the same raw material. All of the data was the same. We didn't rerun any models. We just took the same raw material, and we're trying to present a more quantitative result that will be used or can be used, may be used by the NRR in their analysis.

CHAIRMAN WALLIS: So you're proposing to change the report?

MR. DRIESBACH: We're proposing to repackage the results.

MEMBER APOSTOLAKIS: Well, how can we write the letter now?

CHAIRMAN WALLIS: How can we write the letter, yeah?

MEMBER APOSTOLAKIS: Unless we write a letter of common --

CHAIRMAN WALLIS: This is a big change.

MR. SALLEY: Let me speak for a second. I don't believe it's really a big change. As Jason said, we were somewhat qualitative in how we put the colors to it. Based on what came out of the subcommittee, we will give you the raw data.

I would like you to move into the next

slide and see how we -- it's a repackaging exercise -- and see how it's repackaged. I don't think it changes any of the essence. It doesn't change any of the content of the report.

CHAIRMAN WALLIS: Removed the greens and yellows?

MR. SALLEY: We removed that, and we went with something we feel is a little better based on the comments of the subcommittee. So please take a look at that before you make a decision.

MR. DRIESBACH: So I'm going to introduce Kevin McGrattan again, and he's going to talk about the details, and then we'll move into Ray Gallucci from NRR as far as an example of how these new results could be used by NRR.

MR. McGRATTAN: Kevin McGrattan from NIST again.

Okay. So what you see here is just one sample plot that's typical of the hundreds of plots that are put together when we compare five models against 26 experiments looking at 13 different quantities. You typically see time histories of temperature, oxygen concentration, heat flux, what have you. You typically have one for the experimental measurement and one for the model prediction, shown here, and a decision has to be made how good is that prediction.

Now, normally this is where it ends. This is where we would simply publish this chart and journal and be done with it and call it validation. We want to go beyond that. We want to quantify this.

So the way we did it is, quite briefly, we look at the peak values for both the model and the experiment, M sub P and E sub P, and we form a relative difference epsilon.

You switch to the next chart and you'll see a scatter pot with the results of the dozens of these time history comparisons. So what we're plotting here are these relative differences for all of the experiments shown along the bottom of the graph.

CHAIRMAN WALLIS: For one particular model.

MR. McGRATTAN: For one particular model and for one particular quantity of interest. So here we're looking, for example, at the model CFAST and how it predicts the hot gas layer temperature. That's the average temperature of the upper layer in all of the experiments.

CHAIRMAN WALLIS: So the question might be nuclear plants on the right or the left of this or are they everywhere?

MR. McGRATTAN: What?

CHAIRMAN WALLIS: Are the ones on the right typical of nuclear plants or the ones on the left typical of nuclear plants or they could be anywhere?

MEMBER SIEBER: They could be anywhere.

CHAIRMAN WALLIS: Relate this to the nuclear situation.

MEMBER APOSTOLAKIS: But let's understand this figure because I think it's a key figure.

MR. McGRATTAN: It is a key figure.

MEMBER APOSTOLAKIS: The errors that you're showing, 14 percent up and down and so on, 21 percent, these come from -- the uncertainties come from measurements?

MR. McGRATTAN: Right. Let me explain.

MEMBER APOSTOLAKIS: Okay.

MR. McGRATTAN: A little bit.

MEMBER APOSTOLAKIS: Sure, sure.

MR. McGRATTAN: Where we're coming from. The first set of error bars that you see relate to the experimental uncertainties, and that's the combined experimental uncertainty, uncertainty in the measurement itself, for example, a thermocouple measurement, and the uncertainty in the measurement of the heat release rate which is specified to the modelers. Okay?

If you combine all of that uncertainty in the measurements, what we see is roughly speaking a 14 percent two sigma confidence interval in the measurement. Okay?

Now, we take the model predictions. We take an average of those predictions, and we take two standard deviations of those predictions, and we plot them in black.

Now, the first thing you're going to notice is that the average black line is either going to be above or below that red line. Okay? We call that the bias. If that black line is above the red line, we say the model is over predicting the measurements or the bias is positive.

In addition to that we have the two standard deviations shown in black, and we use the two standard deviations because that's the convention of the experimental intervals.

MEMBER APOSTOLAKIS: You use the standard deviations for CFAST. This is the example you have here.

MR. McGRATTAN: Yes.

MEMBER APOSTOLAKIS: They represent which uncertainty?

I mean you go to CFAST. You will input the heat release rate of the experiment.

MR. McGRATTAN: Right.

MEMBER APOSTOLAKIS: And there is uncertainty there.

MR. McGRATTAN: Right.

MEMBER APOSTOLAKIS: You input that.

MR. McGRATTAN: Right. What we are saying is this scatter represents both the uncertainty due to the uncertainty in the heat release rate, but also the actual model error.

CFAST is not a perfect model. It uses a two zone assumption. So what we're showing here is a combination of that uncertainty in the input parameter plus the error of the model.

MEMBER APOSTOLAKIS: So if --

MR. McGRATTAN: Let me just finish one thought. If CFAST were a perfect model or if any of these were perfect, we would expect to see those black dots within the red bounds. So any time you see the black dots outside of, we have to account for that as being model error.

MEMBER APOSTOLAKIS: So this black dot there, one of them, represents a run of CFAST for this particular experiment, right, whatever it is?

MR. McGRATTAN: Right. For example, this --

MEMBER APOSTOLAKIS: Yeah, this one.

MR. McGRATTAN: -- this point here is the pot that I had before. That's a 27 percent over prediction, and that was the pot that I had up --

MEMBER APOSTOLAKIS: Well, is that the point value that you calculate or what is it?

MR. McGRATTAN: Yes. These are deterministic fire models, and for a given set of input parameters you get --

MEMBER APOSTOLAKIS: So this is the best --

MR. McGRATTAN: -- you get one answer.

MEMBER APOSTOLAKIS: But is this the best estimate or what is it?

MR. McGRATTAN: This is the best estimate from the model using the best estimate of the input parameters.

MEMBER APOSTOLAKIS: Okay, and then you're saying, now, around this point there is uncertainty because of uncertainty in the heat release rate, experimental uncertainty, and so on, and this is by the dashed black line.

PARTICIPANTS: No.

MEMBER APOSTOLAKIS: The thirty-four --

MR. McGRATTAN: The dashed black line is simply two standard deviations of B-26 --

MEMBER APOSTOLAKIS: Oh, of the six points.

MR. McGRATTAN: Of the 26 relative differences.

MR. DRIESBACH: -- of all of the points on this plot.

MEMBER APOSTOLAKIS: So if I want to know the uncertainty associated with a single dot, I don't have that on the graph.

MR. McGRATTAN: Right.

MEMBER APOSTOLAKIS: Why isn't that relevant? I mean, how do you decide what is the best estimate of the heat release rate?

When I say 34 percent is an upper bound of the predictions of CFAST, shouldn't that include the uncertainty in individual dots? Maybe it's irrelevant. I don't know, but it seems to me that's an uncertainty.

That uncertainty is a major driver in the red uncertainties, right? The experimental uncertainty.

MR. McGRATTAN: The focus of our effort here is to assess the accuracy of the models. In order to know what the accuracy of the model is, we have to eliminate that experimental uncertainty or we have to distinguish the error that the model is making from the uncertainty in the input parameters that the modelers were given.

We simply took the numbers that the experimentalist gave us, material properties, heat release rates and so forth. We ran our models. We produced these results. We drew these bounds. That's what we did.

MEMBER SIEBER: And you get a specific deterministic answer. One answer.

MR. McGRATTAN: And we get a specific deterministic answer. One answer, yes.

VICE CHAIRMAN SHACK: Suppose I then went and I just did the experimental uncertainty in the heat input. In CFAST I would get a different standard deviation. The sum of those two standard deviations is really what you've got up there now, and the model one is sort of the other part of that.

MR. McGRATTAN: Right, right.

CHAIRMAN WALLIS: I understand.

MR. McGRATTAN: Like I said, if CFAST were a perfect model, we would expect to see those black dots roughly Gaussian distributed between those two red bands.

MEMBER APOSTOLAKIS: No, because -- no. I have uncertainty in Q-dot. Okay? That was already accounted for when I developed the red lines. Now I run CFAST, and I still have the uncertainty in the input.

MR. McGRATTAN: Right.

MEMBER APOSTOLAKIS: If I propagate that, then CFAST may look much better than it looks now because, you know, it cover the possibility.

MR. McGRATTAN: Yes, exactly, exactly.

MEMBER APOSTOLAKIS: If you don't --

MR. McGRATTAN: But it still would not necessarily fall within those red bounds because we say that CFAST has error associated with it.

MEMBER APOSTOLAKIS: Of course, but it could overlap. It could overlap.

MR. McGRATTAN: It could, and there are situations, for example, FDS, which is a more accurate model, where the error bounds in the FDS predictions are overlapping the experimental.

MEMBER APOSTOLAKIS: The point is this though. In the predictive mode, if I'm doing a fire risk assessment and I want to run CFAST, I will include explicitly my uncertainty in the heat release rate and will propagate it through the code. So am I then doing something wrong by saying --

MR. McGRATTAN: Not at all, not at all. That's a wise thing to do, but we want to know how good is any one of your CFAST calculations. We understand that you will input a range of heat release rates based on your uncertainty about a switch gear cabinet burning. We appreciate that.

What we want to answer the question for any one of those CFAST runs: how good is the answer? If I'm given perfect inputs, if I magically know exactly what the heat release rate is, how good is CFAST going to --

MEMBER APOSTOLAKIS: But I don't think you're answering that.

CHAIRMAN WALLIS: No, you're not.

MEMBER APOSTOLAKIS: That's what you want to do.

CHAIRMAN WALLIS: The uncertainty is experiment dependent. It's not a universal thing with one red line across there. Each one of these points has different inputs.

MR. ARMIJO: But if you put this graph up for MAGIC, exactly the same gas temperature, exactly the same set of experiments, you'd get a different pattern.

MR. McGRATTAN: Yes.

MR. ARMIJO: And maybe it would look better overall, and I guess that's all you were trying to do: compare these codes in a broad sense.

CHAIRMAN WALLIS: In a broad sense.

MR. McGRATTAN: Right.

MR. ARMIJO: That's all you were trying to do.

MR. McGRATTAN: Right, and ironically when we looked at CFAST and MAGIC, given that they're based on the same assumptions and the same simplifications of the physics, the scatters look very similar, but it's not exactly the same. Point by point you're not going to see exactly the same answers produced by those two models, but if you looked at the scatter, it's more or less --

MEMBER APOSTOLAKIS: Let's ask that question differently. I'm about to do an analysis in a compartment, and I'm going to use CFAST. How am I going to use the 34 percent?

MR. McGRATTAN: Okay. We're going to get to that.

MR. SALLEY: Before you get to that --

MR. McGRATTAN: We're going to get to that.

MR. SALLEY: Before you get to that, let me just interrupt for a second. It's our trying to convey the results. If you look at this, across the bottom you'll see all of the different experiments and how they plot it out here. There are some very important things that come to us here the first time.

For example, if you look at where the bias is, you'll see that for this parameter CFAST tends to over predict. You'll also see with the two standard deviations we capture roughly 90 percent of the data.

Now, I will --

VICE CHAIRMAN SHACK: -- what kind of experiments are on the right side.

CHAIRMAN WALLIS: That's right. That was my question. Are the ones on the right-hand side more typical of nuclear plants? Are these NBS experiments designed --

MR. McGRATTAN: This goes --

CHAIRMAN WALLIS: -- to simulate nuclear plants? Is that where the big scatter is?

MR. SALLEY: Across the bottom the way Kevin has this laid out is each one of the experimental series that were used, benchmark exercise two, FMSNL four, that's the results from that specific experiment. The whole family is what we decided long ago was applicable to nuclear power plants.

CHAIRMAN WALLIS: This is new. This wasn't in the report before?

MEMBER APOSTOLAKIS: This is not in the report.

CHAIRMAN WALLIS: This is why we're spending so much time. You're giving us new stuff.

MR. McGRATTAN: Yes. These charts are in the report. What's new here are the black lines. Okay? We did produce scatter plots exactly like this, but after the discussion we had at the subpanel meeting, we decided to take the average in the standard deviations of the relative differences from the model predictions as a means of being more quantitative about what we mean by these colors.

This all gets to how we're replacing these colors. What are we going to replace these colors with?

CHAIRMAN WALLIS: You know, weighting essentially each experiment the same, you're not saying that certain ones are more typical to nuclear plants. You're weighting them all the same.

PARTICIPANTS: Right.

MR. SALLEY: I think if you let Ray work his problem out, then we can come back and revisit this. This may make more sense.

MEMBER APOSTOLAKIS: This is becoming a subcommittee meeting.

CHAIRMAN WALLIS: Well, we're going to stop at 12:30 George. We're going to stop at 12:30

MEMBER APOSTOLAKIS: So I don't know what to do now. We have a problem.

CHAIRMAN WALLIS: Well, maybe we should just let them go to the end and then decide what we do.

MEMBER APOSTOLAKIS: Okay. So tell us how you use --

PARTICIPANT: Why are there more than 26 data points on this plot?

MR. McGRATTAN: One set of experiments involve three compartments instead of one. So we had compartment temperatures in the three, and so you'll see on the right-hand side, which is actually why CFAST was not predicting these well, because this was the temperature in a third compartment away from the fire compartment, and CFAST is showing a weakness in that particular area of predicting a remote target room temperature.

MEMBER APOSTOLAKIS: Does an experiment consist of a number of tests? When you say "experiment," you don't mean one test.

MR. McGRATTAN: We had six sets of experiments, and within the sets of experiments we ran tests. So, for example --

MEMBER APOSTOLAKIS: So the total is 26.

MR. McGRATTAN: The total is 26. the total, 26 fires were lit in six different compartments.

CHAIRMAN WALLIS: Can we move on and finish and then we'll decide what we're to do?

MR. DRIESBACH: So this is an example of what's the output of the study now. So we have tables of means or biases and standard deviations based on the actual relative differences of the model predictions.

MEMBER KRESS: Now, explain to me. The red line on the previous slide, the red lines only represent the area in the heat release rate and the measurement of the temperature.

MR. McGRATTAN: Right. We call that the

uncertainty of the measurements.

MEMBER KRESS: Ninety percent of this is the heat rate.

MR. McGRATTAN: Yeah, the heat --

MEMBER KRESS: A picture you can measure pretty well.

MR. McGRATTAN: Right. The heat release rate is the big driver of that uncertainty, yeah.

MEMBER KRESS: Okay.

MEMBER APOSTOLAKIS: And the problem, Tom, in my mind at least, is that I will account for that uncertainty when I do a PRA.

MEMBER KRESS: Sure. Sure, you will.

MEMBER APOSTOLAKIS: So I don't know whether I'm double counting. I haven't really thought about it. Go ahead, go ahead, go ahead. So what do we do with the table?

MEMBER SIEBER: These tools are design tools though. You use these things to decide at what temperature should a fusable link in a sprinkler melt or does this cable fail or not fail. And if we devote ourselves to PRA and looking for uncertainties and probabilities, we may be misusing some of these tools.

MEMBER APOSTOLAKIS: No. This is supposed to support 805 and 48(c).

MR. DRIESBACH: So the next question then --

MEMBER SIEBER: Well, that's my opinion.

MR. DRIESBACH: The next question that relates to that original question is: how might our user, the people that asked us for this project, how might they use these results?

And we've got Dr. Ray Gallucci, our esteemed colleague from NRR to talk through an example.

CHAIRMAN WALLIS: Now, can I ask you? When you say bias or the deviation in temperature by a percent, do you mean temperature difference?

PARTICIPANT: Delta T over T.

CHAIRMAN WALLIS: Temperature difference?

MR. GALLUCCI: Delta T over T.

CHAIRMAN WALLIS: Delta T over T? Absolute temperature or what temperature?

MR. GALLUCCI: Experimental temperature.

CHAIRMAN WALLIS: But you can't have a percent change in temperature. It's an absolute temperature?

MR. GALLUCCI: It's delta T from CFAST versus delta T from -- T from CFAST minus T from the experiment divided by T from the experiment.

CHAIRMAN WALLIS: T on what scale? Is it Celsius --

MR. GALLUCCI: Go back to Slide 12.

CHAIRMAN WALLIS: -- temperature must have a zero. You're going to divide it by C, delta T over degrees Centigrade? It's got to be delta T over change in temperature from the beginning, right? It has got to be the error in temperature over temperature change.

MEMBER APOSTOLAKIS: I thin you should go to the table on Slide 14. Okay? The first entry --

CHAIRMAN WALLIS: No, they're not. I mean, it doesn't make --

MEMBER APOSTOLAKIS: He -- explain --

MR. GALLUCCI: These are Fahrenheit or Celsius.

CHAIRMAN WALLIS: No, you can't do that. That's absolutely wrong. It's complete --

MEMBER APOSTOLAKIS: Why don't we ask them to explain --

THE REPORTER: My apologies. One conversation at the table please.

MEMBER APOSTOLAKIS: When the first entry says hot gas layer temperature, mean six percent, what does that mean? I'm using now CFAST, and I'm calculating in my compartment -- no, no, no, not here. I'm going to the future now.

MR. SALLEY: Kevin, why don't you slide back up there and answer those questions for him?

MEMBER APOSTOLAKIS: -- table. You're giving me the table, right?

MR. McGRATTAN: The data from the table come from this plot.

MEMBER APOSTOLAKIS: No, but I want to know how this --

MR. McGRATTAN: The six percent percent mean, the black line on this plot, if you look at the table on the left, hot gas layer temperature, under mean bias it says six percent. It's the same six percent.

CHAIRMAN WALLIS: Six percent based on what?

MEMBER APOSTOLAKIS: I'm running CFAST and I get a temperature of 350 degrees Celsius. So that means I'm off by six percent?

MR. McGRATTAN: Okay. Kevin McGrattan again at the mic.

Let me just explain what we mean by these temperatures. We're always talking about a temperature rise over ambient. So if CFAST says 350 degrees C., ambient temperature is usually something like 20 degrees C. --

CHAIRMAN WALLIS: That's a temperature rise.

MR. McGRATTAN: -- and our temperature rise would be 330.

CHAIRMAN WALLIS: That's what you mean by temperature.

MR. McGRATTAN: That's what we mean by temperature. Sorry. We're a bit flippant with temperature because everything else we measure, like an oxygen or a heat flux or that sort of thing are obviously ambient value is zero, but with temperature it's always the temperature rise above ambient.

MEMBER APOSTOLAKIS: That still doesn't explain the table. Let's go to the table again.

MR. McGRATTAN: Okay.

MEMBER APOSTOLAKIS: So I agree that it gives me 350 so it's 320. What do I do with the six percent? What does that tell me? What should I do now?

MR. McGRATTAN: Okay. That's what Ray is going to talk about, and I want to bring him back and he's going to talk to that.

CHAIRMAN WALLIS: George, I'm almost

concluding we have to have a subcommittee meeting on this.

MEMBER APOSTOLAKIS: This is a subcommittee meeting already.

CHAIRMAN WALLIS: This is all new stuff.

MEMBER APOSTOLAKIS: This is a significant change.

CHAIRMAN WALLIS: Well, maybe that's what we have to do then. Okay. Let's go ahead and see what they have, and then we'll come back to that issue.

MR. GALLUCCI: Okay. What we have here are four plots. These are taken from actual plants, actual fire areas, CFAST runs. We have Plant A which did a Radiation Protection Office ordinary combustible fire.

Plant B, the east cableway, an oil fire.

And the make-up pump room in Plant C with ventilation on and off.

To show an example of how you might use the results from NUREG 1824, I'm going to use the red graph here, which is the east cableway fire at Plant B.

This is on a different scale. The red line here is that same plot that comes directly out of

CFAST. Now, we know from the NUREG 1824 results that CFAST over predicts temperature by six percent.

CHAIRMAN WALLIS: I'm sorry. This is a cableway fire? This is in tray or something?

MR. DRIESBACH: It's in a cableway room.

CHAIRMAN WALLIS: Oh, room. Because all of your dimensionless parameters refer to room fires. They don't refer to fires --

MR. GALLUCCI: That's what it is. It's describing the room.

CHAIRMAN WALLIS: Oh, okay. Sorry.

MR. GALLUCCI: Okay. We know that CFAST from the 1824 results over predicts by six percent. So we would adjust the CFAST results by six percent. So you can see that we believe that the true results, if you use the word "true" loosely, would be the blue line.

Now, we know that the standard deviation that came out of the NUREG 1824 was 13 percent for CFAST. We're dealing with hot gas leg temperature specifically here.

If we were to assume a certain distribution for the purposes of illustration, I assumed a normal. I'm just showing that this would be the temperature range that you would say would come out for CFAST as a function of time at 90 percent, two sided confidence intervals.

Next slide.

This very busy slide is an example of what I might do with this if I was going to be doing fire PRA. In green is the hot gas layer temperatures from CFAST. I show the adjusted mean. I show the 90 percent confidence bounds, upper and lower.

Now, let's postulate that I have thermal set cables in this room, and that's what I'm interested in. The damage threshold for thermal set cables has a mean value of 625.

If I want to keep things simple, I just deal strictly is that is a go or no go condition and I ignore the fact that there's actually a spread in damage threshold which I arbitrarily show here with a 90 percent confidence interval of 75 degrees.

And I'll talk about the blue line in a minute.

CHAIRMAN WALLIS: Yeah, I'd like to hear about the blue line. Go ahead.

MR. GALLUCCI: So you run CFAST. You'll notice at the first point where the distributions potentially overlap, again, dealing only with the 90 percent confidence intervals, you're out running around six or seven minutes. You finally hit the 550 or so temperature. That's the fifth percent lower bound on threshold damage with the upper bound from the CFAST run.

So as I progress in time, theoretically the integrated area here would be the increase in probability of damage due to the fire in the room. However, competing with this, what I'm showing here is the probability of nonsuppression. The axis for that is on the right. These are typically exponential. This is an arbitrary exponential, but obviously the probability of the fire lasting ten, 20, 30 minutes is dropping fairly rapidly because someone is going to respond to it.

So all I'm attempting to show here is that instead of what we current -- what we currently have is we have a point estimate coming out of CFAST. We have a point estimate for the damage threshold. So we would just say, okay, damage is possible at eight minutes.

Now that we have NUREG 1824, we have the potential to look at a distributed temperature coming out of CFAST. We probably have always had the potential to look at a distribution on the threshold failure. Whether you want to go through that exercise

I don't know, but remember even though that may seem fairly simple, you've always got this competing effect of the probability of nonsuppression.

So this can be a fairly simple calculation as you might find in the fire protection SVP, which was a strictly point values, or if you're doing a fire PRA and getting a more precise answer as desired, you can simulate this to death.

You can do what was mentioned earlier, is you can put distributions on all the input parameters in CFAST, not on the room size so much, but on the fire size, et cetera, and you will not only have the 13 percent modeling bias that's in there with CFAST. You will have the spread based on the uncertainty at all of your input parameters, and this can get very wide.

The user will be free to do this. Theoretically he has always been free to do this. What he's getting now that he didn't have before is this model, this uncertainty in the CFAST run itself that he can now put into his equation.

MEMBER APOSTOLAKIS: Now, Ray, this presumes that the point value that is used, say, for the Q-dot in CFAST as input is the best estimate of some sort, some sort of a representative value.

MR. GALLUCCI: This, yes.

MEMBER APOSTOLAKIS: Yes.

MR. GALLUCCI: The solid line would represent that.

MEMBER APOSTOLAKIS: Right. Now, we know that this is the result of judgment. Okay. And you're saying later that after I get CFAST I know that it over predicts by six percent.

MR. GALLUCCI: Correct.

MEMBER APOSTOLAKIS: The input can be wrong by more than six percent.

MR. GALLUCCI: Correct.

MEMBER APOSTOLAKIS: So where does that leave me? Because I can select the best estimate input. That's 25 percent --

CHAIRMAN WALLIS: Well, George, what I'm concluding from all of this is that the report has changed significantly. It has got all of this emphasis on uncertainties that some members have a lot of difficulty understanding how the uncertainties were evaluated.

MEMBER APOSTOLAKIS: Right.

CHAIRMAN WALLIS: We really need to go back and look at that in a subcommittee.

MEMBER APOSTOLAKIS: I agree. I mean, we

cannot write a letter with such a major change or we can write a letter on what we have, and then we review the revised report later. But the other --

CHAIRMAN WALLIS: Well, we can't go into a long discussion of uncertainties now --

MEMBER APOSTOLAKIS: No.

CHAIRMAN WALLIS: -- as a full committee.

MEMBER APOSTOLAKIS: And the other thing is though that if we are to have a subcommittee, I don't know if it's appropriate to discuss this now, but if we are going to have a subcommittee meeting, this is a subject that was evident from today's deliberations that is of great interest to everybody, almost everybody who sits on this committee.

So maybe it will be a subcommittee with the whole ACRS.

MR. SALLEY: I'm sorry. I disagree with you, but --

MEMBER APOSTOLAKIS: Otherwise we're going to have a problem again.

MR. SALLEy; I disagree a little bit. You know, we're talking about this heat input, for example. Okay? What heat release rate are you going to use? That's something the fire modeler is going to pick. Most fire modelers are going to pick a conservative value. So he's going to start out with a conservative value.

The goal of this project was to look at the inaccuracies or to answer the question how accurate are the fire models. I believe this project has done that. We can tell you today something we couldn't tell you a year ago, that looking at these fires for this particular example, that we're over predicting by approximately six percent. We couldn't tell you that a year ago.

We can also tell you that what the bands of that confidence are, and that was the goal of this project.

Now, going past this deterministic fire modeling into the PRA applications, again, I argue that that goes further down the road in the application guide.

MEMBER APOSTOLAKIS: It's not just PRA. It's not just PRA. Even in the deterministic world you want to know whether you're over predicting or under predicting. Okay?

First of all, there isn't --

MEMBER SIEBER: In the deterministic world if you have a fire in the room, everything in the room is no longer --

CHAIRMAN WALLIS: George, I'm going to bang this gavel in five minutes and we're going to stop this.

MEMBER APOSTOLAKIS: Well, first of all I'd like to make a comment.

Mark, we are not saying this is not a good piece of work. It's a very good piece of work. It's just that you are presenting to us something that we need to digest, and we cannot do this in the 15, 20 minutes.

MR. SALLEY: This is our attempt from the subcommittee, George, to do a more rigorous job for you.

MEMBER APOSTOLAKIS: And I absolutely appreciate that, that you guys were so responsive, but you have to appreciate also that the committee has a problem now. I mean, can we write the letter based on something that have seen only for ten, 15 minutes and it's a significant change from the report we have or what do we do? Maybe we can --

CHAIRMAN WALLIS: Can we finish this presentation? Can we just go to the last slide and at least get that over with?

MR. GALLUCCI: If we had gone back, previously I showed the --

CHAIRMAN WALLIS: It's going to be one or two minutes. That's it.

MR. GALLUCCI: The first slide showed four different fires. Here's a different one here. This was from Plant C, which was the make-up pump room. All I'm doing here is doing the same thing I did for the other fire. He's the CFAST prediction in red, the adjustment in blue, the 95 percent or 90 percent two-sided confidence limits.

And then what I go on to show here on the last one is here's a case where a regulatory decision would be fairly straightforward with all of the caveats about input uncertainty, et cetera, but here in this room if my damage threshold was, again, the thermal set cable at 625 with the uncertainty bounds, here I can show that even after 60 minutes my upper bound for my CFAST run is still below that.

So in this case I would be fairly confident that CFAST is going to be a result that would say I'm not going to receive cable damage.

That concludes what I have.

MEMBER APOSTOLAKIS: Ray, earlier we had a discussion where the staff expressed its views on standards and so on. I want you to understand that my position at least right now is that I have no position. I'm not saying what you're saying is wrong. I just want to understand it.

CHAIRMAN WALLIS: Who's going to conclude the presentation? Here we go.

Take a minute.

MR. SALLEY: Okay. To wrap this up, Mark Salley, again, from the Office of Research.

To wrap this up in one minute or less, our key bullets on this presentation. Again, state of the art fire modeling, how accurate are the models?

I just talked a few minutes ago that I think we have insights today that we didn't have a year ago as to how the models work and to the accuracy. That's what we set out to do.

We feel that we have enough here for the licensees to want to start moving forward on the 805 applications, that this is a good starting point.

We believe that this strengthens the use of fire modeling. Having gone through this exercise, we feel we have a better understanding of fire modeling and what its limitations are. We're not going to solve all of the world's fire modeling problems. If you came expecting for me to tell you that, I'm not going to.

Things like the application, we've done

our best work with the Q-stars and D-stars to get the broadest range of applications. I think when you look at most compartments and most fires that will be modeled, they will fall within there. We will not get everything. That's where we need to go.

This is the next element. I believe that for my work I need to get this element in place so that I can progress on to that user's guide, and I'm trying to build everything in a logical stepped out approach.

And we would like endorsement and would like to move forward with this document and get on with our next project.

I fully expect in five years' time, after we've worked with NIST, we've done some more experiments, and we've gotten better, I fully expect to come back to this document and revise it. I fully expect NIST to make the models better and we use this as a baseline to rerun them and make them more accurate, and this is a work in progress, if you will, but I need to get this cornerstone in to move to the next piece, and with that --

VICE CHAIRMAN SHACK: What does that have to do with this work that you've just done, that you've just presented today? Is that going to go into the document or that's just an illustration of where you might go next?

MR. SALLEY: What we propose for the closure is we had some qualitative ideas with the colors, and we saw where that gave people heartburn. We said yes. After being so scientific and so rigorous, to come with the colors I see George's point. We will remove that and replace it with the graphs that Kevin showed at the end, and that would be our conclusion and we're on to the next piece.

CHAIRMAN WALLIS: So it will be a different document than what we looked at before.

MR. ARMIJO: But it's a trivial change.

MR. SALLEY: I agree. That's my point.

MR. ARMIJO: It's a trivial change.

MR. SALLEY: It's trivial.

MEMBER APOSTOLAKIS: No.

MR. SALLEY: The same information packaged differently. I've brought no new information to the table, none.

CHAIRMAN WALLIS: So we have really finished, George?

MEMBER APOSTOLAKIS: Yeah. I want to --

MEMBER POWERS: I have a question to ask Mark.

Mark, at the beginning, in your opening statement you indicated this effort was a first step, and it's a very welcome first step. I understand where you're going there. But I see the needs as bigger. I know that you do, too, and I don't know whether this is the appropriate form or not. If not, I will keep my question to you.

But it seems to me that what you're doing here is you're characterizing the heat source produced by a fire, and we have much better models for doing that. You're tapping into the sources of perfectly adequate models for doing this.

Now I ask what about the response. The problem I have with fire is not that it -- it can cause structures, systems and components to fail, to be sure. We know it does that. More troubling to me is that it causes these systems to work badly, and so the response to a fire becomes of interest to me.

My second issue that I have is, yes, you address smoke, but you're looking at smoke in a very localized area, and my problems with smoke are always in a dispersed area, and particularly when we get to cable fires, I see these incredibly corrosive materials, and so I ask: where does the smoke go? And what does it do when it gets there?

Now, these are all steps beyond what you've done here, and I understand that, but does your larger program maybe not explicitly but mentally or conceptually take these next steps because I think we have not had good models on the responses of equipment to fires.

And I think that we don't have good models on how the smoke transports beyond the local region of the fire the greater distance in the plant, and we don't have good models that tell us what does the smoke do when it gets to these remote locations.

MR. SALLEY: Dana, those are excellent questions. Let me try the first one. I understand the wrestling with the heat release rate and how accurate is it, and we go through the curves, and I think Ray did an excellent example of how NRR could use this to improve their process.

Getting to Dana's specific question, if anybody remembers back to the RIC this past year, we had a poster up on the fire research. You'll notice there was a big program. It didn't come up today and it's a program of its whole own life called CAROLFIRE, and that's where we're going to look at a cable, and what is the response of that cable to the fire, which gives us the hot short, which loses the system, which gives us the problems that Dana alluded to.

That is a whole separate program on that target that we're trying to develop. The uncertainty in there is huge. If you go back and look at the SDP today or you go back to read NUREG 1805 that Naeem and I put out, there's a whole appendix in there, Appendix A, which is a different response of a thermal plastic versus thermal set, whether it's a cross-linked polyethylene versus a PE PVC. You can't treat all of the cables equal. Whether it's an instrument cable versus a control cable, huge uncertainties, and we did our best to do that. We have separate research.

So where is this uncertainty, George, is, I guess, where I want to get a little frustrated and argue with you. I think this part we've done a pretty good job. Let me go chase those cables and those targets because there is a lot of unknown there.

Second part, smoke. I think if we learned one thing today, it is look at the smoke predictions. The inaccuracy is huge. If somebody brought me a smoke calc and was trying to factor it out to do the kind of stuff, we are not there, and that's an area that we need to go.

And this document identifies that, and it points us to that in the future, and that's what we need to be talking about five years from now.

MEMBER APOSTOLAKIS: One closing comment.

(Laughter.)

MR. SALLEY: You're not going to get the last word, are you, George?

MEMBER APOSTOLAKIS: I think it's important to state on the record at least my view that the staff, the team ought to be commended for doing this work. It's the first time that anybody tried to do a rigorous comparison of predictions of models, commonly used models with experiments.

The questions you are getting, Mark and the team, do not question the validity of what you have done. It's just that some things, you know, we feel could be done better and so on, and some things we need to digest because they are too recent.

So I hope that this misunderstanding does not exist. I believe this is a very good effort and it will lead really to a step change in the quality of the fire --

CHAIRMAN WALLIS: That's good note to finish on, George. Are we now finished?

PARTICIPANT: A very good last word.

CHAIRMAN WALLIS: Very good last word? We're really finished?

Okay. We'll take a break until 1:30, 1:30.

(Whereupon, at 12:37 p.m., the meeting was adjourned.)