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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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614TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY

MAY 8, 2014

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., John W. Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

DENNIS C. BLEY, Member-at-Large

SANJOY BANERJEE, Member

CHARLES H. BROWN, JR. Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

JOY REMPE, Member

PETER RICCARDELLA, Member

MICHAEL T. RYAN, Member
STEPHEN P. SCHULTZ, Member
GORDON R. SKILLMAN, Member

DESIGNATED FEDERAL OFFICIAL:
JOHN LAI

ALSO PRESENT:
SHERRY BERNHOFT, EPRI
JAMES CHANG, NRC
PROSANTA CHOWDHURY, NRC
JOHN CUSHING, NRC
MIKE GALLAGHER, Exelon
MIRELA GAVRILAS, NRC
JOSEPH GIITTER, NRC
JOHN LUBINSKI, NRC
QUYNH NGUYEN, NRC
SEAN PETERS, NRC
BO PHAM, NRC
JASON REMER, NEI
KEVIN ROACH, NRC
JOHN SEGALA, NRC
JING XING, NRC

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

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

(8:32 a.m.)

CHAIR STETKAR: The meeting will now come to order. This is the first day of the 614th meeting of the Advisory Committee on Reactor Safeguards.

During this meeting the committee will consider the following, human reliability analysis method development process; overview of early site permit process; meeting with Commissioner Magwood; SECY-14-0016, ongoing staff activities to assess regulatory considerations for power reactor subsequent license renewal and preparation of ACRS reports.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. John Lai is the designated federal official for the initial portion of the meeting. We received no written comments or requests to make oral statements from members of the public regarding today's sessions.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed in a listen-in mode during the presentations and committee discussions. We would appreciate it if anyone in the room would silence their cell phones.

A transcript of the proceedings 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.

As an item of interest for this meeting we would like to announce and congratulate Dr. Sanjoy Banerjee for his appointment to his third term on the committee. Congratulations Sanjoy. It's great to have you.

(Applause)

CHAIR STETKAR: With that, we will proceed to the first topic on our agenda which is the overview of the current status of the HRA methods, and I will be leading that session.

As an introduction to this, this is the first time in many years that the full committee has been briefed on this topic. To refresh the committee's memory, our involvement actually derives from a staff requirements memorandum to us in October of 2006 recommending that we work with the staff and external stakeholders to evaluate different human reliability models in an effort to propose either a single model for the agency to use or a guidance on which models should be used in specific circumstances.

So for the committee's benefit we are directly involved in this project. We have had several meetings with the staff at the subcommittee level over the last four years. I'm counting one, two, three, four, five, six, at least seven meetings. We've been trying to meet approximately twice a year to keep track of their progress, and the staff has finally reached a point, I believe, where they have some work products that are useful to brief the committee and get our feedback.

With that, Sean do you want to --

MR. PETERS: Yes, I'll say a few words. I'd like to thank the committee for the opportunity to present the results of this multi-year effort that our staff has collaborated directly with the ACRS and with industry in development of a method for the agency to use.

We believe we've done very high quality work, especially in these first couple of products that we're going to present today, developing a sound scientific basis for HRA and a Level 1 at-power methodology that we worked with industry to develop.

And then Jing's going to tell us a little bit about the method of the process development, some of the details of these two reports that we presented to the ACRS and where our project is heading.

So when the Commission first gave us this assignment I'm not certain that they were adamant about us going to a brand-new method, but this is the decision that we had made together in our management team and research that a new method could encapsulate the best pieces of all the other existing methods that were out there.

And during this process we found that when the Commission wrote the letter to the ACRS they were very concerned about a lot of methods for Level 1 at-power events. Well, since 2006 the agency has become a lot more concerned about areas outside of the Level 1 method.

So at the end of Jing's presentation she'll mention a little bit about the continuing work we're doing where we're trying to develop a method for all modes of operation and for other domains, even not nuclear power.

So this methodology has to be flexible, not just for Level 1 at-power events but for areas outside of the control room for events such as spent fuel storage and transportation, for items such as medical use.

So when you're looking at the scientific basis that Jing, Dr. Xing has developed, you're going to be looking at feasible constructs of that methodology into areas that are not normal for our agency to have been modeling in HRA.

So with that I'd like to pass it to Dr. Xing for her presentation.

CHAIR STETKAR: Before we start, we have a couple, I believe, administrative items we have to get out of the way. Dennis?

MEMBER BLEY: Yes, I have been involved in some of this work, so in those areas I cannot participate in our deliberation.

MEMBER REMPE: And although I haven't been involved in any area of this work, I do have an organizational conflict of interest so I also need to recuse myself from the deliberations on this topic.

CHAIR STETKAR: Thank you. And now Jing, thanks.

MS. XING: Okay. Good morning ladies and gentlemen and thanks for being here with this project. And thanks for Chairman and Sean's introduction so I don't have to go through this slide again.

So for today I'd like to give you an overview of what we have been through over the last six years in responding to this SRM. So I'll first give a quick overview of the HRA method development and then specifically introduce two products.

The first one is a cognitive basis report with development for human error analysis, and the second one is the IDHEAS methods which is represent for an Integrated Decision-tree Human Event Analysis System for internal, at-power event. And at the end I would like to work with the committee and look at our path forward, what we do next.

Can everybody hear me? I don't have a very strong voice, so if at some point my voice too low please remind me.

Just a quick viewchart for what is an HRA, HRA is a part of our PRA process. And just to look at an example, say, if you have an initial event and loss of feedwater and the human action need to do there is to initiate a feed and bleed to avoid core damage.

And to begin with, the human event is a human can fail at this scenario by failure to establish a feed and bleed within the required time of the reactor trip. So within this process HRA is dealing with the question, can human perform the required activities? And even besides, what is the probability of operators failing these activities? Over the last couple years I've been frequently asked the final question, do we have experienced operators? And with all the good effort like they have, they've been trained on the procedures again and again. We have a good interface design, developed various work processes so operators are ready to go.

So what can you model in there? What error are you modeling? Well, that's the ideal world. We wish all those good things would take care of human error. In the reality, the tasks always come in the complicated scenarios which you may not expect them.

For example, we expect there's a loss of feedwater, but in the real scenario there might be multiple loss of feedwater, and the critical cues for loss of feedwater might by masked by some superficial symptom. Therefore operators may not have sufficient time to diagnose the problem and make the correct action in time.

So therefore there are different scenarios that can bring all kind of unexpected task demanding. This task demanding can exceed human's cognitive capacity limit and attack the human vulnerabilities. And moreover, there are various performance influencing factors such as long working hour, mental fatigue, weak training on the particular scenario. All these can aggravate the task demanding, therefore increase the chance for operators to make error.

So in this sense there's always a chance for making error regardless how great the team is, and that's what the HRA is modeling. So the HRA's process is to try to understand what's going on in the scenario, what's the human activity there and to quantify the probability of error.

And over the last 30 years of practice of HRA, the agency has developed a good process for doing HRA and that good process has been documented in the PRA standard. Basically, HRA requires both qualitative analysis and the quantification.

So qualitative analysis would include starting from understanding the PRA scenario and then identifying the human failure event in the scenario to analyze the human task and assess the feasibility of the event.

With that information the HRA method would take you to the quantification where we identify crew's failure mode, classify what kind of errors they make, and analyze the performance influencing factors and then estimate human error probability.

At the end we take everything, look together and perform an integrative analysis. So this has been the HRA process the agency has been using.

MEMBER SKILLMAN: May I ask a question

please?

MS. XING: Yes.

MEMBER SKILLMAN: If you would back up to Slide 5 please? When you were describing the reality and the cognitive capacity vulnerability, you used a word that is very important to me and that is "masking." And I would be curious how to consider or develop or include masking.

For me, masking is a control room where all of the indicators are ignited at the same time. And the operators may be driven to panic. They may have a general idea of what they need to do, but there is so much information overload they are overwhelmed, which is a very error-likely situation, but it's one that happens in our homes, in our cars, or in a control room.

So when you speak of masking how do you quantify or consider it in your calculation?

MS. XING: Okay, thanks. See you give a very vivid example. Information overloading is certainly one of the top things that attack operator's cognitive capacity limit. They can only attend to a few number of things at a time.

So if you have, for example, the critical numbers would be four items you can handle at a time and to combine these items together to process the information. This number, four, has been discovered by many cognitive experiment you can only combine, at most, four things together.

So in the control room in the case you described of hundreds of alarms go off at the same time and plus other things going off, so if you don't have prioritized those alarms, somehow de-complex them, segregate, you say, okay, even there's so many alarms that they come in one pattern, that would consider as one item of information.

However, if you don't have these strategies or sometime that you are off this strategy, you may, say, the majority of alarm comes in one pattern, but there were two alarms that also represent important information and you were not paying attention to those two pieces, alarms. That would be a case of masking. So major information, that major pattern trend masked what's the other two.

MEMBER BLEY: Jing, could I make an addition to that just to -- in the Halden experiments that were done they were asked to develop scenarios that included masking. Your example, Dick, was a good one, but that was a very severe one.

The exercises they put people through

included some scenarios whereby masking they meant more than one thing was happening, and one of them was kind of prominent in front you and because of that you didn't see the indications of the second one.

And they had some cases that were pretty tricky in that regard and caused, you're right, it causes a lot of difficulty for people. Because one of the things you expect people to do they might not do because they're engaged in a second thing. And I'd point you to the reports on those experiments to see some of those examples. They're pretty good ones.

MEMBER SKILLMAN: Good. Thank you. Thank you.

CHAIR STETKAR: I'm going to put you on the spot, Jing, because you didn't really answer this question. You gave examples. He was asking how the methodology handles that.

MS. XING: I think over the next hours we will say how the methodology is handled.

CHAIR STETKAR: Okay, thank you. Be aware of the time. We want to make sure we address that issue.

MS. XING: Okay. So we were on the HRA process. And the good news is we have many method to carry out this process. So these acronyms, you may familiar or not familiar. Each acronym represent one HRA method that's been developed or the agency been using over the years.

And the majority of these methods were developed to handle the internal at-power events. So, and the not-so-good news is this method is each develop their own scope and the purposes. So some methods, for example, have a very good guidance on qualitative analysis, but not so much on how to do the quantification.

And other methods such as SPAR-H is the opposite. And also there's a majority of method that due to various historic reasons, I think, used scientific basis and data but in a limited way. In other word, so we have more data and the scientific knowledge to be used for this method.

And because of the various limitations of the method, one big problem by using this method is the variability. The variability come from two ways. One is the method to measure the variability, so same analyst if they apply different method to the same event they may come up with very different result.

And in the worst, the method also has the analyst-to-analyst variability. Because the methods, most of the methods largely rely on subjective judgment so the guidance may not be adequate, therefore two analysts using the same method may come up with different result.

MEMBER POWERS: When you say different, do you mean qualitative different or just quantitatively different?

MS. XING: Both.

MEMBER POWERS: Well, one of them looks at an event and says there's no human error possibility here at all, and the other one says it's dominated? I mean, or is it -- I'm trying to understand what you mean by --

MS. XING: It may not be that dramatic, but it come to the level in the qualitative aspect and different teams, different HRA teams come up with different set of information.

So one team performed very detailed, a thorough test analysis and show that here are the five key tasks the human would do, and they can perform three of them and the other two will have a high difficulty. And another team that may not perform a thorough qualitative analysis, they would end up at a very high level. This is a feed and bleed event and there's some problems, some factors that would impact the success of this.

MEMBER POWERS: It sounds like you're saying that if I do a bad analysis it's not as good as a good analysis.

MS. XING: Yes, it's the level for detailed analysis and the completeness of the information.

MEMBER POWERS: That isn't a difference, I mean that's a variability. One does an incomplete, undetailed analysis, and when you compare it to somebody that does a complete, very detailed analysis you find that things are left out. It's not variability.

MS. XING: Well, because of that different level of detail and the completeness of the information expected, when you go to carry the information to quantification, to quantify the probability, you would lead to different quantification itself.

James, you have a question?

MR. CHANG: Yes, this is James Chang at Office of Research. The analysts that doing the analysis, predict depends on method. What method best information needed by method based on that information to ask the question.

So different method asks a different question. That gets into that performing the site analysis feedback used by different method that asking different question get at different information that qualitative -- getting the different qualitative information and then that feed into the different quantitative result. This, I think, that Jing talked about is probabilities.

MS. XING: Thank you, James.

MEMBER BANERJEE: Let me just ask a question for clarification because I know nothing about this subject at all. So there are certain actions being performed by humans, and there is a certain likelihood that they get it right or wrong, right? This action. And you associate some probability distribution with this?

MS. XING: Yes.

MEMBER BANERJEE: And that probability distribution is based on empirical evidence of people carrying out this task? Or how do you establish that, the probability distribution of getting it right? Just give us a little basic stuff on this so we can understand.

MS. XING: Okay, basically that's where the variability comes, because different methods have the different HRA method, give you a different way to do that. For example, the ATHEANA method which primarily rely on expert judgment, so you --

MEMBER BANERJEE: So it's not empirical?

MS. XING: Yes. No.

MEMBER BANERJEE: It's based on what people think? Okay.

MS. XING: Basically what you think, okay, how likely this will happen. So you come up in the probability distribution purely based on expert judgment.

On the other hand, some other method like the CBDT, the method is based on some empirical data drawn from operators and other domain, and based on both numerical data, the method itself give you a probability for this particular failure mode and this situation.

CHAIR STETKAR: Jing, let me ask you. Where did the empirical data for CBDT come from?

MS. XING: CBDT come from two parts. And one, so early part was from THERP.

MEMBER CORRADINI: From where?

CHAIR STETKAR: That's not empirical data. Alan Swain and Hank Guttmann made up those numbers and so that's not empirical data. There is no empirical data for --

MEMBER CORRADINI: But before you

challenge it, I didn't understand where it came from.

CHAIR STETKAR: THERP, Technique for Human Error Probability.

MS. XING: It's the very first method which --

MEMBER POWERS: It's as old as I am.

MEMBER BLEY: It was invented to help WASH-1400 and then extended a little bit.

MEMBER POWERS: It was invented to help us keep the stockpile from going boom on us.

CHAIR STETKAR: But those estimates really -- of the authors of that report. I mean they looked at experience but they're not empirically --

MEMBER CORRADINI: But they were judgment. So where's the other part of CBDT?

MS. XING: The other part of CBDT is often used together with the OCR method which is a handy reliability curve. That came from based on a bunch of data collected, I believe, from several countries. James probably know better on the source of that reliability data.

MR. CHANG: James Chang again. Actually that's, Jing mentioned about CBDT and the other method that you see ORE. These are two different methods, actually ORE was based on the, the data was based on a series of the experiments EPRI did in the '70s and early '80s. That's called an ORE, Operator Experience, I forgot what it was.

But the CBDT, the empirical data, I actually don't know where that data, empirical data is from.

CHAIR STETKAR: I believe it was largely expert judgment of the EPRI authors. Just for Sanjoy's benefit there's very little empirical data, in this sense of empirical data.

MEMBER BLEY: That's relevant to the cases people are trying to analyze.

CHAIR STETKAR: There's empirical data for very high failure rate activities, slips and things like that that can be derived from simulator. But they tend to be rather benign type things and things that you can count relatively easily. There's not empirical data available to support --

MEMBER BANERJEE: So when you've been trained on simulators and things observations are made. Is that from part of the database of what happens?

MR. PETERS: That is not part of the database at the moment, the training. However, we have an entire data program that we're working that Dr. Chang here is responsible for for our agency.

And we are teaming up with a nuclear power plant, the South Texas Project Nuclear Operating Company, and we are collecting active training data at this moment and we're trying to incorporate that back into our integrated method. So we are trying to get this empirical data to support these judgments.

CHAIR STETKAR: But that doesn't mean that simulator evidence has been ignored. Because if an expert makes an estimate of a human error probability, the expert has at their hands that information. So it's an informed expert opinion, but it's still an expert opinion.

MR. PETERS: And what we found in those benchmarking experiments, per se, were that the people that had extensive training experience had seen numerous runs of data, and they actually were better at encapsulating the probabilities of what we found in the actual experiments because they kind of knew that failure rate in the back of their mind. Yes, I've seen this failure, oh, maybe one out of 100 times or one out of 1,000 times.

CHAIR STETKAR: But the problem is in terms of empiricism that you have some evidence to support error rates, as Sean said, on the order of kind of one in 100 to maybe one in 1,000. You don't have empirical data to support error rates on the order of once in 10,000 or once in 100,000 that are trying to be predicted by some of these methods.

MEMBER POWERS: That does not make you unique.

CHAIR STETKAR: No, no, no.

MEMBER POWERS: We had exactly the same problem in the seismic field.

CHAIR STETKAR: Sure. And Jing will, if she ever gets to Slide 8, eventually, how this methodology is trying to overcome that limitation.

MEMBER BANERJEE: If this stuff is common knowledge you don't have to educate me. Just move on.

MS. XING: No, that's a very important, many people are asking me the same question. How did you get a number?

Okay, so we talked, because of our variabilities and it was really designed in an enhanced method to reduce the variability. And on the other hand, even we have that many method, the existing methods do not adequately cover in a broad set of application such as in the lower-power shutdown case and the severe accident in the Level 2 and Level 3 PRA. It's an external event, and beyond that is the fuel material and the byproduct handling.

So the last thing we wanted is one method for each of these applications. We can't like every time we have a new application develop a new method. So the agency really desired to have a generic methodology that can support the diversity of these applications.

So talk about agency's need, here's our project goal and the key objectives. The goal is to develop a generic HRA methodology to reduce variability and to support a diversity of applications.

And we don't plan to develop something ideal, solve all the problems, so here are our key objectives. We want the new methodology would conform to the PRA standard and the HRA good practices.

MEMBER BLEY: But for everybody's information, the second is a document published as a NUREG.

MS. XING: Thanks, Dennis.

And we also want to retain and integrate the strengths of the existing methods. We don't want to throw away all the good that it would be doing, and also by doing so it will make it easy. Make the most evolution to the transition to the application of the new method.

And the method should have the enhanced

capabilities to address the key limitations in the state-of-practices. And the desired method have a state-of-art technical basis and be generically enough to support different applications.

MEMBER SCHULTZ: Jing, is there reasonable confidence that we understand that in the practice what the key limitations are?

MS. XING: Yes.

MEMBER SCHULTZ: Is that a list that's been developed and bought into?

MS. XING: Yes, I will talk next of our primarily, several key limitation. One is the lack of strong technical basis. So a lot of time we will say, okay, for example, the method will tell you. Well, fatigue will affect your performance, but how? In what way? That's largely depend on analyst interpretation, therefore that's where the variability was produced.

MR. PETERS: And we performed several projects including international benchmarking project and U.S. benchmarking projects where we analyzed the HRA methodologies with respect to simulated events in a simulator.

And what we found is we've documented those in about five reports, what conditions and capabilities of the various methods were. And we also are participating actively with the OECD's NEA putting forth a new report on methodology capabilities for all these various HRA methods.

So we do have a lot of documented evidence on where they're strong and where they're weak. And that was basically the first part of our project. If people asked the question why are we here eight years after the SRM, the first few years were spent doing those benchmarking exercises trying to figure out the strengths and weaknesses of these various methods.

MEMBER SCHULTZ: Thank you, Sean.

MS. XING: And I have a slide that talks about the details of the key limitations.

MEMBER BANERJEE: You're going to tell us where the weaknesses are, right? Later? Will you tell us where the weaknesses are?

MS. XING: Okay, one weakness as we just said is the lack of --

MEMBER BANERJEE: Oh, do you have a slide which goes through this?

MS. XING: Yes.

MEMBER BANERJEE: All right, so you don't have to do it now.

MS. XING: Oh, actually since you asked, why don't we go there now?

MEMBER BANERJEE: If you wish.

MS. XING: Okay. Because we may not have time to go through that slide.

CHAIR STETKAR: Marshal your time. We have an hour and five minutes.

MS. XING: Okay, so this is some key lessons learned from the benchmarking study of existing method. First of all, we recognize each method has its own strengths. And there are several key limitations from Number 2 to Number 5.

Most method need a strong guidance for performing qualitative analysis or a better interface on how to use the qualitative analysis result for your quantification. And the second, Item 3 is what we just talked. It need a comprehensive and explicit cognitive basis to support why and how a human may fail to perform a required task. And also --

MEMBER BROWN: When you're looking at, when you can do it, do you look at the complexity of the procedure or the thing that he has to do, in other words, the number of components that has to be actuated or the number of steps he has to walk through?

So you do throw that into the mix? It's in some procedures? Take two or three items, you know, you flip a switch, you turn another switch and you're done and everything's good, but others may take six or seven actuations to actually, so you factor that in to this ability to accomplish the reliability part?

And I'm not talking about just the time to do it, but the reasonableness of him actually being able to accomplish it and not lose track of what he's done.

MS. XING: That is factored in the model. In the model, we model that as a task complexity.

MEMBER BROWN: Okay.

MS. XING: So the task complexity including the number of steps, but beyond that the interaction between these number of steps and the things like that.

MEMBER BROWN: Okay. Thank you.

MEMBER BANERJEE: I guess I'm having a problem which I think John in some way alluded to. If there is very little data on very rare type events, how do you establish a probability to address that?

CHAIR STETKAR: Sanjoy, let her get through the presentation. If she ever gets to the end you'll understand how the methodology is going to do that.

MEMBER BANERJEE: Okay.

CHAIR STETKAR: If you keep interrupting in the beginning we'll never get there.

MEMBER BANERJEE: Well, I told her if you're going to address it just say I'm going to do it later.

MEMBER CORRADINI: You can put us off. Don't be polite.

MEMBER BANERJEE: You can just say --

CHAIR STETKAR: Let's get back to Slide 9, please.

MS. XING: Okay, let me finish this slide. And also we talked that the quantification is largely dependent on the performance influencing factors, and the one weakness in the current method is it really need a better guidance on how to objectively assess this and use this performance influencing factors. These are some key weakness in the current method and that's what we try to address in our project. This is human factor errors.

MEMBER BANERJEE: Wow, a lot of slides.

CHAIR STETKAR: That's what I was saying. There's a lot of material to get through here.

MS. XING: But that's a good way to go to the end.

CHAIR STETKAR: Actually need to set the context for the members who haven't really followed this closely.

MS. XING: So to achieve the objectives, here's our strategy framework. Recognizing the importance of a good cognitive basis, we first, our team went through the scientific literature and collect a large amount of information, synthesize them together to establish a cognitive basis for human error analysis.

And based on that we developed a generic methodology for the diversity of HRA applications, and this is intended to address all the HRA approach in the NPP circumstances. From this generic methodology, we can explain of extract explicit method for a specific application, because if you are too generic, needless to say you will be less in specifics.

And the first product we got from is the IDHEAS method that it's specific for internal at-power events. And down the road we will develop the other specific HRA models for other ongoing application.

So where we are in the project. So here are the three product we get from the projects. A cognitive basis framework, the IDHEAS method for internal, at-power events, and generic methodology.

And the cognitive basis report is intended to provide as a basis documentation for HRA and human factors engineer. At present the document is completed, has been through external review, and is being used for HRA development and our human factors practices.

So IDHEAS method for internal, at-power events is intended use only for base purpose in our PRA models, SDP, and ASP programs. So development of the method is completed. The report has been externally reviewed, and we have conducted initial testing of the method which I will briefly show you the test results.

So the generic methodology is still in developing, so for today I will focus the briefing on the first two products.

MEMBER CORRADINI: What did you say about the last one? I'm sorry. Just repeat.

MS. XING: The last one we are still in the developing process.

MEMBER CORRADINI: Okay. And as you develop it you're going to use it in the Level 3 analysis?

MS. XING: We'll use in Level 3 as to pilot it.

MEMBER CORRADINI: Okay, thank you.

MS. XING: Okay, so next we can look at the cognitive basis. So back to our example, feed and bleed, we see a lot of human activities there, but when you break down these human activity from a human standard or perspective you see the human activities include in typical human activities with like detecting and the response to alarms, checks of plant parameters, assess the plant status, diagnoses and loss of feedwater, and decide to initiate feed and bleed, then execute the procedures.

So based on each of these tasks are supported by different underlying cognitive functions. Typically we talk about cognitive major functions are the detection of information, understanding what you detected, making decision and execute actions.

So this is the framework that essentially all the HRA methods in place they used. So the most existing HRA method to recognize, you have human perform their tasks through these cognitive functions.

And there are performance influencing factors such as task complexity, time, fatigue, quality of training would affect, impact these function, therefore they will impact your task performance.

And however because -- I put a gray box there which means that information about exactly why these factors would affect this human function and how. That part of information has been implicitly in the use in the current method.

For example, we know fatigue affects your action execution. But it affects action execution the same way for two-step task versus a seven-step task, and the methods often do not give you explicit information on that. It's relying on analysts' judgment. So that would introduce a variability.

MEMBER BANERJEE: So excuse me. Going back to, the performance influencing factors would be things like the amount of training they've had, the stress. Are these all the things that come into it?

MS. XING: Yes, the typical, there are many, many influencing factors, take the classification, like the time available, task complexity, training quality, procedure quality, and the work process and the fatigue.

CHAIR STETKAR: Jing, just go through your slides. You'll eventually get to this list of things.

MS. XING: Yes.

MEMBER BANERJEE: You're going to deal with that? All right.

MS. XING: Yes. So our effort here is try to make the gray box transparent. Look at these details of the information, influencing factor like we just talked. What mechanism make them affect these functions and how these functions would affect the explicit type of human tasks.

So for that purpose we conducted an extensive literature review of the cognitive psychology of human factors and operation experience information. Try to identify the cognitive mechanisms and align those failures.

And also identify the factors that influence human performance and identify the way in which those factors affect failures. And we take all this information together, develop a structured cognitive framework to serve as a foundation for human error analysis.

The good thing about providing an enhanced cognitive basis, because it would enhance the HRA validity by providing a stronger scientific basis and it would also help improve HRA transparency. So you would enhance analysts' judgment justifications when they apply the method.

And importantly, it would allow us to expand the use of data in HRA. As we talked, the failure data are rare, and from a different circumstance it's very difficult to generalize them and to use.

So with the cognitive basis by looking at the underlying what exactly went wrong we can generalize data from different field to quantify human error probability. And a side benefit, it also enhance our human factors engineering work which is already being --

MEMBER POWERS: I have no doubt that these statements are absolutely true. They're very much not obvious to me. Will you provide an example?

MS. XING: Thank you. So let's take a quick look at how the cognitive basis framework look like. So the cognitive basis worker collect information in these several layers. First we look into the models of how the cognitive functions works. If we understand failure we want to understand how it works first.

And from there we look for various error causes for failures of the cognitive functions. For example, if your failure of the detection, to make primary error causes would be you didn't attend to the key information or the information was misperceived.

And then we're looking to the cognitive mechanisms underlying the error cause. For example, why you would not attend to key information, maybe because your lack of attention or you could overload of your working memory like example we talked earlier.

And then we look at the factors affecting these mechanism and lead to error, say, for example, one mechanism is a lack of attention. And lack of attention because you're fatigued or you're doing a multi-tasking. So therefore when you're multi-tasking you mask the key information so you didn't attend to your key information.

So this is how the cognitive basis look for. This will give you an example of how we structure the information regarding. So starting on the top layer is a failure of a cognitive function. For example, this failure of the detection. And we classify the failure causes into several major categories which we call the proximate causes.

MEMBER BROWN: Did you get these proximate causes from your literature reviews?

MS. XING: Yes.

MEMBER BROWN: There's a statement in your document that says --

MS. XING: Yes, the literature review gives a whole long list of detailed causes. Those are the hard science based on experiment. And the proximate cause is an arbitrary classification developed by our team. So the standard for presenting 30 or 40 different causes, we classify them into these primary causes.

So therefore each primary cause would correspond a bunch of cognitive mechanism that lead to the cause, and then there are performance influencing factors that would trigger these error causing mechanisms.

So let's look at this example. One primary cause for failure of detection is the key information not attended to. The mechanisms are lack of attention or low vigilance which can be caused by the performance influencing factors such as distraction due to the task complexity and alarm salience, you may not have prioritized the alarms really well, and/or mental fatigue.

So the entire report consisted of different chapters for each function, and we had the primary causes, the mechanisms, and the corresponding performance influencing factors. So question to the chairman. Do we like spend some time, take a detailed look or do we think that this is good enough?

CHAIR STETKAR: I think, Jing, you need to cover at least all of the topics. So you need to make sure that you have enough time to get through the basic elements of the IDHEAS methodology also. So organize yourself. You're about halfway through your time and you're about a third of the way through your slides.

MS. XING: Okay, so I think I'll --

MEMBER CORRADINI: I don't think he's going to tell you what to do.

CHAIR STETKAR: No, I'm not going to try to lead specifically, but just make sure that we do need to get through the basic elements of the IDHEAS methodology also, in the remaining --

MS. XING: So I'm using this example to show how this cognitive basis look like. Is there any question on this? All this information are documented in the 300-page report, and the drafted report is in NUREG-2114.

And since we developed the report it has been through many round of internal review and we also had conducted an external review last year by four reviewers and provide us the review and the written comments. So we have two domestic and two international reviewers. All have 20-plus years of experience in cognitive engineering research.

MEMBER BANERJEE: I guess I have the same problem as Dana that without some concrete examples of what you're talking about it's very hard to understand what's going on. Because these are words which we don't know the precise meanings of, you know. So I guess I would appeal at some point to give an example of how this is working.

MEMBER CORRADINI: Before you go to Number -- that. Just stop there wherever you were. 24. So just there. So I guess I'm listening, and what Dana said and what Sanjoy said, I guess I have so little experience I'm looking for that also.

So let me ask about the reviewers. You said all of them had experience in cognitive engineering research applications, all have experience in human performance modeling. Which of these folks had experience in operating reactors or operators such that they could reflect on what they saw empirically compared to what this is?

MS. XING: Among the four reviewers, three reviewers have experience in HRA. And two of the reviewers have been doing HRA for nuclear domain. So they have extensive operator experience, either directly by visiting the site or interacting with the operators.

MEMBER BROWN: But they were not operators themselves.

MEMBER CORRADINI: But they were not operators.

MS. XING: They were not operators, because we use these people mainly to say how extensive we cover the cognitive basis. So we focus on the folks that have the experience in the cognitive engineer research. Next, when we talk the method of how we apply this information to HRA, those we use the people for --

MEMBER CORRADINI: Okay, so we're still -- okay, but you see our bias?

MS. XING: Yes. I see. For this part it's the basic foundation part we use the external review for our more experienced in this --

CHAIR STETKAR: Those external reviewers, however, were all either directly involved in the project or peripherally involved in the project. So they weren't really independent reviewers, were they?

MS. XING: These four reviewers do not involve in the project so they are purely external.

CHAIR STETKAR: Okay.

MEMBER BROWN: You're going backwards in the slides. Is that a reason?

MEMBER CORRADINI: We're okay if you go forward, I think, is what we're trying to say.

MEMBER BROWN: Yes, you can go on to 25.

MS. XING: Okay, just a quick summary of the cognitive basis. So literature review and the resulting cognitive basis provide a foundation for human error analysis, and the limitation for the report is primarily focused on the NPP control room at-power tasks.

So it does not include all of the relevant information for other tasks that are specifically in other applications such as team decision making in the severe accident management. And overall, the basis should be, we try to as much as possible to cover the up-to-date information, but nevertheless as the science is progressing we should have this document dynamically updated to incorporate new information.

The last thing I'd like to mention is this. Our human factors engineer staff had been using this document for their work.

Okay, if no more questions about this section, let's move to the HRA method we develop. There you may see more explicit example how there's an abstract here, more cognitive science is being used for operation.

Okay, just a quick overview of the contributors of our team. This method has been developed by a huge team initially started with almost a 20 staff and eventually condensed it to this set of core staff.

Within this group of staff we have Gareth

Parry and Vinh Dang who are HRA expert and they also have extensive operational experience --

CHAIR STETKAR: They've never operated a nuclear power plant, either one of them. They have no operational experience.

MS. XING: They're not operators but --

CHAIR STETKAR: Thank you. Just for the record.

MS. XING: -- they've been working with operational people in the --

CHAIR STETKAR: They've talked with people who have operated power plants.

MS. XING: Yes.

CHAIR STETKAR: That's important by the way for the committee to understand that.

MEMBER CORRADINI: Who are we talking about? I'm not sure who we're talking about.

CHAIR STETKAR: Gareth and Vinh.

MS. XING: Gareth Parry and Vinh Dang.

MEMBER CORRADINI: Okay, they've never been in a plant. They're just observing the plants.

CHAIR STETKAR: They've been in plants, but they have no direct operational experience.

MEMBER CORRADINI: Okay, thank you.

MS. XING: And John Forester, and also

Mary Presley is a HRA staff from EPRI. And she is the same just like the other two, talked to operating people a lot but not an operator. And John Forester and Stacey who have been doing HRA work doing HRA method development, but their background are cognitive science.

And Erasmia Lois was our previous project manager, and I stepped in as managing person from 2011. And I consider myself as a neuroscientist. That's where my background is. The other part of my background was an electronic engineer. So I try to bring this team together because we need both engineer and the human part to develop this method.

MEMBER BLEY: Jing, can I make a point of clarification?

MS. XING: Yes.

MEMBER BLEY: These are the authors of the work, but all the way through this you had a number of meetings and review sessions with other people and there were at least five, maybe six or seven, but at least five former licensed operators who were members of the staff both here and at the training center. And you didn't mention them I don't think.

MS. XING: Oh, yes. Sorry. Thank you for pointing out. This is the key developers of the report, but in the long process of the project of development at various stages we have recruited people with different background to participate in the work.

Part of them, like Dennis pointed out, we've been using people who either have current operator license or were previously operators, the shift supervisors, trainers from the plant to participate in the different stages of the method development.

So in the past down time, we started the method development by doing the evaluation or assessment of the HRA method to identify the strength and the weakness and come up on a strategy of how to do the work. And we have from FY10 to FY12 that's our major method development period.

And by the end of FY12 we have the primary method developed and then we conducted external review, and we also had a major activity which used, conducted expert elicitation to come up with the probabilities distributions. That's when we used the operators so heavily. And we also conducted initial testing.

MEMBER CORRADINI: Can you just say that again, just so I get it? So the expert elicitation it actually involved reactor operators?

MS. XING: Yes. So I will talk in detail

about the expert elicitation. And in fact they are not, also the primary purpose for expert elicitation is to develop the probability estimation. They first looked and thoroughly reviewed our method and provided lots of input which lead to a lot of modification and revision of our method. So from that perspective I would say operators' experience was very important and an essential part to this method.

MEMBER SCHULTZ: So that then occurred in the interface chronologically between the development as part of the development operators and trainers were engaged --

MS. XING: Yes.

MEMBER SCHULTZ: -- involved, and then they became more involved as you went to expert elicitation and testing. Thank you.

MS. XING: Thank you. Yes.

Okay, so we already talked the key lessons we learned from the existing methods. So the IDHEAS method, it tries to take advantage of the existing, the strengths in existing method and improve these four major limitations.

CHAIR STETKAR: Jing, we've seen this one. In the interest of time go back to 29 because that's important for Dr. Powers and some of the other members who have been looking an example of how this process works.

And you kind of skipped this, and this is setting the stage for a possible example, so it might be worth spending a little bit of time on this slide here.

MS. XING: Okay. Yes, just they're using our feed and bleed example. So for doing the HRA, first we understand the scenario. You have a loss of feedwater and you have to establish a feed and bleed to avoid core damage. And with that understanding we are identifying, so what are the human events in this whole event progress?

So the key human events there is the feed and bleed, so operators, this cannot be automated, so operators have to be the one to establish feed and bleed within 45 minutes after the reactor trip.

So we identify feed and bleed as a human failure event here, so the event would be if you failed to establish it within the time you would fail this entire scenario, would lead to core damage. And within that we know they are going to do the feed and bleed, so next we analyze a test what exactly operators will need to do within the feed and bleed. Later we have a diagram to show this. Because they would first need to trip the reactor, and after the reactor trip they would need to do the diagnosis and recognize that a loss of feedwater, and then they go to the certain procedure to the point of where they decide the feed and bleed need to be established.

Then they need to think about, when should I do the feed and bleed? Should I do it immediately or wait? Maybe I don't have to do it, wait for some other symptom. So that's a key decision making point. And after they make a decision to do the feed and bleed there's a procedure to follow at the feed and bleed stage.

So that's the task analysis process. And before we go to the detail of the quantification you would assess what are the key factors that would impact the success of this event? Can they do it or not? So do they have the right tool? Do they have the procedure? Can they access to the component?

So those are the questions to consider whether human can faithfully perform the action. So ask, well, we have the necessary tool, they can access to it. They have the right staff. They have the right procedure.

In principle this human event is physical. Physical doesn't mean they success, physical success.

Then we go to the quantification to say, okay, look at this human tasks. What are the major failure mode?

Of course different HRA method will give you a different way to classify the failure mode. And then our method is some failure mode would be missing key alarm, and that one possibility here if they're missing some key alarm they couldn't immediately diagnose the loss of feedwater. And they also need to perform, execute the procedure. So some segment of the procedure are complicated, so there's a failure mode that they could fail if there's a complicated actions.

So after you identify the failure mode you also analyze what are the performance influencing factors. Our method of providing you a set of performance influencing factor for each major failure mode, for example, if you're missing a key alarm it's a potential performance factor could be you didn't recognize the urgency of this alarm, so 100 alarm goes off you think this one's not important.

Or the interface is not well designed so you didn't prioritize as important alarms. Or another factor could be the distractions. This is a very complicated scenario. It's not just a loss of feedwater, you may have other maintenance of work that's going on at the time and there may be an inspection going on.

So all this distraction can distract operators and mask the key information so it lead to they didn't notice some key information there. So that's the analysis of performance influencing factor. After that we'll come to an easy time. Our model provide you a decision tree, basically tell you if you didn't perceive the high urgency of this alarm you don't have an optimal interface design and you have lots of distractions.

With all this bad thing going on you have a very high probability to fail this act, versus if all these things occurred you have a lower probability to fail. So we use our expert based on their experience and the data we collected, they estimate the likelihood of the failure probability for this different situations.

And so therefore we got in the probability for this individual task, but there are many tasks in this whole scenario. So at the end we want to locate all these tasks as one thing and to look at the dependency between these tasks and to come up a combined failure probability for this whole event, feed and bleed. That's the plan.

I hope this example get you some --

MEMBER BANERJEE: So you have, presumably this event has occurred a number of times so you have a database.

CHAIR STETKAR: Presumably the event has never happened.

MEMBER BANERJEE: Never happened, the loss of feedwater?

CHAIR STETKAR: We've never done a bleed and feed in any nuclear plant at any time in any place in the world. It has never happened. We've done it as simulators.

MEMBER BANERJEE: Only. Okay.

MEMBER BLEY: Everybody does it every year in the simulator, but that's --

MEMBER BANERJEE: Yes, but there's been never a real incident where this has happened?

MEMBER BROWN: Not in the commercial world.

CHAIR STETKAR: Let's just keep on. Jing's got a lot of slides to get through here.

MEMBER BANERJEE: So there's no real benchmarking against --

CHAIR STETKAR: She's got a lot of slides. She'll eventually get to the point where you're going to see where the numbers come from.

MS. XING: The international benchmarking study, and before that there was another benchmark. So there are a couple benchmark study to benchmark several key events but not all of them.

MEMBER SCHULTZ: Your example's going to expand from here with more detail?

MS. XING: And so we can talk of this feed and bleed that so far only appeared in benchmark in the simulator, but not --

MEMBER BANERJEE: Has never occurred in practice.

MS. XING: Never occurred in practice but we were always prepared for that. Okay. So this diagram give you a transition. Say how we use the cognitive basis in the method.

So the method, the start of it is analyze the PRA scenario and identify human event. And then along with great amount of task, with great amount of task in the cognitive, align the pumps or start a valve, a close valve. We look at the cognitive team activities they do, like monitor the plant, diagnose problems, following procedures.

And first we look at the cognitive functions that support this task, say if you monitor the plant you will need the detection function. So for each function we identified a set of failure mode.

So for the detection function we have the failure mode including key alarm not attended to, or data misleading or not available, critical data misperceived and wrong data source attended to. So I would say the development of this failure mode came from two sources.

First, we use the cognitive basis and look at our list of error causes, see all these error causes can be a failure mode, then we used the operation experience brought by the expert in our team.

A lot of error causes are not that critical or wouldn't happen in the control room for a well trained crew. So we selected this set of failure mode that we think the most representative of what is a current control event would occur.

And that this development of failure mode, we look at what performance influencing factors would affect a particular failure mode. Again the identification of this set of most pertinent performance influencing factor come from two source of information.

First, it come from our cognitive basis where we listed the potential performance influencing factors and also go through the cognitive mechanism we know what performance influencing factor would theoretically affect a key alarm not attended.

And again that gave us a very long list of the potential candidate. And that's when we consult and use the operation, the knowledge, you know, our team, and also consult the operators. So what performance influencing factors which are the most pertinent in term of operation.

And this is good. By using this knowledge we can shrink down a long list of candidate to several key factors. But the downside is, when our team expert doing this and also when we consulted operators, the MELCOR model the people have are the internal at-power events.

Therefore some factors that may be really important for a lower-power shutdown are not, could be deselected in this model. That's why we say this model is specifically developed for internal at-power events.

So if we want to use this model for other purposes, we need to go back and look at, reexamine the failure model, reexamine the performance influencing factor to recover from the situation. Okay, this give you an illustration of the IDHEAS, how the method works. So as we talked earlier, the method that started from qualitative analysis, we provide document guidance for every step of the qualitative analysis by how to analyze a PRA scenario, how to identify human failure events.

And the guidance we took from a fire HRA, how to assess human failure events feasibility. Of that we developed a guidance for test analysis. One key part for the task analysis is a guidance to establish a crew response tree to graphically delineate the tasks that operator needed to do.

MEMBER CORRADINI: Can I ask a question here?

MS. XING: Yes.

MEMBER CORRADINI: So you break down how something can fail in an event tree.

MS. XING: Yes.

MEMBER CORRADINI: How do you know when to stop making the event tree complex? To me this looks complex but maybe it's very simple. So is there a history here or is this more judgment?

MS. XING: Both. Like that's always a key question in any task analysis, when you stop the breaking.

MEMBER CORRADINI: Because as you make each event tree and each branch point you have to come up with a number, and the more detailed it is the less you have a chance of knowing what that number is.

MS. XING: Yes, I think in the document we provided some guidance on how to weight this and when to stop. But still that would need an analyst judgment, exactly details on. The good news is later in our testing we find that it actually appeared easier than we thought based on guidance we provided and analysts that can come up more or less with similar set of tests.

MEMBER CORRADINI: And I know we only have a short amount of time, but I guess when I think of this with a fault tree and event tree with things I can eventually get to a failure rate that I have an empirical number that I can plug in. Here I'm struggling to figure out if I make enough branch points what number do I put in.

MS. XING: Okay, say if you make a three-branch point instead of one and you make that three less number, when ideally if our method work perfectly, by adding this three number together it should be equivalent like you break at a high level.

MEMBER CORRADINI: Yes, that part I get. What I'm asking is, as I subdivide this do I actually have the data or is the expert judgment easier? I can't tell.

MS. XING: Yes, we don't have data but we have guidance.

CHAIR STETKAR: Hold on. You two are not communicating with one another, and Jing it's important to emphasize the fact that the thing in the upper right hand corner of this slide that Dr. Corradini is characterizing as an event tree is not an event tree in the sense that people are used to thinking about. It is not something that is quantified. It is a depiction of the progression of a scenario that is used to identify opportunities for error.

MEMBER CORRADINI: Okay.

CHAIR STETKAR: So it's a crutch for the development of a scenario narrative, if you will. It is not used for quantification. The branch points that you see highlighted as 4, 5, 6, 7, 8, 9 there, do not have any numbers associated with them whatsoever.

MEMBER CORRADINI: Okay.

CHAIR STETKAR: It is simply a tool for understanding. So your tool for understanding might be different from my tool for understanding because you might need to think of more minutia than I might. But ultimately, if we structure our thought process appropriately, your minutia might coalesce to my higher level thinking. And that's the important point of the thing.

MEMBER CORRADINI: Okay.

CHAIR STETKAR: So the thing in the upper right doesn't have any number associated with it whatsoever. The thing in the lower right does.

MEMBER CORRADINI: Okay, got it. Thank you. Keep on going.

MS. XING: Okay. So in the event tree you mentioned we identified the human failure event as failure of feed and bleed. And then going to task analysis as Dr. Stetkar just described, so these are the different tasks and the potential tasks in the feed and bleed.

So the ones that are highlighted are considered as a critical task, and we also have a guidance on what should be considered as a critical task. So after we identify these critical tasks we will take each critical task to quantify the failure probability.

Say for example, the first one, Enter FR-H1. That means that you identify the loss of feedwater. For this task, for each individual task we locate the failure mode, what failure mode could associate this?

For example, data misleading, so make you not able to identify the loss of feedwater. Or critical data can be misperceived so there could be other failure mode. Essentially, for each task there can be several failure mode associated. So once we identify these failure mode, then for each failure mode we develop a decision tree.

The decision tree is a representation of the pertinent performance influencing factors as we talked. For example, if the data misleading have three factors influencing it.

MEMBER BANERJEE: So what could those factors be? Like you thought that --

MS. XING: I try to remember. Data misleading.

MEMBER BANERJEE: This is, I think, where we're having really concrete problems. How do you get this and how do you assign numbers to that?

MS. XING: Okay, let me give you a concrete example.

MEMBER BANERJEE: Well, you could just go back and say what is that ABC or whatever it was.

MS. XING: Let's look at this. This is an example.

MEMBER BLEY: Can I help before you start? The decision tree doesn't pick the context. The qualitative analysis sets the context.

MEMBER BANERJEE: No, I realize, yes.

MEMBER BLEY: This decision tree, and I don't even like the language, decision tree, but this structure, logic structure, lays out all of the kind of large clumps of context that the authors thought would be important to a particular kind of failure event.

Now when you actually use it, you do your qualitative analysis, you identify the context. You come to this and you say, where is my context on this tree? Oh, in this case I have cognitive workload is low, but HSI is poor and the urgency is low. That's Number 5 there. And that's what I come.

I just come and I look at Number 5 because I've already identified the context. This structure was a way to lay out all of the possible contexts for analysis as context.

MEMBER BANERJEE: But eventually you come up with some numbers, right?

MEMBER BLEY: Well, you get them from here.

MEMBER BANERJEE: From here. So this is the critical thing to give you the numbers. I mean I can lay out any set of scenarios that I --

CHAIR STETKAR: This is the calculator. It doesn't tell you what buttons to push on the calculator. The qualitative analysis tells you --

MEMBER BANERJEE: Right, right.

CHAIR STETKAR: -- what buttons to push, essentially.

MEMBER BANERJEE: Qualitative analysis, but everybody can do a little bit different qualitative analysis. Eventually, if I understood it, you have to pull this out, each item in the qualitative analysis, break it down into some form of a decision tree on which you eventually put some numbers, right?

MS. XING: Yes.

MEMBER BANERJEE: I mean that's really the end game. And I guess I'm trying to understand how you arrive at that.

MS. XING: Okay, we're getting there really soon.

MEMBER BANERJEE: Okay.

MS. XING: After the ask, we know in this decision tree.

MEMBER BANERJEE: Well, how do you establish that decision tree?

MS. XING: Okay, so so far this is a whole process. Next --

MEMBER BANERJEE: Yes, after that point, no problem.

MS. XING: How we establish the number.

MEMBER BANERJEE: How you establish the tree at all.

MS. XING: How we establish the tree, okay, so here for in a critical failure mode. And we have from our cognitive basis literature review we have a long list of candidates, what factors can affect this failure mode, it can lead to data misperception.

And let's see, we have 20 candidate factors from the literature. That may not include all, but as much as we can from the science that can tell us and from experience. And, but not all those 20 factors are equally important to data misperceived.

And so we used our operational team and the consulting operators to say, okay, of these 20 factors which one do you think is really important that can cause a data misperceived, make up the misperceived data? So we've been going through many round of this selection. This is primarily --

MEMBER BANERJEE: I guess I don't understand how you sequence them this way. Why does mental fatigue follow distraction or, I mean it seems to me this is all just --

MS. XING: There's a scientific reasons behind that because one leads to another, leads to another, independently. And which also come from the operational people that, okay, if I come to data, if somebody in my team misunderstood the data I would first look at whether the data source is good or not.

So if the data, if there's a malfunction and the data source itself has a problem so that's the first cause. Okay, that's why we put that one at the top. After that they would say, well, normally this shouldn't misperceive the data. It happened. I want to look at what are the kind of distractions.

So if they're doing multi-tasking and lots of distraction that's mostly likely causing it. So this is a kind of --

MEMBER BANERJEE: This is sort of, you've got a way to --

MS. XING: Yes, we go down logical.

MEMBER BANERJEE: -- go systematically through this process.

MS. XING: Yes.

MEMBER BANERJEE: Based on some understanding.

MS. XING: Right. So eventually the tree I just showed you, as you can imagine what took us such a long time to develop this tree because every tree we tried, and many different possibilities, and tried logically find the one that we think is the most reasonable and accepted by our operator peers. We not say this is ideal, but it's the best --

MEMBER BANERJEE: Do you have evidence to support this?

MS. XING: Yes. And actually from the scientific literature we have evidence, not just a whole bunch of literature. If a distraction, let's say multi-tasking, and lots of literature will tell us if you're doing multi-tasking, say, just two tasks you switch back and forth quick enough, normally there would be ten percent chance you would make an error.

But if you switch them really slowly at a very lower pass there's only five chance of error. So there are data behind our decision here. And the test, that's how we build these decision trees.

And the next thing is assign the error probability for each test in the decision tree, so that we used in the formal expert judgment panel. So here's just an example. You saw it in the tree. For this failure mode, okay, alarm not attended to.

If you have a high distraction, poor alarm design, lower perceived urgency, it's a human error probability. I only give the central value here. We have the distribution for this. The central tendency for probability is 2.5 minus 1 versus past four or five which show that you are late.

You have a high distraction but your alarm design really helps. And also in your training you were taught that this alarm has a high urgency you should pay attention to. So the error probability -- so we gave our expert this scenario. Asked them to think of a scenario in their training or operation.

They will never be in a feed and bleed in their operation, but that they have seen the cases like this very often. So even this situation, what is the likelihood of the error probability?

And for our expert panel we also provide the data as much as we can. For example, the data I just mentioned, the literature showed that when you have a high distraction, multi-tasking, there's ten percent chance you would make an error.

MEMBER CORRADINI: So let me summarize this just so I understand. So in accident at-power, accident scenarios which really matter, the central value is one out of four chances you'll fail. And probably the upper bound might still be one out of two.

MS. XING: I really don't remember.

MEMBER CORRADINI: It doesn't matter. I'm inventing that.

MS. XING: Yes.

MEMBER CORRADINI: But if coming into this it's getting close to a flip of a coin.

CHAIR STETKAR: In some really bad situations it might be like a flip of a coin.

MEMBER BLEY: TMI. Might have been just about --

MEMBER CORRADINI: I was eventually going to go there, but okay. But I'm understanding this correctly?

MS. XING: Yes.

MEMBER CORRADINI: Fine, okay. Move on.

MS. XING: And as we say our expert elicitation process, our operators frequently say, well, this will never happen. So was high distraction, poor alarm design, bad training, because we will never have this. I say, okay, yes, you probably never have this but just say if this happened what is the likelihood of error? So that's the probability here.

So we're not estimating how frequently this will happen, we are estimating given this situation what is the chance to make an error.

MEMBER BLEY: Just an aside. When you

present it on a table like this it makes that much clearer.

MS. XING: Than a tree.

MEMBER BLEY: The tree fools a lot of people. The tree looks like it's a sequence of things that you're modeling and it really isn't. It's just a display of these possible sets of contexts.

CHAIR STETKAR: Even calling it a scenario is not quite. It's a combination of things.

MEMBER BANERJEE: It's really not a tree.

CHAIR STETKAR: It's not a tree in the way people think of, in an event tree progression.

MEMBER BANERJEE: It's not in a systematic, it's just a combination.

CHAIR STETKAR: It's a matrix.

MEMBER BANERJEE: Yes, it's just a combination.

MEMBER BLEY: And the language is a bit of a holdover from a previous development, CBDT, which give that and invented this thing and, you know, it works, but we have a lot of trouble in the elicitation with people trying to come to grips with that.

MEMBER BANERJEE: It's just the various combinations.

MS. XING: Yes, it's just the various

combinations.

MEMBER BANERJEE: There ain't no hierarchy here.

MEMBER BALLINGER: Where does operator confidence come in here? Somebody that really, really knows what they're doing, very well trained, knows the plant can deal with a lot higher distraction than somebody who doesn't.

MS. XING: Yes, and this is a typical HRA question we were asked though, who are you modeling? Because there's a basic individual difference. We will say we are modeling let's say an average or representative operator. So these operators had, so assumptions that these operators has been well trained and have a procedure to perform the work.

MEMBER BALLINGER: But have you modeled both? Have you modeled an incompetent, for lack of a better word, operator versus a very highly trained operator to see what the differences are?

MEMBER BANERJEE: There should be another column there which says operator competence or something.

MS. XING: But that's each of this number, not just to have a probability but it has a distribution. You would think a good operator would fail on the right side --

MEMBER BANERJEE: But you don't explicitly put operator column there. That's what he's saying.

MEMBER SCHULTZ: Well, it is implicit, but it's a performance influencing factor, and this is detection so you'd say minimal distraction. Start there.

MS. XING: Yes.

MEMBER BROWN: Jing, you said an average operator, but yet when I went and looked your own document we were given, the IDHEAS method development, it states based on your review that the review should focus on research related to highly trained or expert personnel rather than novices.

So there's a range. It didn't say average, it said highly trained. You said average, and I'm trying to connect that --

MEMBER BLEY: Jing, let me offer something to all of these comments. When we did elicitation and you always, it just comes up. It usually comes up in the other way because you've got operators and trainers who know their people are really good.

And when I'm leading an elicitation, and I did on some of this, you know, where I was there was this guy. I always called him Charlie but it was before I --

CHAIR STETKAR: And it's appropriate -- but you're right. You do not want me on the panel.

MEMBER BLEY: But if Charlie had the watch at 4:00 in the morning he didn't sleep too well. Maybe you don't have anybody like that and they always go, oh, yes, let me rethink what I'm doing here and they try to express that in their uncertainty. You never know which guy's on the watch.

MEMBER BROWN: The only thing I was taking issue with, the comment that they were using an average operator based on their --

MEMBER BLEY: And they were urged to think more broadly.

CHAIR STETKAR: Now, in fairness we were given two documents. And one of the documents was the psychological basis document, NUREG-2114. And in that document, which I'm staring at right now, there is an explicit performance influencing factor that's characterized as knowledge, experience, and expertise.

So in principle the methodology does allow you to evaluate that. Now whether or not that particular attribute is evaluated in this particular construct explicitly of this matrix, I'll call it rather than an event tree, is a matter of justification.

MEMBER BROWN: Well, that's where I got this, out of that document 2114. It was in Section 1.

CHAIR STETKAR: And there's an appendix.

MEMBER BROWN: I did not read the appendix.

CHAIR STETKAR: No, there's an appendix in the IDHEAS methodology that elaborates for every crew failure mode the justification for the particular performance influencing factors that were used to construct, again, what I'll call the matrix, what other people are calling decision trees, for that crew failure mode.

So there's kind of a traceable path. You might disagree with some of the decisions, but that's, you know, that's why it's --

MEMBER BROWN: The only thing I was wanting, just to make sure that the idea that it was highly trained, average, to novice had been discussed or mentioned, and that the only thing was her statement seemed to focus on something other than what the review focused on. And I understand if you have a metric that addresses the difference then that's fine.

MS. XING: I think that's a very important question, and the final report would make sure we make the wording clearly so people would --

MR. CHANG: This is Jim Chang. The HRA that we felt is for predictive, any for predictive analysis. So unless we say that we don't know which operator, which crews in the scenarios, and even the SDP situation for event analysis that we say, okay, most of situation come to succeed, but now we will go back to analyze that what's, if that thing has happened at a different day, different crew at a scene that might be fail that situation.

So in essence we put a crew that more in fact did put into an uncertainty instead of going to the detail in this level.

MR. PETERS: So as James is indicating, when we do an SDP analysis we can in fact change our models to allow the modeling of a specific crew. So if we develop out this generic methodology for SDP purposes we can go back and do it that way.

But when we're doing a prospective HRA where you're trying to just go with a general plant model, you don't know which crew would be operating at any one time. So it doesn't make sense for us to model that particular capability.

MEMBER BROWN: Okay, move on.

MS. XING: Yes, just to, I think we already talked a lot of how we got the numbers. And just want to show you the overall, the process we get as an expert elicitation. We use the expert elicitation to get the numbers.

We adopted the, by far the most formal expert judgment process which was developed by this agency called a SSHAC process. In the SSHAC process it has a different type of expert involved. Each type of expert have explicit rules so to minimize the bias and maximally elicit information.

And it also have, this expert have a face-to-face workshop to challenge each other and the deliberation therefore for maximum interaction. So the SSHAC process does not try to attain a consensus but try to give a community distribution of an opinion of their work.

So our process, we have this group of expert, data expert, which are the cognitive scientists, went through the literature and all kind of database, try to get as much data as possible that can be used for an expert to at least benchmark their judgment. And we have resource expert who are primarily the formal operators and the current trainers from existing plant. So they provide lots of useful input to the model we developed.

And the experts, their input largely revised this model we develop from the failure mode and to the performance influencing factors in that event tree, and the definition of the influencing factors.

I forgot to mention we also developed a questionnaire for you to judge the presence or absence of the performance influencing factors. They provide a lot of input for doing that from the operation experience.

MEMBER BANERJEE: So why did you choose this incident that never occurred in a plant and not some other which is more common?

MS. XING: Why did I choose feed and bleed?

MEMBER BANERJEE: No, I mean this whole thing which has never occurred, only occurred on simulators.

MS. XING: Actually a lot of the event we modeled, feed and bleed never occurred in a real plant, but because it's a very important part of training and also we have benchmark study on that.

MEMBER BANERJEE: So do you have anything which has actually occurred?

MS. XING: Yes, we --

CHAIR STETKAR: Sanjoy, we don't routinely melt nuclear plants. You know, we don't have

--

MEMBER BANERJEE: We have done a few but that's okay.

CHAIR STETKAR: But the vast majority of scenarios in a risk assessment address things that have never happened.

MEMBER BANERJEE: That's true.

CHAIR STETKAR: And this is developed for the context of a risk assessment. It's not developed for the context of driving your car to the grocery store.

MEMBER POWERS: But if you're trying to validate the methodology would you not want to look at least to some extent at situations that have occurred in a nuclear power plant?

MEMBER BLEY: Yes. Let me toss something out and let other people add to it. Yes, Dana. But what many of us believe and what I think the research supports is that the kind of errors you make all the time that are easily corrected have a different basis for what causes them. And those do happen all the time. We're looking for those cases that go beyond that and put you in a situation you're not as likely to recover from. So it's different driving forces.

MEMBER POWERS: Well, I can certainly

appreciate that, but wouldn't you look first at the ones that you know a lot about before you take a spring into something that's more difficult?

MEMBER BLEY: I think in fairness you do, but you don't build a model about it and spend a lot of time working on it. Try to understand it and use that to build the basis for what you do in the future.

MEMBER POWERS: I wonder why you wouldn't do that to just convince yourself that you were, I mean, would not be uncommon for Sanjoy and I to look at a complicated thing by looking at a flat plate first. He's more confident than I that he can do by that analysis.

Well, we're both getting older. We may neither one of us be able to do a flat plate analysis anymore. But we'd certainly start with that before we did a study on this.

MEMBER BANERJEE: So to give you a much clearer example on let's say nuclear plants, even though, I mean I don't want to mention the word thermal hydraulics at North Anna or something, but you'd start with things that you can predict and have happened, turbine trips or whatever the hell, you know, instability events and things like that. If you couldn't do those, I mean how can you do anything more?

MEMBER CORRADINI: I thought Dennis' answer says that they can.

MEMBER POWERS: It was the next step that was troublesome is that they don't bother to model it. They're so confident that they can handle those easy ones that they don't demonstrate that. And that's where I think we're having difficulty.

MEMBER BLEY: There's data, you know. There is a lot of data.

MEMBER POWERS: But there is, but you're saying --

MEMBER BLEY: -- those kinds of things.

MEMBER POWERS: I mean this is all based, as we've made very clear at the beginning, on cognition. And what you're saying is the cognition during these common events is a bit different than the cognition in these rare events, and so you're going to model it somewhat differently.

But I don't think it's a sea change in modeling. I think the structure might look very similar. The words within the boxes won't be very different.

MEMBER BLEY: It is a sea change. And I think it's, and we're not building a clockwork model. We're not building a physics model. We're building an influence model and then using judgment to quantify it at least at this point.

MEMBER BANERJEE: But if I understood the process, Dennis, you're breaking this into actions which are clearly like a FR-1 or whatever it was and then something like that. So you're subdividing --

MEMBER BLEY: Identifying things people could do that could cause a problem.

MEMBER BANERJEE: Yes, a complicated chain of what can happen into a sequence of simpler actions, and then you're analyzing each of these, at least the way you had it set up for that feed and bleed.

Go back to that slide please where you had it all nicely sequenced. Yes, that one. Yes. So now you identify some of these as important ones, and some of the blue ones are important, and then you analyze this further in some form of a matrix and you assign some probabilities and you move forward in a systematic way.

Now that procedure that you've got works for anything whether it is a simpler action or more complicated thing, right?

CHAIR STETKAR: Absolutely. It absolutely does.

MEMBER BANERJEE: So I mean, to validate

that procedure you could take something that has actually occurred rather than which has been simulated, because that performance factors in what actually occurs --

MEMBER BLEY: But when I said we don't model it, we did go back to a number of real-world events like the Robinson fire and we laid it all out in this way and looked at how it overlaid.

MEMBER BANERJEE: Well, I think that's a good answer.

MEMBER BLEY: The questions earlier that, you know, how finely do you break this up, we had three or four different groups do that same thing. Some divided it real finely. Some divided coarsely. The ones that divided it too finely to make sense of it all then we clumped things to get influencing factors and looked, and yes, lined it up.

So we were able to lay out the structure of the model for real-world events and use that to help define how you do that in the future so we don't get quite as much variability. But two different groups will still get some variability when they --

MEMBER BANERJEE: Well, that's to be expected. Yes.

MEMBER BLEY: But at that level, yes,

that's been done for a number. We did it, I forget how many events, but that was done for quite a few events quite a few years ago now. Well, probably the year 2011, the year of Robinson. We did Robinson and a half a dozen other significant events.

MEMBER BANERJEE: I think we've belabored this probably.

MS. XING: Okay. So we're about to wrap up.

MALE PARTICIPANT: Slide 44.

MEMBER CORRADINI: I know we have to get to the end, but can you go back to the tabling?

MS. XING: Okay.

MEMBER CORRADINI: And you can tell me where you said this. I missed it. So this now identifies a whole set of context with an estimate, and then of course I'm sure a range and a shape to the estimate.

MS. XING: Yes.

MEMBER CORRADINI: So when you apply this inside of an analysis how do you know which context appears? Does the context appear by the damaged state that the plant is at?

MS. XING: Okay, so --

MEMBER CORRADINI: In other words, how do

I know that I'm in failure scenario 1 versus failure scenario 7? Did you say that and I missed that?

MS. XING: That's in the method that we developed. For each of these factors we have a questionnaire. We ask them like four questions. I don't remember exactly what's the, for example, what do you mean by high distraction? Let's say one question could be are you performing a multi-task? So were there other urgent things going on such as fire inspections and --

MEMBER CORRADINI: No, no, no. Maybe I'm not making myself clear. So I'm just trying to figure out, I understand what you did.

MS. XING: Yes.

MEMBER BLEY: Mike, let me try to help you. Jing, I think, was explaining to you how we use that but you're asking how do you know what it is. When you do the qualitative analysis you've laid out what possible things could go wrong, but you've also said what could make these more likely or less likely, either things that are modeled in the PRA or subsequent other failures, maybe some instrument failures or something like that.

So you get to a particular action and maybe just to make it clear, maybe you came up with three different sets of confusing things that might be going on or not confusing things. An instrument's broken and some subsidiary piece of equipment that we don't really model has failed.

Well, one of those cases is a case that creates high distraction. Something else is going on in the plant besides this one event we're looking at and it turns out we had poor design on the alarm.

MEMBER CORRADINI: So it's the plant damage state at the time.

MEMBER BLEY: The plant damage state and the qualitative analysis goes beyond the plant damage state. Well, the real plant damage state which is much more broadly defined than the PRA plant damage state.

CHAIR STETKAR: It's called in the jargon many times, to help you, the operational narrative. They call it qualitative analysis. The story of the scenario gets back to originally Dick's questions about suppose you have this event where the entire control room is lit up. Well, there's some frequency of that. I'm not going to figure out how you got the frequency. That's different.

But getting the frequency, not the frequency but the scenario, you know, what has happened in the plant that has caused all of these alarms to light up, some of which are relevant to this particular thing that you're modeling within the fine structure context of this particular PRA branch point, but in total what else is happening that the operators are exposed to? That total narrative then provides guidance about where you are on this set of the matrix, you know, which set you pluck out.

MEMBER BLEY: And probably the most likely situation is when we try not too often which is one thing goes wrong and it actually matches up procedures and you step through. There's no distraction. The alarm is perfect for the situation. And it's damn unlikely that you fail on this.

MEMBER CORRADINI: Okay.

MEMBER BLEY: And really fail. I mean you might throw the switch and then put it right back, you know, something like that.

MEMBER CORRADINI: So then given that you have a story board that informs the failure scenario, where are there benchmark tests that provide a story board to see if your failure scenario gets you the failure rate you thought? In other words, do you go to Halden?

What do you do -- I know I was at some of these subcommittee meetings and somehow I'm back to my same question as at the subcommittee, which is since I can't do it at a plant and I don't have data for it, where do I invent the story board that gets me to failure scenario 1 versus failure scenario 7? Because it's always failure scenario 1 that always tends to lead us down the -- so is that done at Halden? Where is that done? So I can check that failure scenario 1 really is 2.5 plus or minus a factor of 2.

MEMBER BANERJEE: That was in some ways the point we were making exactly. Where is that empirical evidence?

MEMBER BLEY: That was a goal of the benchmark studies was to create scenarios, similar scenarios, some that are kind of straightforward and others that have the masking that gets you into these places where there is these difficult situations.

MEMBER CORRADINI: Is that TBD?

MEMBER BLEY: No, that was done, and not everybody will agree 100 percent, but in general the people who built a good story about what could be going on included those kind of things that were actually there, only they were less likely because they don't happen all the time and have a model for that.

MEMBER CORRADINI: So that's back in the framework of what you said --

MEMBER BLEY: But it's not --

MEMBER CORRADINI: No, I understand.

MEMBER BLEY: -- a number that we would always use because you'll never have that same situation.

MEMBER CORRADINI: I'll just say it back to you. So what you're saying is, how I know which one I should pluck out when I'm doing an analysis, it depends upon the story or the context and that's been exercised in the past, is that you feel good about that number given the context?

MEMBER BANERJEE: Including the stress of a real event. Because, you know, the problem is you give a student something to write, an exam, he'll write it perfectly if you don't have to count the mark. If you count the mark they'll fail it. So it's a completely different situation.

MEMBER CORRADINI: Well, they don't do as well.

MEMBER BANERJEE: They don't do as well. Most of them will get significantly lower marks if you --

MS. XING: So that's why a lot of HRA analysts from the benchmark is so important that you have a good qualitative analysis guidance, and that's what we tried to do in this method.

CHAIR STETKAR: Yes, and that's one of the fundamental conclusions. I have to be careful because we're running quickly out of time here. Because one of the fundamental conclusions when they looked at the different HRA methods that a universal deficiency was a lack of guidance on developing that narrative, that operational narrative.

It's not -- right now the IDHEAS methodology report has that guidance, I'd say distributed. It's not very well coalesced at least in my own mind. I think there's still work to be done in that area.

MS. XING: In the peer review and the initial testing we got the feedback. The qualitative analysis guidance we provided in this report is an improvement to the existing method. However, they still want the users, the people who are participating and testing in the review, they think there still should be a better and more detailed guidance on how to tell the operational story, how to capture this information so will lead you to the correct --

MEMBER BANERJEE: So by narrative you mean that little plot that you had in that slide. Is that it?

CHAIR STETKAR: No.

MEMBER BANERJEE: That's not the narrative?

CHAIR STETKAR: That is the context of that particular action for the particular branch point in the particular PRA model that says do the bleed and feed. It isn't the context of, I need to do bleed and feed during a fire that has failed thousands of other alarms some of which ought to tell me to maybe go bleed and feed. That bigger narrative is, sets that overall context.

MEMBER BANERJEE: Yes, I've got it. But you have to do these things systematically. So you start with the bigger narrative, then you go down and you move down systematically, and then eventually you get to that sort of narrative that you have. Not the previous slide, but we've seen it.

And then you eventually get down to that matrix which has all that stuff. And we've got to do this in sequence, right? That's how you arrive. What I don't understand is what is new about this compared to all these other things? Is there something new, or has everybody else done it?

MS. XING: Okay. Yes, several places new. In one place in term of a qualitative analysis, and we didn't invent too much other than the graphic representation of the test, but some scientists that that is, for many existing document, to put them into one document in a structured way like this.

The blue text to show the major steps in the qualitative analysis and we have a guidance on how to do each one. What are the expected output --

CHAIR STETKAR: Jing? We're running out of time here. Seems like in my opinion anyway, and Jing can chime in, there's nothing entirely new about this methodology. However, it plucks from other methodologies things that they do well and enhances things that they don't do well.

So, for example, one methodology might do the qualitative analysis part better than others. This plucks from that methodology the way it does things better. Another methodology might lay out the thought process for developing that matrix, if you will, better than others. So this plucks from that methodology. So it isn't anything fundamentally, you know, resoundingly new, except for perhaps, even the link to the cognitive psychology is not particularly new, it's a little bit more structured.

So it wasn't, although it's characterized as a new methodology, it's not something where you wipe the slate clean and start from scratch. It's designed to pick elements, best practices if you will, from things that the staff reviewed and coalesce them into something that hangs together a little bit.

MEMBER BANERJEE: Yes, okay.

MS. XING: Thank you, John. Yes. That's why the method to start with was integrated.

MEMBER BANERJEE: So it would be nice to see a matrix thing. I pulled this from here, pulled that from there. I'm just kidding. No, I'm not there, thanks. That's sufficient.

CHAIR STETKAR: Jing, if you could just go, to give the committee, if you could go to your Slide 51 just to give the committee an idea of where you're headed on this, I think that's about all we have time to cover.

MS. XING: Okay.

CHAIR STETKAR: There you go.

MS. XING: Okay, so here's where we are in the path forward. For the cognitive basis, one is that the report is essentially done so we've been using it, you know, HRA and the human factors. So in the long term plan we should update it every once in awhile if we have resource.

For the IDHEAS methodology we have the

method development essentially completed. We had an initial test here, so initial test result I would say is very promising in the positive, but we really need to do really formal testing before we really roll it into application. That's for our user's request.

So we want test it, fully test it, and also we need to develop a user's manual. Right now it's a 300-page report. Our users don't like that. They want something more handy.

And the generic methodology, we plan to complete the method development by 2015 and tailor it for specific applications afterwards.

MR. PETERS: And on top of that we are piloting this generic methodology currently in the containment filter events rulemaking effort. So Dr. Xing is leading an effort to pilot that generic methodology at this moment.

MS. XING: So that's my last slide.

MEMBER SCHULTZ: So is that the current next application? You have it listed as Level 2/3 PRA.

MR. PETERS: This generic methodology is supposed to be able to handle events in Level 2 and 3 PRA, but its first piloting will be in the containment filter events rulemaking.

MEMBER SCHULTZ: Okay, good. Thank you.

MEMBER CORRADINI: That will be the first one. Did I hear that right?

MR. PETERS: Yes, it is.

MEMBER CORRADINI: So we'll expect to see this when staff comes back and talks about how they're going to implement a hardened vent and procedures thereupon?

MEMBER BANERJEE: What does that have to do --

MEMBER CORRADINI: Well, I mean, to me, if this is the first application of this, now it actually, the rubber hits the road, because now I have to decide below certain pressures I don't want to vent because CAP comes in and I want to make sure everything functions, and above a certain pressure I open it up and I can't get back to any of my ECCS again.

MEMBER BALLINGER: That's my exact, that was my question. That's exactly.

MEMBER CORRADINI: So anyway.

CHAIR STETKAR: Good discussion. We're on time.

MEMBER CORRADINI: Yes, sir.

CHAIR STETKAR: Any of the members have any other questions for Jing?

MEMBER BANERJEE: We don't need a letter

or anything.

CHAIR STETKAR: We are writing a letter.

MEMBER BANERJEE: Oh, we are?

CHAIR STETKAR: We are writing a letter. Are there any other questions for Jing?

MS. XING: I will be available from now to the end of the day, so if you have additional question during lunch break of the process writing letter I can provide --

CHAIR STETKAR: Thank you. Appreciate it.

MEMBER REMPE: But if there are questions tomorrow you will not be around is what you're trying to tell us?

MS. XING: I will also be around if you need. Sorry.

CHAIR STETKAR: Anything else? If not, Jing, thanks a lot. You covered a lot of material. There's an awful lot more. And with that I'll turn it back to myself, and we will recess until 10:50, ten minutes to 11:00.

(Whereupon, the foregoing matter went off the record at 10:35 a.m. and went back on the record at 10:49 a.m.)

CHAIR STETKAR: We are back in session and the next topic on our agenda is an overview of the Early Site Permit process and Dr. Powers will lead us through that.

MEMBER POWERS: I will.

CHAIR STETKAR: You will.

MEMBER POWERS: I will endeavor to. We're in the midst of doing an early site permitting process and it struck me and of course, this will be the first one that we've done. And it struck me in the middle of some very nice presentations from the staff and licensees on this that I was the only one on the committee that had actually been through an Early Site Permit process prior to this.

So we thought collectively that it might be worthwhile for the committee to get just a little bit of background on this whole Early Site Permit process which worked reasonably well, I think, in the four previous instances and seems to be working just fine on the fifth as well.

But to give you some insight into what is done and what the intention is and how it's done and things like that, so I'm going to turn it to John and say educate us, John.

MR. SEGALA: Okay, thank you, Dr. Powers. Good morning. My name is John Segala. I'm the Chief of the Licensing Branch 1 in the Division of New Reactor Licensing in the Office of New reactors. Among other things that my branch does, we are responsible for managing the safety review of the PSEG Early Site Permit application review.

Just a really quick background. The relation for me here is that I was the project manager on the safety site for the Clinton Early Site Permit back in 2005, so I've been through this at least once before.

With me to my left is Mr. Prosanta Chowdhury, he is currently in my branch and he's the lead project manager for the PSEG Early Site Permit application review. Prosanta and I will be making the formal presentations today and answering questions.

To my right is Mr. Jack Cushing. He's in the Environmental Technical Support Branch. He was also previously involved in the Early Site Permit application reviews and he was involved in the review of the NEI industry guidance on developing a plant parameter envelope for the ESPs. So Jack has extensive knowledge on the plant parameter envelope in terms of the ESP process.

We've also invited one of our legal staff, Mr. Kevin Roach, over there from the Office of General

Counsel. He may be able to clarify or answer questions on aspects of our presentation related to hearings or regulations. He's also presently involved in the PSEG early application project.

So go to the next slide.

We're here today, as Dr. Powers said, to provide an overview of the Early Site Permit application review process. We will briefly describe how the ESP fits into our licensing process and touch on the regulations governing the ESP application and its review. And we will briefly describe the concept of a Plant Parameter Envelope and answer any questions.

I'm going to provide just for the next couple of slides the sort of high-level view of an ESP and the overall of how that fits into the Part 52 process and then I'll turn it over to Prosanta to take it from there.

An Early Site Permit is an approval of a proposed site as suitable for a nuclear power plant. At the Early Site Permit stage, the applicant doesn't have to commit to building a reactor or to specify a reactor design that it would build there. The ESP resolves both site safety and environmental issues that are independent of a particular reactor design.

As you all are aware, the ACRS only reviews the safety aspects of the Early Site Permit application review, but we will touch on aspects of the environmental review as we go through the presentation.

MEMBER POWERS: It's fair to say in subcommittee meetings and what not, especially when they have public comments, we often have people asking us questions about the environmental aspects of it or the -- especially the need for it. And they're just outside of our domain of influence. They come up and we basically tolerate them, but there's no answer we can give them because it's outside of our domain both of expertise and charter.

MR. SEGALA: I would think at that point, maybe you could just share those comments with the environmental group.

MR. CUSHING: Yes, definitely, the public doesn't distinguish and that's an issue we also have in our public meetings. We get a lot of safety-related comments as well. And we do try to provide an answer to them in the Final EIS when we have to answer comments, but we also turn those over to the safety side and we'll bring a safety PM along with us to help answer. Because we really can't ask the public to know where things -- the dividing lines are.

MEMBER POWERS: It's way too subtle for

somebody outside.

MR. CUSHING: Right.

MEMBER POWERS: But I mean it does come up and like I say we tolerate, but there's just not a -- the wrong people are in the room to answer the question.

MR. SEGALA: Unfortunately, the public just sees us as NRC and they don't really distinguish very well.

The NRC must issue either a Combined License under the Part 52 process or a Construction Permit and Operating License under Part 50 before a reactor can be constructed and operated. So an ESP does not do that.

Next slide, please.

MEMBER POWERS: But it is very important an ESP does do a substantial fraction of what a potential licensee would have to do if he was adopting a Certified Design from a site and doing the whole thing.

MR. SEGALA: This slide here is just to show you where Early Site Permits fit into the overall Part 52 regulation. Part 52 is comprised of three major licensing processes. One is an Early Site Permit. One is Design Certification. And the other one is a Combined License. All three of these, if you look at the box on the middle left, all three of these processes start with the option to enter into pre-application activities with the staff prior to submittal of the application. These can be very important especially in areas where there's new concepts are being developed or where the applicant is conducting work that's going to be needed to support the application and develop the application.

Bringing the NRC staff on board early helps facilitate the review when the application is submitted. It also helps identify any new regulatory tools that the staff needs in order to be ready for the review of the application. That could be computer codes or what not.

The two larger rectangles on the left show the Early Site Permit and the Design Certification application review process. For the Early Site Permit siting information is required and for the Design Certification, design information is required. The ellipse in the middle captures the Combined License review, application review, the hearing that takes place, and the Commission's decision on issuance of the Combined License. The Combined License application can reference either an Early Site Permit, Design Certification, both or neither, as long as it provides the sufficient information that the staff needs to complete its review for the Combined License.

Referencing an Early Site Permit NRR certified design can be of value because a good portion of the review would have been completed earlier in the process. The Combined License will also include something known as ITAAC. These are inspections, tests, analysis, and acceptance criteria that the staff has determined are necessary to demonstrate that the as-built plant meets the regulations.

The Combined License would also include any necessary license conditions. You could have license conditions on these like start up testing requirements or whatever.

The vertical dashed line shows the major construction activities would occur after the issuance of the Combined License. The square to the right dashed line, the verification of the ITAAC, shows that following construction and before fuel loading the licensee would complete the ITAAC to demonstrate the plan is constructed, as constructed, meets the acceptance criteria.

The NRC would also verify that this has, in fact, occurred and that the Commission would follow with the necessary finding that the acceptance criteria has been met and would authorize operation. The licensee would then at that point commence fuel loading and startup activities.

At this point, I'll turn it over to Mr. Prosanta Chowdhury and he'll discuss Limited Work Authorization and how that can be allowed before the Combined License.

MR. CHOWDHURY: Thank you, John. Good morning. Once again, I'm Prosanta Chowdhury. I'm one of the project managers under John in his branch in DRNL. And I am the lead project manager for the Early Site Permit application review that's ongoing at the NRC right now that is in the PSEG site, Early Site Permit.

As John alluded, on this slide, number five, you'll see that an applicant -- I'm going to give you a very high level points here about the Limited Work Authorization. An applicant has the option of requesting approval to begin a limited amount of site preparation activities. This option does not provide the applicant with approval to construct or operate a nuclear plant.

And this is spelled in our regulations where they can request for and what specific information should be provided if they do make a request. The high-level regulation is 52.17. By requesting a Limited Work Authorization, the applicant can request permission to begin specific activities before a COL is issued.

A COL, LWA, or Limited Work Authorization, can be issued with an Early Site Permit or before a Combined License. An ESP can also be referenced in a Combined License application which the applicant may submit in the future.

MEMBER POWERS: It's worthwhile to point out that, in fact, Vogtle in their ESP did apply for a Limited Work Authorization.

MR. CHOWDHURY: That's true.

MEMBER POWERS: And in particular, they needed to clear some site ground and prepare a pit so that they could put in a proper foundation. Where you're going to put the foundation and what not was actually deferred into the construction period, I think, because you can't build a nuclear power plant, but you can dig the hole.

MEMBER SKILLMAN: For the LWA work scope, how much inspection does the NRC provide?

MR. CHOWDHURY: During the LWA work?

MR. CUSHING: I am not aware of the level of inspection. It's for safety-related construction work, so construction inspection program would have to address and I don't think anyone here has that particular knowledge.

MR. NGUYEN: Quynh Nguyen. The inspections are run out of Region II.

MR. CUSHING: We can get you an answer to that.

MEMBER BLEY: I hadn't thought about this, but the LWA is for construction work, right? Because beforehand they can do -- I think they must have done site studies on the site and maybe looking first at soil samples and seismic. It's just construction itself.

MR. CHOWDHURY: It's limited work that is site related.

MEMBER POWERS: Down at Vogtle, they did the main circ water as part of it, access roads, clearing ground, laydown areas, construction support areas. All of this can be done, as long as you're not building a nuclear power plant.

MR. CHOWDHURY: For Vogtle, they had placement of engineered backfill, mud mats, retaining walls, leaning concrete backfill, waterproof membranes, etcetera.

MEMBER BROWN: Did they put base mats, stuff like that in it? You said mats and I was wondering --

MR. CHOWDHURY: Mud mats.

MEMBER BROWN: Okay, I'm sorry. I misunderstood you.

MEMBER SKILLMAN: That's why I asked the question because the engineered fill becomes a major piece of what's going to be Chapter 3 of the Safety Evaluation. The question is what kind of inspection is involved in the LWA work scope?

MR. CHOWDHURY: I found out something about the ITAAC related to LWA for Vogtle. So that gives some inspection, tests and acceptance criteria under one of the categories. So I think -- what I think is that they should -- our, the NRC, will have a list of inspection criteria and inspection items that they will do. I don't have the details.

MEMBER POWERS: That particular engineered fill had to have a particular seismic acoustic velocity to it and they had criteria to meet and tests to do in the course of putting it in. I don't know whether --

MEMBER CORRADINI: We had a presentation on exactly that, very detailed. And I remembered, I thought they had to inspect what was there and how it was put in, but --

MEMBER POWERS: What I know is they explicitly did because they came in and gave us an interim report on laying down the first and the second layers and showed photographs and then they had a bunch of test data they had done on the seismic velocities and stuff like that. I cannot remember exactly when they did -- digging the hole was allowed in the Limited Work Authorization.

Now how much of putting the layers in came under the LWA and how much came under the COL. I just don't have a good sense of the timing here.

MEMBER SKILLMAN: I am just curious from the slide how much can you do to get inspected?

MEMBER POWERS: In general, you can do anything you need to do as long as you're not building a nuclear power plant.

MR. CHOWDHURY: Right, and during the placement, for example, in Vogtle's case for stability of subsurface materials and foundation, during the placement of the backfilled materials there was an inspection done.

MEMBER POWERS: I mean it's a fairly prescribed process. I mean there's a certain amount of tamping and the quality of the material that goes in was very highly specified and things like that.

MR. ROACH: This is Kevin Roach from NRC OGC. I'll just add that the scope of what's permitted under an LWA is defined in 50.10(d). It says any person to whom the Commission may otherwise issue a license may request a Limited Work Authorization, allowing that person to perform the driving of piles, subsurface preparation, placement of backfill, concrete, or permanent retaining walls within an excavation installation of the foundation including placement of concrete any of which are for an SCC of the facility for which either a construction permit or a combined license required under paragraph 8 of the section.

MEMBER SKILLMAN: Thank you. I would still like to know about the inspection.

MR. CUSHING: We'll get you information on that.

MEMBER SKILLMAN: Thank you.

MR. CHOWDHURY: Next slide is the applicant interest in Early Site Permits, Slide 6. Once the NRC issues an ESP, it is good for 10 to 20 years and it can be renewed. The applicant can then decide when is the right time to apply for a CL or Combined License. The Plant Parameter Envelope approach which we'll cover later lets the permit holder to put off making a decision on a reactor design selection at the

Early Site Permit stage until the applicant or the company decides to apply for a CL.

As mentioned earlier, an applicant can choose to apply for an Early Site Permit because it identifies and resolves siting issues prior to a Combined License phase. Thus it reduces an applicant's regulatory and financial uncertainties when planning for the future. So that's the big advantage the applicant gets of this. However, if there is an application for a Combined License referencing an ESP, the NRC will determine whether the design falls within the parameter envelope contained in the Early Site Permit application.

These are the high-level regulations on Slide 7 that are applicable to an Early Site Permit application review and also a couple of guidance documents that the staff uses, as well as the applicant to review the application. Primarily, NUREG-0800 which is the Standard Review Plan, the NRC uses that and then the Review Standard 002 which is still valid and active is looked at and reviewed concurrently with the Standard Review Plan so that if there are any gaps it will be covered.

In fact, the staff has compared these two recently, these two documents and not officially, but unofficially documented that all the -- anything that RS 002 had in terms of ESP review is covered under SRP and there are other documents, internal documents that are developed, for example, a review template in certain areas that cover all aspects of the ESP in our review.

So required reviews for an Early Site Permit application, Slide 8, the NRC reviews ESP applications for safety, security, health, and environmental factors to ensure that there is reasonable assurance that any nuclear facility at the site could be constructed and operated in compliance with the provisions of the Atomic Energy Act and the Commission regulations.

The NRC reviews an ESP in two major areas, namely Safety Review which includes site safety and emergency planning and security, feasibility of security plan and the environmental review. In accordance with the regulations in 10 CFR Part 2, the NRC issues a Safety Evaluation Report which is of interest to ACRS, documenting its evaluation of the application from a safety perspective. The NRC uses this information to determine whether the site is suitable for constructing a nuclear power plant.

The staff conducts the safety review to

determine if the application meets the regulation requirements laid out in NRC regulations which are part of the Code of Federal Regulations and in the Atomic Energy Act.

Now let me touch a little bit on the emergency preparedness review which is conducted primarily to evaluate significant impediments, population distribution, transportation rules, etcetera, and evaluate offsite emergency plants or emergency preparedness information in consultation with the Federal Emergency Management Agency under their regulation to verify certifications of participation by local, state, and federal agencies or in the alternative, demonstration that reasonable assurance of adequate protective measures do exist.

MEMBER POWERS: Let me just inject here. I find the cooperation and synergism that the staff has established with FEMA in this regard is just extraordinary. They really have a working relationship with each other that moves very smoothly, I think.

John, you might want to comment.

MR. SEGALA: I think I agree. We've had members of FEMA come to the ACRS meetings.

MEMBER POWERS: Yes, they show up at the

meetings, they answer questions.

MR. CHOWDHURY: We do have a Memorandum of Understanding in place with FEMA, particularly --

MEMBER POWERS: Well, Memorandum of Understanding, we've got lots of those.

(Laughter.)

MR. CHOWDHURY: And relationship as well.

MEMBER POWERS: Working relationship is what's more impressive is that they understand where the expertise -- their respective expertise lies and they mesh together well.

MR. CHOWDHURY: That is correct.

MEMBER REMPE: And that extends not just for licensing, but also when they do these joint exercise, I assume?

MR. CHOWDHURY: That is true. That is an integral part and the relationship between the NRC site of the emergency preparedness exercise and the offsite FEMA site have been working very well. That's true. Thanks for the comment.

Emergency planning information side of the story, an applicant may choose to submit a partial emergency plan describing the major features and that's covered under NUREG-0197. And I'm not the expert of it, but just to mention that that's the guidance document that the staff uses. Or they can submit a completely integrated onsite and offsite emergency plans.

MEMBER POWERS: And they have gotten both.

MR. CHOWDHURY: They have gotten both.

MEMBER POWERS: And we're -- the current one we're getting a complete and integrated plan, but we've done partial plans in the past. It does just exactly what he says. It's to identify any impediments that may arise.

MR. CHOWDHURY: Right.

MEMBER POWERS: Up until now we've done all of the Early Site Permits have been for sites that already have nuclear power plants there. Do you think we'll ever do one with a greenfield site?

MR. CUSHING: The Victoria Station, when they were in for a Combined License, they started to convert to an Early Site Permit. And then they terminated the review, mainly because I believe the price of natural gas and the business model changed. But that was a greenfield site.

MEMBER POWERS: It would be interesting to do -- see how the emergency planning was done on a greenfield site, because with existing sites you've got an infrastructure, you're pretty sure there are not going to be any major impediments. But a greenfield site would be interesting to do.

MR. CHOWDHURY: Was Bellefonte a greenfield site?

MR. CUSHING: No, I don't believe so. They had existing --

MEMBER POWERS: Right. It seems like a greenfield site is a perfect choice for ESP just because there's so much new that you're going to have to do.

MR. CUSHING: Right, and definitely you don't have the infrastructure built in --

MEMBER POWERS: You have a weather tower.

MR. CUSHING: Right.

MEMBER POWERS: You've got lots of things that you just don't have.

MR. CUSHING: Right. There's a lot more surveys to be done.

MR. CHOWDHURY: On the security review side, as it pertains to the Early Site Permit application review, by reviewing the security plan, the NRC simply ensures the ESP applicant provides sufficient information and technical basis to demonstrate that the site characteristics and potential hazards do not present impediments that would preclude the development of adequate security plans and measures. So it's a short plan. It's not a complete security plan that comes at the COL stage.

Additionally, the staff conducts, as was mentioned before, environmental reviews under the National Environmental Policy Act or NEPA, to evaluate in-person construction and operation of the site and certainly Jack is an expert and also as far as the PSER, the site permit application review goes, Allen Fetter who is in the audience is the environmental project manager who deals with this.

The staff's findings in both areas are documented in respectively Safety Evaluation Reports or SERs that is presented to ACRS. And the Environmental Impact Statement or EIS. I think that's provided to EPA.

MR. CUSHING: EPA and the public, we issue a draft for public comment and then we answer the comments, go final, and it's provided to EPA and to the mandatory hearing.

MR. CHOWDHURY: Slide 9, this is a schematic of the Early Site Permit application processing. What John showed you earlier is the overall Part 52 process. And this is just a piece of that process.

This outlines the steps in an ESP review as I mentioned. The rectangular-shaped boxes indicate an NRC action. The starbursts are areas where members of the public can get involved. As shown, there are several opportunities for the public to share comments and ask questions about the NRC's review of the application.

During the safety review, members of the public can attend meetings, where the Advisory Committee on Reactor Safeguards, ACRS, examines the staff's assessment.

Also, the staff conducts periodically as needed, public meetings with the applicant and open to the public for the most part and they can participate in those meetings.

MEMBER POWERS: And I will say that we pretty consistently had comments from the public at our ACRS review meeting, subcommittee meetings, especially. And I compliment the public. I think in general those comments have been useful, informed. Sometimes the outside of our domain of thinking is considerations, but I still have found them useful and contributing to the discussions.

MEMBER SCHULTZ: Prosanta, the public meetings that you just mentioned is that taking place in the scoping activities starburst there?

MR. CHOWDHURY: On the environmental side, yes.

MEMBER SCHULTZ: Yes. So that's a representative of some series of public meetings that are held?

MR. CUSHING: We have a scoping meeting prior to writing the Draft EIS.

MEMBER SCHULTZ: Okay.

MR. CUSHING: And that's a meeting with the public and that's where we're gathering information from the public about the environment around there, their concerns. And we address those in a Draft Environmental Impact Statement. After we issue that, it goes out for public comments. We have another public meeting and the public meeting for the draft is transcribed, so we capture all their comments and then we address them in the Final EIS and modify the EIS as appropriate.

MR. SEGALA: And that is the difference between the bottom path which is the environmental review and the safety path is the SER on the safety side does not go out for comment, whereas the Environmental Impact Statement does go out for comment. But also when we're in that -- on the safety review top portion when we're reviewing the Safety Evaluation Report, at that point we have numerous public meetings that members of the public are invited to on the safety side. So we're showing you sort of the whole picture of both sides of the reviews that go on in parallel.

MR. CHOWDHURY: In the mandatory hearing, the Atomic Safety and Licensing Board examines the request for any -- requests for the public to participate in the hearing. And a mandatory hearing is held after the staff publishes both reports, the Safety Evaluation Report and the Environmental Impact Statement. And then the Commission decision is that hexagonal box at the end.

This slide, Slide 10, shows a comprehensive -- some of the areas that the safety review is done and safety review is a comprehensive and in-depth review of the applicant's analysis and evaluation as presented in the application, ESP application, I mean.

It begins after the application is docketed. So during the safety review, the staff evaluates various technical areas and this is a partial listing of that. As I mentioned, emergency preparedness is listed there, security plan feasibility, seismology, geology, hydrology, meteorology, those are key aspects of the safety review.

All of our reviews follow a systematic approach. For the safety review, the staff documents its conclusions about whether or not there's reasonable assurance that the site is acceptable for a nuclear power plant based on the regulations in Part 52 and quality assurance programs.

As I mentioned before, as we do the review, the staff relies heavily on the guidance provided in the Standard Review Plan, NUREG-0800. But then in concurrence with paying close attention to all the regulatory requirements for the ESP.

MEMBER POWERS: Which of all of these categories that you have up there is most difficult for the staff to do? I know which ones are the most difficult for the ACRS to read.

(Laughter.)

MR. CHOWDHURY: Probably hydrology.

MEMBER POWERS: I would say hydrology is the most confusing for our review.

MR. CHOWDHURY: And that's what we have been experiencing also.

MEMBER POWERS: Geology is by far and away the hardest one to read. Hydrology is the most confusing to me.

MR. CHOWDHURY: And it has been. So my experience so far in handling this ESP application review process is hydrology is the area where we have -- I wouldn't say we have stopped or are having extreme difficulties, but we are still going through a comprehensive acceptance criteria of any new methodology that might be coming in or is on the horizon, particularly post-Fukushima events.

John, you had a comment?

MR. SEGALA: Well, I was just going to add hydrology and seismology, geology, as a result of Fukushima that's been a big area of study and the technical organizations that are doing that review are supporting both NRR and NRL. So they're being stretched to the --

MEMBER POWERS: Yes, the seismology group has a fairly developed catechism and procedures. The hydrology, like you say, you've got two problems. What the hydrology is, what the alternatives are and now what happens when you put a multi-ton structure on the thing and it affects the hydrology.

CHAIR STETKAR: One of the -- I admit hydrology is difficult, just a good Board, I guess, I guess I've been -- I've looked at ESPs. I've not been involved in them, so I don't know. But I've looked at site characterizations for COLs. I guess I've been a bit disappointed in the meteorological history that people have used. They tend to use five years' worth of data from -- the point of a greenfield site is good. Some meteorological station that's maybe a hundred miles away from the site and they pluck off five years' worth of data or something like that and that's supposed to characterize the site meteorology projecting out for -- pick a number, 40, 60, 80 years.

Have you emphasized -- you said post-Fukushima, obviously, there's been a lot more attention on hydrology and seismology. Is there more attention now to meteorology? Because we do have really good meteorological records of -- people really have the incentive to go look for that, both local and regional meteorology. They go back now a century or so.

MR. SEGALA: I am not sure personally what's changed as a result of Fukushima in terms of meteorology.

CHAIR STETKAR: I'm not asking about Fukushima, I'm asking for the next thing that happens.

MR. SEGALA: What I can say is that the regulations and the guidance and the staff's practices for an ESP review of meteorology is the same as what we would do for a similar review on the COL stage.

MEMBER POWERS: And to date, the questions that have come up have been exactly the same.

MR. SEGALA: Yes.

MEMBER POWERS: Especially in the ESP, you're not just projecting for 60, you're potentially projecting for 80 years.

CHAIR STETKAR: Right, you have no idea when time zero is.

MEMBER POWERS: And so we get into these questions of what does the future look like. Well, murky is about all you can say.

MR. CUSHING: And during our pre-app, we do discuss with the applicant the requirements they need for meteorology so that they don't collect two years of the wrong data before they send it in. So we do try to let them know the type of data and the reg. guides require.

CHAIR STETKAR: Thanks.

MR. SEGALA: I did want to add in the Clinton Early Site Permit review that was the first time the staff had entertained the probabalistic seismic approach and so that was a big challenge at that review, but I think since then the staff has laid out the guidance for doing those reviews.

MEMBER POWERS: I thought that development of that guidance went very smoothly. I was quite impressed with it. It was a brand new approach because they had a very difficult seismic site and I was -- they brought in a technology that had been established in some areas and applied it, the staff to go up the procedure for accepting and it went very smoothly from my perspective.

MR. CHOWDHURY: Slide 11 talks about Plant Parameter Envelope. I think it would be of interest to all of you. Many of you may already know about this. I'm going to just touch a little bit on Plant Parameter Envelope concept. And just to mention here as John mentioned earlier, Jack Cushing to our right, was involved in the NEI document, NEI 10-01, right?

MR. CUSHING: Right.

MR. CHOWDHURY: Which gives the industry guidance for Plant Parameter Envelope. And some of our ESP applications actually used Plant Parameter Envelope including the most recent one that I am involved with.

So the Part 52 allows for approval of a site for future nuclear power plant as a separate licensing action well in advance of decisions on the applicable technology selection and when to build. So in those instances where the ESP applicant has not specified a particular technology, ESP applications may nonetheless use the Plant Parameter Envelope approach as a surrogate for actual facility information to support the requested safety and environmental reviews.

Under the PPE approach, applicants do not reference a specific reactor technology. So what it is, PPE, is a set of reactor and owner-engineer parameters listed in the Early Site Permit data, expected to bound the characteristics of the reactor that might be later deployed at that site.

A Plant Parameter Envelope assessed for postulated values are parameters that provide details to support the NRC staff's review of an Early Site Permit application. So these are the bounding parameters that they provide in absence of a reactor technology selection at the time of the ESP.

If design parameters, however, exceed the bounding PPE values of the Early Site Permit, then the staff will have to conduct additional reviews. Alternatively, the applicant has the choice to choose the reactor technology when they submit the Early Site Permit application.

MEMBER BLEY: What's the mechanism to get a change to the parameters to allow building a different plant that doesn't quite fit those parameters?

In the Design Cert area, when you get to the COL you have to essentially make a change. Is it the same process for -- ESPs?

MR. CHOWDHURY: It is the variance process, the process of variance that an applicant can come with at the time of the COL.

MEMBER BLEY: So it's part of the COL.

MR. CHOWDHURY: The COL.

MR. SEGALA: But they have to demonstrate at COL that the design they've selected falls within the Plant Parameter Envelope and if a particular value exceeds that envelope value then they need to come in with an analysis or something to demonstrate that that's acceptable or redesign something or whatever,

MR. CUSHING: In the environmental space, we issue a Supplemental Environmental Impact Statement for Combined License that references an Early Site Permit and what we look for is first of all the design they selected bounded by the Plant Parameter Envelope. If it's not or if it's not in some particular manner, we would evaluate the impacts in that Supplemental EIS of anything that exceeds the Plant Parameter Envelope. So that's how we deal with it in environmental space with the -- and the majority of the plant parameter values are developed so that the Environmental Impact Statement can evaluate the impacts of constructing and operating the nuclear power plant, you know, thermal output, consumptive water use, those types of things.

CHAIR STETKAR: I mean in practice from the safety perspective, for example, the seismic response spectrum is not enveloped by the particular design. The process, at least at the COL stage would proceed essentially the same way regardless of whether you have an ESP or whether you're doing a design cert with the site analysis as part of the COL, is that right? I've forgotten whether it's a variance or exception or whatever the legal term is to the --

MR. SEGALA: For ESPs there's variance; for COL, there's departures.

CHAIR STETKAR: Whatever word you use, okay.

MR. CHOWDHURY: Continuing with PPE, Plant Parameter Envelope, it's essentially two-step licensing process. The ESP comes with data that's technology neutral and then technology selected and provided technology-specific information at the COL stage.

When reviewing the PPE as part of the ESP, the NRC essentially approves the PPE rather than specific technologies that the PPE values are drawn from. So as such, any plant technology that can be demonstrated to be bounded by the PPE is suitable for use at the COLA stage and we talked about the variance.

Slide 13, briefly talks about ACRS review and you know this better than we do because this is your review, but the process talks about ACRS review. Each ESP application and staff's Safety Evaluation Report that we present to you and you examine that and then ACRS reports to the Commission.

MEMBER POWERS: What we actually review is the SER and we report to the Commission on the SER. You guys actually review the ESP application. We examine the application, but our review is written of the SER.

MR. CHOWDHURY: As I showed on the flow chart, the procedure requirements for hearing is in 10 CFR Part 2 and it takes one of two forms. It is uncontested hearing, if there is no contentions filed, for example the case of PSEG ESP application, there are no contentions filed. But it's still mandatory. And if contentions are filed, then it will be a contested hearing.

MEMBER POWERS: Well, they have to be admitted.

MR. CHOWDHURY: Yes, contentions have to be admitted, correct.

Kevin, do you have anything you want to say about these hearings, briefly? Except for a high-level couple of items that I've shared.

MR. ROACH: I don't have anything to add. If anybody has any questions I can clarify.

MEMBER POWERS: It's out of our hands at that point.

MR. CHOWDHURY: Thank you. The ESP issuance -- that's Slide 15. And the Commission issues the ESP with terms and conditions, as it deems appropriate. The terms for the ESPs is valid for 10 to 20 years. And an applicant can -- an ESP holder can apply for renewal and that application must be submitted between 12 months to 36 months before the expiration of the permit they have in hand. It must contain information necessary to bring previous application up-to-date. And if approved, it will be good for another 10 to 20 years.

And site use for other purposes than is prescribed in the permit could involve new requirements or even termination of the permit.

MEMBER SCHULTZ: Prosanta, does that mean that when one would go forward with the COL that there isn't also an update to the Early Site Permit? Let's say it was 18 years ago that the Early Site Permit was granted and you begin the COL process. Is that going to require an update of emergency plans, security plans?

MR. CHOWDHURY: No, what was approved in part of the ESP remains. If there are substantial changes in -- emergency planning does have a requirement of new and significant information at the COL stage.

MEMBER SCHULTZ: Okay, I thought so.

MR. CHOWDHURY: Yes, it does. But unless it's required at the COL stage by regular COL regulations, then the answer is no.

MEMBER SKILLMAN: Prosanta, let me ask this. Valid for 10 to 20 years. Does that mean it's valid for 20 years or is it valid the first day into the 11th year to the last day of the 19th year? It's just the terminology.

MR. SEGALA: I think what it means is an applicant can request up to 20 years.

MR. CHOWDHURY: And then the ESP can be granted up to 20 years. That's how the regulation reads.

MR. SEGALA: They can request for a

10-year permit, a 15-year permit, a 20-year permit.

MEMBER SKILLMAN: Okay, and that is an option?

CHAIR STETKAR: But they can't request anything more than a 20-year --

MR. CHOWDHURY: And even if they request for 20 years, the granting of the permit by the Commission may be less than that period.

MEMBER SKILLMAN: Thank you.

MEMBER BLEY: Is there any reason you would apply for -- not you -- they would apply for less than 20?

MR. CUSHING: Nobody has.

(Laughter.)

MEMBER BLEY: It doesn't cost you more.

CHAIR STETKAR: Five dollars for a five-year permit.

MEMBER SKILLMAN: It's like a parking meter. Thank you.

MR. SEGALA: NRC has a flat rate.

MEMBER SKILLMAN: Let's go back on the flat rate. When does the review meter start to run?

MR. CHOWDHURY: Review of what, the application?

MEMBER SKILLMAN: Yes.

MR. CHOWDHURY: Starts?

MEMBER SKILLMAN: Yes.

MR. CHOWDHURY: The review -- here's how it works. We receive the application. We permit a 60-day acceptance review and then we docket it. Once we docket the application in the docketing letter, generally, we issue an overall review schedule. So I'll give an example. In August of 2010, we accepted the PSEG Early Site Permit application. But actually the review clock started first of October because that's when we internally decided that we can be ready to begin this, given other activities and other tasks.

So that's when it starts. The starting gate remains there. And then our end date, of course, fluctuates in most cases, or in all cases. So does that answer your question?

MEMBER SKILLMAN: Yes, thank you.

MEMBER POWERS: I will comment. In the past Early Site Permits, we got -- we, the ACRS, got them as a block. We're doing this one broken up in parts more like we're doing the Design Certification. And it's fine. The staff is doing a good job what they're bringing to us and what not. We've not run into any problems. It is the first time we've looked at them in a piecemeal fashion. But so far, that hasn't been a headache.

MR. CHOWDHURY: That's a good point. And we did that for this application as well as the other point I want to make is that we do have in our internal schedule, we do have a milestone for completion of the ACRS review and presentation. So we go by those and then however we work it out with ACRS, we do that, whether it's piecemealing or all together, but we still meet that date. If we can't, we extend or change it.

MEMBER SCHULTZ: How does the process work for the last bullet? An applicant would perhaps contact the NRC to describe what changes to the site might be proposed, another facility or something?

MR. CHOWDHURY: I think they will have to submit officially what changes, what new information, and then we have to review that. Just like I'm guessing. I have not been exposed to that, but my guess would be that we will still do sort of an acceptance review of the new information that they submitted. Or we decide for them to submit and they submit.

MEMBER SCHULTZ: It hasn't happened, but it's there for the possibility.

MR. ROACH: There is a requirement in Part 52, 52.35 that addresses site, use of site for other purposes.

MEMBER SCHULTZ: Thank you.

MR. CHOWDHURY: Last slide, 16, is what we have so far issued, Early Site Permit. Clinton, 2007, Grand Gulf, 2007; North Anna, 2007; and Vogtle, 2009. And the only PSEG application under review right now is the PSEG site application. And we have presented several safety evaluations to the ACRS.

MEMBER POWERS: We haven't given you enough questions up until now? I would just comment, I think the Early Site Permit process and it was new to us when we started this, but I think in general it's gone very smoothly. I think -- I see lots of advantages for doing that and certainly in the case of PSEG, I think they're using that in the right way. They think they might, but their economic climate is not such that they're going to build a nuclear power plant on that site, but they can do a lot of the leg work and ground work, so to speak, to get the site approved and it looks like a pretty good site as far as I can tell as far as we've gone in the review so far.

Do members have any other questions they'd like to pose? Well, thank you, John. Very helpful. It's yours, Mr. Chairman.

CHAIR STETKAR: Thank you very much. And again, thanks to the staff. We will recess for lunch.

I will remind the members to be back here promptly in time for the 12:30 meeting with Commissioner Magwood, so don't --

(Whereupon, the above-entitled matter went off the record at 11:45 a.m. and resumed at 2:15 p.m.)

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

2:15 p.m.

CHAIR STETKAR: We are back in session. The next topic we're going to hear about is subsequent license renewal and before I turn it over to Dick, I'll characterize this as hi, we're the ACRS. We're here to bayonet the wounded. I understand you had a good meeting with the Commission.

(Laughter.)

And with that, I'll turn it over to Dick.

MEMBER SKILLMAN: Good afternoon. Welcome to each of you. I'm Gordon Skillman. I'm the chairman of the Plant License Renewal Subcommittee. We're going to discuss agenda item 5, SECY-14-0016, ongoing staff activities to assess regulatory considerations for power reactor subsequent license renewal.

We have about two hours to discuss this important topic.

The full committee will review issues pertaining to the SECY. A subcommittee was held on April 8th to review this SECY and briefly, the SECY addresses the potential for extended operation of power reactors beyond 60 years and also addresses the topic of adequacy of the current regulatory framework for subsequent power reactor license renewal applications.

This afternoon, we will hear presentations from the Division of License Renewal, the Division of Risk Assessment, the Nuclear Energy Institute, and the Electric Power Research Institute.

We have not received written comments or requests to make oral statements from members of the public regarding today's sessions. The entire meeting is open to public attendance. There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed in a listen-in mode during the presentations and the committee discussion.

A transcript of this meeting is being kept and will be made available as stated in the Federal Register notice. I ask that participants please use the microphones located throughout the meeting room addressing the full committee.

The participants are requested to please identify themselves and speak with sufficient clarify and volume so that they can be readily heard. I also ask that you put your electronic devices on mute.

We will now proceed with the meeting. And I welcome and call upon John Lubinski to begin the presentation. John?

MR. LUBINSKI: Thank you, Dick,

appreciate it. I'm John Lubinski. I'm the Director of the Division of License Renewal in NRR. With me for the briefing today I have Bo Pham, who is Branch Chief in the Division of License Renewal in NRR, and Dr. Mirela Gavrilas, who is Acting Deputy Director of the Division of Engineering in the Office of Research.

I'd like to start by thanking the committee for both the opportunity to be here today and also the subcommittee meeting, as Dick mentioned, on April 8th. I appreciate the feedback.

And also, I look forward to coming back again as we continue to look through and work through the technical issues associated with subsequent license renewal and develop guidance. And we look forward to those interactions as well.

Go to the next slide.

I'll quickly cover the agenda for today. We're going to start with Bo Pham providing an overview of licensing and oversight during the first 60 years of operation which includes our first license renewal period. We believe this is important to understand because this informs the recommendations we're making for subsequent license renewal.

To support that, the staff reviewed the policies, regulations, guidance, and technical information to determine if changes were needed to the regulatory basis or the policies before we could review the first subsequent license renewal application. Our conclusions are, we believe, the policies and principles supporting license renewal are appropriate for subsequent license renewal. And based on those policies, we believe there are some regulatory changes that need to be considered and are currently before the Commission in SECY 14-0016. But we'll talk about those changes as well.

Then we will talk about the technical review issues that we're dealing with. Dr. Gavrilas will discuss those. Those issues will be addressed in guidance documents that as I said earlier, we will come back and brief the ACRS in more detail on those issues. So with that I'll turn to Bo Pham.

MR. PHAM: Thanks, John. Good afternoon. In order to be -- before we even get into the discussion about license renewal, I'd like to start with a discussion regarding safety during the first 40 years of plant operation.

To ensure safety, the NRC relies on the current regulatory framework and processes. This includes an iterative relationship and feedback between our regulations, licensing, and oversight activities in order to assure adequate protection of public health and safety at every point in time during the plant's operation.

The regulatory process ensures that potential safety, security, and emergency preparedness issues are resolved when they are identified. This includes resolution of issues of both on a plant-specific basis and a generic basis when they affect more than one plant.

So plants are required to maintain their licensing basis including changes that enhance plant safety. These include enhancements which are voluntary on the part of licensees such as changes made under the 50.59 process; 10 CFR 50.59, that is. Enhancements which require NRC approval such as license amendments for implementation such as NFPA 805 or power uprates. And enhancements mandated by the NRC such as actions in response to Three Mile Island and the Fukushima Near-Term Task Force.

Aging management is important during the first 40 years of operation and is ensured through our regulations, licensing, and oversight as shown here on this visual. Aging management tends to be associated with license renewal, but in fact, management of these activities under the existing regulatory program already address aging management through implementation of process and techniques that are capable of identifying aging effects before they impact safety and allow actions to be addressed, taken and addressed, including mitigation or repair or replacement.

Next slide, please.

So for the first license renewal for 40 to 60 years, the NRC established two fundamental safety principles summarized on this slide. First, with the exception of the detrimental effects of aging, the existing regulatory process is adequate to ensure safe plant operation. As indicated on the previous slide, this process includes the continued implementation of licensing and oversight activities and ensure potential safety, security, and emergency preparedness issues are addressed when identified.

Second, each plant's licensing basis must be maintained during the renewal term. As additional stipulation for license renewal, licensees must implement license renewal Aging Management Programs as part of their new licensing basis. These principles were established during the development of 10 CFR Part 54 and have guided us through to where we are today. Plant's have safely operated in the period of extended operation since 2009 with collectively more than 56 reactor years of operation beyond 40 years.

Next slide.

As part of the staff's procedure to determine what's needed for subsequent license renewal, the staff reexamined the policies and principles for license renewal and determined they remained valid and acceptable for subsequent license renewal. The staff then evaluated whether any changes were needed to the regulatory framework, based on following the two principles of license renewal I just covered.

The staff also looked at identifying any issues that were unique to license renewal and whether the issues -- where any issues were needed to maintain safety specifically in the 60 to 80 year timeframe. The staff included these proposed changes in its SECY paper to the Commission and is currently seeking the Commission approval to confirm the principles of license renewal continue to be valid for subsequent renewal. And in order to have a strong and clear alignment between our regulations, guidance, and implementation activities, the staff is able to initiate the rulemaking process which would commence with the development of a regulatory basis as provided in the SECY paper.

Next slide.

The SECY paper recommendations provide the Commission with four options. I'll start by focusing on the regulatory changes proposed in Option 4 of the paper as that was the one that the staff had recommended for implementation. I'll also note that Option 2 and 3, if Option 4 was approved, Options 2 and 3 would be included in that.

Option 4 includes the suggestions for rule revision specifically applicable to subsequent license renewal and included requirements to ensure that the effectiveness of Aging Management Programs is maintained through the 60 to 80 year timeframe and also a reduction in time before a subsequent license renewal application can be submitted to the NRC for renew.

With respect to the aging management aspect of it, that requirement, the program has three components. The first will require licensees to perform self-assessments to determine to effectiveness of the Aging Management Programs. The second component will require licensees to report age-related degradations to the NRC. And the last would require licensees to report certain changes to subsequent license renewal activities.

One of the drivers for the suggested changes that the staff had recommended came from -- partly came from the insights that we gained from conducting audits at three facilities. Audits we call the AMP effectiveness audits where part of the findings from the staff there was the fact that the documentation that was available did not clearly provide an auditable trail of how Aging Management Programs were maintained or modified over time based on any implementation, operating experience, or lessons learned of implementing those aging management activities.

Therefore, the staff feels that the suggested rule change would ensure consistent and timely feedback to alert the NRC as well as the industry of any changes to aging effects and degradation mechanisms and make it possible to share lessons learned in aging management activities across the fleet.

MEMBER SKILLMAN: When you say suggested rule change, specifically which rule are you referring to, please?

MR. PHAM: On this slide, we're talking about the recommendations in Option 4 for maintaining the -- enhancing the effectiveness of Aging Management Program.

MEMBER SKILLMAN: So that's specifically directed to the AMPs?

MR. PHAM: Yes.

MEMBER SKILLMAN: Thank you.

MR. PHAM: So there are three components of that. The staff feels that providing this information is critical to the staff having reasonable assurance of adequate protection during the 60 to 80 year timeframe mainly because it continues to focus on aging management and the safety impacts. It improves the effectiveness and efficiency of the NRC's oversight and inspection activities. And probably most importantly, it provides an enforceable mechanism to ensure Aging Management Programs' effectiveness is maintained in the 60 to 80 year timeframe.

While the industry has taken some initiative to developing an assessment tool, solely relying on this as a voluntary initiative, the staff feels would limit the enforceability of the activities for the NRC.

The details of what would actually be in the actual requirements themselves, the staff is hoping would be further developed as we get approval from the Commission to go forward with the rulemaking process, but at this time we're asking the Commission for the approval to undertake that and further enhance the stakeholders.

MEMBER BLEY: Could you repeat about two sentences back where you talked about industry initiative and something wouldn't allow you to be effective? Could you repeat that again?

MR. PHAM: Well, what you will probably hear from the presentation of the industry is that they have taken efforts, for example, look at the means to do a self-assessment of the Aging Management Program. The concern the staff has is sort of the regulatory reach of what some people refer to as the regulatory footprint. For lack of a better way of saying it, the enforceability of a voluntary initiative by the industry. I think at best and it's a case-by-case situation if you look at it, but at best when the industry has taken a voluntary initiative, the burden becomes enormous on the staff to -- without a clear mandate of a requirement, the burden is put on the staff to define whether if a licensee decides not to undertake a voluntary initiative that they said they would, to whether -- it's tenuous whether the staff can really make a strong case for enforcement regarding that.

I can't talk to that in absolute terms. It would have to be on a case-by-case basis. But that's just an example of the burden that we think that the staff would not have to be clear.

MEMBER BLEY: You said they proposed an approach that they published.

MR. PHAM: Yes.

MEMBER BLEY: Now in other cases, NRC has endorsed not as a voluntary program, but they have endorsed an approach suggested by industry and say do it except for the following areas where you want to do something different. That's a possibility, right?

MR. PHAM: It is a possibility.

MEMBER BLEY: If it stays voluntary, you don't have any way to enforce it.

MR. PHAM: I think it would limit our ability to enforce it.

MEMBER CORRADINI: Why is that? I'm confused. I'm with Dennis. I don't understand.

MEMBER RYAN: I have a question specific to that. How can you -- if you have a license condition, that's an enforceable requirement?

MR. PHAM: Yes.

MEMBER RYAN: That's the vehicle by which you could enforce an enforceable requirement.

MEMBER BLEY: And there are other vehicles.

MEMBER RYAN: And there are others, too.

MEMBER CORRADINI: I guess the question that Dennis was going down was why do you need a rule when a license condition for continued operation could be an effective mechanism?

MR. PHAM: I guess the way I would characterize it as you're right, a license condition is a legal, enforceable requirement, just as a rule is. But I guess one way to look at it is, if you're going to put the same license condition to every plant going through on the same thing, the staff's perspective is if you're going to do that why not go through the rulemaking process which allows for a lot of extensive further engagement with all the stakeholders to get the input at that level rather than just doing it on a case-by-case basis and doing the same thing.

MEMBER RYAN: The other side of it is before you have a rule, you have a few opportunities to try it out, so that when you get to the actual rulemaking you've got a little bit of experience to help you make a better rule.

MR. PHAM: So the gist of all our recommendation is let us go into the rulemaking process, so that we can further explore that. That's the whole concept of the rulemaking so that we can engage all the stakeholders and figure out what is the best path forward.

MEMBER BROWN: I would argue that -- I'm just listening to these smart guys. If you've got a license condition, you put one on each of the plants that gives you then a longer term flexibility as things -- for different plants have different circumstances gives you the flexibility to accept something whether having to deal with a rule that you have to -- that's been put in place which is pretty ironclad.

So to me, you have the ability to deal with a specific change if they requested it to their license condition. You don't necessarily have to evaluate or say now do I have to consider this for every other plant that's taken --

MR. PHAM: I would say, in general, license conditions are best used when it's plant specific rather than a generic condition that applies to everybody. John?

MR. LUBINSKI: If I could add two points to that. As Bo said, you may hear about what the industry is proposing. We have not seen anything from the industry yet. We just know from the ACRS subcommittee, there's a slide that said they had guidance. So we have no idea --

MEMBER BLEY: I didn't realize that.

(Laughter.)

MR. LUBINSKI: That's number one, I want to clarify is that nothing is in front of us. Nothing has been proposed. It's just we've heard that and you can ask Jason Remer when he gets up, the details about that. But number two, when you talk about imposing a license condition, we cannot just unilaterally impose a license condition. The licensee needs to accept that. If the licensee were to challenge and say where is it in your regulations that requires this and we can't point to a spot in the regulation. They can say no and if we choose not to give them the license based on that we're in front of ASLB trying to defend a position where we have no regulatory foundation.

So that's why even though it's a license -- you're talking a license condition route, it still needs to be voluntary on the part of the applicant to do that activity. We cannot just unilaterally impose a license condition.

And then as Bo said, I totally agree with him. If you're talking about something that's a consistent approach across the board, you want to go to a predictable process of rulemaking and make sure that everyone is treated consistently. License conditions are best used for licensee-specific activities.

MEMBER BALLINGER: You used the word voluntary. In this case, given the NEI and EPRI and the industry, isn't it more of a case of being volun-told? I mean the industry is all over this aging management issues. I mean I think they're committed, are they not?

I mean when they tell you it's voluntary, we're going to do it, they're doing it.

MR. PHAM: Yes, but I mean from a regulatory perspective, that's only as good as you've bought into a situation when somebody decides they have a good basis that they don't want to do it and it becomes a legal consideration of whether the NRC can actually take enforcement action on it.

MEMBER BALLINGER: I think I led us astray. It was just the way you phrased something bothered me. They can't get a license to operate beyond 60 years without a new rule, right?

MR. PHAM: No, they can. The rule does not prohibit going beyond 60 years. Now what we're proposing to the Commission is before that first application comes in, we would like to entertain going through a couple of these issues through rulemaking to add the additional requirements.

MEMBER BALLINGER: Okay.

MR. PHAM: If we don't do this, then the rule stands today and as I said, anything voluntary on the part of licensee would truly be voluntary at that point. And from the standpoint of what they're doing today, we don't have clear evidence to say what they're doing today would meet the intent of this rule, nor if they're proposing new guidance we have not engaged with them yet to talk about any details of how it's achieving these objectives. Next slide.

MR. PHAM: Next slide.

Going forward, Option 4 also considered a change in the time before a subsequent license renewal application can be submitted to the NRC for review. Current requirements allow for an applicant to submit an application the very day it enters a period of extended operation for the first license renewal.

The staff feels that this situation might not provide sufficient time for a licensee to gain the experience, the operating experience, of implementing the aging management programs and gaining the lessons learned and operating experience from that. Therefore, there must be sufficient time for the licensees to implement these programs during the first period of license renewal to demonstrate the effectiveness of the program.

This information will be critical to the staff in its assessment of program effectiveness in that 60-to-80-year timeframe. So, to address this, the staff is recommending a reduction in the timeframe, the current timeframe, the current 20 years that licensees are allowed to submit their application for subsequent renewal.

The specific timeframe that would result out of that would come out of any efforts that we have with rulemaking. And once again, that would require additional and further engagement with the other stakeholders.

MEMBER CORRADINI: Can you just repeat that last part, since I wasn't in the Subcommittee meeting? Can you just repeat the last part?

MR. PHAM: So, in order to address the staff's concern about the lack of operating experience in the first period of extended operation for license renewal, the staff is proposing to reduce the 20-year out that licensees are allowed to submit an application for subsequent renewal.

So, as of today, the current rule allows for a licensee to submit an application up to 20 years out from the end of license.

MEMBER CORRADINI: Oh, that's what I --

MR. PHAM: Okay.

MEMBER SCHULTZ: Without pinning you down, what do you think is reasonable?

MR. PHAM: You're kind of pinning me down.

(Laughter.)

MEMBER SCHULTZ: This is a discussion. Ten years?

MR. PHAM: I would say, sir, I don't have all the information. And like I said, that would need to come from additional engagement with the different stakeholders and the industry's perspective.

MEMBER SCHULTZ: Thank you, sir.

MEMBER RICCARDELLA: This is a limit on how early they can do it. Is there a limit on how late they can submit?

MR. PHAM: Well, how late they can do it is stipulated by the timely renewal rule, which is more of an administrative act perspective to say, you know, prior to the five years, prior to the end of life, they would have to submit the application for the administrative review.

MEMBER RICCARDELLA: Isn't that more likely? I mean, what utility is going to come in -- I mean, usually, they are looking at when is the latest I can submit it, not when is the earliest. I mean, is anyone likely to try to submit 20 years before?

MR. PHAM: I mean, based on our experience, you have sort of a 20-plus span among all the different licensees out there right now. And so, you do have a pocket of plants right now that are going to start, like about maybe a handful of them, they are going to run out of their license. They are going to end the First Period of Extended Operation by the 2029 timeframe. But there is also another group that won't happen until 20 years after that, basically. So, it is hard to kind of make that call.

MEMBER CORRADINI: I guess where I was going with the question was, first, we have to clarify. I am still struggling with, I am trying to understand if there is something missing in the current rule that you need a rule for, or is it a slow evolution? The fact that you would take a couple of pilot cases and talk with the industry through this might be the best way to do it than to go through the whole rulemaking process.

I am missing something. I am looking for the one or two triggers that require a rule versus a slow evolution of degrading.

MR. PHAM: I would say, no, I would say, given the current role, a licensee could submit an application as early as 20 years out.

MEMBER CORRADINI: Right.

MR. PHAM: And the NRC could hold onto the application and not begin its review --

MEMBER CORRADINI: Right.

MR. PHAM: -- to accommodate what we are looking for here.

But if you look at that, that is not a practical case to do it, either, because what will happen is, by the time the NRC, the staff, picks up the review, there is going to be a lot of updating to the actual document that was submitted itself. And so, you go through a much longer round of RAI, a sort of reconstitution of the information that was provided. This doesn't present itself in a very practical scenario.

So, I think what the staff is proposing is more of an upfront, transparent expectation, so that all the stakeholders can understand what we are expecting.

MR. LUBINSKI: And I think, as someone said earlier, kind of the pilot-type situation or the gradual; this will be one that, if the rulemaking did not go forward, we could look towards the industry on when they are submitting the applications. And the first application may come in 10-15 years out, you know, 12 years out. And we may look at that and find it to be acceptable. And then, the minute the first one starts coming in 20 years out, that is where we could, as Bo was saying, look at it and say, "You don't have enough operating experience right now."

We are looking at this as an acceptance review standpoint, and we continue to ask them RAIs, but we don't think that is the best way to do business. We are saying we want to be predictable and say that.

But, if we were to go back and not make this a rule, from a safety perspective, we would be able to make sure we got the information we needed moving forward.

Also, in answer to the question of licensees wanting to come in earlier, there are incentives for licensees to come in early, as early as 20 years. Predictability, from the standpoint of whether or not they are going to have a license to operate beyond 60 years. I understand there's also financial benefits to getting the license early. When you are making capital investments, you are looking at the longer-term versus only a 60-year term.

So, that is one of the reasons that they are looking at coming in earlier, and we heard some of that this morning during our Commission meeting.

MEMBER SKILLMAN: Bo, I am going to ask you to go very quickly. We are out of time on your watch.

MR. PHAM: Okay.

MEMBER SKILLMAN: We have several other individuals or organizations that have come to present. We have got to move very quickly, please.

MEMBER CORRADINI: But can I just clarify?

You answered my question in timing, and I was looking for a technical reason that a step change in something after 60 years. And what I heard was timing. So, my interpretation is there is a slow evolution of these issues, but there is nothing that is dramatically changed when I go from 40 to 60, 60 to 80?

MR. PHAM: No, the whole point of that particular requirement that we proposed was to allow a licensee to gain more operating experience.

MEMBER CORRADINI: Okay, fine.

MR. PHAM: Yes. We don't have that information now.

MEMBER CORRADINI: Thank you.

MR. PHAM: Okay, the next slide.

I am going to try to do my best to get through this.

For this next slide, as I previously mentioned, licensees are responsible to the maintenance of the licensing basis. There are three ways up there that the licensing basis can change over time.

What I was trying to convey with this particular slide is that what wasn't recommended as an actual rulemaking in the paper, but we did provide an extensive discussion about, was the staff concern that -- the discussion regarding the coordination that will occur between the subsequent license renewal effort and the Fukushima effort.

And the reason that came up was because during the initial assessment of the regulatory framework the staff looked at things surrounding a plant's environment that could change over time, like the local water table, meteorological pattern, and determined that some of these changes might, as a plant operates further out from its original license, these changes could be significantly different from the original or the plant's current licensing basis. And there wasn't a clear, there wasn't a specific requirement for licensees to assess these changes against plant safe operation.

However, during the process, the staff also acknowledged that the staff in the Fukushima activities effort are also looking at the same thing. And so, the discussion we provide in the paper is just wanting to acknowledge that validating or verifying the validity of these changes over time in a plant's surrounding environment parameters would be more appropriately left in the Fukushima effort, which is a more broader, holistic look at plant licensing basis, rather than addressing it as part of that license renewal.

MEMBER SKILLMAN: Okay, let's move, please.

MR. PHAM: Other considerations, I won't go into, but the next slide I was going to summarize through the Options 2 and 3 and the requirements for that. I think some of the other speakers might speak to those as well.

MEMBER SKILLMAN: Okay.

MR. PHAM: And those were in the SECY paper itself.

Next slide.

I am going to talk briefly about the non-concurrence that arose as we were developing the

SECY paper. The non-concurrence requested that staff provide a consideration for the Commission to require upgrading of PRA in the applications for subsequent license renewal.

The staff considered it and weighed it against what I spoke earlier about and with the principles of license renewal. While the PRAs provided value and insights in identifying areas where we can increase or limit or decrease focus areas from a regulatory perspective, we did not agree with the suggestion to add this --

(Noise of shuffling paper on microphone.)

CHAIR STETKAR: I warned you.

MR. PHAM: Yes.

CHAIR STETKAR: Move your paper back.

MR. PHAM: And we did not agree with the statement from the non-concurrence because of several reasons.

First is that we did not think that PRA is required for plant safety today. While it provides valuable insight into identifying focus areas that may need more or less focus, it is used to supplement the staff's current deterministic approach in license renewal right now.

The use of PRA is also not an issue unique to license renewal, which we spoke about with the principles of license renewal.

And finally, the staff feels that the current regulatory framework, as stated in the statements for consideration for Part 54, as well as the Commission's policy on PRA use, allows for the use of PRA today.

And then, I am sure Joe Giitter will speak more about that for his part as well.

MEMBER SKILLMAN: Thank you.

For those in attendance, we will hear from Joe Giitter here in a few minutes.

Let's move --

MR. PHAM: Sorry for the long version, but I am now passing it over to Dr. Gavrilas to go over the technical aspects.

MEMBER SKILLMAN: Thank you, Bo.

MS. GAVRILAS: I am going to cut it short because I think you know about how we engage and how we try to canvass the state of knowledge. I am skip over the background information in the interest of time.

But I will mention a couple of things from this slide. The most important one is we have Memoranda of Understanding with the Department of

Energy and with the Electric Power Research Institute. In the context of those Memoranda of Understanding, we are participating in the programs and exchanging information. And that is a very valuable contributor to the base knowledge that the staff has.

In addition to staying aware of what the industry is doing, what DOE is doing, what the international community is doing in aging-related issues, we have embarked on a couple of activities. The staff has undertaken some activities specifically aimed at addressing our concerns.

One of those important activities just was mentioned by Bo, and I am not going to go through it again. We audited the effectiveness of aging management programs at three plants, and I will repeat what the conclusion of that audit was. It is not that the aging management programs were not implemented. We found them and they were there, and they were evolving.

What we didn't find was the rationale behind how the programs were evolving. So, I think the staff who looked at those aging management programs was concerned that we are five years into the PEO and we can't find why a program has evolved, what aging mechanism, what degradation mechanisms that aging-related triggered the evolution. And we are concerned that after 20 years there is going to be no trackability basically in a program. So, just to summarize what you heard from Bo.

Next slide, please.

The other very significant effort that the staff engaged in was the follow-on to the proactive materials degradation assessment which was first completed in 2007. It was published in 2010. So, in 2008, we initiated this follow-on effort, which looked not just at piping and vessel internals, which were covered by its predecessor, but also started looking at the reactor pressure vessel, at electrical cables, as well as the concrete structures.

And the way this program works, it was a cooperative effort between us and the Department of Energy under its Light Water Reactor Sustainability Program. And we had 28 internationally-renown experts who populated four panels. They used phenomena identification and ranking techniques to come up with what we called the most significant technical issues for subsequent license renewal.

A caveat on those technical issues, they involved, they looked at phenomenology; they looked at degradation mechanism. They looking at nothing that had to do with maintenance or any other life-cycle aspect of the issue.

Next slide, please.

So, the comment I got when I went through it in the Subcommittee was that I was at 30,000 feet. I am moving it up to 50,000 feet for this occasion, and I am going to quickly talk about only the high-susceptibility degradation scenarios.

And what you see on this slide are the things that we know something about and the things that we don't know enough about for the 60-to-80-year timeframe. And what I mean by we don't know enough about has to do with either we don't understand the mechanism or we don't have models to predict or a combination of the two.

So, in the piping and core internals panel, the conclusion was that, with regard to primary water stress corrosion cracking, we know what we need to know. And if we are doing testing now, it is because we are using new materials, but the base of knowledge is strong.

The panelists also felt that we have enough information for pitting and microbially-induced corrosion, what stagnant water does to balance-of-plant system.

The big concern that came off in the piping and core internals panel was irradiation-induced degradation of core internals. Everybody feels that there is not enough information for the 60-to-80-year period.

In the reactor pressure vessel, there is a broad base of knowledge that was accumulated over the past four decades, and the general consensus was that, while neutron irradiation embrittlement is a high-susceptibility degradation scenario, we also have high knowledge.

And there was one something that had to do with environmentally-assisted degradation that was low knowledge, but it was medium susceptibility.

In electrical cables, again, we understand the thermal and irradiation effects. However, we are doing work with regard to condition monitoring, especially with regard to having better confidence with regard to the ability of cables to operate in accident conditions. So, that is what you are seeing under low knowledge.

Under concrete structures, the panelists agreed that things caused by outside conditions, such as freeze-thaw damage, are well-understood by now. And when you see low knowledge, alkali silica reactions are well-understood from a chemistry perspective, but what is less known is the impact that that reaction is going to have on the structural of properties of the structure.

And I apologize, I went so fast, but my intent today was just to give you a broad overview of what is going on, and we have made the offer before to come back in front of you. And, frankly, to do justice to all these topics, I think I calculated you need about 20 people, and I am not one of those in front of you.

CHAIR STETKAR: I think for the Committee's benefit we have already started some discussions with the staff to proceed at the Subcommittee level on more focused technical exchanges.

MEMBER SKILLMAN: Thank you, Dr. Gavrilas, for making it so brief and so sharp. Thank you.

MS. GAVRILAS: Thank you.

MEMBER SKILLMAN: Okay, Bo, back to you. One or two more slides?

MR. PHAM: Yes, thank you.

So, in summary, the staff is requesting the Commission to approve its recommendation in the rulemaking process, which would commence with the development of regulatory basis. We expect the Commission's SRM in the near future to start developing the regulatory basis for the rule. This effort will require considerable interaction with the stakeholders.

The staff will continue research, support, development of effective aging management programs to support subsequent license renewal and will document its conclusion in the revision to the Generic Aging Lessons-Learned Report and at that time come back to the ACRS again to discuss the findings in more detail.

Next slide, please.

In summary, we believe that the two principles of license renewal that I have provided in my earlier slides provide an effective basis for ensuring safe operations during the license renewal period and are an effective basis for subsequent lessons renewal.

I believe that the staff has provided an overview of the regulatory framework changes proposed in the SECY Paper 14-0016 and the technical work being summarized by Mirela.

This concludes our presentation, and the staff is ready to answer any questions you may have at this point.

MEMBER SKILLMAN: Bo, thank you.

Colleagues, do you have questions for Bo or Mirela, please?

(No response.)

All right. Thank you very much.

And I would call upon Joe Giitter to please come forward for his portion.

And, Joe, I would ask you, please, to lead us through this as swiftly as you are able, please.

MR. GIITTER: I will. Yes, I will.

MEMBER SKILLMAN: Thank you.

MR. GIITTER: Thank you again for the opportunity to discuss why I believe that subsequent license renewal -- yes?

CHAIR STETKAR: You are going to have to operate the system with your left hand.

MR. GIITTER: With my left hand?

CHAIR STETKAR: Meaning we are a low-budget operation.

(Laughter.)

MR. GIITTER: Thanks. I'm going to run through this quick because I know we are limited for time.

First and foremost, I believe that the regulatory framework for renewing the license for plants up to 80 years of operation should explicitly consider risk insights. And I believe that is supported by the 1995 Commission Policy Statement on the use of PRA, which states, "The use of PRA should be increased in all regulatory matters to the extent supported by the state of the art."

However, when the SECY on subsequent license renewal came to my Division for concurrence, there was no discussion of substance on the role that risk would play in ensuring the safe, continued operation of plants beyond 60 years.

Next slide.

As you have heard earlier from the license renewal staff, the regulatory framework for subsequent license renewal is largely based on processes that were developed 20 years ago for initial license renewal.

What I am proposing is that you look forward 20 years instead. On the one hand, envision newer passive reactors, say AP-1000s or Small Modular Reactors that have updated, high-quality PRAs that are effectively used to manage risk at those plants.

Operating alongside of those plants are older designs that may not have updated PRAs because there is no requirement for a PRA, let alone an upgraded PRA. And so, without a PRA requirement for its subsequent license renewal, these plants may have outdated PRAs that may not reflect plant risk. There is no guarantee that the PRAs are going to be maintained. Right now, the PRAs are at a fairly-good level because of voluntary initiatives, and a lot of those voluntary initiatives are initiatives that benefit the licensee, like risk-informed tech spec 4-B, which increases allowed outage times; to a certain extent, the fire PRAs that are done for NFP 805. But, without those voluntary initiatives, it is not clear to me, anyway, that PRAs will be maintained and upgraded.

So, the fundamental question is whether this incongruous situation where you have newer passive plants that have requirement for maintaining and upgrading PRAs that are operating alongside of older plants -- and we are talking about some plants that were designed back in the sixties and seventies; they don't have a requirement for PRA and, in fact, have a risk profile that may be two orders of magnitude greater than the newer reactors. So, to me, that represents an incongruous situation.

Next slide, please.

As you heard earlier from the license renewal staff, the regulatory framework for license renewal relies on the Maintenance Rule to ensure active component reliability, and it relies on the aging management program associated with license renewal to ensure the passive components are reliable.

And although these approaches are fundamentally different, I believe that both the Maintenance Rule and the aging management program can benefit from a maintained and upgraded PRA.

With regard to active components, there is no doubt that the Maintenance Rule, which is risk-informed and performance-based, has improved active component availability and reliability and resulted in more effective maintenance practices. The effectiveness of the Maintenance Rule could even be further strengthened by an updated high-quality PRA.

With regard to passive components, the aging management program for license renewal treats all components equally, regardless of how they contribute to risk. Yet, our experience with risk-informed ISI tells us that some passive components are more risk-significant based on the likelihood of age-related degradation and the consequences of failure. And I am going to illustrate that with my next slide.

This is a table that is taken from the

risk-informed ISI methodology that is used by EPRI. And the table illustrates at a high level one of the methods, the EPRI method, to do risk-informed in-service inspection. And I am going to simplify this.

At the top of the table, there is a consequence category that is based on conditional core damage probability of a particular break. The degradation category is based on the potential for pipe rupture. So, for example, the high category includes two severe loading conditions, water hammer and vibration fatigue. If these loading conditions are accompanied by a degradation method such as flow-accelerated corrosion, then there is a higher potential for pipe rupture. So, the inspection would place emphasis on flow-accelerated corrosion in those sections of piping in the medium- and high-conditional core damage probability category.

A very similar approach could be taken for evaluating the age-related degradation as part of a license renewal program, but it would require an up-to-date and accurate PRA to ensure that the appropriate SSCs are scoped-in based on risk.

Let me go to the next slide to further illustrate this point.

Under the current license renewal aging management program, as I said, all safety-related passive components are scoped-in. However, as the Committee members know, safety-related components are determined based on stylized accident scenarios that are neither realistic nor necessarily risk-significant.

If we look at the experience from risk-informed licensing applications, you can conclude that a significant fraction of safety-related structures, systems, and components are actually not safety-significant. You can see that in the table here. This was based on the South Texas experience.

Conversely, we know that there are structures, systems, and components that are safety-significant that were not identified as safety-related under a deterministic approach. In this case, it was 1 percent of the non-safety-related systems.

In the next slide, I wanted to make a point. Risk-informed ISI has been used extensively in the U.S. and abroad to focus resources on SSCs having the greatest risk significance. However, as with all current risk models, it is assumed the failure rate is constant.

The chart on the left, which I know you have all seen, illustrates a bathtub curve. With time, all structures, systems, and components will eventually begin to wear out, and the failure rate can no longer be considered constant. Many of our international counterpart regulators, who are also considering life extension and even adopting aspects of NRC's license renewal process, have begun to evaluate methodologies for incorporating aging effects in the PRA.

For example, just a couple of months ago, the Canadian Nuclear Safety Commission sponsored a seminar on this topic and encouraged the NRC participation, and we did have some folks from Research who participated in that.

The NRC Office of Research also conducted some studies in this area, including NUREG/CR-5632, which looked at flow-accelerated corrosion using reliability and physics techniques. And that was actually co-authored by George Apostolakis.

Again, looking to the future, as these methodologies become further refined, it is not unreasonable to expect updated PRA models to incorporate aging effects in a model of risk-significant failures of passive components. I believe that such an approach could be an essential tool to understand and manage the risk associated with operation beyond 60 years.

Next slide.

This slide illustrates the differences between the two approaches that you have heard about. Without a PRA requirement, the NRC would, by default, approve operation of plants to operate beyond 60 years without explicit consideration of risk. Right now, for license renewal, initial license renewal for the 40-to-60-year period, licensees are required to do a Severe Accident Mitigation Alternatives Assessment which is based on the best-available PRA results. However, the SAMA analysis is a one-time requirement that would not be repeated for subsequent license renewal.

So, the path that I am advocating today leverages risk insights based on high-quality, plant-specific risk profiles and our best understanding of age-related phenomena to help ensure that these plants will continue to operate safely and efficiently beyond 60 years.

A question came up during the full Committee meeting, and I want to address it here. Why wait for a subsequent license renewal rulemaking? And as I said before, in recent years the biggest improvements in PRA quality have been the result of voluntary initiatives, but there is no guarantee that that is going to continue into the future. And without additional incentives, I don't have a lot of confidence that licensees are going to voluntarily update and maintain their PRAs.

MEMBER SKILLMAN: Joe, let me ask you to back up just a second.

MR. GIITTER: Sure.

MEMBER SKILLMAN: You said "during the full Committee meeting". Do you mean during the Subcommittee --

MR. GIITTER: I'm sorry, the Subcommittee meeting.

MEMBER SKILLMAN: Okay. Let's restart the tape. Go ahead.

(Laughter.)

MR. GIITTER: Okay. I'm sorry. During the Subcommittee meeting, this question came up.

MEMBER SKILLMAN: Thank you. Thank you.

MR. GIITTER: Thank you for pointing that out.

So, a PRA requirement for subsequent license renewal would be one way of ensuring this.

In response to the non-concurrence, there was a discussion of efforts underway in support of the Near-Term Task Force Recommendation 1 and the risk-management regulatory framework as potential means of addressing a PRA requirement for operating reactors. I can tell you I have staff supporting both of those efforts, and you have probably seen -- or maybe you haven't seen -- the latest version of the SRM on NTTF-1. But I'm not convinced that you are going to see a PRA requirement coming out of either one of those initiatives.

In fact, based on cost estimates that were developed by the staff and industry, it was concluded that the cost to existing Part 50 licensees was greater than the safety benefit. And that was in the attachment to the NTTF SECY Paper.

Because the Working Group on the Near-Term Task Force Recommendation 1 did look at an approach for modeling which was modeled after the approach recommended by the Risk Management Task Force. It required licensees to develop plant-specific PRAs, and that was a conclusion.

This is primarily because the scope of a 50.109 backfit is limited to radiological health and safety and common defense and security; and, also, because the threshold is a substantial increase in safety. So, there is both a scope and a threshold requirement for the backfit rule, 50.109, that is not the case for a regulatory analysis that would support a rulemaking effort.

Therefore, I think that there is a unique opportunity here to consider the role of PRA in subsequent license renewal. My objective in the non-concurrence was primarily to bring this issue to the Commission, because I felt it needed to be in front of the Commission as an option.

The Commission meeting, of course, was this morning. That was discussed, and I feel that the Commission has had the opportunity to consider this in their deliberative decisionmaking process. So, in that sense, I believe that the non-concurrence served its function.

MEMBER SCHULTZ: Joe, you mentioned the discussions that you had with the Commission, and you have got some good description here. With regard to implementation -- and we will focus specifically on the 60-to-80-year timeframe -- with regard to implementation of a full-scope, state-of-the-art PRA, when would you recommend that be done, besides today?

(Laughter.)

In other words, is there some timeframe

that you think it would be appropriate within the --

MR. GIITTER: That is a great question.

MEMBER SCHULTZ: -- 60-years' framework?

MR. GIITTER: Yes, that is a great question. And there's time, you know, clearly, before subsequent license renewal. But, actually, now is a good time -- if industry is going, if that is going to be an expectation or requirement, now is the time to start thinking about it, because it provides ample opportunity --

MEMBER SCHULTZ: Thinking about it, but in terms of your experience, in terms of implementation of PRA --

MR. GIITTER: Yes.

MEMBER SCHULTZ: -- for the purposes that you have described in slide 8 --

MR. GIITTER: Right now --

MEMBER SCHULTZ: What is the right timeframe here?

MR. GIITTER: Yes. Right now, I would say the average PRA, if you look at an average PRA at a particular plant, I would say they are in better shape now than they have ever been. And that is primarily because of the voluntary initiatives.

So, I think the incremental effort -- and

I might add that, for example, most plants already had fire PRAs. Half of the plants have fire PRAs because of NFPA 805. There are fleetwide implementations of fire PRAs because licensees want to be able to come in and take advantage of risk-informed tech spec 4-B. So, I don't know the exact number, but I would say 75 to 80 or more percent of the fleet currently has fire PRAs.

A number of licensees will be developing seismic PRAs, of course, in response to Near-Term Task Force Recommendation 2.1.

So, the state of the art of PRA is further along now than it has been in some time. And I think if this were to be a requirement for subsequent license renewal, and the licensees were serious about it, now would be the time to invest in the additional resources, maybe once the Fukushima actions have been completed, to go the rest of the way.

Because I think right now the gap between the operating reactors and the new reactors is relatively-small. The new reactors only have to upgrade their PRA one year from the date that a new standard goes into existence. And then, they have to maintain their PRAs every four years or update their PRAs every four years.

So, I think now is the right time to

consider that. The exact date -- maybe you are asking me a different question. When would they actually have to have it updated? I would say when they came in with their -- there's flexibility. They could do it when they came in with their application or they could do it before going into the period of beyond 60 years of operation.

MEMBER SCHULTZ: And in an indirect way, you gave a very good answer. Thank you.

MEMBER REMPE: But one of the drivers for doing this would be to be monitoring the risk associated with passive component failures. And the capability to model that in the PRAs, is it done at all even?

MR. GIITTER: Yes, and that is something that my initial thinking was to bring the operating reactors up to the same standard as the new reactors. And that is something that could come later, as the methodologies get further improved, because I realize that we are not quite there in terms of the state of the art and being able to model passive components. So, you know, that is something that could be done later on.

Again, if there were a standard, an ANS/ASME standard on that, then that would trigger the update to the PRA. But that would be some years down the road, once the methodology catches up.

CHAIR STETKAR: I think -- this is my personal opinion -- that the last three minutes have exemplified the trap that people tend to fall into. You immediately asked the question about, how does the current PRA model the aging effects of a piece of pipe? Well, the fact of the matter is it doesn't. That doesn't mean that that is the whole point of doing a PRA. The whole point of doing a PRA is to provide an integrated risk perspective for everything in the plant. You don't need to quantify the frequency at which a piece of pipe can fail to understand what the potential risk form that failure may be.

MEMBER CORRADINI: You can do a binary and see the --

CHAIR STETKAR: You can do sensitivity studies. You can do any number of things. You need the tool first. So, this is not, in my view, about quantifying the likelihood of a crack forming a piece of concrete. It is about the likelihood of understanding what the risk of that crack might be.

MR. GIITTER: Sure.

CHAIR STETKAR: And that is a much different perspective. And the problem is these discussions tend to degrade into that: well, you can't model this crack propagation because it is too uncertain. That is not the whole point. The whole point is --

MEMBER SCHULTZ: Passive components and active.

CHAIR STETKAR: Passive and active, all within an integrated framework.

MEMBER SCHULTZ: They all age.

CHAIR STETKAR: They all age, and sometimes failures of passive components, even if you assume they are guaranteed to fail, might not be all that important. But, unless you have the tool to --

MEMBER REMPE: Then, the argument should be presented that way.

CHAIR STETKAR: You asked the question about aging the passive components. In Joe's defense, I don't think he mentioned that in his non-concurrence.

(Laughter.)

MEMBER CORRADINI: Well, just to take her side, that is the one part which is not risk-informed, the yellow and the green, if we go back to slide 3, right?

MEMBER SCHULTZ: The diagram may have thrown off on that.

CHAIR STETKAR: I may have, but that is a bit of the problem of having the discussion about micromanaging what is or is not in a particular PRA at a particular snapshot in time and using that as an argument of why PRA can't be used for anything.

MEMBER CORRADINI: So, can I ask one question?

MEMBER SKILLMAN: Just one more. I'm still on watch and I'm still in charge, and we are running out of time.

(Laughter.)

So, Dr. Corradini, yes, sir, but let's let this man go.

MEMBER CORRADINI: So, you need rulemaking for this?

MR. GIITTER: I believe so.

MEMBER CORRADINI: Why?

MR. GIITTER: Because based on everything I know, I don't think that a PRA requirement would pass the backfit rule, the 51.09 backfit rule.

MEMBER CORRADINI: Okay. I seemed to remember that was your reasoning, but I forgot. Okay. Thank you.

MEMBER SKILLMAN: Thank you, Mike.

Colleagues, any other question for Joe?

(No response.)

Joe, thank you very much for coming forward.

I will now call on Jason Remer for NEI to make his presentation, please.

CHAIR STETKAR: By the way, we are fine on time. This notion of 35 minutes for a Subcommittee discussion does not apply to full Committee meetings. So, we have got, on time watch, we have an hour left in this briefing.

MEMBER SKILLMAN: Okay, please.

MR. REMER: All right. Good afternoon. Thank you very much. I appreciate you letting me be here for the second time, before the full Committee this time.

I want to give you a brief rundown, trying to cram an hour's worth of material into 20 minutes. So, we will see how we can do here.

So, why is subsequent license renewal real important for the industry? Basically, going to -- let's see here.

Okay, we will get our technology down here.

Here is an outline. Factors supporting long-term operation. It is built upon a successful license renewal program. How we are preparing for that. How aging management is a living process and makes up the heart of the program. Looking at the analysis of the SECY Paper and, then, a summary.

So, factors supporting long-term operation. I am going to go fast through these.

Current energy mix. The takeaway here is nuclear is a giant part of our nation's energy. In fact, it makes up most of the non-emissions, emission-free electricity in the nation. Electricity demand is growing slowly, but it is growing. We need nuclear if we are going to come anywhere close to meeting the energy and environmental targets set by the President.

It is also reliable. You know, we are not coming in here saying, "Hey, let us renew these plant licenses because we have got a bunch of plants that are operating poorly." No, to quite the contrary, we have a very high, almost a record high availability and reliability. From 2013, the number is 92.1. Compare that to coal, 55 percent; gas, 56; wind, 31; solar, 27.

Nuclear is very reliable, 24 hours a day, seven days a week. Ice storm, windstorm, tornado, what have you, they are online and they are there, and they have operated successfully through many years, many decades now.

We couldn't be coming to you asking for a renewal of license if it wasn't safe to work the power plant. I worked at Arkansas for about 18 years. It is hard to tell somebody, "We'll do nuclear safety right, but you get hurt in the plant." You know, you trip and fall or you break your leg, or whatever. Nuclear is very, very safe. In fact, I have heard it said that nuclear is safer than working in an insurance office, to work in a nuclear plant. And I have been there and I would agree.

Why is it important from an energy supply standpoint? Here is a graph. You have probably seen this several other places.

But, if you look at the area under the green curve, that represents all existing nuclear plants operate for 80 years. It probably won't be all of them. We think around maybe 80 percent. It is hard to put a number on it.

But the area under the blue or the green line is a tremendous amount of energy through the course of many years, and represents a lot of economic activity, a lot of clean air, a lot of good jobs, a lot of importance for our country and our communities.

We are also heavily invested in capital spending. In 2012, we spent $8.5 billion across these programs: uprates, extended operation, equipment replacement, regulatory.

We talked a little bit this morning about older plants. Well, if you go out and look at the plants, if you go through the plants, you see that most of the equipment, at least the rotating equipment and things that move, have been replaced at least one time, sometimes two times. So, this is where the replacements are happening.

Of course, we can't talk nuclear without talking clean air benefits as far as emissions. Very, very low, nuclear. If we replace that with gas or some other form of energy, we are going to increase the emissions.

And we have got to have good community support. This green line shows the number of people that agree that renewing their license of a nuclear plant that continues to meet the federal safety standards, 82 percent, that is extremely high. And so, we have got a good story there.

Okay. So, built upon successful programs. We talked a little bit about this before. But we have got many plants that have achieved license renewal. They have followed the rule, 10 CFR Part 54 and Part 51 for environmental.

We had a false start early on in 1991. We fixed the program in 1995, and it has been extremely successful. I think all of our plants will eventually apply for license renewal, if they continue to operate.

MEMBER POWERS: Big "if".

MR. REMER: I'm sorry?

MEMBER POWERS: That's a big "if".

MR. REMER: Well, yes, it is. It is a big "if" because we are facing a lot of challenges right now in some markets for these assets.

The regulatory guidance is solid and founded upon many years of work. These are some of the examples of the documents that have been put together: regulatory guidelines, EPRI documents, NEI guidance documents, and, as you heard from the staff a few minutes ago -- and we would agree with them -- that the basis of license renewal is sound. The basic regulatory structure is very sound, and we want to continue that process.

Here is a little slide of the current status. We won't talk about that anymore.

We are preparing for --

MEMBER SKILLMAN: Let's talk about that --

MR. REMER: Okay. All right.

MEMBER SKILLMAN: -- for the members, please. Let's go back one.

MR. REMER: All right.

MEMBER SKILLMAN: I think that little pie chart is an important piece that we are talking about.

MR. REMER: Okay. So, where we are at here, we have got 73 that are approved and licensed; 27 are in a period of extended operation right now. By the end of the year, I think the number is going to be 35. I mean, by the end of this year, it will be a lot bigger. Intend to renew, 17; under NRC review, 13. I am not sure that that "13" is exactly right, but everything is going in the queue or coming to the queue.

So, again, very successful programs, not that it has been without, I'm going to say, trouble; I'm going to say a great job. I know this Committee or the previous Committee gets involved in every one of those. It is looked at with a fine-toothed comb. A lot of RAIs, a lot of exchange of information, a learning process. Documents get revised. But we move forward with that and have a very successful program, as confirmed by the reviews that the NRC does before these programs are put in place.

MEMBER POWERS: Everything you have said, I pretty much agree with in getting things started. What we are looking forward to, I think, is, now that we have people in the license renewal, because the license renewal involved a lot of new aging management programs, in many cases those programs were being imposed on plants that had troubles maintaining their existing program that they had. And now, they have these additional aging management programs.

How well are those aging management programs being conducted, doing their job, and things like that?

MR. REMER: Yes, well, it is a good point. aging management programs, of course, are put in place when you receive your renewed license. Most of those programs aren't brand-new programs. They are programs that have existed since the start of plant operation. Some of them are new.

MEMBER POWERS: About a third on the average.

MR. REMER: Well, about a third are brand-new, right, a lot of one-time inspections. We have beefed it up. I worked at a power plant, and I know when I started in 1981, you look at the concrete; you look at some of the steel, and you say, "That's going to be here forever. Let's not worry about it."

You did your rounds. You looked at it. But in some cases you didn't look at it as deeply as you should have, you know. And so, I think we have corrected that.

To the point you made about how well they implemented it, when you put aging management programs in place, you update your procedures in your plant to incorporate them with everything else that is going on in your site. You have EQ. You have chemistry control. You have operator training. You have a myriad of things. And so, it gets pushed into that whole program that ensures the safety of your plant operations.

So, if they are properly maintaining their equipment according to the Maintenance Rule, if they are properly reporting deficiencies and deviations according to Appendix B, if they are running all those programs, they are also running the license renewal program properly because it is part of the whole.

I won't say there's not plants that haven't had difficulties and problems here and there. But, by and large, the process and the program, which is what we are talking about today, the structure works. It is a solid structure.

Does that answer your question?

MEMBER POWERS: Well, I think it is to the extent that you can --

MR. REMER: Yes.

MEMBER POWERS: -- because we haven't got enough experience under our belt yet.

MR. REMER: I think we do. I think we have plenty of experience. And I will get into this a little bit later on.

But, since most of these programs were started when the plant was started, you don't have, if you are in a PEO for five years, you don't have five years of experience; you have 45 years of experience in these programs. We didn't start doing chemistry control when you entered a PEO. You couldn't have. We wouldn't have been here. We would replace too many steam generators because of that.

So, you have a lot of experience. So, to say that you have to start --

MEMBER POWERS: Yes, but it is probably not an optimal --

(Laughter.)

MR. REMER: No, it is not. Unfortunately, we have suffered because of some of those things we didn't understand early on.

So, to say we have got to get it after the PEO starts, and it is not valid experience, I don't think is a sound, logical argument. I think we do have a lot of insights from many decades of work.

It is important that we continue to improve. OE, experience, research data, other things that come, that improves our process.

All right. So, talking about industry groups getting ready for this, we have got fairly-robust groups put together to look at license renewal. We meet on a regular basis, quarterly, with the NRC Division of License Renewal. We meet regularly, and we just made a presentation last week on our electrical R&D. EPRI, DOE, and NEI got together and presented the status of that program.

We have industry guidance that we have put together. We also have a fairly-diverse set of license working groups in the mechanical, electrical, civil, and implementation area that meet two times a year to share lessons learned, to help each other do self-assessments and reviews, and are getting us ready for this next round.

There is also an Executive Working Group we just put together and an ASME Special Working Group as well.

MEMBER SKILLMAN: Jason, let me ask you this.

MR. REMER: Yes.

MEMBER SKILLMAN: Who from outside of NEI is involved in the Executive Working Group? What level of CNOs or key utility personnel are --

MR. REMER: We have like key vice president level and above, people from like three or four of the major utilities. We have legal representation from people that have actually been involved, were involved in the first round of license renewal. We have DOE and EPRI involvement in that Committee, and we will probably add to it as we see there are more people we need to add into that.

We are also interfacing with the Owners' Groups. We are trying to go out and make sure we include everybody in this because we have no interest in doing something that is not going to improve safety and continue to help us operate these plants safely.

MEMBER SKILLMAN: So, just to make it clear in my mind, this is not just a license renewal executive group? This is a subsequent license renewal executive group?

MR. REMER: That's exactly right. Because we formed a group like this in the first round of renewals to help us with focus, to make sure we got everybody onboard. Because we are going to be asking the plants to do some things, initiatives, together. And so, we don't want those to be surprises; plus, we want to hear the best lessons learned there are out there.

And if nobody is interested in doing subsequent renewal, then NEI has not got a job to do in that area. So, we have people come forward to say, "Yes, we are interested. We want to look at this." And it is very targeted right now in SLR.

MEMBER SKILLMAN: Thank you.

MR. REMER: Yes.

Close coordination with Research. You are going to hear Sherry in a few minutes talk about this. I won't go into this. But we are very closely coordinated. We meet regularly with the LTO and the Light Water Reactor Sustainability Program. I have been to their meetings. I try to stay up on what is going on.

We have industry representatives that are in leadership positions in EPRI that help keep the R&D focused on what actually needs to be done to continue this process.

Somebody asked about schedule and timing. This is a little paper here that I will go over a little bit, but I will leave it with you, just talking about the fact that right now we are kind of behind in the process. And I hope you understand that when I finish this description.

2029 is when our first license, renewal license expires, like Gannett and others. You have to have a five-year minimum to get in under the timely renewal. Nobody wants to put a license in, spend two years of work, tens of millions of dollars, and not have some assurance that you can continue to operate. So, you have got five years.

So, you get your four years' margin. We need the NRC to approve that license by 2020. It takes a couple of years to do that at best case. That's 2018. It takes a couple of years to prepare that application. That's 2016. Guess what? That's right around the corner.

And so, that is why we need to get going with this, is because really we are right there. And right now, I think we heard a previous presentation that previous license renewal came in 13 years before the license expired. And so, really, there is probably no way we are going to be able to meet that requirement -- I am sorry, it is not a requirement -- meet that goal this round.

But this is just to show you that we have got our work to do; we have got our work cut out for us. 2029 seems like a long way away. Some of us won't be here then, but we have got our work to do.

The heart, as we have talked about before, of the license renewal and subsequent renewal process is the aging management program. Here is just an example of some of the programs that are out there on AMPs. About two-thirds of those or so are existing programs. The other third or so are newer programs. Many have to do with one-time inspections.

A lot of this stuff is already being done. The GALL, which is NUREG-1801, codifies this, a very helpful document. It is about this thick. It has everything you ever wanted to know about aging management programs in it. This thing evolves and changes. We are working with the NRC now to provide input on a GALL Rev 3, or I think what they are calling GALL SLR. So, a lot of activity there.

It is a lessons learned. So, the very best of what we are finding from the industry, from research, gets cranked into this thing. And so, we all have the very best information and data to use in our plants.

MEMBER POWERS: When you say "The very best gets incorporated," that means you're leaving some stuff out?

MR. REMER: No, I think what I was meaning by that is we just are able to pull in what is available as we go through. Of course, you have got to screen for things that don't apply. One plant may have one thing, and like a BWR doesn't have PWR information. I wasn't meaning to imply we leave things out.

MEMBER POWERS: Well, it does raise the issue of quality control of things going in here. Is there some equivalent to peer review on these things that you incorporate?

MR. REMER: What this document is, of course, is a NUREG. It is not a regulatory requirement. It is a way to do business.

And before you incorporate these programs into your plant, you have to run it through your plant quality assurance program, 10 CFR 50, Appendix B. And right now today, every site, every plant in the nation has committed to a couple of aspects of Appendix B for their aging management programs. So, yes, it does get run through a quality assurance program before it is used.

You can't just take these and slap a cover on it and send to the NRC and say, "Here we go." No, you have to do very detailed work. Each one of these AMPs requires many, many, many hours of work and research and writing, and it is a huge, huge program.

Here's a kind of graphic description of how the process works. I don't know where I am on time.

CHAIR STETKAR: Don't worry. We're fine. Keep going.

MR. REMER: Okay.

CHAIR STETKAR: Our schedule, we have through 4:15.

MR. REMER: Okay.

CHAIR STETKAR: So, we're okay.

MR. REMER: Well, just rope me in when I am going too far.

This is a graphic of how the aging management process works. You start there at the long middle block. You see "Develop/Modify Aging Management Programs". That is when you start a license renewal application for the first time.

You implement those activities through the procedures in your plant. Usually, you don't write procedures that say, "Hey, I'm an aging management procedure." What you do is you write procedures for whatever it might be. Inspecting the concrete in a reactor vessel, that will be the procedure.

Part of that is meeting the requirements of the aging management program. Other parts will be things you want to do because the vendor said, "Hey, you had better do these activities." Part of it is because you have had lessons learned in your plant and you want to do those activities.

So, to address partly the thing I heard earlier from the staff about not being able to find how the OE gets put into our aging management programs, it is that, as it gets absorbs into the whole, it is still traceable back to aging management, but you don't have a procedure say, "This is an aging management program."

You have a process where you manage and maintain your equipment. To do it any other way, literally -- I don't want to overexaggerate here -- there's dozens and dozens of programs that have to be implemented in a nuclear power plant, dozens. I was going to say hundreds, but maybe not hundreds; dozens at least.

If you had each one of those, a procedure for each one of those, you would be in an untenable position. And so, it is difficult as it is. There's hundreds of procedures out there, and you have to give a procedure to a person to go do a job. And you don't want to confuse him. And there's many, many reasons why we do it the way we do it.

But it is incorporated into the plant procedures. Those processes are implemented. You ask yourself the question, did I meet the criteria?

When I go out to inspect this particular component, did it meet the criteria in the aging management program, yes or no?

And many times it is not that pure, but you have to look at it. You do failure analysis, if you need to. You figure out what was the problem.

Then, you feed that back into your aging management program. You go through the Corrective Action Program, which every site implements in their aging management program. You modify the AMP. You repair/replace the equipment. Sometimes you can't fix the component, so you have got to replace it.

(Phone interrupts.)

MEMBER SKILLMAN: Five minutes.

MR. REMER: Sorry about that. Okay. Got the phone timer.

Anyway, so it is a living program. Specific OE comes in. Codes and standards come in. Research comes in. The GALL report comes in. This is a never-ending process that we continue at our plant sites.

So, I can tell you for sure this process is implemented and does work. And when it doesn't work, flags get thrown up and we take corrective action on it. And you will see it in our OP process as well.

In addition, the NRC has quite a few levels of inspection procedures that they go through to make sure these processes are working.

I did participate -- I didn't participate, but I visited Robinson when they were doing that assessment and I read the Nine Mile and Gannett report. And we didn't see any major deficiencies that were identified there.

I know I have heard that, that there were some deficiencies you could see, the process not working. I think they should have been identified in those reports, if that would be the case. And we just didn't see that.

So, moving right on into my five minutes left, detailed analysis of the paper. You have seen this before. Bo said this, and we fully agree with it.

Is it two principles and processes drive license renewal? Current regulatory process is adequate. And secondly, the design basis and licensing basis of the plant is maintained to the same level, the same requirements, as during the original licensing term. That is the key to the license renewal. It is the key to subsequent renewal.

We agree with the staff and we commend them on really a fine job of work in laying out these processes. We believe that the process and regulations are sound and an support another round of license renewal.

Environmental issues I already dealt with. We do need to revise the guidance. We agree with that, and we are participating with the NRC in that. We don't believe a PRA update is required.

We are somewhere between 85 and 90 percent agreement with the staff on the what; we just don't agree that rulemaking is required to make that happen.

We believe that to do Option 4 would be out of step with the implementation of cumulative effects of regulation. Specifically, we need better estimating. If we say it is going to be more efficient, then we should see studies and documents that show that. And we should consider implementing requirements or desires to -- requirements rather than rules, I mean guidelines rather than rules. That is part of the SECY. So, there are other ways to skin this cat.

Let's see, the bottom line for these non-safety-significant issues, schedule for rulemaking may impact industry plans and NRC staff resource requirements for the application reviews. And we are concerned about that.

CHAIR STETKAR: I'm sorry, Jason.

MR. REMER: Yes?

CHAIR STETKAR: Go back there.

MR. REMER: Okay.

CHAIR STETKAR: You made a really quick, but a profound statement.

MR. REMER: Okay.

CHAIR STETKAR: It says, "For these non-safety-significant" -- what non-safety-significant issues?

MR. REMER: Well, these changes we feel that have been identified, while good and important, don't have a safety impact.

CHAIR STETKAR: In your view? Okay.

MR. REMER: In our view, they --

CHAIR STETKAR: In the context of the SECY?

MR. REMER: -- don't drive a safety-significant problem. If there is a safety-significant problem out there that needed to be corrected, we don't want to wait until SLR to fix it. We want to fix it now. And we would say, "Staff, let's fix the problem now."

So, we are saying, while these things -- and we agree with much of the structure of it -- are important, they don't represent a safety-significant issue.

I am going to jump onto the summary here and let you read that. One of the things I want to point here is we have a couple of industry initiatives underway that mirror the staff's recommendations for use of OE. We believe that can be improved, and we are working on that ourselves.

We also already perform AMP effectiveness across the fleet. We would like to put standards in voluntarily that will make that more uniform and more predictable. And so, with that, we already have the main core of what we need.

And let me just say something about the 20-year lead time. We really need 20 years. We can't back off that.

And I would say that, if an application comes in and it doesn't show you that you have applied OE, it doesn't show you that you understand your plant equipment, then the staff can always ask questions and always reject the application and say, "You didn't demonstrate that you understand OE and you didn't include it in your proposal."

CHAIR STETKAR: Jason, in some sense, I can understand the first time that I, as a plant owner or operator, go through the license renewal process maybe I need 20 years to have some confidence that, indeed, I have my license renewed by the time I need it. But, if I have been through that process once, why do I now need 20 more years?

MR. REMER: Yes, I agree.

CHAIR STETKAR: I understand the process. I have "X" percent, where "X" is a large number, of my aging management programs in place.

MR. REMER: Right.

CHAIR STETKAR: I have been, I hope, keeping them up-to-date. I hope I have been using operating experience.

So, why do I now need 60 years into my -- or let's say 40 years into my operating license, now why do I need 20 more years to get this?

MR. REMER: That's right, and I think it would reflect poorly on your existing programs if you had to say, "I need these years" in the PEO.

CHAIR STETKAR: Well, but you are saying you need, the industry needs 20 years.

MR. REMER: Well, this was for the application to be turned in. This is for the --

CHAIR STETKAR: You're saying it's going to take the staff 20 years to review your application?

MR. REMER: No.

CHAIR STETKAR: It hasn't in my experience lately.

MR. REMER: But particularly in Option 4, the item under --

CHAIR STETKAR: No, I understand, but you're saying -- maybe I am misunderstanding you -- that the industry says you need that 20-year lead time for the SLR application. And I am trying to understand why that is necessary, given the fact the only reason I am applying for SLR is I have already been through it once.

MR. REMER: Okay, got you.

Mike?

MR. GALLAGHER: Yes, Mr. Stetkar, maybe I can answer that question.

My name is Mike Gallagher. I am Vice President, License Renewal Projects for Exelon, and I am on the SLR Working Group that Jason mentioned and the EPRI Integration Committee Chairman for Long-Term Operations. I think some of you folks have seen me here before for an application or two.

So, on the 20 years, in my mind, there's a couple of issues here.

One is, do we need 20 years? Well, the experience in the original license renewals is that the average application was 13 years before expiration, and the full range was utilized. There were actually some applicants that were greater than 20 years and some applicants that were slightly less than five years.

And that's all based on the business needs for that particular applicant. So, we think that that flexibility needs to be there, and we think energy planning is not getting simpler; it is getting more complicated. So, a longer timeframe is needed.

But, you know, I have a fundamental issue on reducing that timeframe on the principle of that you don't have enough aging management experience, and that is why in the period of extended operation, that is why it should be less than 20 years.

When I go into the period of extended operation, I have 40 years of aging management experience. I don't have one day; I have 40 years.

The programs that are developed, say, as an example, for our Limerick Project, 45 aging management programs; 30 of them were existing; about half of those were enhanced to go into the period of extended operation.

The new ones, most of those are the electrical programs where you do the initial inspections. You are required to do the initial inspections before the period of extended operation, and the others are one-times, which you are required before the period of extended operation, confirm whether or not you have an aging mechanism and, if so, you turn it to a periodic.

So, there is a lot of experience going into the period of extended operation. So, just fundamentally, you know, we disagree with you need experience in the period of extended operation to be able to submit an application.

The third point I would make with that is, when we submit an application for subsequent license renewal, we have to describe how our aging management program will be implemented, and we have to have operating experience to show how we did implement them. And we have to convince the staff that they are effective to continue on.

So, they will have the information in the application that we would need to justify why we can continue with these programs.

So, I think the 20-year worked out well. The original rule waited 20 years because it was felt that you needed 20 years of plant-specific operating experience to submit an application. And, in fact, now you would have at least 40 years of plant-specific operating experience.

CHAIR STETKAR: Thanks. That helps.

MR. REMER: Let me finish up here with this slide.

MEMBER SCHULTZ: Can you go back to the slide you were on, though?

MR. REMER: Sure. Yes. Absolutely.

MEMBER SCHULTZ: I don't have the number. It was Option 4.

MR. REMER: Option 2?

MEMBER SCHULTZ: No, no.

MR. REMER: Option 4?

MEMBER SCHULTZ: It was on Option 4. Current industry initiatives underway.

MR. REMER: Oh, okay.

MEMBER SCHULTZ: I can ask it without the slide up.

MR. REMER: Yes.

MEMBER SCHULTZ: But my question is, you have got some reports here that are coming out this year on industry initiatives.

MR. REMER: Yes.

MEMBER SCHULTZ: But you didn't mention -- if you did, I missed it -- what the industry commitment is for implementing these new programs.

MR. REMER: Yes. Okay. Good. Thank you.

MEMBER SCHULTZ: Is it two years or three years, or when does everybody got to be onboard?

MR. REMER: Yes. Thank you.

I think John mentioned we haven't provided them the draft document yet, but we have a meeting planned in June where we are going to do that, or we are going to actually do a tabletop walkthrough. Because we intend to implement these irregardless of what happens, unless there is uncertainty with the rule, and it may be we have to back off on that because we don't want to duplicate programs.

But the commitment we will make to implement these is through our Strategic Issues Working Group, executives, basically CNOs, who will agree that everybody will implement these. And once that agreement is made, then it will go across the industry and it will be implemented. And we hope to see that probably the first quarter, implemented in the first quarter of next year.

MEMBER SCHULTZ: But I did hear what you said, which was "These ought to be implemented independent of any program going forward."

MR. REMER: Right. That's right.

MEMBER SCHULTZ: So, I hope that any decisions related to rulemaking would not upset the cart here.

MR. REMER: I hope not because it will be some effort on our part to implement these. And if we see things going a different direction, we will have to evaluate what goes on there.

But we see this as just an improvement in the process we already use. We have already got OE going. This just tightens it up for our passive equipment. We already do program effectiveness across the industry. This just gives us a better standard.

So, we will commit to do these, and we will do them. We don't want to put a license condition, though, to make them happen and it is sought. We don't think that is necessary.

This will be a lot like the Buried Piping Program, which has been successful and been implemented through voluntary initiative.

MEMBER SCHULTZ: All right. Thank you.

MR. LUBINSKI: If I could, if you don't mind, since the question was asked earlier about this with respect to the NRC requirement, and just to clarify, when we were talking about this earlier in Bo's presentation, we were talking about requiring them for the subsequent license renewal. And the questions were, couldn't you get some industry experience with the first couple that come in?

The way Jason is describing is a little different because this would apply to the current license renewal period. So, that could be where the question of experience is coming in, and I appreciate your question of when it would be implemented because, again, if it is during the current license renewal, that would provide some information to us on how effective the programs are and the dedication of the licensee --

MEMBER SCHULTZ: Yes, and I took it to be just that way.

MEMBER RICCARDELLA: Just a comment. I mean, your lead plants are already at 15 years.

MR. REMER: Yes, yes.

MEMBER RICCARDELLA: So, you are going to get some time in the current license renewal period.

MR. LUBINSKI: Depending on when they implement the program and when the first application comes in, we may already have some data before the first application even were to come in, which is different than initiating it at the year 2029 and, then, trying to get that and make a determination then.

MR. REMER: Thanks, John.

MEMBER SKILLMAN: Jason, please proceed to closure.

MR. REMER: Okay, proceed to closure.

(Laughter.)

I will proceed to this slide. We believe that we want to do license renewal, subsequent renewal; we believe there is interest, and we, though, rely on certainty in the regulatory process. We need that because that factors into the equation, which is an economic analysis, and will make a difference whether plants decide to do it or not.

The existing license renewal process provides a very sound and solid foundation for subsequent renewal, safe operation. Our schedule is tight. We don't believe the criteria rises to the level that rulemaking is required. We believe that non-rulemaking initiatives can take care of and address almost all the needs that we see here from the staff.

So, thank you very much.

MEMBER SKILLMAN: Jason, thank you.

Colleagues, any further questions for Jason?

(No response.)

With that, I call upon Sherry Bernhoft from EPRI to come forward. Thank you, Sherry.

Jason, thank you.

MS. BERNHOFT: All right. Thank you, and good afternoon.

I understand that I am between you and being able to adjourn.

MEMBER POWERS: No such luck.

(Laughter.)

MS. BERNHOFT: Oh, that's true. You still have your followup discussion.

MEMBER SKILLMAN: Sherry, you have got your originally-allotted timespan.

MS. BERNHOFT: I do? Is it the one hour or the 20 minutes?

MEMBER SKILLMAN: It's the 20-25 minutes.

MS. BERNHOFT: Okay. Thank you. I appreciate that.

MEMBER POWERS: What if we like her better and want to keep her longer?

(Laughter.)

MEMBER SKILLMAN: Let's let her go and see what happens.

(Laughter.)

MS. BERNHOFT: I don't know if I like that "see what happens".

(Laughter.)

All right. Quickly, I am sure you are all familiar with EPRI, but to make kind of my disclaimer slide, we are funded by our utility members, but our work is independent, and our utility members, they include every plant or every utility in the United States that operates a nuclear power plant, in addition to a large scope of international plants as well. So, we draw on that large pool of knowledge when we talk about updating our programs and sharing our operating experience.

It is about 60-percent funded by the U.S. and by 40 percent funded by internationals right now.

The Long-Term Operations Program at EPRI was formally started in 2009, but I want to emphasize that R&D and all of the areas that we have talked about so far, as far as degradation, aging, safe management of plant components, inspection, evaluations and repairs, that type of research within EPRI has been going on for decades. So, normally, pulling it together into the LTL program, which occurred in 2009, was really a proactive response to our members to help support them, to have discussions like we have been able to have today to talk about how this forms a good, solid technical basis for subsequent license renewal.

Part of our program is we also demonstrate the technologies and we look at leveraging all of our research opportunities across EPRI, and we also work very closely with our research partners. As you recall during the Subcommittee, Rich Reister from the Department of Energy, Light Water Reactors Sustainability Program, was able to talk as well. And though they are not on the agenda today, I want to make sure that you understand that that is a very, very important research partner for us.

So, next slide, please.

These are some of the basic elements for implementation. We have talked a lot about aging management programs. Let's talk about what goes into a good aging management program or what makes aging management programs successful.

These are the elements of aging management programs where research does have a large influence in the success and the outcome of these. We do a lot of fundamental research to understand aging degradation.

We do a lot of work on inspection methods. That includes the detection and the measurement and how we use that to evaluate safety margins. We do a lot of work on mitigation strategies. That is everything from improvements in chemistry -- I heard us talk about the steam generators earlier. No one wants to go through ANEEL 600 again.

We also talked about stress improvement techniques, welding, welding overlays. We are assigned to do a lot of work and really pushing the state of art in condition monitoring. We see this as the next new frontier for long-term operations of the plants. We will get better insights from online monitoring, condition monitoring.

And that leads to how do we predict remaining useful life, a very important question, a lot for our members, so that they can make informed decisions about how to best safely and economically operate their plants long-term and, also, for working with the regulators on those safety margins.

And, of course, it comes down to, when do you make your decisions for repair and replacement? It is the overall life cycle of the plant and the components that we are concerned about to support safe, long-term operations.

One of the projects that we did last year at EPRI B and, of course, we had quite a bit of support from NEI and the Working Groups that Jason talked about earlier -- is we did kind of a parity check. We looked at all the EPRI R&D programs and we did a cross-mapping of those to the aging management programs.

And that was for two reasons. One is that we wanted to make sure that, first, all of the research was being done to adequately support or inform the aging management programs, to make sure there was basically nothing we had missed. And the second was to make sure that, as we were talking about this research, we had the right priorities on it.

What we found from this parity check is we took the aging management programs and really put them into three different categories. And I have examples of them on the one side, but those three categories were:

We identified a subset of the aging management programs where we felt additional research is going to continue to help inform us on how those materials or those properties may change with the longer period of time, say the 60 to 80.

We also had a large number of what we call the established programs. And those are things like the chemistry, the steam generator, the flow-accelerated corrosion programs. Those are programs where the aging mechanism is well-defined, the inspection techniques are well-defined. We don't see the need from a research standpoint to change those programs for the 60 to 80 years, but research will continue for continued enhancements in those programs.

And then, there are quite a few programs that have been talked about, I think Mike addressed with his response to questions, where they are really more, you know, one-time, plant-specific-type programs where research is not right now a key player in those.

So, we typically put those into those three different categories and bins.

On the next overhead, these are those eight aging management programs I talked about where we see the need to continue to work with our research partners to continue to build out our understanding and our knowledge base on these.

And I want to emphasize that the existing aging management program, as outlined in the GALL Rev 2, they are sufficient or they are very adequate. They are in use right now. They will allow the detection of aging. They will allow us to continue to manage the aging, and they will allow the utilities to make the important repair/replacement safety decisions.

Where the research is, is it will continue to help us to understand the basis for some of the aging mechanisms from a mechanistic standpoint, allow us to improve some of our inspection techniques, possibly our mitigation techniques, and, also, reduce some of the uncertainties that we have for the trend correlations out towards the 80-year mark.

So, again, I want to emphasize that the aging management programs are adequate. We just feel that we could improve our technical knowledge and basis of those out towards the end of the operating curve.

I will talk about these briefly in the next few overheads. So, again, this kind of recaps those R&D areas.

And I want to talk just about the RCS metals. That is the first population of those aging management programs. So, to tee-up that discussion, let's talk a little bit about how the industry overall approaches management of RCS metals.

The industry spends over $50 million a year -- and I am not talking about the DOE research right now; I am talking about the EPRI programs and the Owners' Group programs -- we spend over $50 million a year on RCS metal research. Those programs are coordinated under an initiative that we call NEI 03-08. This was formally put in place in 2004. It was at the drive of a number of the industry executive to start proactively managing the materials degradation issues that we were starting to see throughout the industry.

There are certain elements of the

NEI 03-08 program that are very important. Some of those are that they require that the utilities have a program in place for inspection, evaluation, management, reporting, sharing of information. It also pulls in INPO as a part of assessing the effectiveness of those programs, and it also has a routine sharing and communication of this industry experience with the NRC. So, this has been in place since 2004, and this was whether a plant was is in their period of extended operation, has an aging management program or not. They are under NEI 03-08 for these.

The industry programs that are managed under this initiative include, I think, ones that several of you have heard of before. And that is, for the BWRs, the Vessels Internals Program; for the PWRs, the MRP program; our steam generators; our NDE; Primary System Corrosion Research that does a lot of fundamental research for us; our water chemistry, and, of course, the PWR Owners' Groups.

We also have GE, the other major vendor, is involved through the BWRVIP program. So, all the major vendors are also involved in this effort.

And as I said before, we have extensive international coordination and collaboration, and work with the DOE program on these. So, it is a very comprehensive, large body of research that we get out of this.

Also, we have systematically developed a program to identify the issues and drive our strategic planning for the management of metals research. There are two documents we have. They are both publicly available. One is called the Materials Degradation Matrix, or the MDM, and the other one is called the Issue Management Tables, or IMTs.

Now the MDMs go through all of the RCS metals component-by-component. We look at the metallic properties and we look at what we think could be the potential aging degradation or drivers for aging on each of those properties and materials.

And we sit down on a routine basis with a group of experts, expert solicitation, and we go through these MDMs and the Issue Management Tables, and we make sure that our prioritizations are still up-to-date based on expert solicitation, inspection findings, and research results, and operating experience.

The MDMs were a contributor to the EMDAs that were talked about earlier. They were one of the input documents.

We also through in 2010 and we went back through and we looked at the MDMs and we said, if the plants are going to continue to operate from 60 to 80 years, do we also need to understand what those gaps are or those areas for additional research and information based on that?

So, we went back through and we actually put in what we called flags for the long-term operations, which is the 60 to 80 years. So, again, this drives our strategic planning and our prioritization process for the research. And we share this with our research partners; for example, you know, DOE.

So, sitting back and looking at what we have pulled out of the MDM and our understanding and expert solicitation, these are kind of the areas that we have binned the needs or what we have to make sure we are really focused on for the long-term operations. That is, of course, understanding the effects of the increased neutron fluence, any possible late-life stress corrosion/cracking initiations, and increased fatigue usage. I mean, it makes sense. It is just increased exposure to the environment, the neutrons, the temperature, and increased cyclical fatigue.

So, we went through. We did another parity check on all of our research to make sure that this is all covered for the critical components that we have been talking about for long-term operations, which are the RCS metals, the reactor pressure vessels, the electrical cables, and the concrete. So, that is how we prioritize and manage our work.

Next, what I would like to turn to in however much time I have here is I want to just hit very briefly on those eight aging management programs that I talked about, so you get some scope of what is actually happening in those areas, what we know, and some of the areas where we are continuing to do some of the work.

I will mention that what I put in the background material, I covered it in the Subcommittee, but I won't have time to cover it today, is I did put in a couple of examples of what I call those Category 2 aging management programs in that background material. So, you can review those, if you want, afterwards. But I will just cover the eight right now.

For today's presentation, I went ahead and I combined two of the aging management programs because they both deal with the vessel internals. That was an area I think that was talked about in the EMDA presentation as well.

The issues are really both the same. We just want to look at the anticipated trend from stress corrosion/cracking, the initiation, the possible growth rate, with the neutron fluence and exposures to the environment.

There are BWR programs and, then, the MRP is primarily under our MRP-227-A document. And I will note that, if you see a document -- and you will see quite a few of them on the next page -- if it has the "alpha" designator, that means that we have submitted that to the NRC and it has formally been reviewed and approved and accepted by the NRC as a method for aging management.

I want to emphasize that both the BWR program for internals aging and the PWR program for internals aging, these are living programs. We have done extensive work with industry experts on modeling and understanding of IASCC. We developed inspection guidelines. We have several technical reports, and these reports are continuing to be updated based on operating experience and inspection results.

The next overhead, I am not going to go through this in any kind of detail. This shows you several reports. This is a type of example of the industry when they go through and they are going to do their management of their vessel internals. They can look at the different components that tells you how to do the inspection and evaluation, the repair and design criteria, and any mitigation-type recommendations. And again, the "alpha" designator means those have been reviewed and approved by the NRC.

And several of these, for example, in the BWR aging management program for internals, 35 EPRI reports are referenced in that one aging management program.

Continuing to go forward, we are continuing with our international collaboration for understanding an IASCC modeling, and it is aimed at reducing uncertainties, improving our crack growth rate information, and, also, looking at how we would mitigate and repair or possibly even replace, those types of strategies. It is really the future of our replacement, our future R&D.

A comment was made earlier on needing to actually get materials on internals. And so, we do have three active programs, actually, four programs right now, where we are working on actual internals materials. We have harvested materials from those Zorita plants. That is a retired plant in Spain. And that is actually a co-funded project between EPRI and NRC Research.

Some of that material does have DPAs, up to 58 DPAs. We will be doing some mechanical testing and microstructure testing on those materials, and we are looking to do some further irradiation on those.

We have got the GONDOLE project that is focused on void swelling. Some of the materials from the GONDOLE projects are up to 85 DPA.

And then, we have the work with the Halden crack growth rate. That is primarily looking at crack growth rates in lithium environments, representative of PWRs. And we have some materials in there from about the 60 DPA. And we also have some harvested baffle bolts that we will be working on testing on as well.

The next program is the cracking of nickel-based alloys.

MEMBER POWERS: I have a question about them. Looking at those materials --

MS. BERNHOFT: Yes?

MEMBER POWERS: -- it has been my observation that results from any individual laboratory can be quite precise or reproducible. But when you compare results to another laboratory, there are substantial discrepancies between those results, different configurations, a different way of doing the experiments and things like that. What do you do about that kind of thing?

MS. BERNHOFT: That is a very good question. Right now, we have implemented quality standards on our labs that do that work. You know, the MTE standards are imposed.

I don't want to go into a lot of detail, but, very quickly, the project that we have going on on the IASCC, it is a co-funded project between ourselves and the U.S. Department of Energy. There are over 3,000 datapoints right now on IASCC. They sat down, starting two years ago I think it was; they went through datapoint-by-datapoint to question the rigor and the validity and the test conditions for each of those datapoints before they put them on the curve.

And of that, I would say they screened out about half of the datapoints and, then, put that on the trend correlation curve. And it actually improved that trend correlation curve quite a bit to ensure that it was high-quality data that we are putting on.

We are actually going through that same exercise right now with a lot of international data on concrete irradiation. So, a lot of it is expert panel review of the data. It is a very valid point.

Other questions?

(No response.)

Okay. So, moving on to the crack in the

nickel-based alloys, you know, it starts with the Alloy 600. It is primarily in the PWRs, the boric acid leak and corrosion on that. This is under our MRP program. It is a living program. It is adopted into the ASME Section 11 Code cases. Inspection guidelines have been developed. And as you know, we are doing the head penetration cracks, the CRDM cracks. And, of course, the bottom-mounted nozzle instruments are the ones that people primarily know of in the steam generator tubing.

We have developed models on the wastage and the crack growth rates, and our future work is planned on updating these crack growth rate models, coming up with some better inspection techniques for the bottom-mounted nozzles, and pushing the state of the art on the Alloy 690, see if we can get some crack trend correlations on that.

The next area is talking about the thermal aging embrittlement of the CASS, or the cast austenitic stainless steel materials. The issue really here is the thermal aging of the pipes and the components that are outside of the reactor pressure vessel. The embrittlement or the radiation embrittlement of these are covered under the internals aging management programs.

Our present technique right now is we do have kind of a flaw evaluation tolerance approach to how we manage this. And most of it is done by visual inspections and replacement of these components.

We have done a screening criteria, identified the more critical components in each of the plants, and those are the ones that we target for inspections.

Looking towards even present operating and future operating, we do have a Joint Committee that we formed between the BWRVIP, the MRP. We have engaged some outside expertise, and we also have several of our utility members that are part of this Working Group to specifically address the screening criteria, the uncertainties, how you evaluate the fracture toughness properties. And they have actually had a couple interactions talking with Bob Hardies' staff from the NRC to develop those and formalize those guidelines.

MEMBER RICCARDELLA: Are you making any progress on inspection of CASS material?

MS. BERNHOFT: That is somewhat of a challenge, you know, because of the material properties. So, right now, visual is still, that is our primary mode, is enhanced visual.

The next area that we have talked about, and this has been also talked about somewhat before, is the reactor pressure surveillance programs. And really, what it is, it is the need to monitor for the fracture toughness properties of the reactor pressure vessels and the nozzles, due to the irradiation exposure.

The primary way we do that right now is with a surveillance capsule program. With that, we have developed the integrated surveillance capsule program for the BWRs, and with the PWRs we do have the embrittlement trend correlations and quite a few publications that we have put out on those to support the industry and the embrittlement trend correlations.

Going on to the next overhead, as we talk about the 60 to 80 years --

MEMBER POWERS: Could I interrupt you and --

MS. BERNHOFT: Yes.

MEMBER POWERS: -- ask if you have any insights on DOEL reactors?

MS. BERNHOFT: You're talking the DOEL situation?

MEMBER POWERS: Uh-hum.

MS. BERNHOFT: Yes. We do stay in close contact with them, of course, and there have been quite a few industry phone calls on that.

You know, the hydrogen flaking issue, as we know, has come out, and we are aware of their more recent test experiences. And we have people that are from EPRI that are working with both the utility and the regulator to try and understand some of the basis for how they perform those most recent rounds of testing, to ensure that we understand what went into that testing and how we can understand those results that came out of that testing. But, right now, we don't have all that information.

MEMBER POWERS: We have had vessels produced by the same source?

MS. BERNHOFT: In the United States there are a few vessels that were produced by the Rotterdam facility; that is a correct statement.

MEMBER BALLINGER: Have those been inspected? I would assume they have.

MS. BERNHOFT: Right. I would have to go back and look at my notes on that one, but I can get back with Tim Hardin on that for you, if you would like.

MEMBER BALLINGER: Yes.

MEMBER POWERS: Well, you know, my perception is that, yes, they got inspected --

MS. BERNHOFT: Yes.

MEMBER POWERS: -- and they didn't see

anything.

MEMBER BALLINGER: Yes, that is my perception as well.

MEMBER POWERS: But a negative result, I mean, it is kind of a peculiar negative result.

MS. BERNHOFT: Yes.

MEMBER POWERS: They may not have looked hard enough.

MEMBER RICCARDELLA: Clearly, they would be part of the Section 11 inspection programs --

MEMBER POWERS: Yes, yes.

MEMBER RICCARDELLA: -- that have been done. But whether that was looking specifically for that type of problem --

MS. BERNHOFT: Yes.

MEMBER RICCARDELLA: -- I am not sure.

MS. BERNHOFT: Yes. And the one thing is it really does come back to the manufacturing process is unique to what was known as the DOEL vessels versus the U.S. vessels.

MEMBER POWERS: I mean, presumably, what Rotterdam did was roughly the same for all of them. It was just kind of a peculiarity, as I understand it, from one particular ingot at DOEL. And the question is, did they do a peculiarity on any other particular --

MS. BERNHOFT: That is a good question. I mean, I said that data has not all been provided. So, I really don't want to speculate on that.

MEMBER SKILLMAN: Please proceed.

MS. BERNHOFT: Okay. Thank you.

MEMBER SKILLMAN: Thank you.

MS. BERNHOFT: Okay. So, with regard to reactor pressure vessels -- and I am talking the surveillance capsule programs, which is what we use to determine the embrittlement trend correlations -- we do know that, as plants are continuing on their life, that we are starting to deplete the number of surveillance capsules available.

So, we have a couple of programs available that we are implementing right now. One is that we have taken a look at the surveillance capsules that are still in-vessel and we have worked with those utilities to delay or push out into the future the retrieval time for those capsules, so that we will have a higher exposure on those capsules that are in the vessel right now before we retrieve them. So, when we do retrieve them, that we can put them out further in the curve.

The other one that we are doing is we are going back and we are looking at capsules that have already been removed. And we have the plan, and we are working with host utilities right now to reinsert those capsules back into vessels, also to get additional exposure on those.

MEMBER RICCARDELLA: Reconstitute existing samples?

MS. BERNHOFT: Yes, the samples that we have, like I said, we have identified the host reactors, and we will start reinstalling those back into continue --

MEMBER RICCARDELLA: But they have already been tested. So, you have to put them back together somehow, right?

MS. BERNHOFT: Right, but they are large samples.

MEMBER RICCARDELLA: Yes.

MS. BERNHOFT: So, we put in that.

And then, also, the DOE has a program where they are going through and they are doing the APT testing on the irradiation samples to see if we can get more, interrogate more what is happening at the grain-boundary structure with that.

The other thing that comes up more recently is now we start looking not just at the beltline areas, but we are looking at the nozzle areas as well. As you continue to exposure or have higher fluences, you do need to start accounting for what is happening at the nozzles as well.

That covers the RCS metals.

On the cables, we do have an active program on cable aging management. For 25 years we have been doing research on cables.

They have developed a License Renewal Electrical Handbook, several cable aging reports, guidelines, and several reports that have been generated from forensics testing on cables.

More recently, we have worked very closely with the DOE, EPRI, and NRC Research, and we have come up with a detailed integrated roadmap to help. So, we feel right now, if people are implementing the EPRI aging management programs and the License Renewal Handbook, they have an adequate program for managing their cables.

Looking into the future, we are continuing to do the research on the submergence that was talked about. We are coming up with guidelines for actually being able to take advantage of people who are abandoning cables, to be able to harvest those cables, so we can test some actual field-returned cables.

We agree with pushing the state of art on conditioning monitoring, improved lifetime predictions, and we want to come up with an overall toolbox for cable aging management.

The next area is concrete and concrete structures. This becomes a very interesting area recently with a lot of operating experience. With that, we started doing active research in concrete about, I would say, the 2008-2009 timeframe.

More recently, we have developed an advisory structure for our concrete research to obtain input from our members and, also, to share operating experience and the results of the research with our members.

Of course, we have been working with alkali silica reactions. And the question becomes, then, the radiation, the gamma heating, the creep fatigue.

Some of the projects that we have completed, we have completed extensive literature search on the radiation effects, and we have also been able to obtain quite a bit through DOE and their bilateral agreements. We have obtained quite a bit of international research that has recently been completed on irradiation concrete, mostly coming out of the Finns and out of Japan.

Looking at that data, we have put together curves and correlations that show that, out to about

80 years of operation, you really don't see a large effect on the effects of the radiation, the mechanical properties of the concrete, out towards about 80 years of operation.

But, with that, we have also been doing some modeling of boric acid attack on spent-fuel pools.

MEMBER POWERS: When you say "out to 80 years," is that because that is as far as your database goes?

MS. BERNHOFT: That's correct.

MEMBER POWERS: Oh, okay. So, you didn't really see anything at 80 years? You just ran out of things to look at?

MS. BERNHOFT: Yes. And as you will see on this next overhead, we want to continue, our ongoing efforts is we are going to continue to interrogate what is happening out there at the 80 years.

And I didn't put in the whole detailed overheads that I had for the whole Subcommittee, but what we have shown is that the smaller containments, okay, so primarily the two Westinghouse plants, the smaller containments with the higher fluences, the area of most concern is going to be the biological shield wall and the reactor support structure in those smaller containments.

And the data shows that, for that leading higher-fluence-type population, out to around 80 years is where you start getting to some questions. Our next phase of our research, working with the DOE right now, is we are going to be irradiating some actual concrete samples, representative to some of those bounding plants out at the 80-plus years; then, be able to pull those samples out of the reactor and do the interrogation, the mechanical properties.

With that, we are also looking at the creep fatigue. We are looking at a lot of databases from the Department of Transportation.

MEMBER POWERS: It is the neutron or the gamma flux that is causing that?

MS. BERNHOFT: It is probably the neutron fluence, but we also wanted to look at the gamma heating effects. And how we are trying to design the testing right now is we are working very hard on how we test and be able to separate those two elements, and then, look if there is any kind of synergistic effect. It is not an easy test to design, but those are the types of discussions that we are going through right now with people who are really smart in concrete, which we are lucky that Oak Ridge has quite a few people that are that smart with concrete.

MEMBER POWERS: I mean, what is the chemical that is sensitive?

MS. BERNHOFT: Pardon?

MEMBER POWERS: What is the sensitive chemical? Is it the cementitious materials or the aggregate?

MS. BERNHOFT: It is probably the aggregate.

CHAIR STETKAR: Let me insert a little bit here of time pressure.

We are planning to have a Subcommittee meeting sometime this fall -- we don't have the date set -- that is going to explore this particular issue, concrete aging in probably gorier detail than anybody wants to have it.

MEMBER RICCARDELLA: Well, and there was a lot of data presented at the Subcommittee as well on this topic.

CHAIR STETKAR: So, we are going to be revisiting this in quite a bit of detail, I think.

MS. BERNHOFT: Yes, to simplify things, I did pull out a lot of that data we talked about.

MEMBER RICCARDELLA: Yes, and Oak Ridge did, too.

MS. BERNHOFT: Yes, Oak Ridge. Oak Ridge

has some really smart people.

CHAIR STETKAR: Sherry will be back.

(Laughter.)

MS. BERNHOFT: Oh, people smarter than me on concrete will be back, I trust.

(Laughter.)

MEMBER SKILLMAN: You are making good progress. Let's go. You're almost there.

MS. BERNHOFT: That's right. Okay, my last overhead.

MEMBER SKILLMAN: Yes.

MS. BERNHOFT: Okay. So, in summary, there is a technical basis that has been formed for aging management programs, and these are the key elements of that. And here's some really cool pictures about how you use the aging management programs.

And thank you for your time.

MEMBER SKILLMAN: Thanks a lot.

Colleagues, any questions for Sherry?

(No response.)

Thank you for coming.

MEMBER POWERS: When you --

MEMBER SKILLMAN: Dana?

MEMBER POWERS: When you look at these aged cables, are you just looking at the electrical properties of the insulation or what is it that you are looking at? You said you were harvesting cables.

MS. BERNHOFT: The criteria that we look at is what is called elongation to break. So, we are really looking at the insulating properties left of the cable insulation material, because, you know, you start to get the breakdown and that is how you get to the cable failures. The measure that you usually come back to is one that is called elongation to break.

MEMBER POWERS: Okay. So, you are just looking at what its mechanical integrity is? You are not looking at whether it has become electrically-conductive or not?

MS. BERNHOFT: You're talking about the core conductor material? No.

MEMBER POWERS: The insulation itself has lost electrical capacity, insulating capacity.

MS. BERNHOFT: Yes, we interrogate that. We look at if it is still serving, if it is preventing, you know, CASS to ground. So, we look at that.

So, the elongation to break is correlated with a lot of the forensics testing we have done, that we have found that basically cables that still have 50 percent elongation to break have not failed in service. We have also found, correlating that with the EQ data, they have not failed.

MEMBER SKILLMAN: Thank you.

MS. BERNHOFT: Thank you.

MEMBER SKILLMAN: Dana, any more?

MEMBER POWERS: I wish they would do more with the cables.

CHAIR STETKAR: By the way, we are kind of planning to start engagement with the staff and with the stakeholders on each of these major technical issues kind of earlier than later. So, I am pretty confident we are going to be hearing more about cables, too.

The first one we are teeing-up is the concrete issues, but it is certainly on our radar to get better informed on many of these topics.

MEMBER SKILLMAN: Thank you.

The bridge line, if anybody is on the bridge line, would you please identify yourself?

(No response.)

It has been confirmed to be open.

Bridge line, is anybody there, please?

(No response.)

Thank you.

Would you close the bridge line, please?

Anybody in the audience, would you care to make a statement, please?

(No response.)

Hearing none, thank you.

Mr. Chairman, back to you.

CHAIR STETKAR: Thanks, Dick.

I appreciate everybody. We did have a little bit of schedule slip here.

So, what I would like to do now is we will adjourn the session that is on the record. We will reconvene at 4:45 and start our deliberations over the letters. And the first thing that we are going to tee-up is on subsequent license renewal.

So, 4:45.

(Whereupon, the foregoing matter went off the record at 4:26 p.m.)

HRA method development

Jing Xing
Sr. Human Performance Engineer
RES/DRA/HFRB

ACRS briefing on HRA, 5/8/2014

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

SRM-M061020

SRM-M061020 directed the ACRS to

"work with the staff and external stakeholders to evaluate the different human reliability models in an effort to propose a single model for the agency to use or guidance on which model(s) should be used in specific circumstances"

Outline

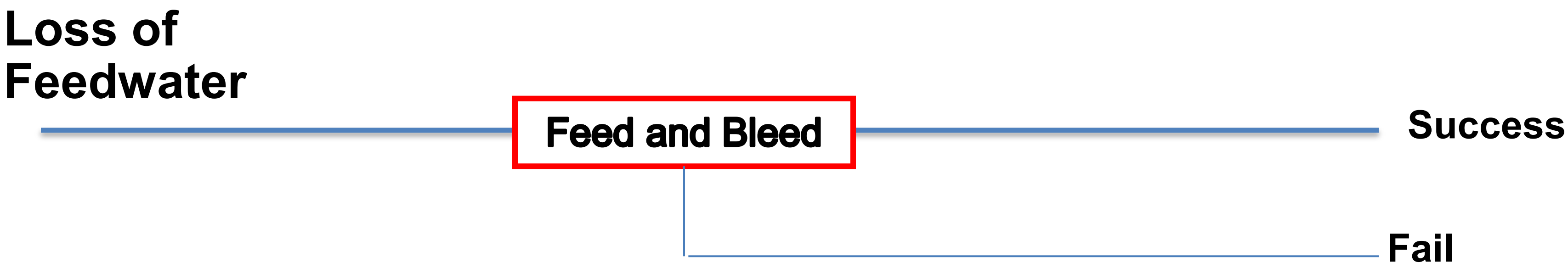
I. Overview of the HRA method development

II. Introduction to the Cognitive Basis

III. Introduction to IDHEAS –
An Integrated Decision-tree Human Event Analysis System for internal, at-power events

IV. Path forward

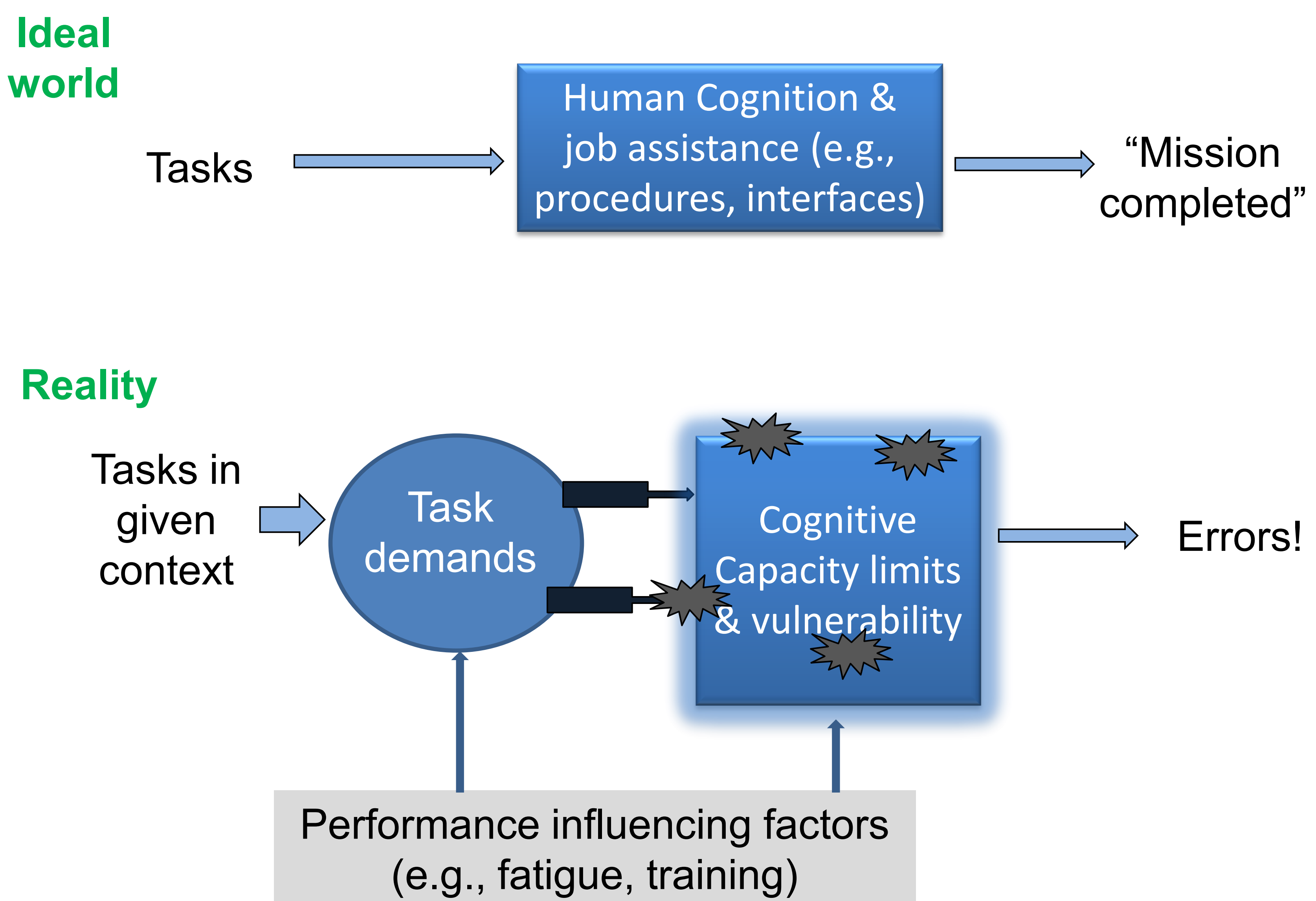
From PRA to HRA



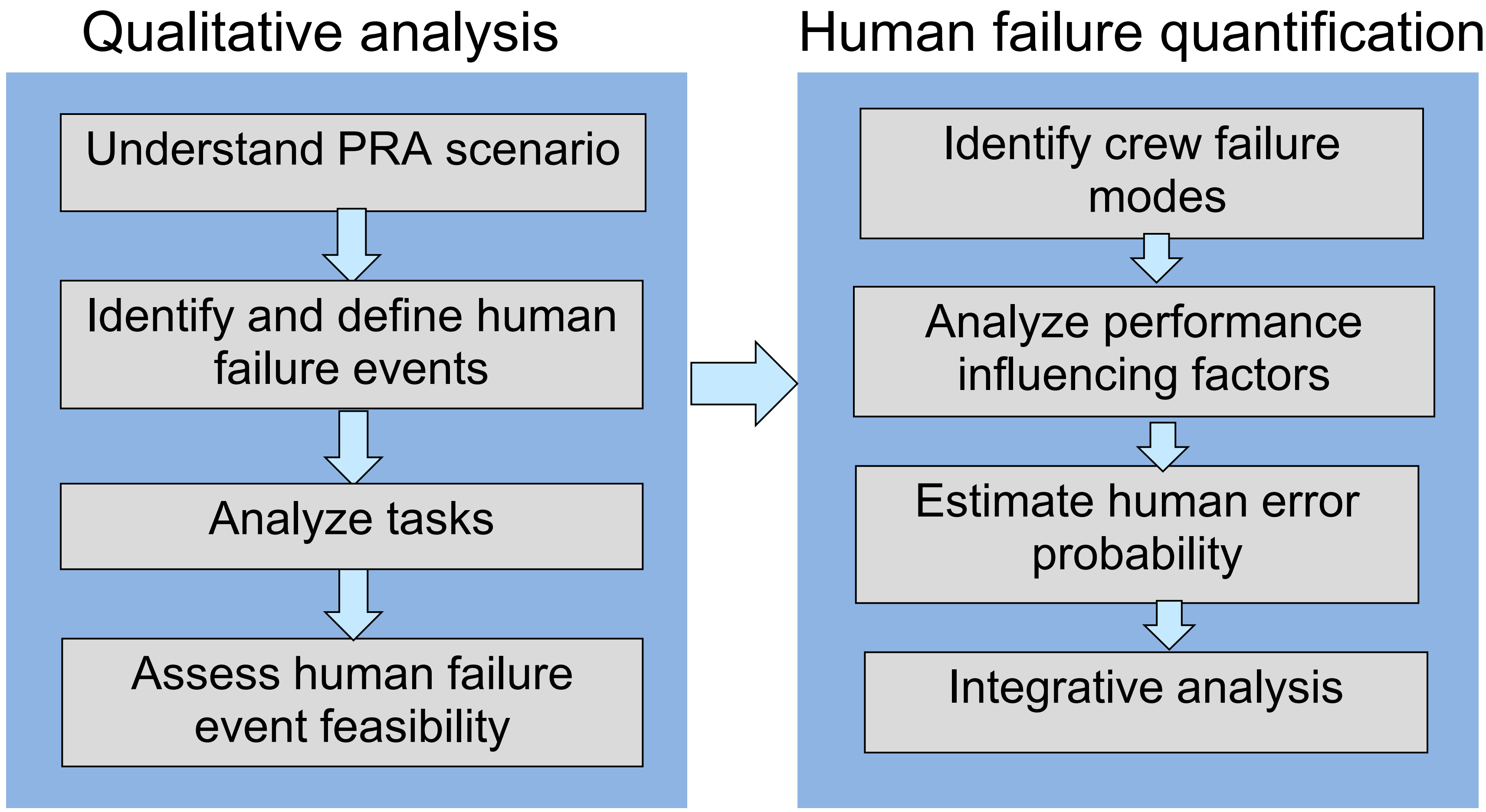
PRA scenario	Loss of Feedwater followed by a manual reactor trip.
Plant state by which response must be completed	Initiate feed and bleed to avoid core damage.
Human failure event	Failure to establish Feed and Bleed within 45 minutes of the reactor trip.

- Can human perform the required activities?
- What is the probability of operators failing the event?

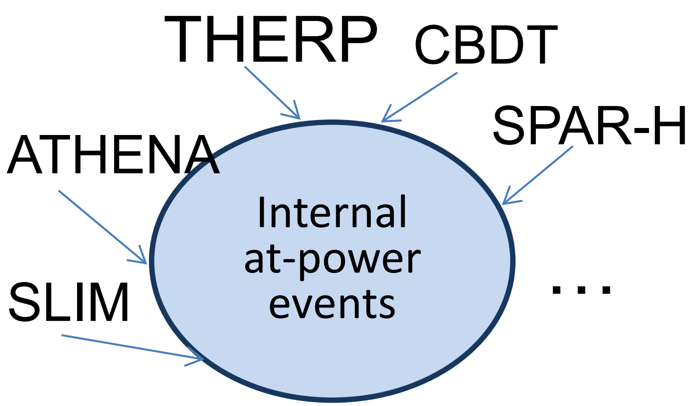
Why can an experienced operator fail the task ?



HRA process

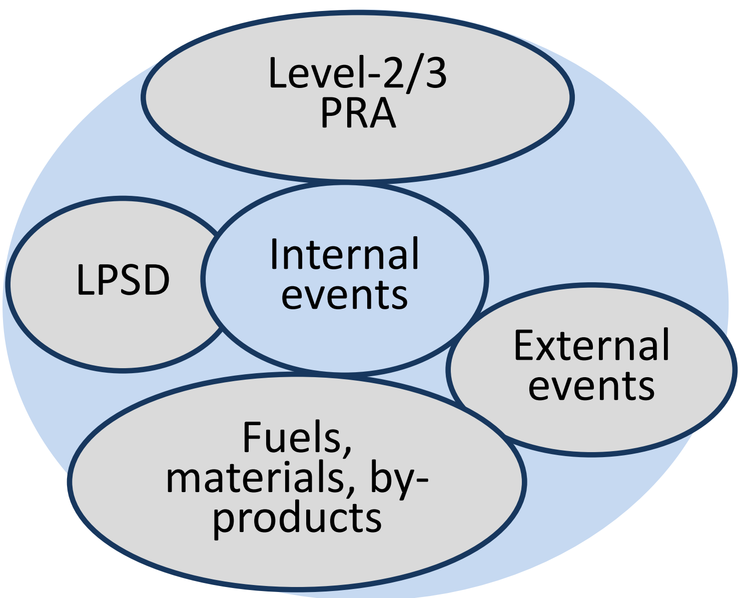

Qualitative analysis
Understand PRA scenario
Identify and define human failure events
Analyze tasks
Assess human failure event feasibility
Human failure quantification
Identify crew failure modes
Analyze performance influencing factors
Estimate human error probability
Integrative analysis

Need for Single Integrated Method



- Multiple methods for a limited application
- Each with limited scopes
- Scientific basis and data limited
- Variability when applying methods

Need an enhanced method to reduce variability



- Existing methods not adequate to cover a broad set of applications
- Not desired - each application having its own method
- Little data for external / Level-2 events

Need a generic methodology to support a diversity of applications

Project Goal and Key Objectives

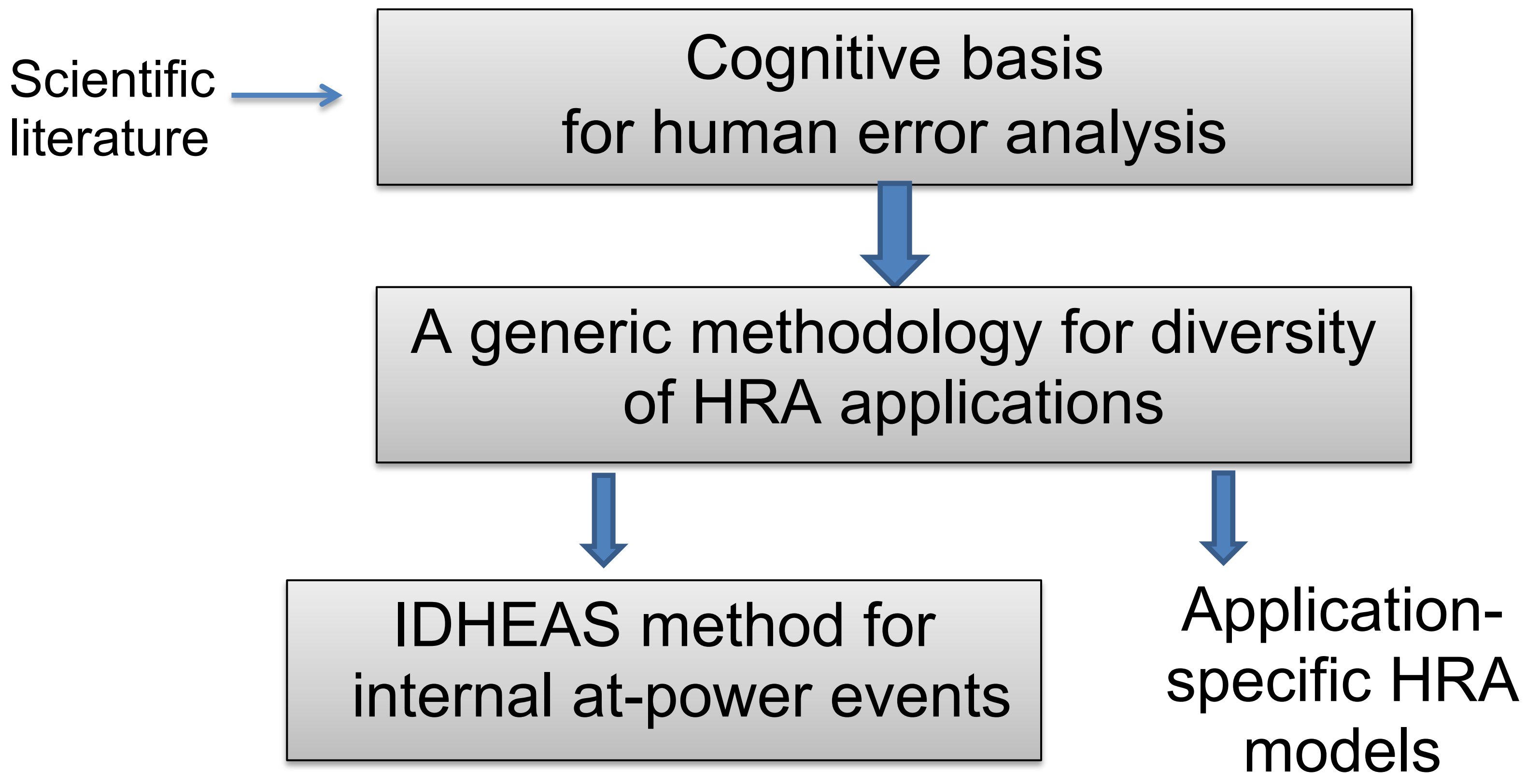
Goal

- Develop a generic HRA methodology to reduce variability and support a diversity of applications

Key Objectives

- Conform to the PRA standard and HRA Good Practices
- Retain and integrate the strengths of existing methods
- Have enhanced capabilities to address the key limitations in state-of-practices
- Have a state-of-art technical basis and be generic and flexible enough to support a diversity of applications

Strategic framework



Products and intended use

Product	Intended use	Status
Cognitive basis for human error analysis	• HRA • Human factors engineering	• Completed • Externally reviewed • Being used
IDHEAS method for internal, at-power events	• Internal, at-power event PRA (PRA models, SDP, ASP, etc.)	• Development completed • Externally reviewed • Initially tested
Generic methodology for HRA applications	• HRA for all HRA applications (e.g., Level-3 PRA, LPSD, ex-control room operations)	• Draft report • Initial piloting in Level-3 PRA

Outline

I. Overview of the HRA method development

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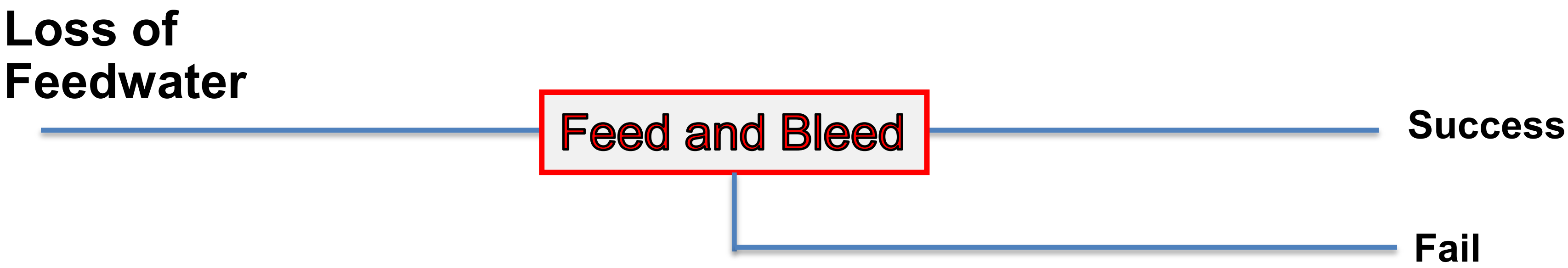
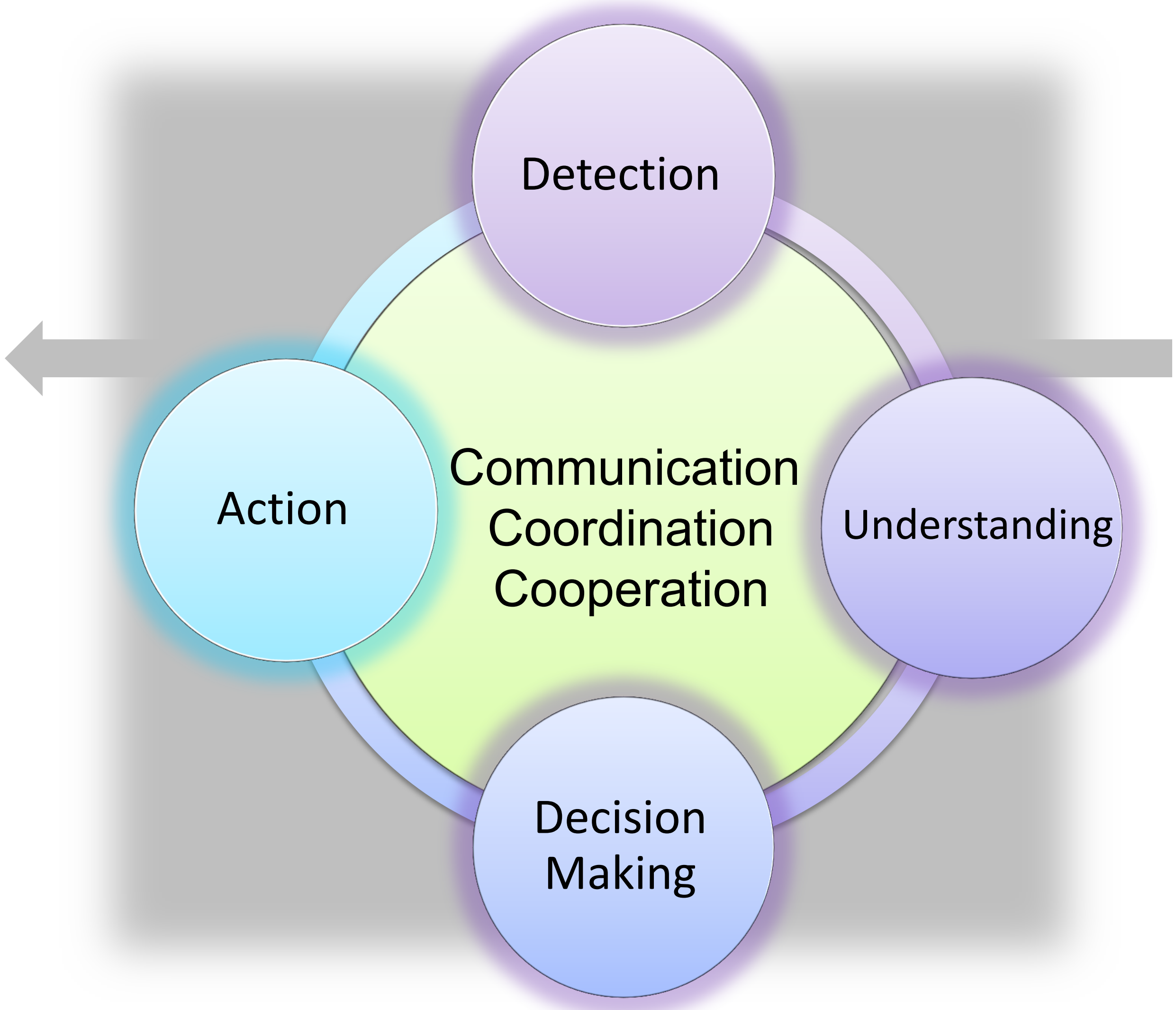
Basis for HRA – Human performs tasks through cognitive functions



Human activities	Underlying cognitive function
• Detect and respond to alarms • Check plant parameters	Detection
• Assess plant status • Diagnose the loss of feedwater	Understanding
• Decide to initiate feed and bleed	Decision-making
• Execute procedures	Action execution

Cognitive Basis used in HRA methods

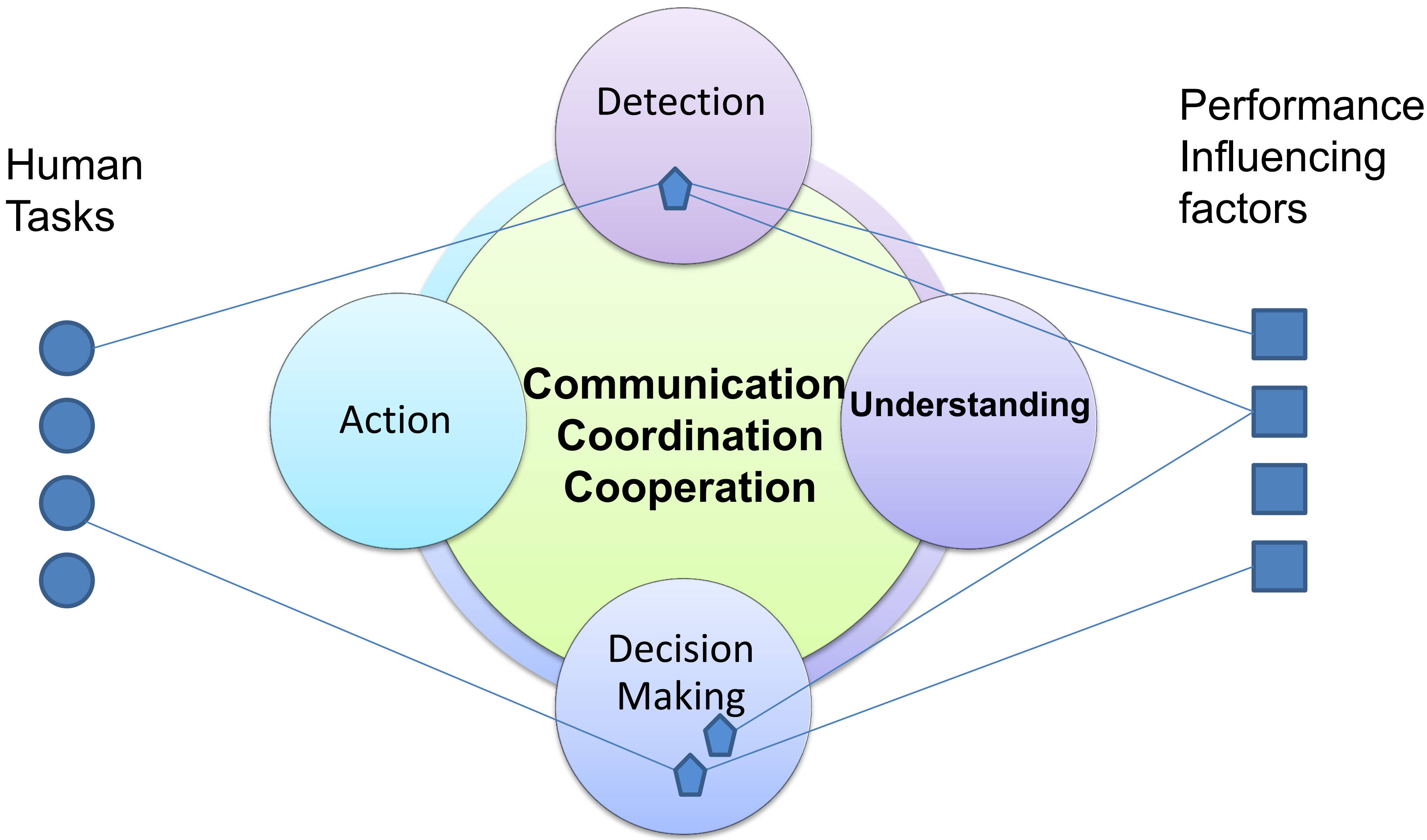
Human tasks in human failure events



Performance influencing factors

Enhance the Cognitive Basis for HRA

Making the "gray box" transparent



Goals of the Literature Review

- Identify cognitive mechanisms underlying NPP operator failures in internal, procedural events
- Identify factors that influence human performance and identify they way in which those factors affect failures
- Develop a structured cognitive framework to serve as a foundation for human error analysis

Enhance HRA with a stronger cognitive basis

- Enhance HRA validity – provide a scientific basis for HRA
- Improve HRA transparency – enhance analysts' justifications when applying HRA methods
- Expand the use of data for HRA – generalize data from different fields to quantify human error probability
- Enhance human factors engineering – provide scientific basis to support the development of human factors review guidance

Developing a structured cognitive basis framework

Systematically identify underlying human error information and organize it into a structured analysis framework:

Models how the cognitive function works

Error causes for failure of cognitive functions

e.g., Cue/information not attended to, information misperceived

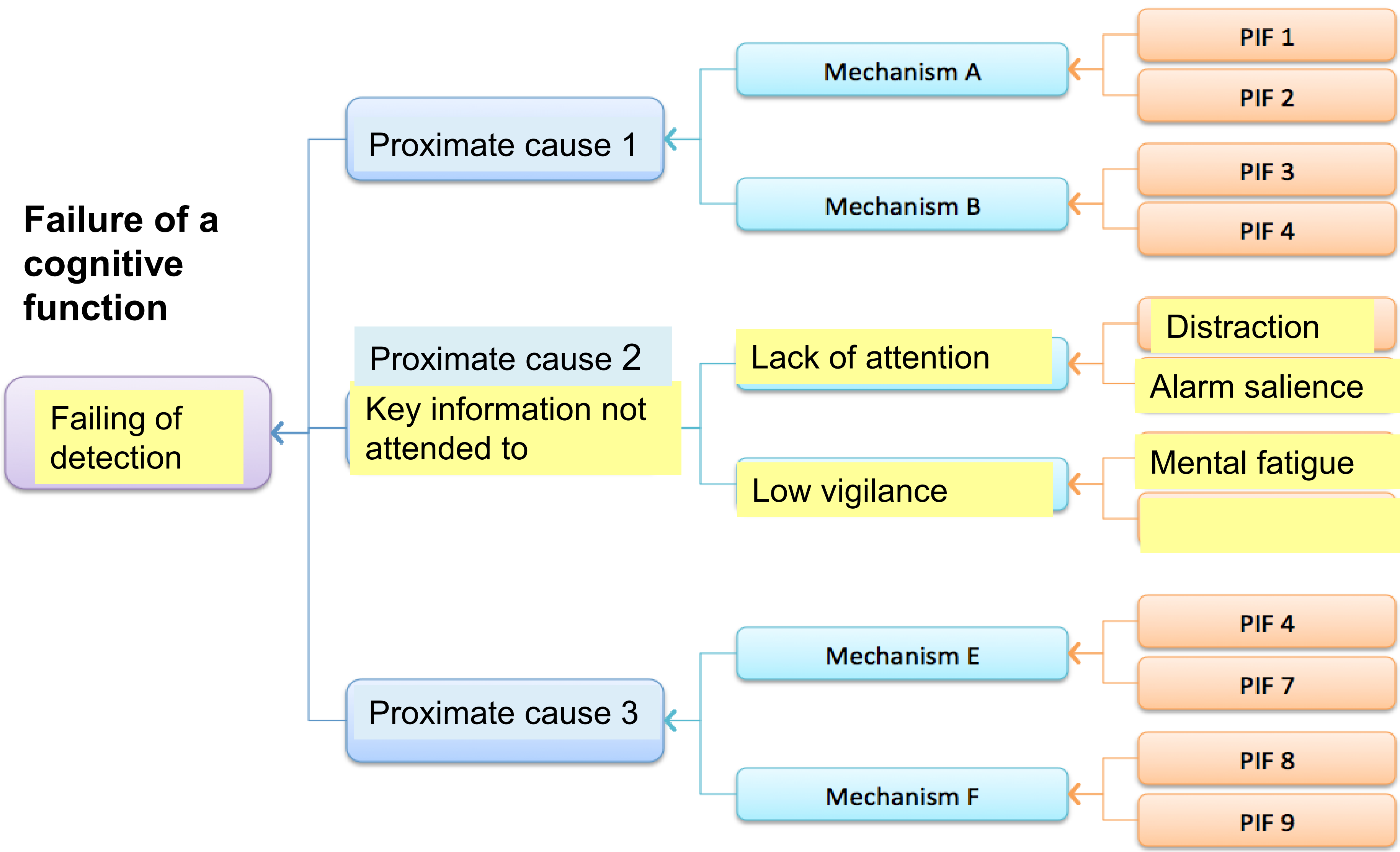
Cognitive mechanisms underlying error causes

e.g., lack of attention, overflow of working memory

Factors affecting the mechanisms and leading to error causes

e.g., multi-tasking, fatigue

An example of the structured Cognitive Basis



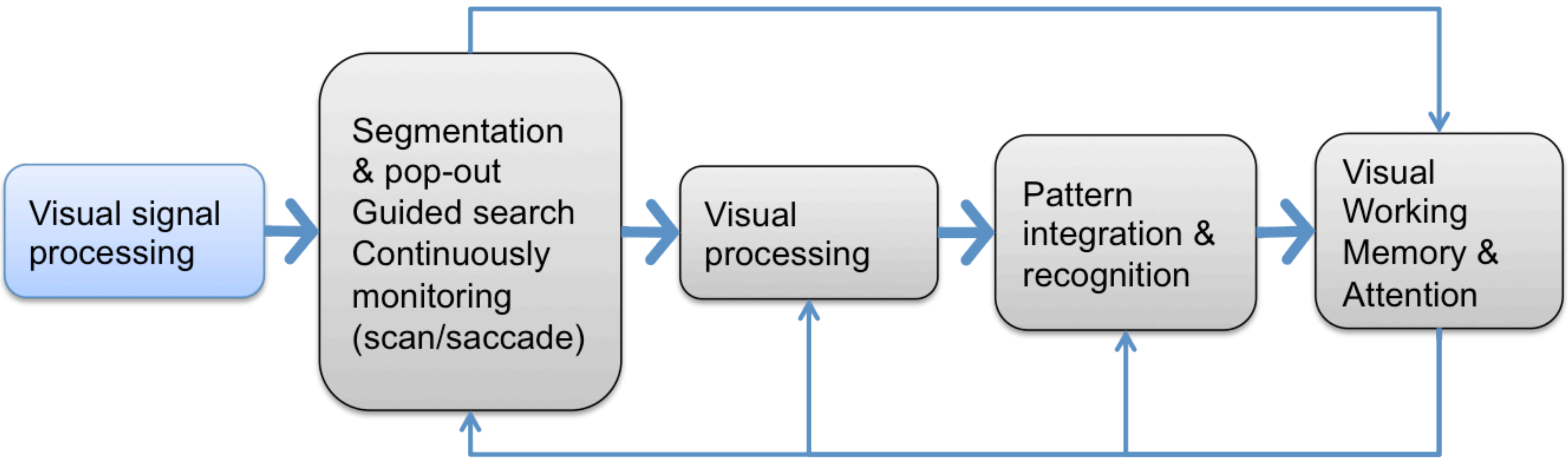
Detection - Scope in NPP internal procedural events

Detection is the process of perceiving information in the work environment, allowing humans to perceive large amounts of information and focus selectively on those pieces of information that are pertinent to present activities.

Scope of *Detection* in NPP internal procedural events

- **Detect salient signals**
- **Identify and perceive pertinent information**
- **Monitor parameters**
- Pursue motion targets
- Visual discrimination
- Weak signal detection
- …

Detection – How the brain achieves the function



Visual signal processing—sense and pre-process visual signals for perception.

Segmentation/pop-out—extract salient information.

Visual feature perception—perform preliminary visual analysis of features such as contrast, color, shape, and motion.

Pattern/object integration—integrate multi-dimensional visual features into a coherent pattern or object.

Detection – Cognitive mechanisms that makes the function reliable

Cue Content - Content of the cue has to be salient enough to be detected by these functions.

Vigilance in Monitoring - Human ability to attend to or monitor cues will naturally degrade over time as a byproduct of fatigue.

Attention - Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring other things.

Expectation - Perceiving the environment is subject to expectation (experience and bias) prime.

Working Memory - Working memory held the perceived information or items of information to identify or monitor; it is capacity limited.

Detection – Error causes and proximate causes

Proximate Cause - Cues/information not perceived

- Cue salience is low and not detected
- Unable to maintain vigilance
- Mismatch between expected and actual cues
- Working memory capacity overload

Proximate Cause - Cues/information not attended to

- Too many salient cues
- Overreliance on primary indicator

Proximate Cause - Cues/information misperceived

- Cues are too complex or similar
- Prior experience biases expectation
- Memory processing error

Detection – Effect of PIFs

Proximate Cause - Cues/information not perceived	**PIFs**
• Cue salience is low and not detected	Human-system interface (HSI)
• Unable to maintain vigilance	Fatigue, fitness-for-duty
• Mismatch between expected and actual cues	Training, procedures
• Working memory capacity overload	Workload, task complexity
Proximate Cause - Cues/information not attended to	
• Too many salient cues	Task complexity, HSI
• Overreliance on primary indicator	Training and experience
Proximate Cause - Cues/information misperceived	
• Cues are too complex or similar	HSI, task complexity
• Prior experience biases expectation	Training and experience
• Memory processing error	Fatigue, workload, time

External Review of Draft NUREG-2114

Four reviewers completed the review and provided written comments

- 2 domestic and 2 international reviewers
- All have 20+ years experience in cognitive engineering research and applications
- 3 reviewers have experience in developing human performance models
- 3 reviewers have experience in HRA

Summary of the Cognitive Basis

- The literature review and the resulting Cognitive Basis provide a scientific foundation for human error analysis
- The Cognitive Basis focuses on human cognition for NPP control room at-power tasks. It does not include all of the relevant information for other tasks such as those in severe accidents.
- The Cognitive Basis should be dynamically updated to incorporate new relevant knowledge as it becomes available

Outline

I. Overview of the HRA method development

II. Introduction to the Cognitive Basis

III. Introduction to IDHEAS

IV. Path forward

Contributors

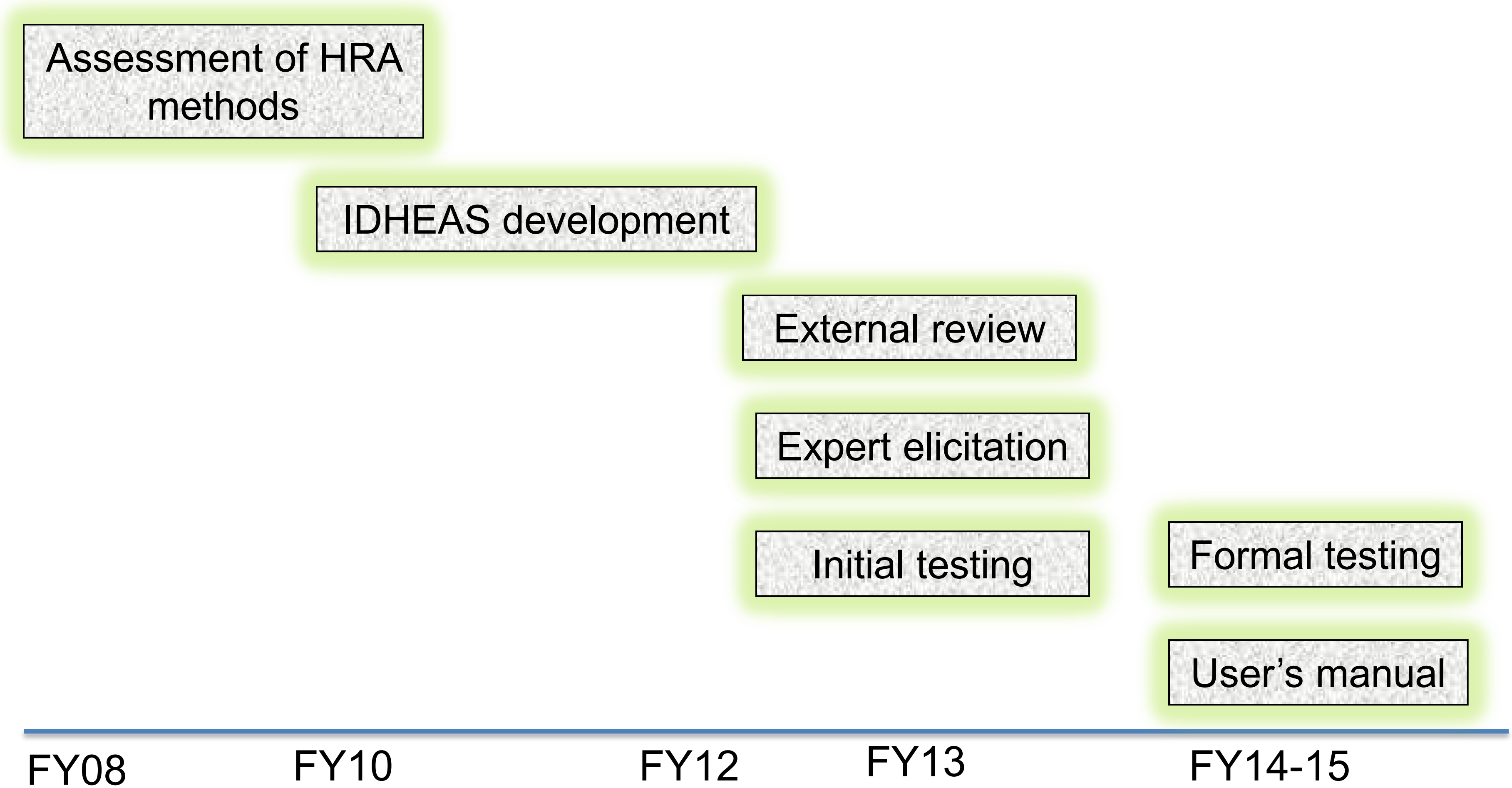
NRC/EPRI Draft Report

An Integrated Decision-Tree Human Event Analysis System (IDHEAS) Method for NPP internal at-power operation

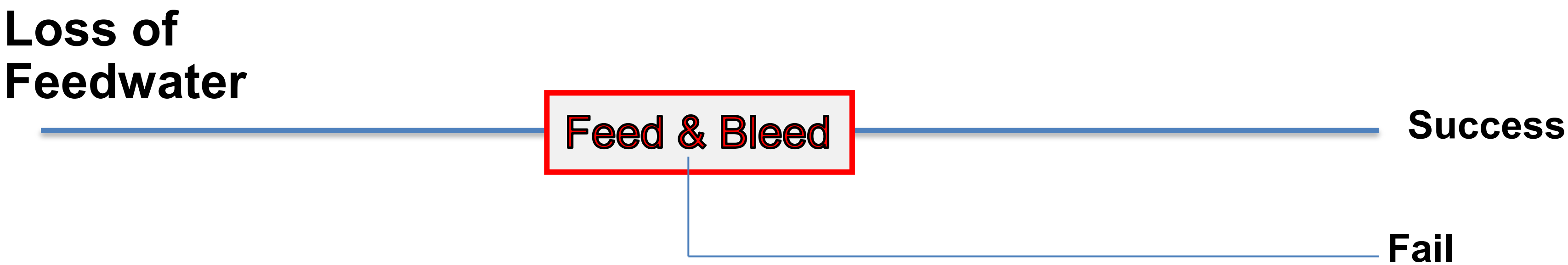
Gareth Parry[1]
John Forester[2]
Vinh Dang[3]
Stacey Hendrickson[4]
Mary Presley[5]
Erasmia Lois[6]
Jing Xing[6]

[1]ERIN Engineering & Research, INC.
[2]Idaho National Laboratory
[3]Paul Scherrer Institute
[4]Sandia National Laboratories
[5]Electric Power Research Institute
[6]U.S. Nuclear Regulatory Commission

Timeline of IDHEAS development



HRA process – What can go wrong and what is the likelihood?



Human failure event - Failing to establish feed & bleed within 45 mins of the reactor trip.

Qualitative analysis

- Understand PRA scenario
- Identify and define human failure events
- Analyze tasks
- Assess human event feasibility

→

Human failure event Quantification

- Identify crew failure modes
- Analyze performance PIFs
- Estimate human error probability
- Perform integrative analysis

Key Lessons Learned from Benchmarking Existing HRA Methods

1) Each method has its own strengths;
2) Most methods need stronger guidance for performing qualitative analysis or better interfaces for using qualitative analysis results to quantify human error probabilities;
3) The methods need comprehensive and explicit cognitive basis supporting why and how a human fails to perform a required task;
4) Additional guidance is needed on how to objectively assess and use performance influencing factors;
5) The use of the methods needs better documentation.

IDHEAS takes the advantages of 1) and improves 2-5).

Use of the Cognitive Basis in IDHEAS

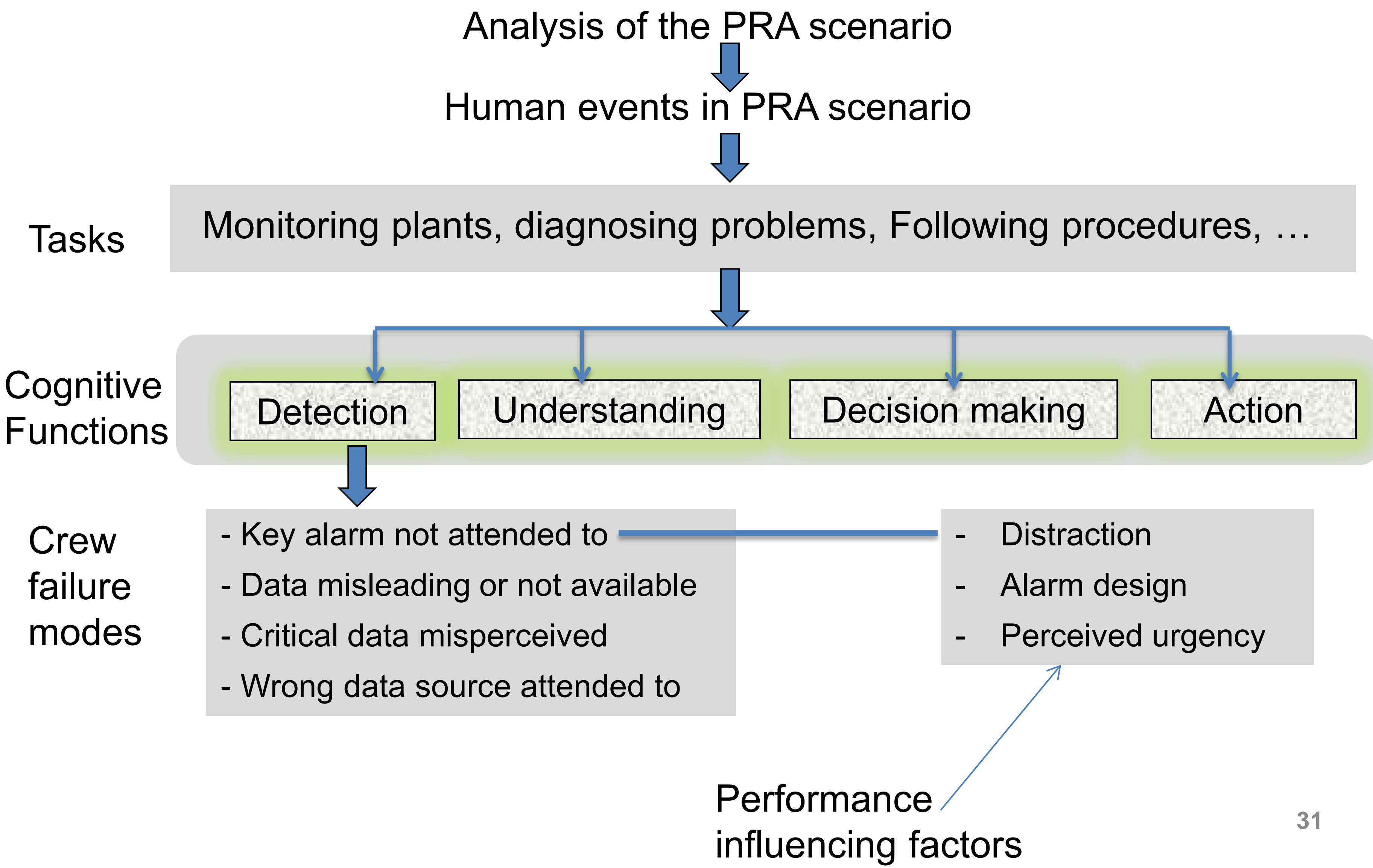


Illustration of the IDHEAS process

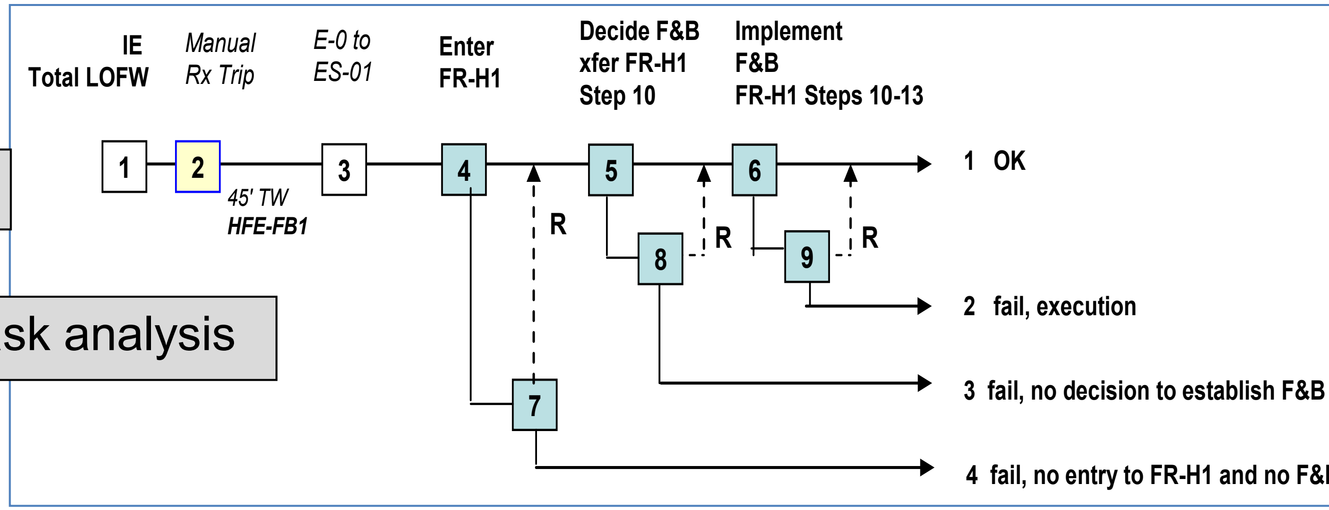
Qualitative analysis

PRA scenario

Define HFE: fail F&B

HFE Feasible?

Task analysis



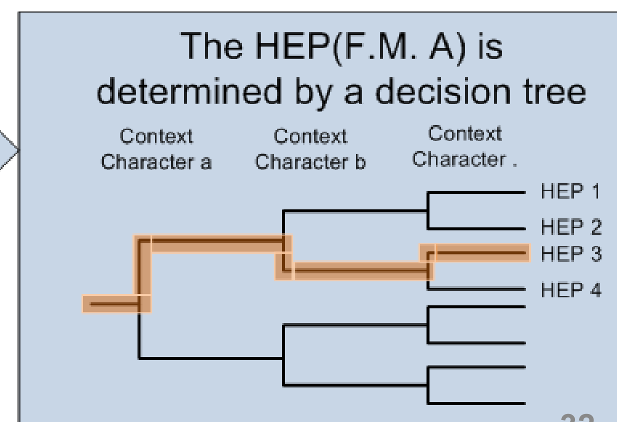
HEP quantification

Tasks

- Enter FR-H1
- Critical Task 2
- Critical Task K

Failure modes

- Data misleading
- Data misperceived
- Failure Mode ..



Key features of IDHEAS

- Integrated guidance for every step of the HRA process
- Structured qualitative analysis guidance
  - Human failure event identification
  - Task analysis and crew response tree
  - Feasibility assessment
- Human error probability quantification model developed from the cognitive basis
  - Crew failure modes describe failures of human tasks
  - Decision trees used to estimate human error probability
  - Questionnaires used to assess performance influencing factors
- Detailed guidance for documentation

Qualitative Analysis Structure

PRA scenario analysis

↓

HFE identification & definition

↓

Task identification and representation

Task 1 — Task 2 — Task 3 — Task 4

Task definition and cognitive analysis

- Definition (operators,, cues, tools, strategies)
- Objectives
- Cognitive functions
- Task context

Analysis of interaction between tasks

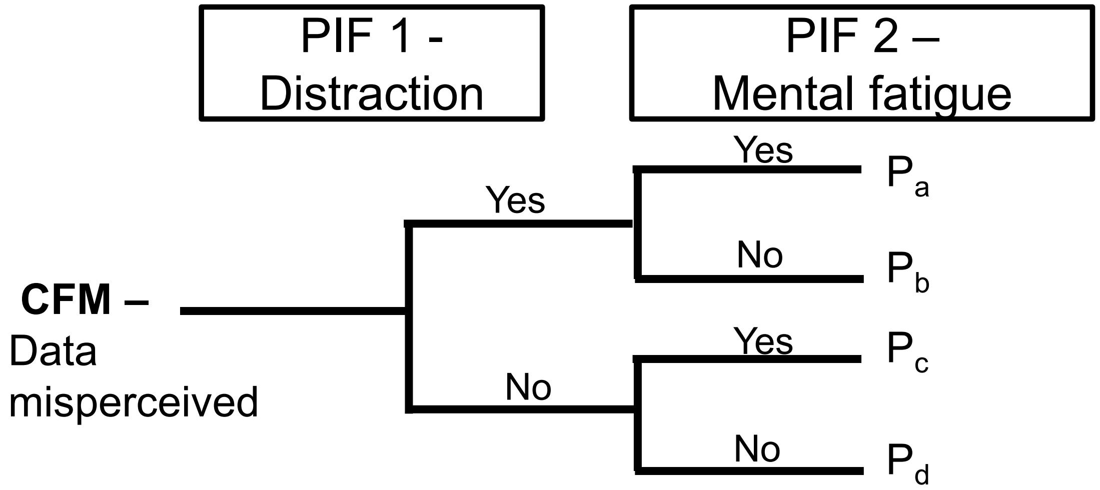
- Prior and parallel tasks to the critical task
- Expected timing and duration of the tasks and cues
- Assessment of the Workload factors for every critical task

Crew Failure Modes and Phase of Response

	Phase of Response		
	Plant Status Assessment	**Response Planning**	**Execution**
Crew Failure Mode	Key alarm not attended to	Delay implementation	Fail to initiate execution
	Data misleading or not available	Misinterpret procedure	Fail to execute simple action
	Premature termination of critical data collection	Choose inappropriate strategy	Fail to execute complex action
	Critical data misperceived		
	Wrong data source attended to		
	Critical data not checked with appropriate frequency		
	Critical data dismissed/discounted		
	Misread or skip step in procedure		
	Critical data miscommunicated		

HEP quantification - Decision Tree Approach

- PIF characteristic decision points
- Decision paths represent crew failure situations
- Probability assigned to each path



- The quantification of the HEP takes the following form for a PRA scenario:

$$HEP(HFE|S) = \sum_{CRT\ sequence} \sum_{CFM} Prob(CFM\ |CRT\ sequence, S)$$

Estimation of human error probabilities

- The human error probability of a failure mode varies with different failure scenarios (i.e., combinations of the performance influencing factors);
- The probability for each failure scenario was through a formal expert judgment panel

Crew failure mode – Key alarm not attended to

Failure scenario	Performance influencing factors					Human error probability
1	High distraction		Poor alarm design		Low perceived urgency	2.5E-1
2						
3						
4	High distraction		Good alarm design		High perceived urgency	4.4E-3
5						
6						
7	Minimal distraction		Good alarm design			< 0.00001

Objectives of IDHEAS expert elicitation

1) Estimate the HEPs of the DT paths for every CFM;

2) Identify additional factors contributing to the CFMs;

3) Elicit experts' opinions about the effects of PIFs on the CFMs.

A formal expert elicitation method -SSHAC

SSHAC is a formal, structured, interactive process for eliciting experts' judgment on complex technical issues.

Formal – The full cycle of expert elicitation is well planned and managed by the project management team

Structured – Different types of experts with well-defined roles and responsibilities

Interactive – Using workshops for experts to interact and integrate the judgment

The team structure of IDHEAS expert elicitation – adapted from SSHAC

- Data experts (DE) – Compile CFMs and HEP database and present the information
- Resource experts (RE) – The domain experts that provide experience/judgment on the failure likelihood and causes of CFMs
- Evaluators – The HRA analysts that integrate inputs from DE/RE/other evaluators to estimate HEPs
- Technical integration lead (TI lead) – Propose strategies of the elicitation and resolve technical issues during workshops
- Project managers – Manage the project and facilitate workshops
- Peer reviewers – Provide peers to the whole process

The process of IDHEAS expert elicitation – adapted from SSHAC

- Preparation – Project plan, reading materials, database, worksheets
- Piloting / Training – Ensure that all the team members understand the project, process, and individual's role/responsibilities
- Workshop #1 – Elicit domain experts' experience and judgment on the likelihood and causes of the CFMs in IDHEAS
- Between workshops – Domain experts complete their documentation and evaluators make their initial estimates of the HEPs
- Workshop #2– Evaluators assess, revise, and integrate their HEP estimates
- Documentation – Project team documents all the results

Expert elicitation of HEPs

Experts: DE – Data experts, RE- Resource experts, PE - Proponent experts,
TI – Technical integrators, PM – Project manager

Preparation

- DE identify & compile data
- PM prepare procedures & worksheets
- Training & piloting

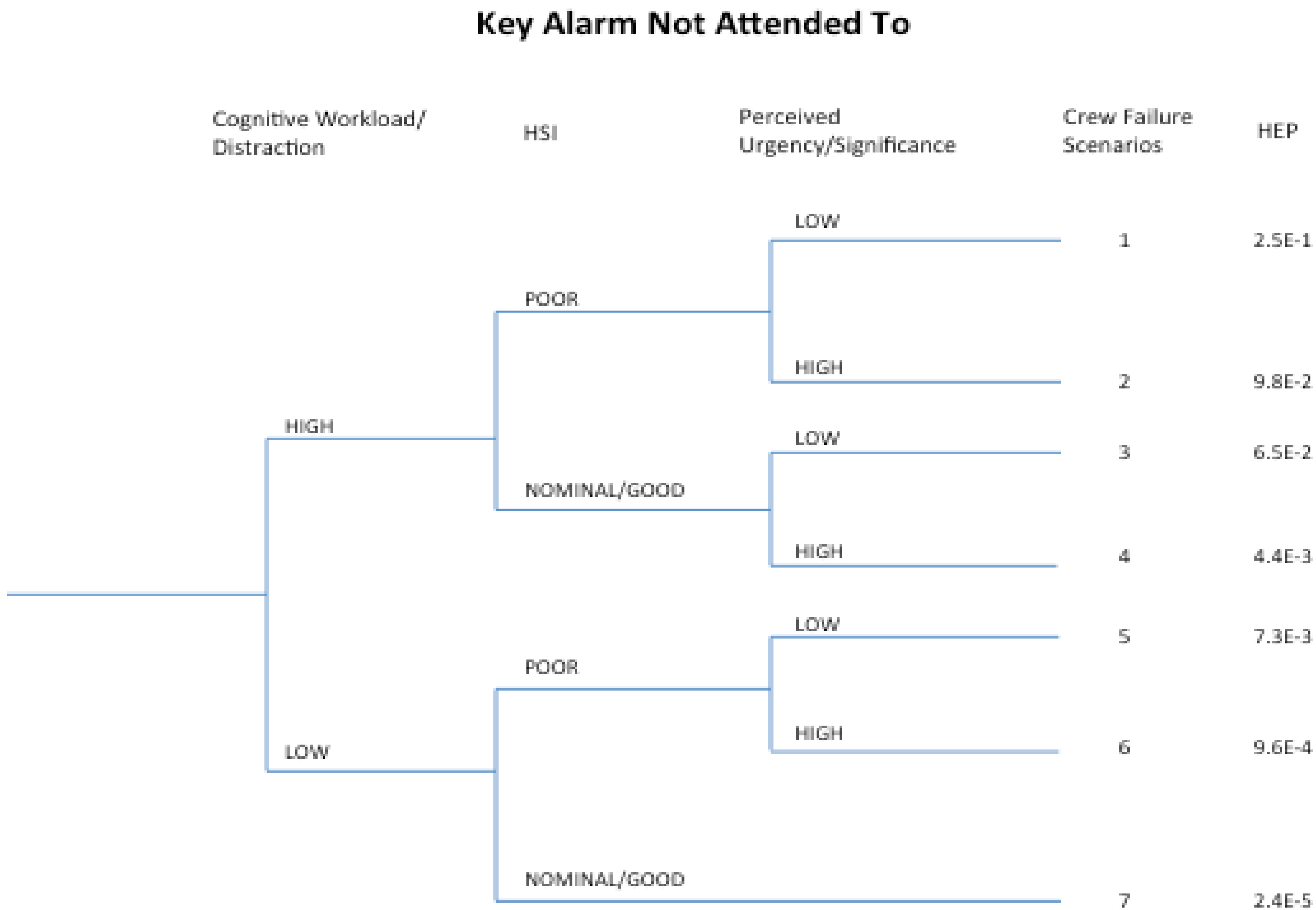
Workshop #1

- DE present model & data
- RE rank DT branches & assess PIFs
- PE question data and PE's judgment

Workshop #2

- PE estimate HEPs for selected branches
- RE question PE's estimation
- TI integrates HEPs

Example of the HEPs for a decision-tree



Summary of the expert elicitation

- The project team re-defined the CFMs and modified the PIFs of several DTs based on the inputs from the experts.

- Experts were unable to estimate the HEPs of two CFMs: *Choose Inappropriate Strategies* and *Miscommunication*, due to their ambiguous definitions.

- The HEPs for several DTs could not be integrated to generate a community distribution due to insufficient information or lack of confidence from the proponents.

- The modified SHAAC process worked reasonably well. The completeness and quality of the results were limited by experts' fully understanding the IDHEAS method and the time resources.

Purposes of initial testing

- Demonstrate how the method works
- Verify the functionality and feasibility of the method elements
- Identify areas for improvement
- Gain initial insights into inter-analyst variability
- Gain lessons on developing IDHEAS user's guidance

Testing teams

	# of analysts	Scenarios tested	Scope of testing
Team 1	3 analysts – IDHEAS developer and HRA practitioners	• US Simulator Study HFE **1A/1B** and **2A** • Cooldown in SBLOCA	• Simple exercise • Focused on quantification
Team 2	1 analyst, previously worked with a team on the tested scenarios	US Simulator Study HFE **1A**/1B, **1C**	• Thorough testing of the full method • Detailed documentation
Team 3	1 analyst, previously worked on the US Simulator Study report	US Simulator Study HFE **1A**/1B, **1C**, **2A**, 2B	• Thorough testing • Used templates for testing • Used similar documentation to that in the US Study

Summary of testing – general results

- Method works – All the parts work as they are intended, with improvement to the weaknesses in state-of-practice
- Good transparency and traceability
- Clear and comprehensive documentation
- Reasonable inter-analyst variability
- Labor consuming, yet clear templates compensate for time in deliberation
- A user-friendly manual is desired

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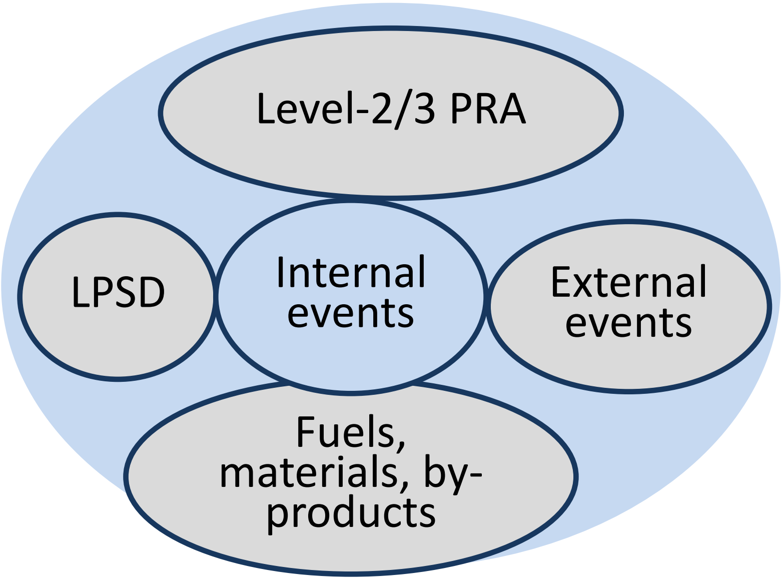
SRM mission "One method" – "Are we there yet"

Goal and Objectives	External review	Testing
Develop a new HRA methodology to reduce variability and support a diversity of applications	✓	✓ (Preliminary)
- Conform to the PRA standards and HRA Good Practices	✓	✓
- Retain and integrate the strengths of existing methods	✓	✓
- Have enhanced capabilities to address the key limitations in current state-of-practices	✓	✓ (Preliminary)
- Have a state-of-the-art technical basis	✓	✓
- Generic and flexible to support a diversity of applications		

A generic methodology supporting the diversity of HRA applications



In the diversity of HRA application -

- Broad spectrum of human actions with lack of detailed procedures
- Coordination and cooperation among multiple entities
- Complicated decision-making
- Performance influencing factors in severe conditions (e.g., radiation, environment, authorities, leadership)

Path-forward

Product	Path -forward
Cognitive basis for human error analysis	Use it in the NRC's human factors engineering and HRA practices
IDHEAS method specific for internal at-power events	Test and apply to HRA applications **(2014)**
Generic methodology to support a diversity of applications	Complete the methodology development **(2015)** Tailor it for specific applications, e.g., Decision-making in Level 2/3 PRA **(2015 – beyond)**

Conclusions

- State of the art basis
- Building/testing tools for staff use
- Integrated with the HRA program for continuous improvement

Backup Slides

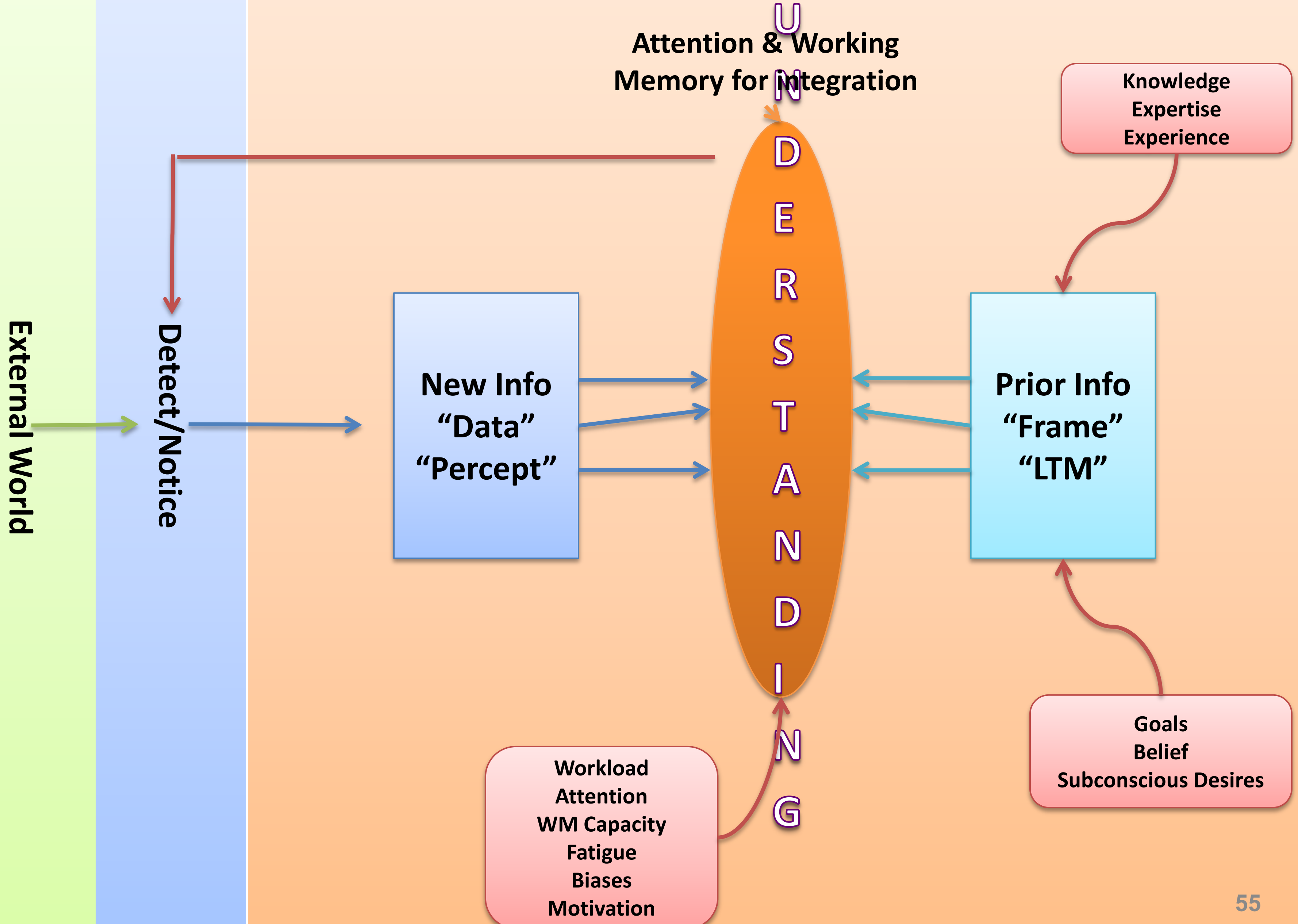
Understanding - Scope in NPP internal procedural events

Understanding is the evaluation of current conditions to assess the plant status or to diagnose the underlying causes of any abnormalities.

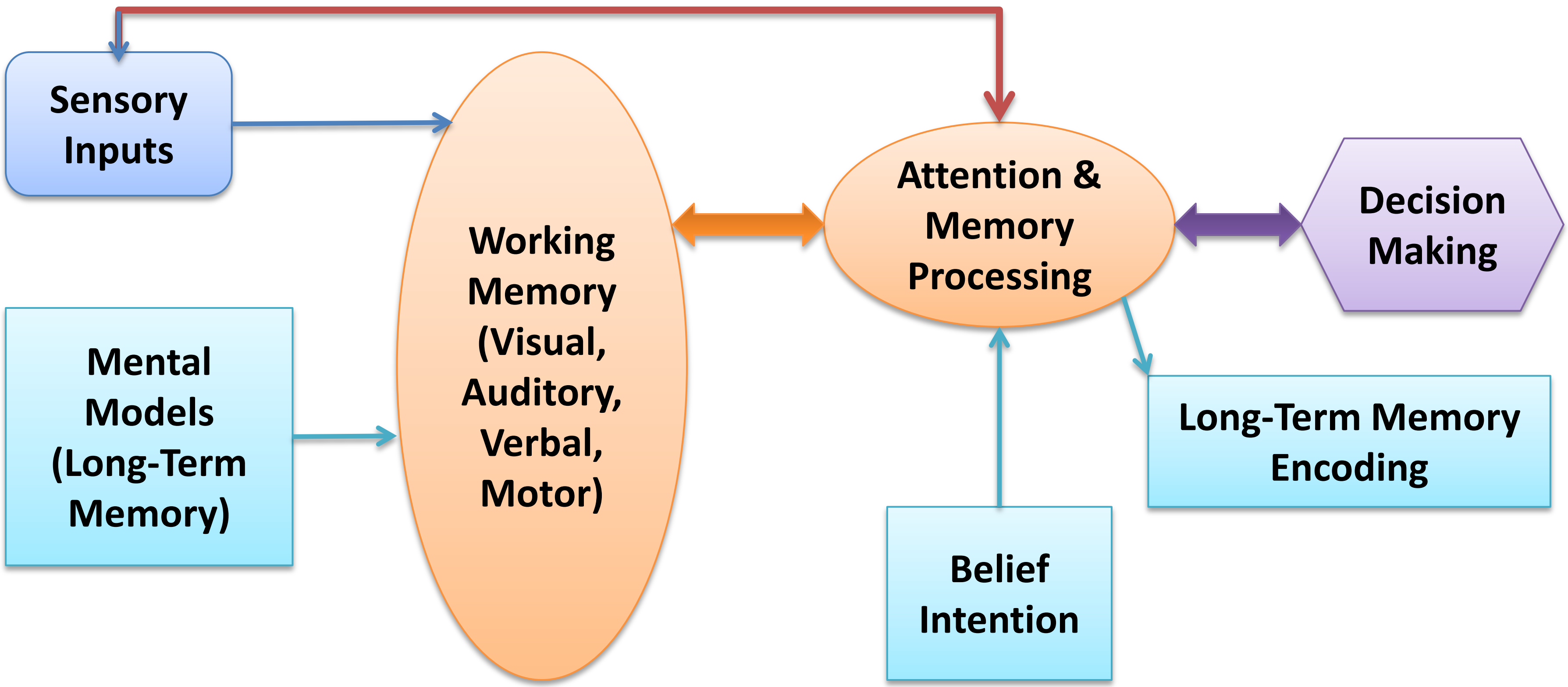
Scope of *Understanding* in NPP internal procedural events

- Assess and verify information
- Develop a coherent representation
- Maintain situational awareness
- Diagnose abnormalities
- ...

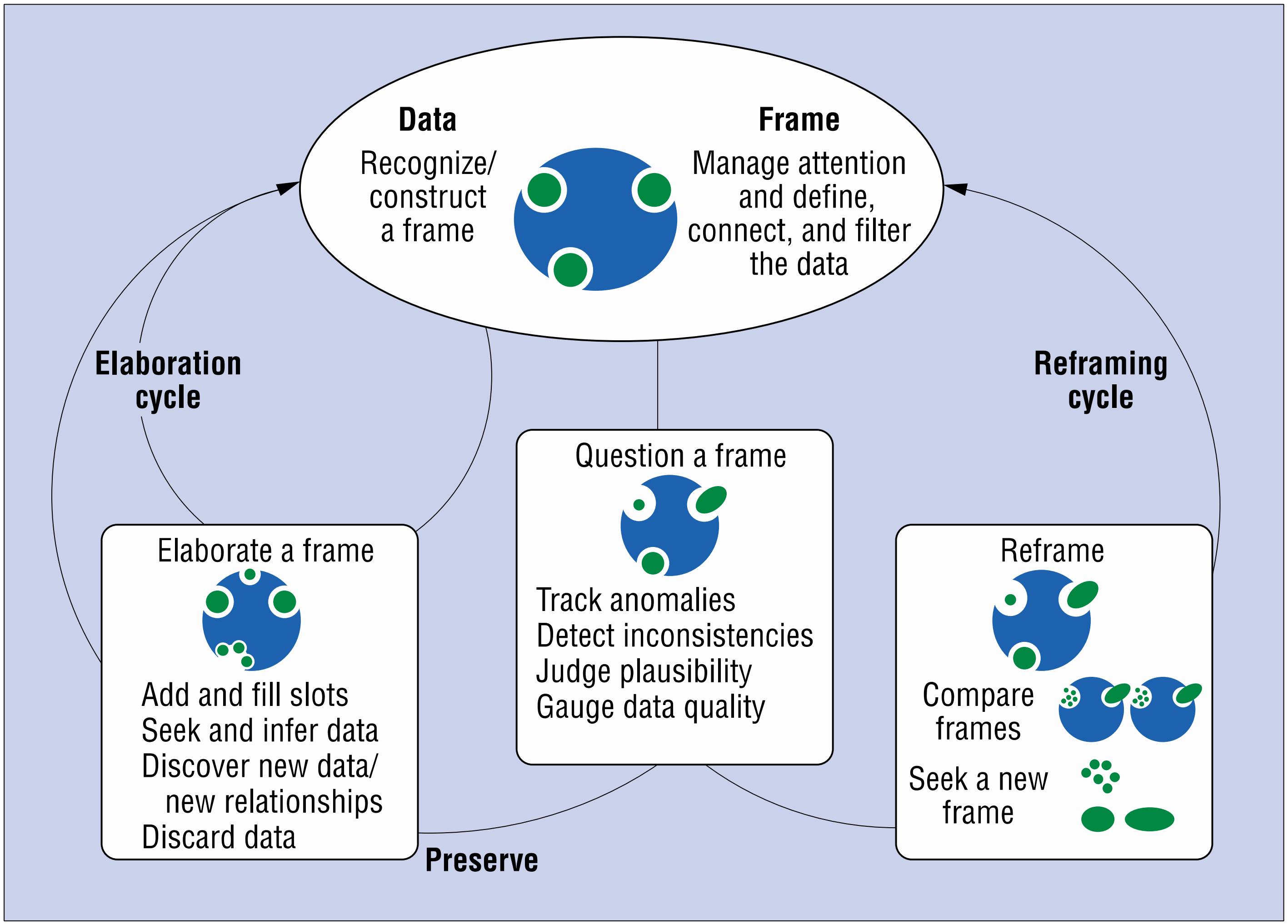
How human achieves Understanding



Dynamic process of understanding in complex tasks



Cognitive process for understanding



(Klein et al, 2006)

Understanding– Cognitive mechanisms that makes the function reliable

Data content- meaningful information, not misleading or conflicting

Mental model (frame) - Mental model is developed through training and experience

Integration of mental model and data - Mental model is integrated with data to generate understanding

Attention and Working Memory – Attention control ensures all parts of the cognitive process for understanding are achieved; Working memory is to be managed for its resource limitations.

Belief process - Beliefs modulate the integration process

Understanding– Error causes and proximate causes

Proximate Cause - Incorrect data

- Information available in the environment (including procedures) is not complete, correct, or otherwise sufficient to create understanding of the situation

Proximate Cause - Incorrect integration of data, frames, or data with a frame

- Improper aspects of the frame selected for comparison with the data

Proximate Cause – Incorrect frame

- Frame or mental model inappropriately preserved or confirmed when it should be rejected or reframed

Understanding– Effect of PIFs

Proximate Cause - Incorrect data

- Information available in the environment (including procedures) is not complete, correct, or otherwise sufficient to create understanding of the situation

PIFs

- Complexity
- HSI

Proximate Cause - Incorrect integration of data, frames, or data with a frame

- Improper aspects of the frame selected for comparison with the data

PIFs

- Workload
- Training

Proximate Cause – Incorrect frame

- Frame or mental model inappropriately selected or confirmed when it should be rejected or reframed

PIFs

- Workload
- Complexity
- Fatigue

Decision-making (DM) - Scope in NPP internal procedural events

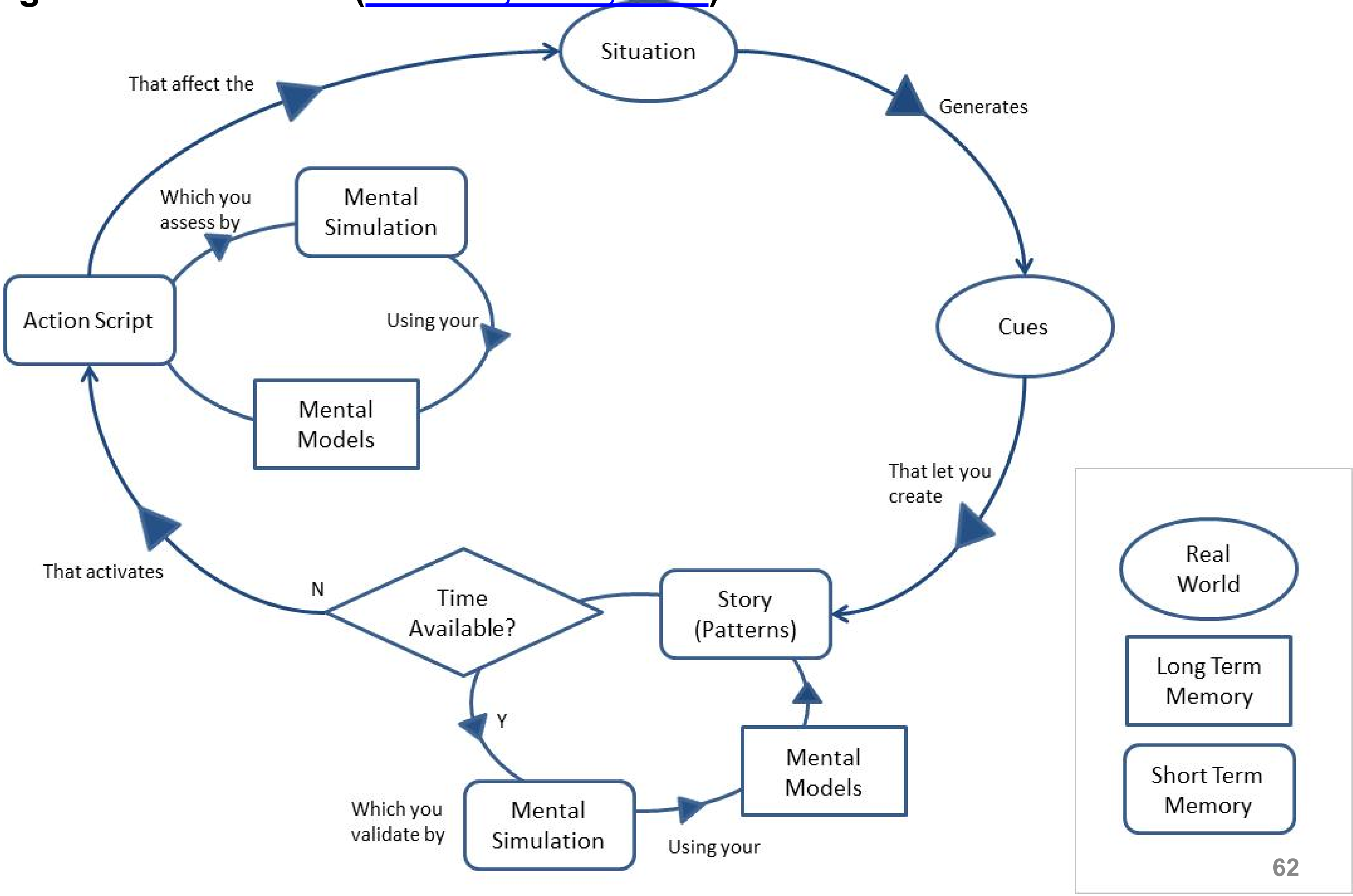
DM is the judgment of what should be done and the decision to do it. *DM* within an NPP is characterized as involving experts and being largely driven by procedures in internal, procedural events.

Scope of *DM* in NPP internal procedural events

- **Program sequences of action execution**
- **Choose alternative strategies**
- **Modify plans**
- ...

DM – How the objectives are achieved

Integrated NDM model (Greitzer, et al., 2010)



DM – What makes the function reliable

Goal management – Decisions to be made have clear goals and can be prioritized.

Pattern recognition – Recognize the pattern of the situation/goals through training and experience.

Mental simulation – Assess the pattern and the outcome of the decision.

Inhibition of bias and wishes – Biases and wishes interfere *DM*.

Attention and working memory - Focus on information pertinent to DM and bind relevant information.

DM – Error causes and proximate causes

Proximate Cause - *Incorrect Goals or Priorities Set*

- Goal conflict. A conflict may arise in the operator's mind between the goals of safety and the continued viability of the plant.

Proximate Cause - *Incorrect Internal Pattern Matching*

- Not updating the mental model to reflect the changing state of the system.

Proximate Cause - *Incorrect Mental Simulation or Evaluation of Options*

- Inaccurate portrayal of the system response to the proposed action. This failure mechanism manifests in the operator incorrectly predicting how the system will respond to the proposed action.

DM – Effects of PIFs

Proximate Cause - *Incorrect Goals or Priorities Set*

- Goal conflict. A conflict may arise in the operator's mind between the goals of safety and the continued viability of the plant.

PIFs

- Task complexity

Proximate Cause - *Incorrect Internal Pattern Matching*

- Not updating the mental model to reflect the changing state of the system.

PIFs

- Workload
- complexity

Proximate Cause - *Incorrect Mental Simulation or Evaluation of Options*

- Inaccurate portrayal of the system response to the proposed action. This failure mechanism manifests in the operator incorrectly predicting how the system will respond to the proposed action.

PIFs

- Complexity
- Workload
- Training

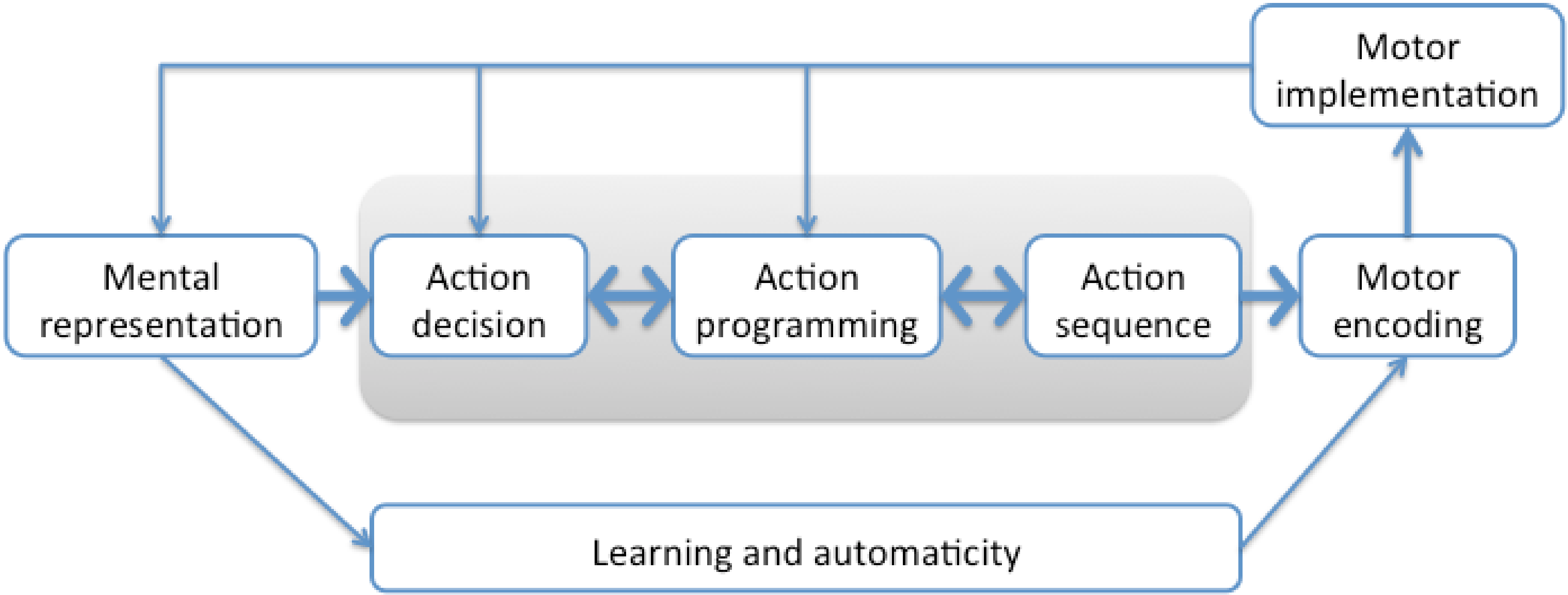
Action execution - Scope in NPP internal procedural events

Acton execution refers to executing physical control actions to achieve a particular goal. Execution is implementation of an action on the level of a single manual action or a predetermined sequence of manual actions. The action(s) must involve the manipulation of the human-system interfaces of the plant and would consequently alter plant status.

Scope of *DM* in NPP internal procedural events

- **Execute a simple action**
- **Execute a complex action**
- **Perform controls**
- …

Action execution – How the objectives are achieved



Hierarchy Pathway - The hierarchy pathway involves movement programming, storing, and sequencing, and movement execution.

Automaticity Pathway - Action automaticity is the ability to implement actions without occupying the brain with the low-level details required, allowing it to become an automatic response pattern.

Sensory Feedback - Human goal-directed behavior depends on multiple neural systems that monitor and correct for different types of errors.

Action execution – What makes the function reliable

Cognitive Control of execution - Cognitive system must be capable of running mental processes that virtually simulate action sequences aimed at achieving a goal.

Cognitive control for task switching - This process reconfigures mental resources for task switching.

Sensory feedback in execution - Precise and continuous sensory inputs make adjustments to physical movement to enhance action correctness and accuracy.

Error-monitoring and correction - Goal-directed actions depend on multiple neural systems that monitor and correct for different types of errors, especially errors in delayed or sequences of actions.

Motor learning and automaticity - Routine sequences of actions are executed automatically for the scope of the learning and training environment.

Action execution – Error causes and proximate causes

Proximate Cause - *Failed to take required action (did not attempt action)*.

- Action not initiated
- Action initiated too late

Proximate Cause - *Executed desired action incorrectly*

- Omitted one or more steps
- Incorrect order of steps
- Incorrect position (e.g., turn switch to wrong position)
- Action prevented because of interlock

Executed undesired action

- Blocked a needed function from initiation (e.g., an engineered safety system)
- Stopped or turned off a needed function (e.g., an engineered safety system)
- Unnecessary initiation of a function (e.g., manual trip)

Action execution – Error causes and proximate causes

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- Stopped or turned off a needed function (e.g., an engineered safety system)
- Unnecessary initiation of a function (e.g., manual trip)

PIFs

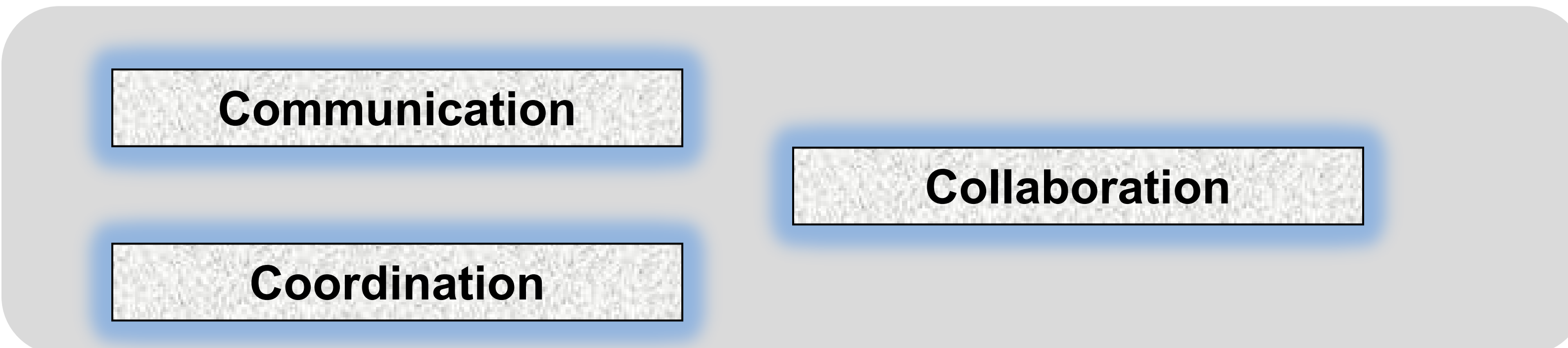
- Workload
- Procedures

- Workload
- Complexity
- HSI
- Training
- Procedure

Teamwork - Scope in NPP internal procedural events

Teamwork is the process of combining of individuals' cognitive processes, allowing team members to interact dynamically, interdependently, and adaptively toward a common and valued goal.

Scope of *Teamwork* in NPP internal procedural events



Communication – exchange of information between crew members.

Coordination - team members organizing their joint activities to achieve a goal. In particular, members must support the other members as required and monitor their own and others' workload.

Collaboration - the manner in which members of a team are working together.

Teamwork – How the Objectives are Achieved

MODEL OF TEAM COLLABORATION
Focus on Macro-Cognition (Letsky, et al., 2007)

Problem Area Characteristics

Collaborative Situation Parameters:

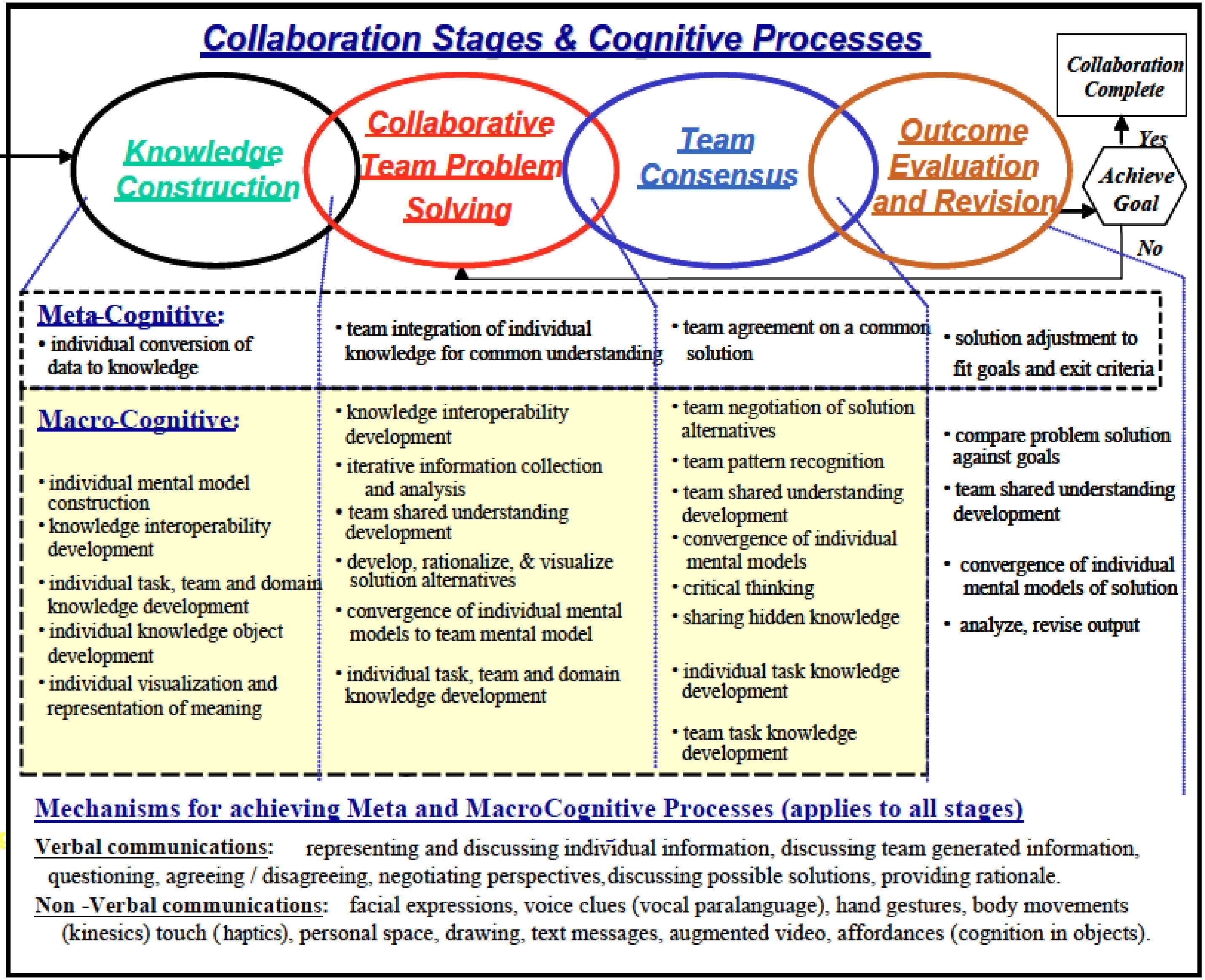
- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
- human-agent interface complexity

Team Types

- asynchronous
- distributed
- culturally diverse
- heterogeneous knowledge
- unique roles
- command structure (hierarchical vs. flat)
- rotating team members

Operational Tasks

- team decision making, COA selection
- develop shared understanding
- intelligence analysis (team data processing)



Teamwork – How Teamwork is Achieved

Communication

- Initiate assertiveness - communicating ideas and observations in a manner which is persuasive to other team members
- Exchange information - clearly and accurately between team members
- Confirm information communicated

Coordination

- Prioritize and coordinate tasks and resources.
- React flexibly to changing requirements of a task or situation
- Give help to other team members in situations in which it appears they need assistance

Collaboration

- Leadership - Directing and coordinating the activities of, and motivating other team members, assessing team performance, and establishing a positive atmosphere
- Cooperation - Two or more team members working together on a task which requires meaningful task interdependence without any leadership
- Following directions – Following directions from a more senior team member in the accomplishment of a task

Teamwork–Mechanisms that Make the Function Reliable

- Adaptability
- Shared situational awareness
- Mutual performance monitoring
- Team leadership
- Mission analysis
- Effective communication infrastructure
- Team decision making
- Assertiveness
- Team cohesion and interpersonal relations
- Conflict resolution

Teamwork – Cognitive Failures and Error Causes

Failure of communication

- Source error of omission
- Source error of commission
- Target error of omission
- Target error of commission
- Incorrect timing of communication (e.g., delayed, premature, too fast/slow)

Failure of leadership

- Decision making failures
- Failure to verify that the RO, BOP and/or other operator have correctly performed their responsibilities
- Failure to consider information communicated by an individual
- Failure to iterate the communication process sufficiently

Teamwork – Effect of PIFs

Social/Environmental PIFs

- Time pressure
- Group thinking
- Team dynamics
- Excessive authority gradient

Personality/Individual Difference PIFs

- Leadership style
- Deficiency in resource/task management
- Knowledge/experience
- Risk Perception
- Excessive Professional Courtesy

Generic human-error model

Human errors modeled as failures of the cognitive functions

Human tasks

Cognitive Functions

- Detection
- Understanding
- Decision making
- Action

Cognitive Process

Contextual factors

D1 – Manage the goals
D2 - Establish a decision-model
D3 –Evaluate pros and cons
D4 – Make decision (strategies, choices)
D5 - Plan action scripts
D6 - Simulate / evaluate the decision / plan
D7 – Implement the decision

- ❑ Conflict goals
- ❑ Multiple competing goals cannot be prioritized
- ❑ Multiple decision-making groups and control authority may be diffused

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Presentation to the ACRS Full Committee
Early Site Permit Process Overview

John Segala, Branch Chief, NRO/DNRL/LB1
Prosanta Chowdhury, Project Manager, NRO/DNRL/LB1
Office of New Reactors

May 8, 2014

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

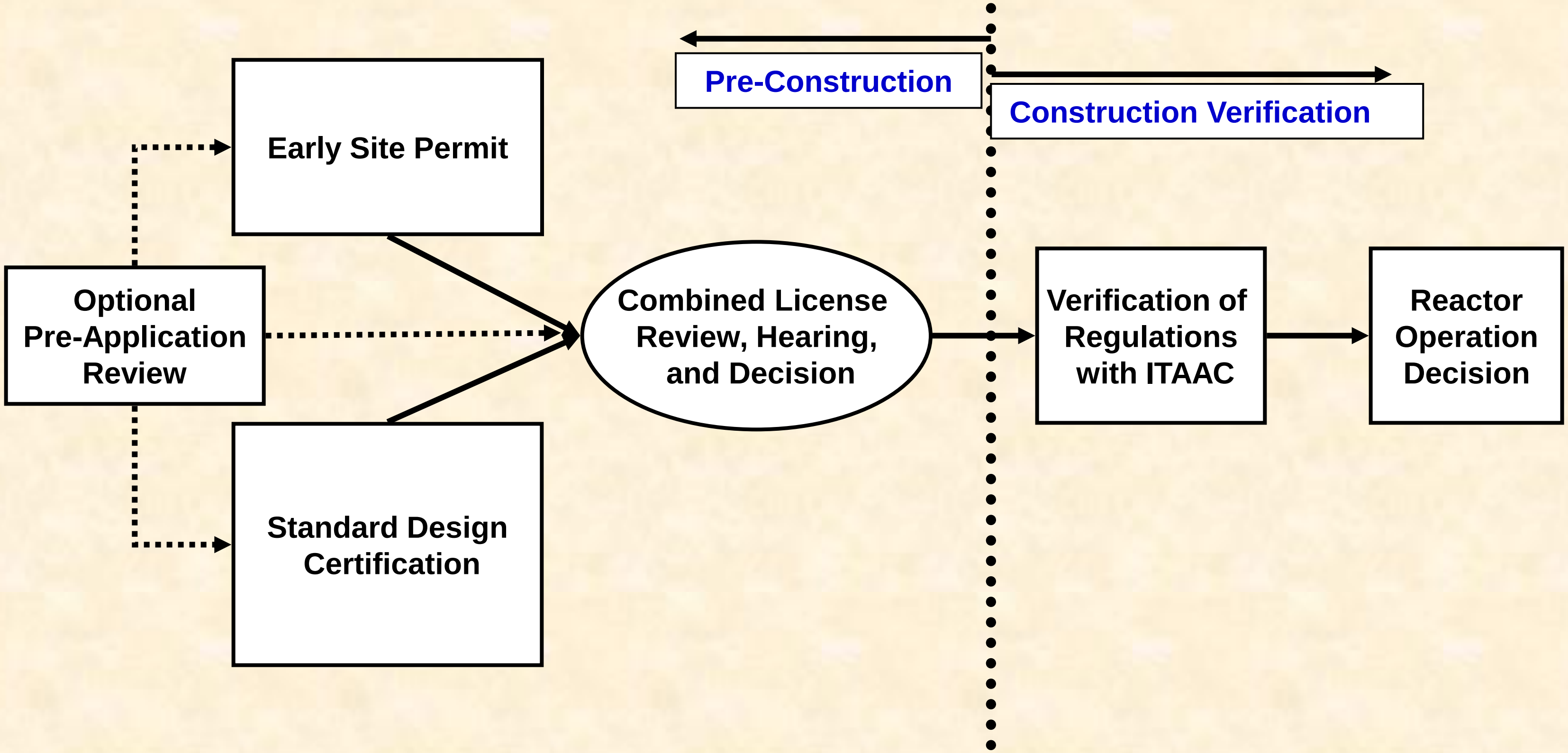
Purposes of Today's Meeting

- Describe how an Early Site Permit (ESP) fits into our licensing process
- Describe regulatory basis and ESP safety review process
- Discuss concept of Plant Parameter Envelope (PPE)
- Answer questions

Early Site Permit (ESP)

- An ESP is an approval of a proposed site as suitable to support a nuclear power plant
- An ESP does <u>not</u> allow for construction of safety significant portions of the plant, and it does <u>not</u> allow for operation

Part 52 - Fitting the Pieces Together



- Licensing decisions finalized before major construction begins
- Inspections w/ITAAC to verify construction
- Limited work may be authorized before COL issuance

Alignment of an Early Site Permit with other NRC Approvals

- An applicant can apply for a Limited Work Authorization, which provides approval to begin specific activities before a Combined License is issued
- A Limited Work Authorization can be issued with an ESP or before a Combined License
- An ESP can also be referenced in a future Combined License application

Applicant Interest in Early Site Permits

- An ESP is valid for up to 20 years so that applicants can decide when to seek approval to build a plant
- An applicant chooses an ESP to identify and resolve siting issues early, and to reduce regulatory and financial uncertainties when planning for the future

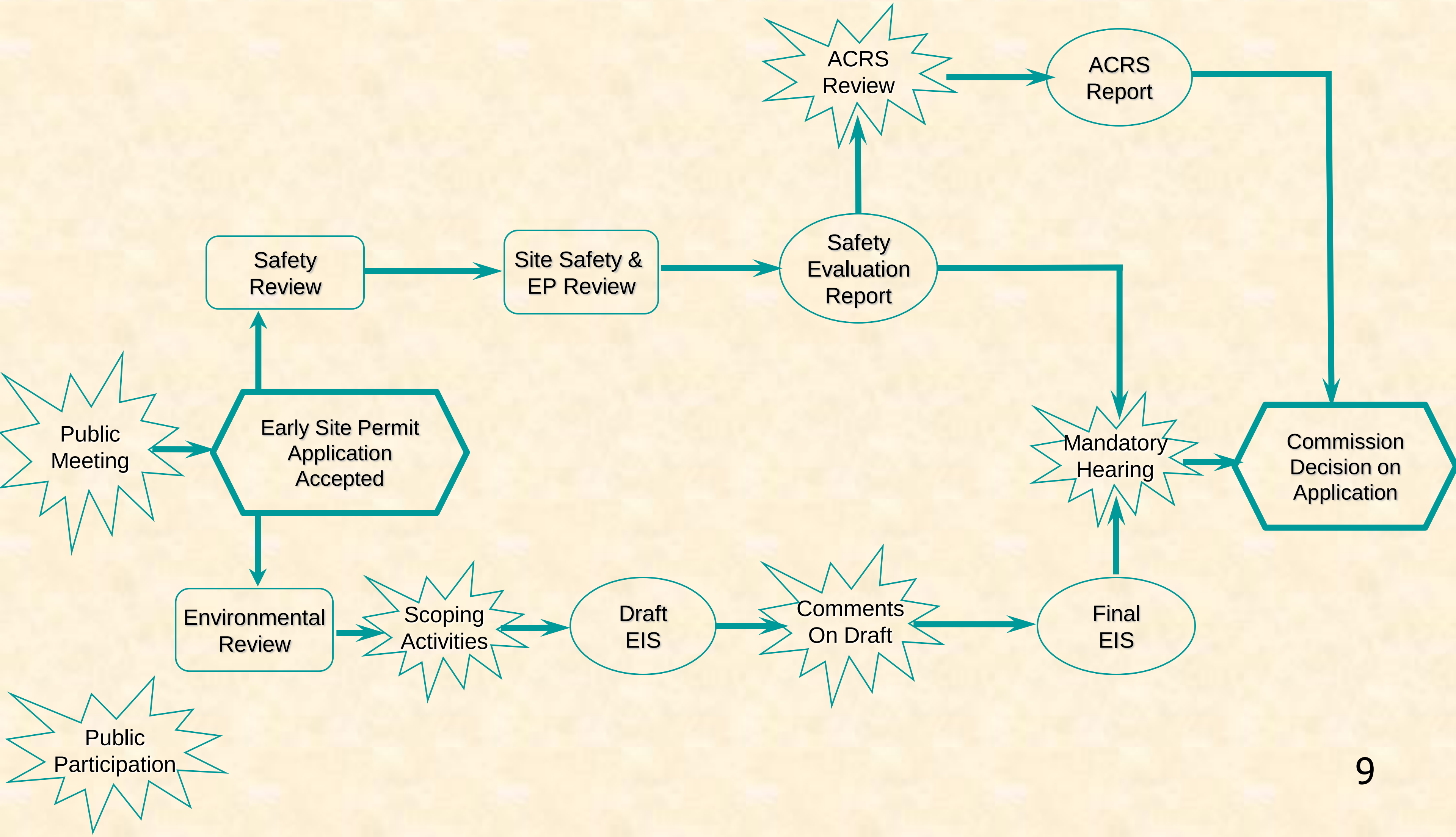
Regulations and Guidance

- Regulations:
  - 10 CFR 52, Subpart A
  - 10 CFR 50 (Emergency Planning & other areas)
  - 10 CFR 51 (Environmental Report)
  - 10 CFR 100 (Reactor Site Criteria)
- Guidance:
  - Review Standard (RS) 002
  - NUREG-0800 (Standard Review Plan)

Required Reviews for an ESP Application

- Atomic Energy Act authorizes the NRC to protect public health and safety, and to provide for the common defense and security
- The safety review team creates a Safety Evaluation Report (SER) addressing
  - Site Safety
  - Emergency Planning
  - Security
- The environmental review team creates an Environmental Impact Statement (EIS)

Early Site Permit Review Process



ESP Safety Review

- Areas of review include:
  - Seismology
  - Geology
  - Hydrology
  - Meteorology
  - Geography
  - Demography (population distribution)
  - Site Hazards Evaluation
  - Radiological Effluent Releases
  - Radiological Dose Consequences
  - Emergency Preparedness (with FEMA)
  - Security Plan Feasibility

Plant Parameter Envelope (PPE)

Approving a Site without a Selected Technology

- Plant Parameter Envelop (PPE) bounds variety of technologies
- PPE values compared to selected technology at combined license stage
- If design parameters of the selected technology exceed bounding PPE values of ESP, additional reviews conducted
- Alternatively, the applicant can specify the technology to be used at the ESP stage

Plant Parameter Envelope (PPE)

Approving a Site without a Selected Technology

- Two-step licensing process
  - Technology neutral ESP
  - Technology specific COL

- Development of PPE and NRC approval

ACRS Review

ACRS Review

- ACRS reviews each ESP application and staff's Safety Evaluation Report (SER)
- ACRS reports to Commission on safety portions of ESP application

Hearings

Hearings

- Procedural Requirements in 10 CFR 2
- Hearing takes one of two forms:
  - Uncontested (but still mandatory)
  - Contested when contentions are admitted

ESP Issuance

Commission issues ESP with terms and conditions, as it deems appropriate

<u>ESP Terms</u>

- Valid for 10-20 years
- Renewal application – between 1 and 3 years before expiration of permit
  - Must contain information necessary to bring previous application up-to-date
  - Good for an additional 10-20 years
- Site use for other purposes could involve new requirements or termination of the permit

ESPs Issued and Under Review

- The NRC has issued four ESPs:

  Clinton (IL) - March, 2007

  Grand Gulf (MS) - April, 2007

  North Anna (VA) - November, 2007

  Vogtle (GA) - August, 2009

- The NRC is currently reviewing the PSEG Site ESP application

Early Site Permit

Questions?

EPRI Long Term Operations Program R&D for Aging Management

Sherry Bernhoft
EPRI, Program Manager

Presentation to:

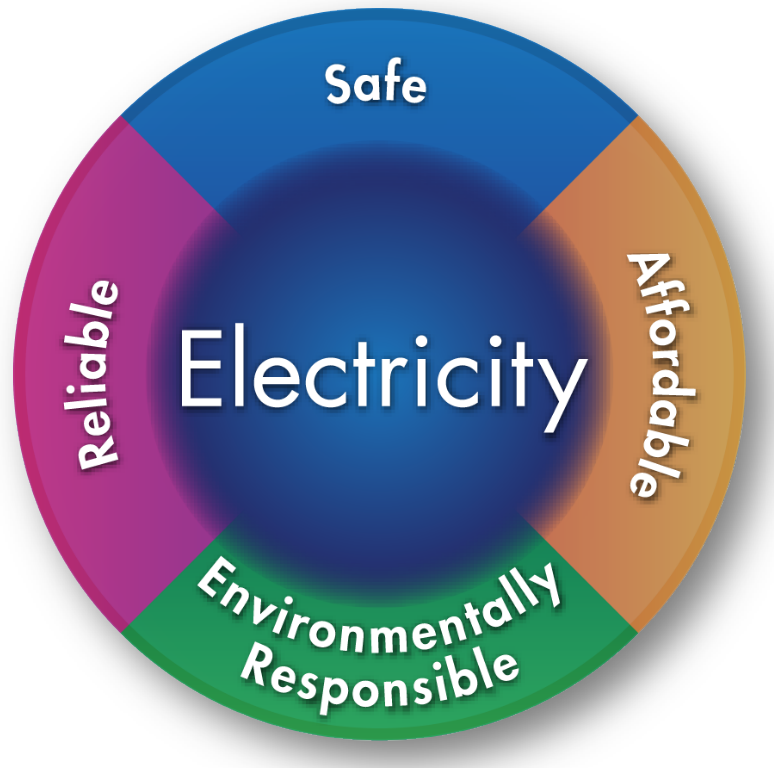
Advisory Committee on Reactor Safeguards

May 8, 2014

Together…Shaping the Future of Electricity

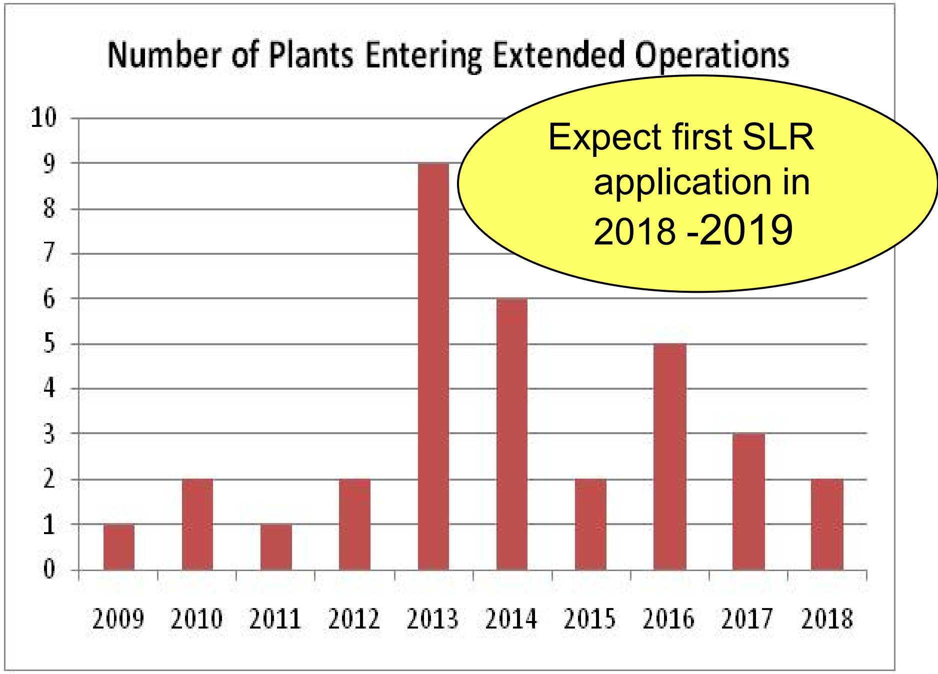
EPRI's Mission

To conduct research, development and demonstration on key issues facing the electricity sector on behalf of our members, energy stakeholders, and society



EPRI LTO Program Goals and Objectives

- Technical basis for safe, reliable plant operation through extended lifetime



- Demonstrated technologies to support long-term plant management

- Research projects integrated with other EPRI programs

- External collaboration: DOE, NRC Research, EDF, NEI, Owners Groups and IAEA

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Basis for Implementation of Aging Management

- R&D to understand aging degradation
  - Mechanism and failure modes
  - Initiation and growth rates
  - Inspection and Evaluation Guidelines
- Inspection methods
  - Detection and measurement
  - Nondestructive examination and qualification
- Mitigation strategies
  - Chemistry
  - Stress improvement techniques
  - Weld overlays

- Condition Monitoring
  - On-line monitoring
  - In-field detection
- Prediction of Remaining Useful Life
  - Health Monitoring software and algorithms
- Repair & Replacement Decisions
  - Life Cycle Management Guidelines
  - Advanced welding for irradiated materials
  - Integrated Life Cycle Management (ILCM)

EPRI R&D Projects – Cross Referenced to GALL, Rev 2

- **EPRI Report 3002000576**
  "Assessment of R&D Supporting Aging Management Programs for Long-Term Operations"

- Report cross-references the EPRI R&D Projects to the AMPs

- Three categories of AMPs
  - On-going long-term R&D
  - Established Programs
  - One-time plant specific inspections

Examples:

- On-going long-term R&D (8)
  - Effects of irradiation
  - Thermal effects
  - Reactor Pressure Vessel embrittlement
- Established Programs (20)
  - Chemistry
  - Steam Generator Inspections
  - Flow Accelerated Corrosion
- Plant Specific (22)
  - Fuel oil
  - Fire Protection System

Category 1 Summary – On-Going R&D for LTO

GALL AMP ID	AMP Name	Potential LTO Impact on AMP
XI.M9	BWR Vessel Internals	Irradiation and environmental effects on material performance
XI.M11B	Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components	Environmental effects on material performance
XI.M12	Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)	Thermal aging and possible irradiation effects on material performance
XI.M16A	PWR Vessel Internals	Irradiation and environmental effects on material
X.M31	Reactor Vessel Surveillance	Neutron fluence on reactor pressure vessel materials
XI.S6	Structures Monitoring	Alkali silica reactions susceptibility and irradiation effects on material properties
XI.E1	Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements	Combined effects of thermal and radiation exposure
XI.E2	Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used In Instrumentation Circuits	Combined effects of thermal and radiation exposure

R&D for Aging Management

Category 1 Aging Management Programs:

- BWR & PWR Vessel Internals
- Cracking of Ni-Alloys
- Thermal Aging of Cast Austenitic Stainless Steel (CASS)
- Reactor Pressure Vessel Surveillance
- Electrical Cables
- Concrete and Containment Structure

Reactor Coolant System Metals

Industry Materials Issue Management

- Industry spends > $50M per year on materials R&D
- Industry Initiative NEI 03-08
  - Proactive management of material degradation issues
  - Communication of Operating Experience to Industry and NRC
- Industry programs under the initiative:
  - BWR Vessel and Internals Program (BWRVIP)
  - Materials Reliability Program (MRP - for PWRs)
  - Steam Generator Management Program (SGMP)
  - Nondestructive Examination Program (NDE)
  - Primary System Corrosion Research (PSCR)
  - Water Chemistry Control
  - PWR Owner's Group Materials Subcommittee
- Extensive International collaboration

Integrated Materials Issues Strategic Plan

- Systematic Approach to Managing Materials
  - Identify vulnerabilities
  - Assess condition (inspect & evaluate)
  - Mitigate degradation mechanism
  - Repair or replace as required
- Approach Used:
  - Materials Degradation Matrix (MDM) and Issue Management Tables (IMTs)
  - Updated on a routine frequency
  - Expert solicitation

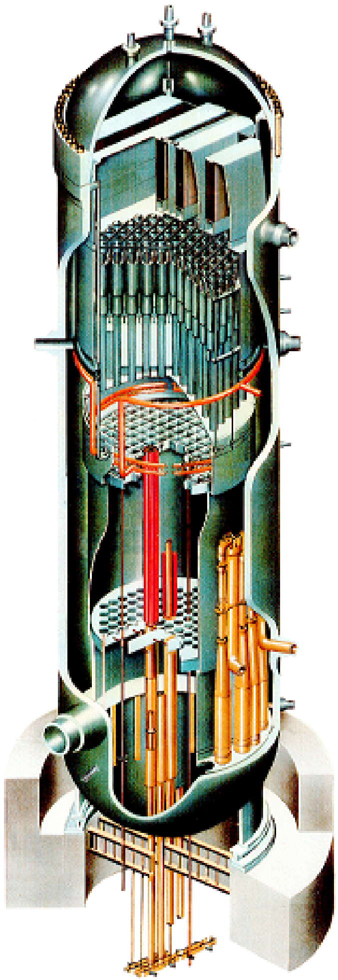
In 2010 LTO 'Flags' were added to the MDM

Materials Degradation Issues Identified for LTO

- Increased neutron fluence effects
  - RPV embrittlement
  - Core internals
    - Irradiation Assisted Stress Corrosion Cracking (IASCC) initiation
    - Reduction in toughness proprieties
    - Void swelling
  - Impact on core periphery materials (fluence and temperature)
- Late life Stress Corrosion Cracking (SCC) initiation
- Fatigue usage
  - Increased fatigue cycles
  - Environmental effects on fracture properties

XI.M9 & XI.M16A Vessel Internals

- BWR Vessel Internals Program (BWRVIP)
  - See next slide
- Materials Reliability Program (MRP)
  - MRP-227-A
- Issue: Anticipated trend of SCC initiation and growth with increased neutron fluence and exposure to the environment
- ***Living issue programs***
  - Extensive R&D has been completed on modeling and understanding IASCC
  - Inspection Guidelines
  - Technical reports are updated based on Operating Experience, inspection results and research



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Example - BWRVIP Guidelines to Manage Degradation

Component	Assessment (I&E) Guidelines	Inspection Guidelines	Repair/Replace Design Criteria	Mitigation Recommendations
Core shroud	BWRVIP-76, R1	BWRVIP-03	BWRVIP-02-A/-04-A	BWRVIP-62, R1/-190
Core spray	BWRVIP-18, R2	BWRVIP-03	BWRVIP-16-A/-19-A/-34	N/A
Shroud support	BWRVIP-38	BWRVIP-03	BWRVIP-52-A	BWRVIP-62, R1/-190
Top Guide	BWRVIP-26-A	BWRVIP-03	BWRVIP-50-A	N/A
Core Plate	BWRVIP-25	BWRVIP-03	BWRVIP-50-A	BWRVIP-62, R1/-190
SLC	BWRVIP-27-A	BWRVIP-03	BWRVIP-53-A	BWRVIP-62, R1/-190
Jet pump assembly	BWRVIP-41	BWRVIP-03	BWRVIP-51-A	BWRVIP-62, R1/-190
CRD guide/stub tube	BWRVIP-47-A	BWRVIP-03	BWRVIP-17/-55-A/-58-A	BWRVIP-62, R1/-190
In-core housing/dry tube	BWRVIP-47-A	BWRVIP-03	BWRVIP-17/-55-A	BWRVIP-62, R1/-190
Instrument penetrations	BWRVIP-49-A	BWRVIP-03	BWRVIP-57-A	BWRVIP-62, R1/-190
LPCI coupling	BWRVIP-42-A	BWRVIP-03	BWRVIP-56-A	N/A
Vessel ID brackets	BWRVIP-48-A	BWRVIP-03	BWRVIP-52-A	BWRVIP-62, R1/-190
Reactor pressure vessel	BWRVIP-74-A	N/A	N/A	N/A
Primary system piping	BWVIP-75-A	N/A	N/A	BWRVIP-62, R1/-190
Steam dryer	BWRVIP-139-A	BWRVIP-03	BWRVIP-181	N/A
Access hole cover	BWRVIP-180	BWRVIP-03	TBD	BWRVIP-62-, R1-190
Top guide grid beam	BWRVIP-183	BWRVIP-03	BWRVIP-50-A	N/A
Bottom head drain line	BWRVIP-205	N/A	BWRVIP-208	N/A

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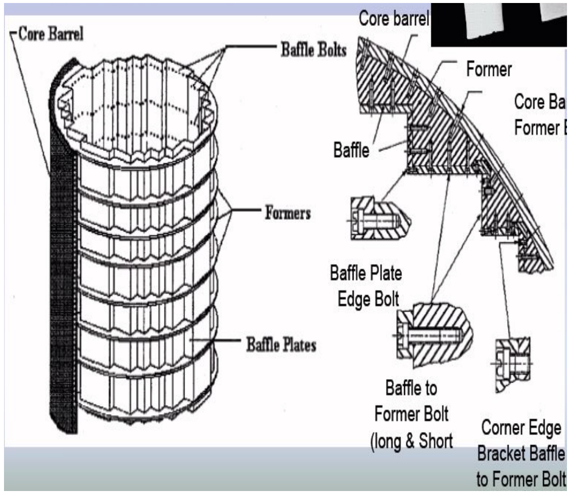
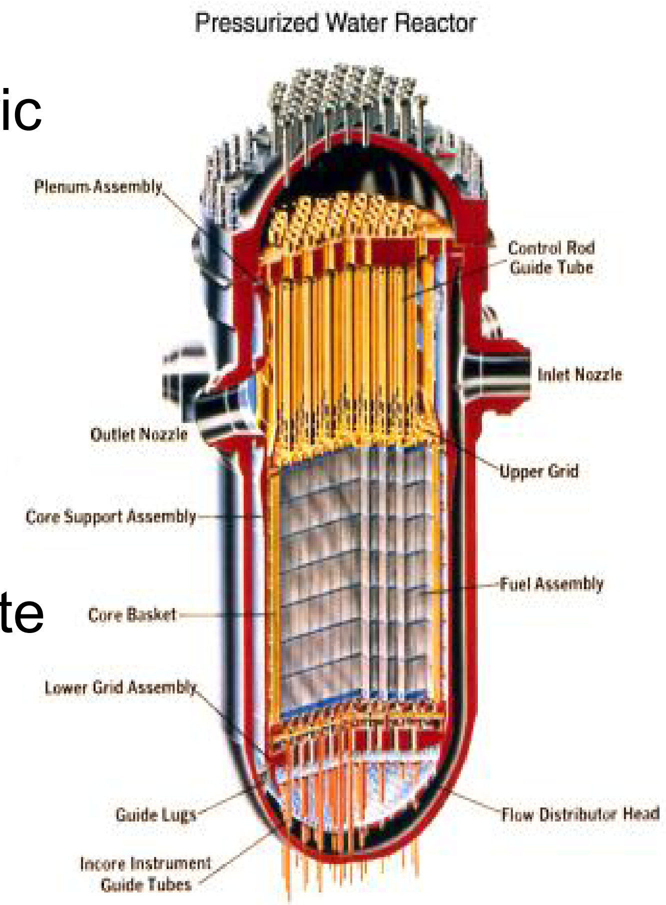
Vessel Internals - Ongoing and Future Efforts

- Continued international collaboration on IASCC modeling
  - Reduce uncertainties
  - Improved crack-growth rate correlations
  - Mitigation, repair and replacement strategies
- Zorita harvested materials testing (co-funded with NRC Research)
- GONDOLE void swelling
- Halden crack-growth rate work
- IASCC testing on baffle former bolts



XI.M11B Cracking of Ni-Alloy

- Materials Reliability Program (MRP)
- Issue: PWR nickel-alloy cracking due to boric acid leakage
- MRP ***is a living issue program***
  - ASME Section XI Code Cases
  - Inspection Guidelines
  - Head penetrations inspection NDE
- EPRI work on wastage and crack-growth rate models incorporated into the ASME Code
- Future work
  - Updating crack growth models
  - Bottom mounted nozzle inspection technologies
  - Alloy 690 cracking



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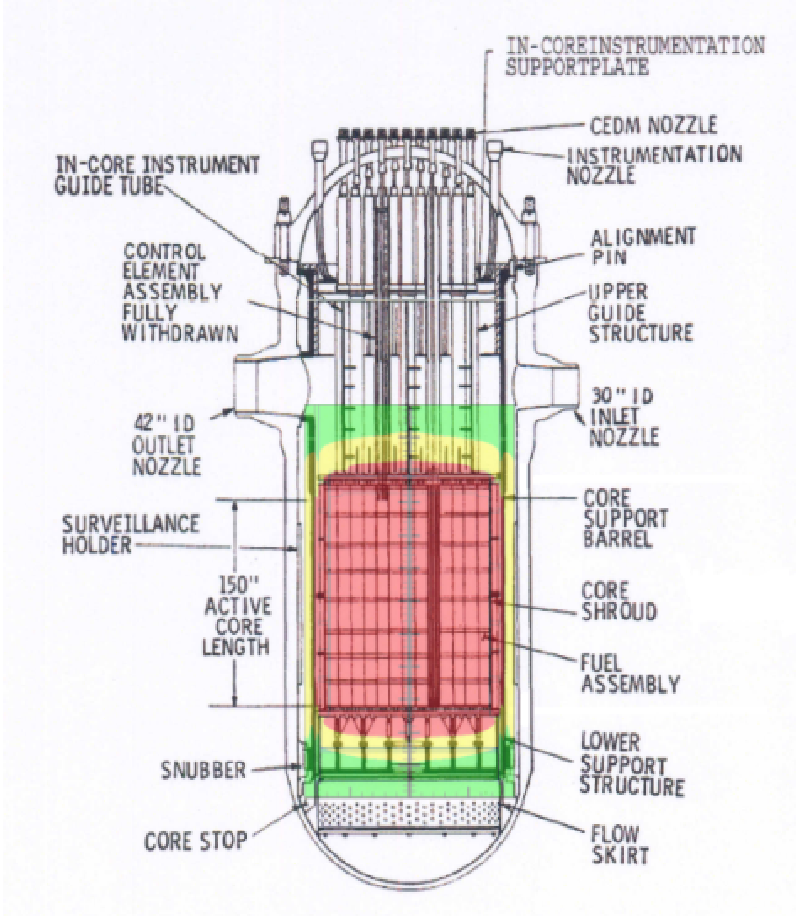
XI.M12 Thermal Aging Embrittlement of CASS

- Issue: Thermal aging of pipe and components outside RPV
- Irradiation embrittlement is addressed for the PWRs under XI.16A and BWRs under XI.M9 internals aging management
- EPRI technical reports for aging management of CASS cover:
  - Thermal Aging in PWRs
  - Thermal Aging and Neutron Embrittlement
  - Flaw Tolerance Evaluation for CASS materials
- A joint BWRVIP-MRP working group formed to address:
  - Screening criteria
  - Evaluate uncertainties
  - Evaluate fracture parameters
  - Interacting with the NRC staff on guidance development

XI.M31 Reactor Vessel Surveillance

- Issue: Need to monitor fracture toughness of the RPV and nozzles due to irradiation
- BWRVIP Integrated Surveillance Program (ISP)
- MRP reports:
  – RPV Integrity Primer
  – Embrittlement Trend Correlation Master Curve
  – Static Tensile Testing of Pressure Vessel



Ongoing/Future Efforts on RPV

- Extension or replacement of the BWR ISP
- PWR Coordinated RPV Surveillance Program
- PWR Supplemental Surveillance Program (PSSP)
- Atomic Probe Tomography test of irradiated samples
- MRP and PWROG will evaluate:
  - Impacts for components in the extended beltline weld region

Surveillance capsule data exists for up to 80 years of operation, and a trend correlation is established. Actions are in place to expand and improve the trend correlation with addition surveillance capsules.

Electrical Cables

XI.E1 and XI.E2 Insulation Materials for Cables

- EPRI Plant Engineering
- Issue: Aging of the cable insulation materials
- EPRI Cable Aging Management is a ***living issue program***
  - License Renewal Electrical Handbook
  - Cable Aging Reports
  - Medium and Low Voltage Aging Management Guidelines
  - Life Cycle Management Planning Source Books
  - Multiple reports on results of forensic testing on reported cable failures

Ongoing/Future Efforts for Cable R&D

- Integrated DOE-LWRS, EPRI and NRC RES roadmap
- Submergence
  - On-going work based on operating experience
- Material degradation and harvesting of field aged cables
  - Developing harvesting guidelines
- Condition monitoring
- Improved life-time predictions
  - Correlation to actual in-plant temperature and radiation levels
- Tool box for cable aging management

Concrete and Containment Structure

XI.S6 Structural Monitoring

- Prioritized Issue Management Table
- Utility member Advisory Group
- Issues:
  - Alkali silica reaction (ASR) on structural integrity
  - Irradiation and gamma heating
  - Creep-fatigue
- R&D Projects:
  - Completed extensive data collection of irradiation effects
  - ASR technical support
  - Mechanistic model of Boric Acid attach on Spent Fuel Pools

Ongoing/Future Efforts for Concrete R&D

- Integrated DOE-LWRS and EPRI Roadmap
- Alkali Silica Reactions (ASR)
  - Mapping of potential at-risk aggregates
  - Testing method and NDE development
  - LWRS has lead on mechanistic model and structural integrity
- Irradiation and gamma heating effects
  - Thermal and accelerated radiation confirmatory testing starting in 2014
- Creep Fatigue
  - Large database from Department of Transportation
  - Application to NPP civil structures
- Boric Acid Impacts on SFPs
  - Mechanistic models of BA attach on concrete and rebar being developed
- Tool box for concrete and concrete structure repairs

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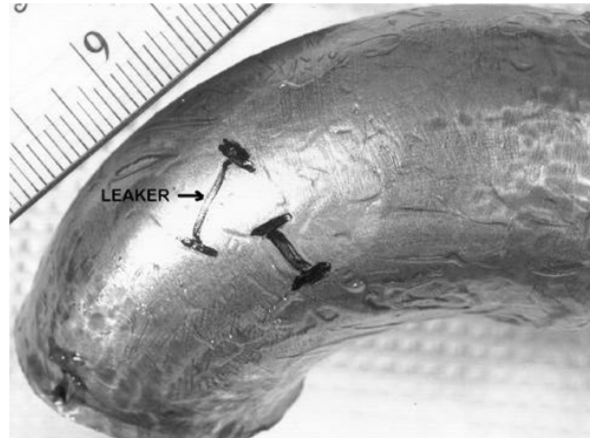
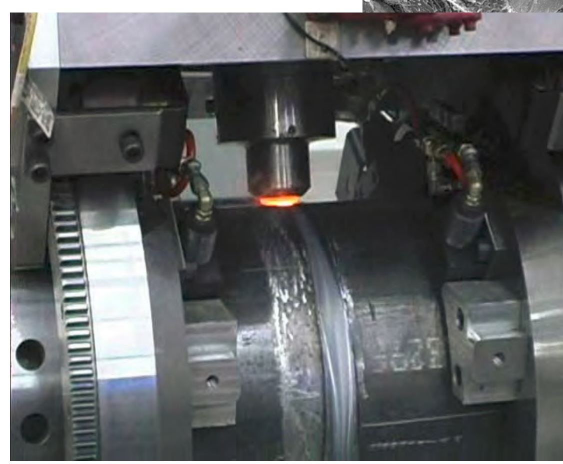
Summary – Technical Basis for Robust Aging Management

- R&D to understand aging degradation
- Inspection methods
- Mitigation strategies
- Condition Monitoring
- Prediction of Remaining Useful Life
- Repair & Replacement Decisions





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Together…Shaping the Future of Electricity

BACK UP SLIDES

R&D for Aging Management

Category 2 Aging Management Programs - Examples:

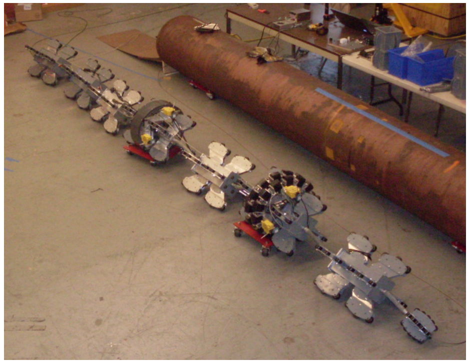
Steam Generators
Buried and Underground Piping & Tanks
Flow Accelerated Corrosion
Water Chemistry

XI.M 19 Steam Generator Program

- Utilities are required by Technical Specifications to establish a steam generator program
  - All US utility programs are modeled after NEI 97-06 which references the following six EPRI SGMP guideline documents
    - Steam Generator Integrity Assessment Guidelines
    - Steam Generator In-Situ Pressure Test Guidelines
    - Steam Generator Examination Guidelines
    - Steam Generator Primary-to-Secondary Leak Guidelines
    - PWR Primary Water Chemistry Guidelines
    - PWR Secondary Water Chemistry Guidelines
- These guidelines incorporate a balance of prevention, mitigation, inspection, evaluation, repair and leakage monitoring
- These same 6 guidelines are referenced in the GALL (XI.M 19)

XI.M41 Buried and Underground Piping and Tanks

- Industry Initiative developed in response to operating experience
  - Implementation managed by NEI 09-14
- Utility Implementation
  - Programs developed
  - Inspections in progress
  - Long range asset management plans being developed
- Continuing EPRI R&D Projects (Buried Pipe, Tanks, Cathodic Protection, and Coatings)
  - Programmatic support and Guidance
  - Corrosion analysis
  - Inspection methodology advancements
  - Mitigation Strategies
  - Repair and replacement options



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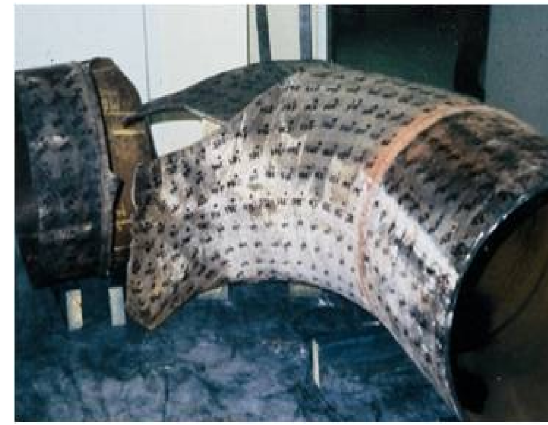
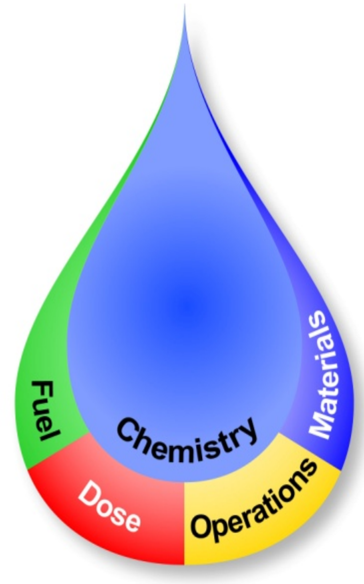
XI.M17 Flow Accelerated Corrosion (FAC)

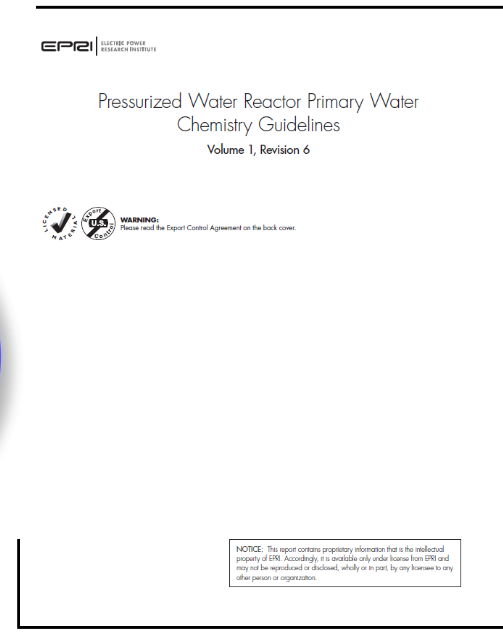
- Industry Programs developed in response to operating experience
  - Implementation managed by NRC GL 89-08
  - Programmatic Guidance in EPRI NSAC-202L
- Utility Implementation
  - Mature Programs
  - Long history of Inspections
  - High Wear Systems replaced with resistant materials
  - Operating experiences shared in active industry user's group (CHUG)
- Continuing EPRI R&D Projects
  - Programmatic Optimization
  - Knowledge Transfer
  - FAC and Erosion analysis
  - Inspection methodology advancements

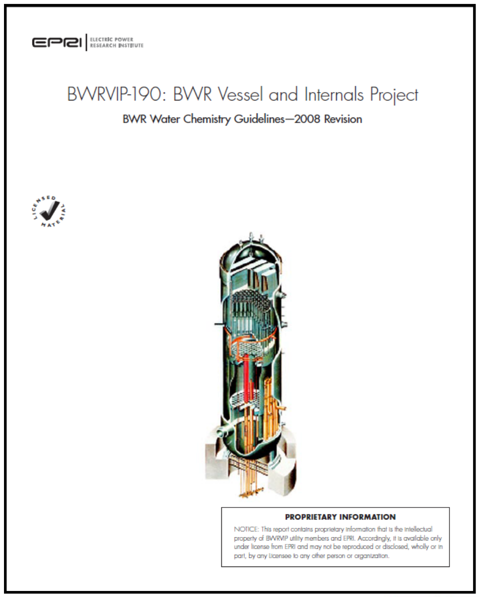


XI.M2 Water Chemistry

- Water Chemistry Guidelines are a part of NEI 03-08
- Goals:
  - Materials integrity and mitigations of corrosion
  - Fuel reliability and performance
  - Radiation dose control
  - Plant-specific optimization
- GL Updates and revisions
  - Based on operating experience, US and International
  - Recent R&D
  - Inspection results
  - Continuous improvements







Subsequent License Renewal US Industry Perspective

Briefing for

Advisory Committee on Reactor Safeguards

Full Committee

May 8, 2014

S. Jason Remer
Nuclear Energy Institute

Outline

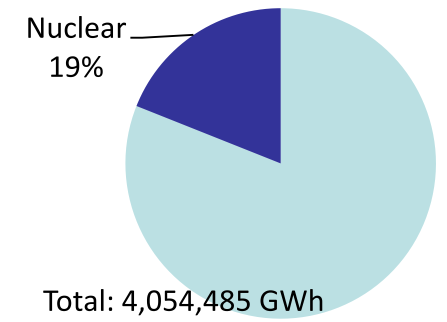
- Factors Supporting Long Term Operation and SLR
- SLR Built Upon Successful LR Programs
- Industry and Government Preparing for SLR and Long Term Operations
- Aging Management – a Living Process
- Detailed Analysis of SECY Paper
- Summary

Factors Supporting Long Term Operation and SLR

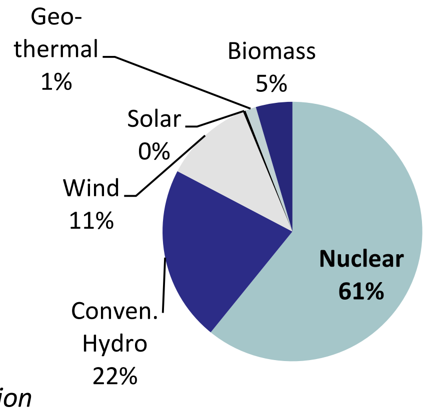
Current Energy Mix

- **Nuclear power is a clean, reliable base load energy source**
  - Provides 19% of U.S. electricity generation mix
  - Provides 61% of U.S. emission-free electricity
  - Avoids about 700 MMTCO2 each year
  - Helps reduces overall NOx and SOx levels
- **U.S. electricity demand projected to increase ~28% by 2040 from 2011 levels**
- **100 GWe nuclear capacity - 100 operating plants**
  - Fleet maintaining close to 90% average capacity factors
  - Most expected to apply for license renewal for 60 years of operation

Electricity Production, 2012



Net Non-Carbon Emitting Sources of Electricity, 2012



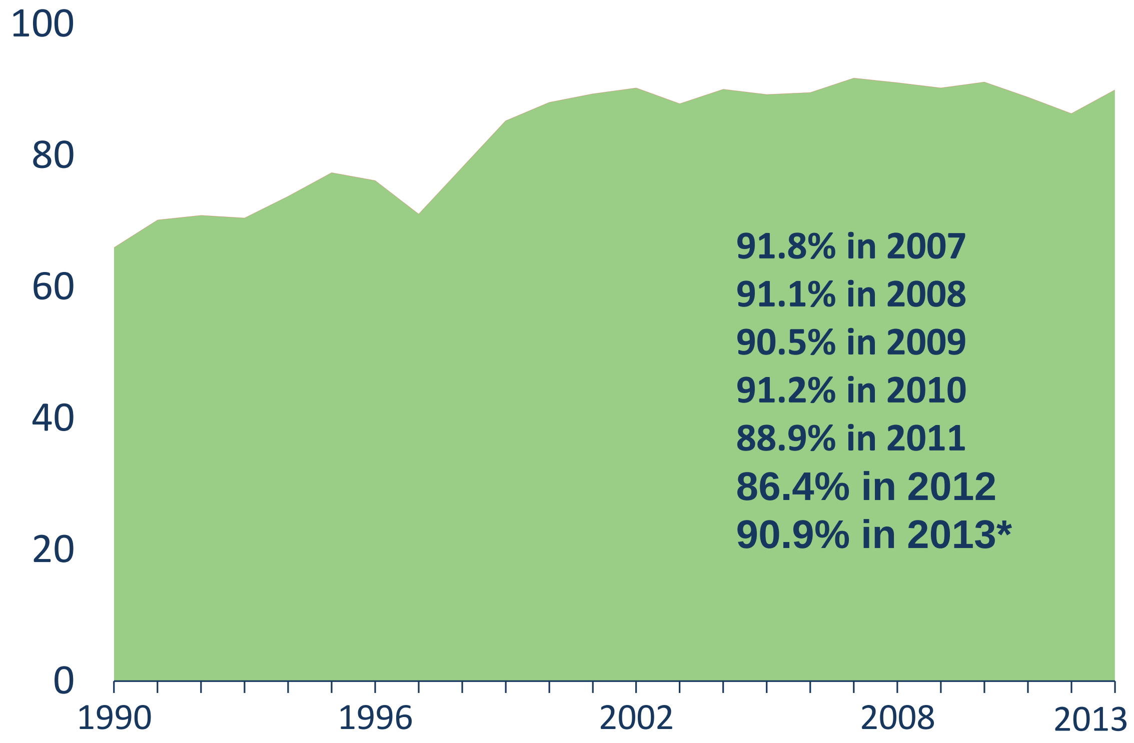
Source: Energy Information Administration

Sustained Reliability and Productivity

Highlights

- 2013 average includes San Onofre 2 and 3, which did not operate, and Fort Calhoun, which had a 2% capacity factor for the year. The industry's average capacity factor without those units was 92.1%.
- Number of refueling outages:
  - 2013 = 51
  - 2012 = 63
  - 2011 = 65

U.S. Nuclear Plant Capacity Factor (Percent)

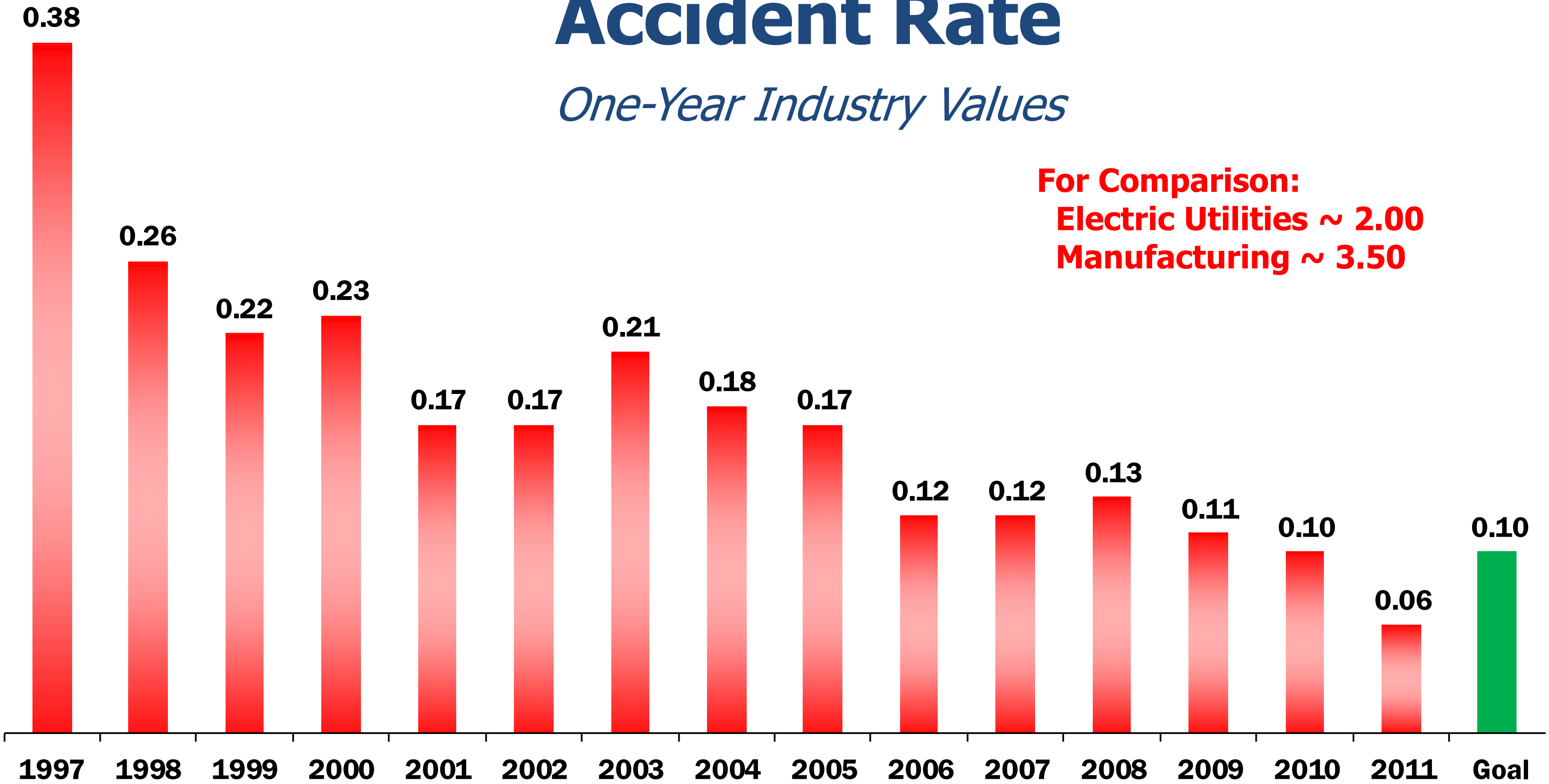


Source: Energy Information Administration

** NEI estimate*

U.S. Nuclear Industrial Safety Accident Rate

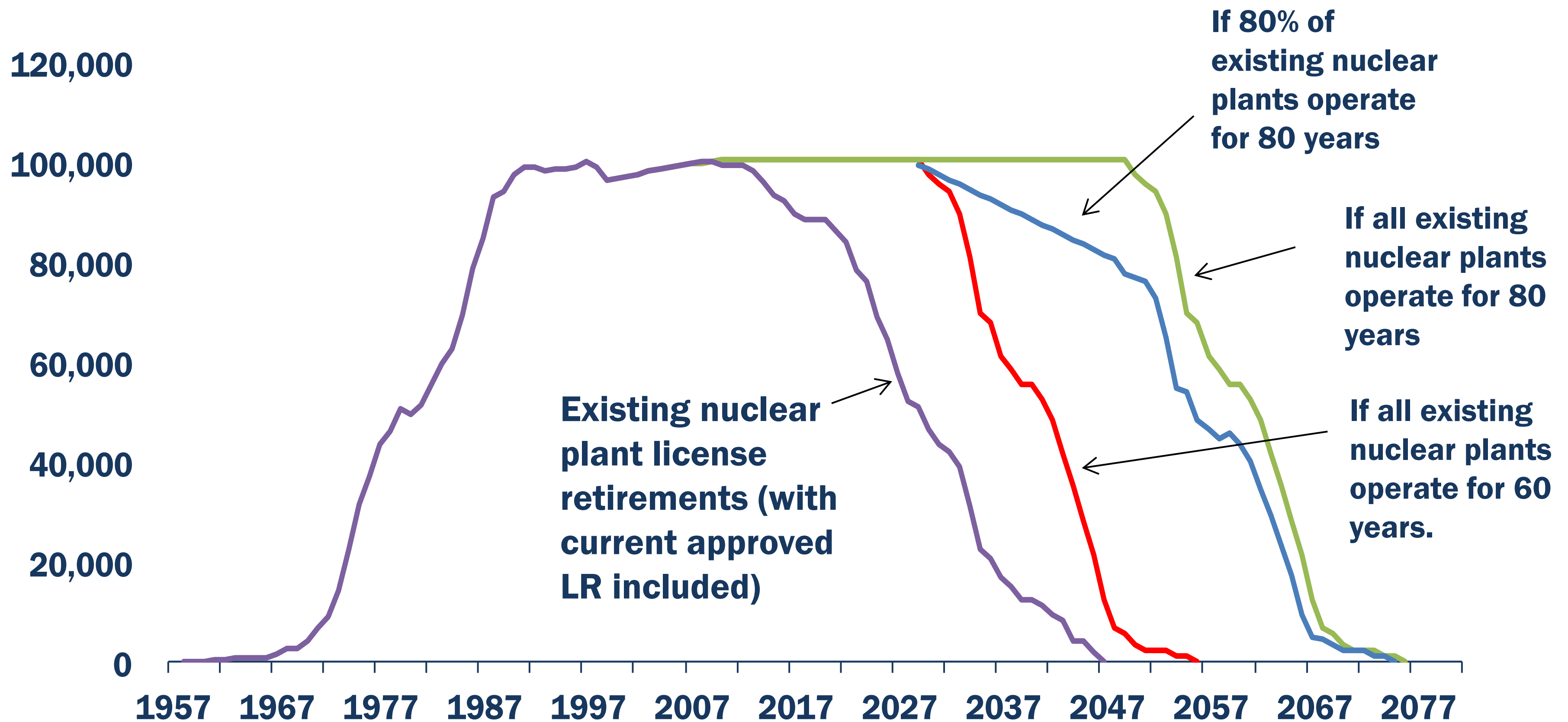
One-Year Industry Values



ISAR = Number of accidents resulting in lost work, restricted work, or fatalities per 200,000 worker hours.
Note: Starting in 2008, data includes supplemental personnel. Source: World Association of Nuclear Operators - Updated: 4/12

Projected U.S. Nuclear Power Capacity

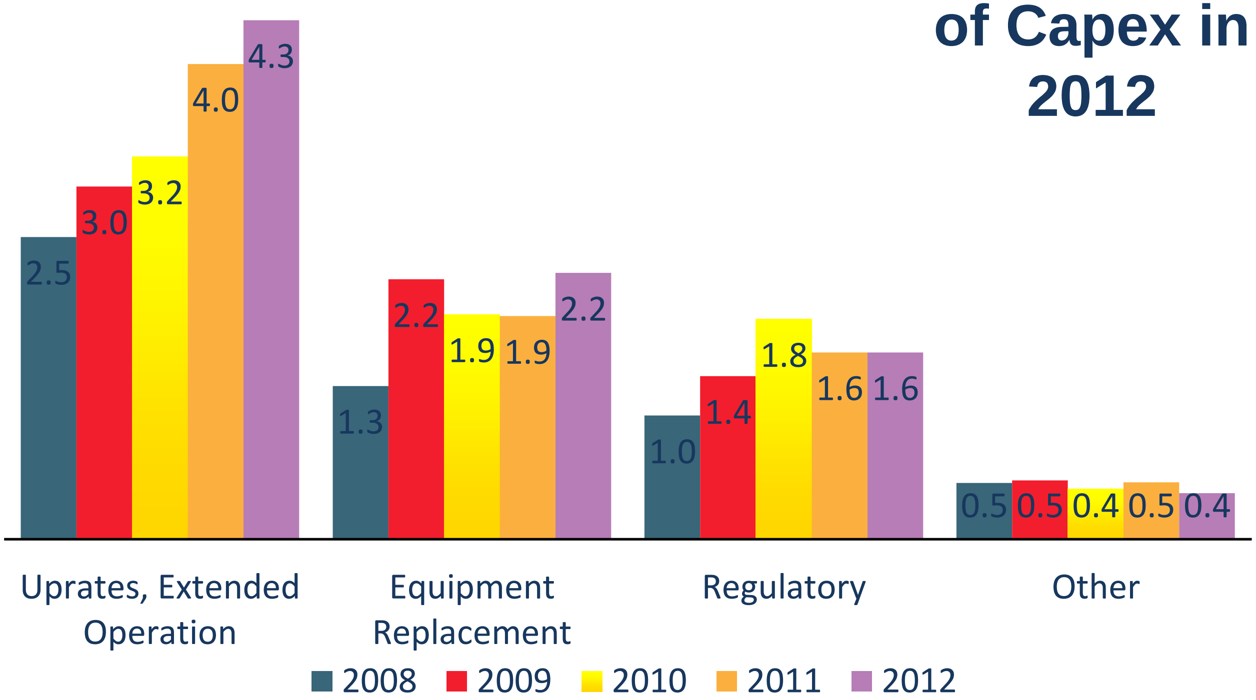
(Megawatts)



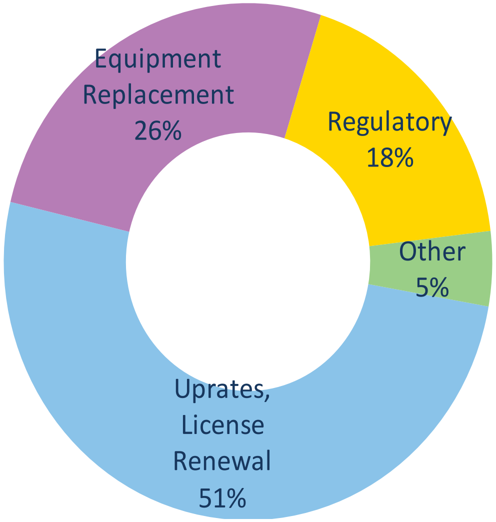
Sources: Energy Information Administration, Nuclear Regulatory Commission Updated: 4/14

2008-2012 Nuclear Capital Spending

(2012 Billions of $)



Distribution of Capex in 2012

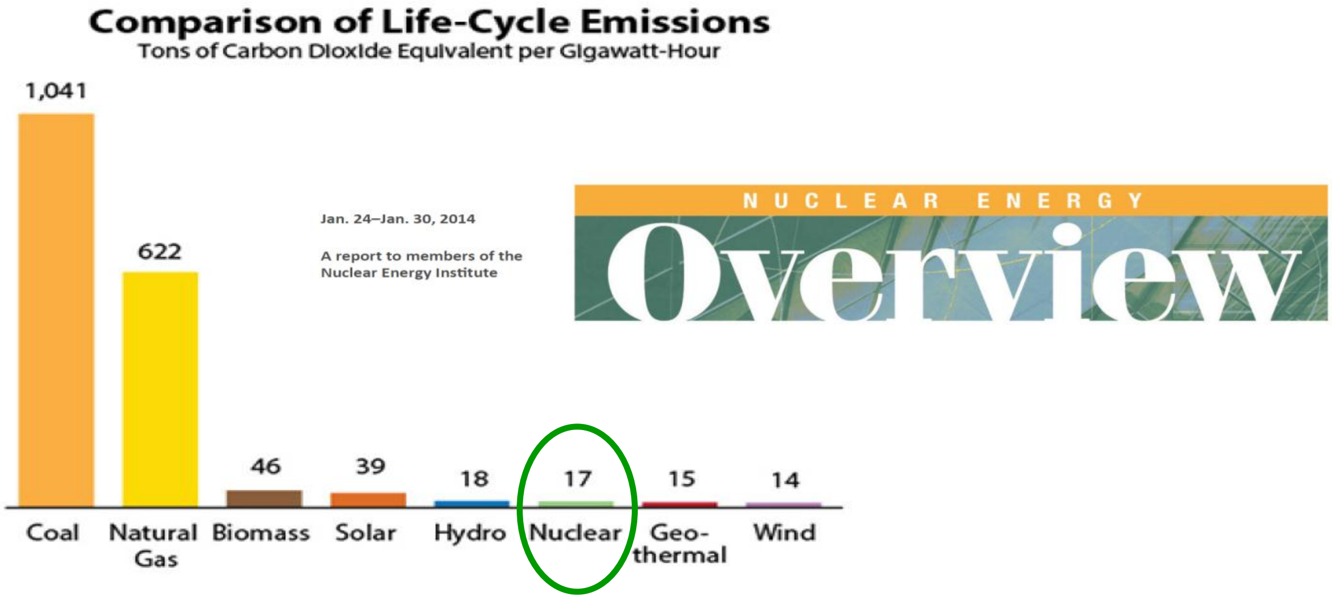


Source: Electric Utility Cost Group

Environmental Benefits

Life-Cycle Emissions

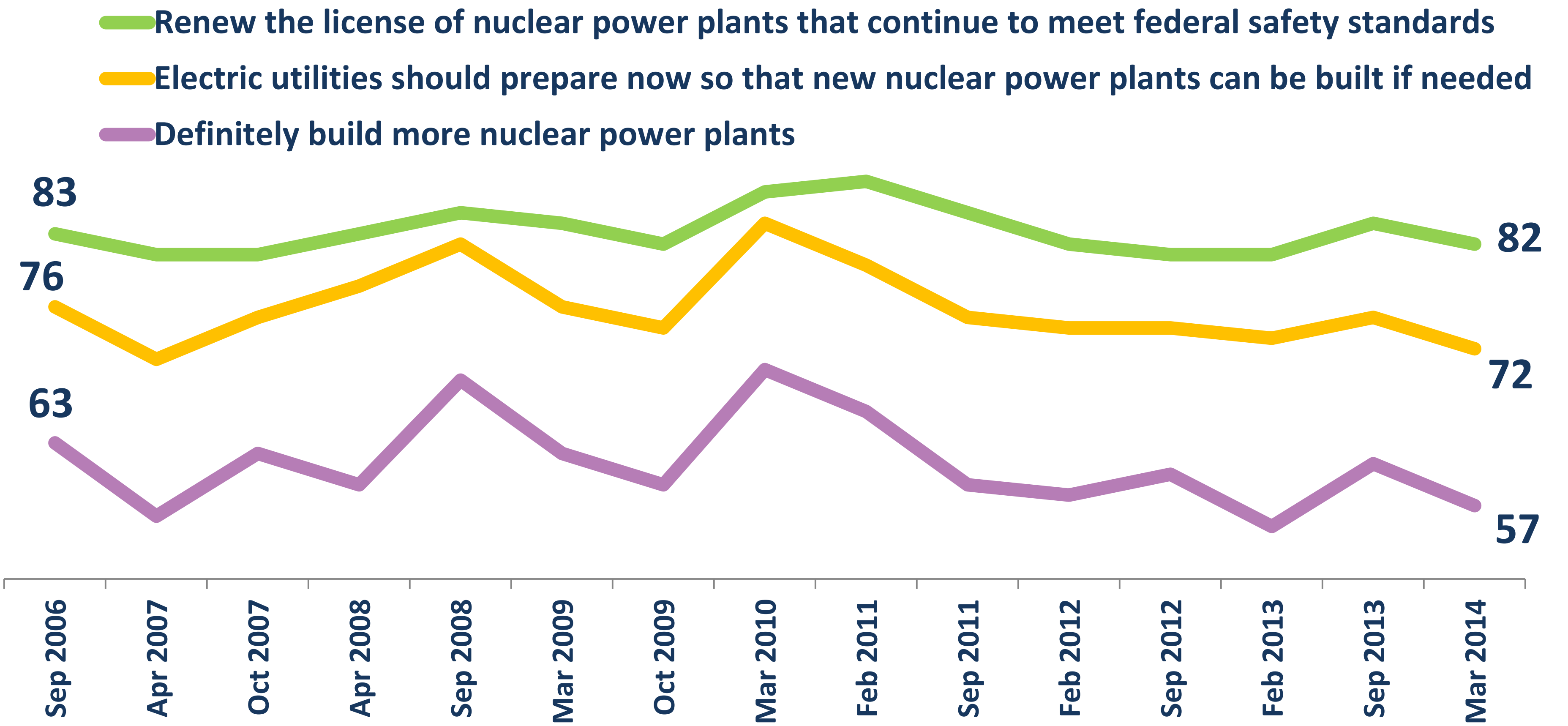
Nuclear energy's life-cycle carbon emissions are comparable to those of renewable energy sources.



Independent studies show that nuclear energy's "life-cycle" emissions of carbon dioxide are about the same as wind and geothermal power and significantly less than other electricity sources. A life-cycle measurement takes into account the facility's construction, the mining and processing of fuel, routine operation, disposal of used fuel and the ultimate dismantling of the facility—in other words, its entire life cycle.

License Renewal and New Plants

% Agree



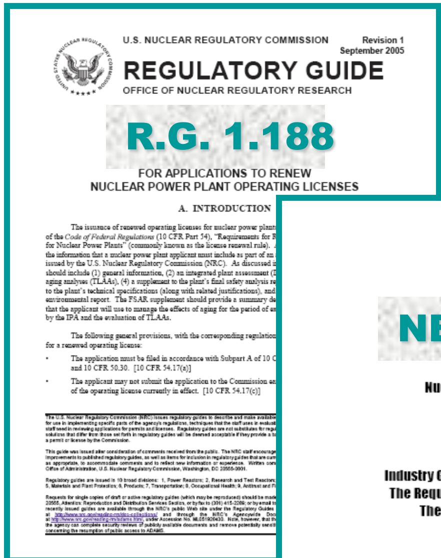
Source: Bisconti Research, Inc. with GfK Roper and Quest Global Research

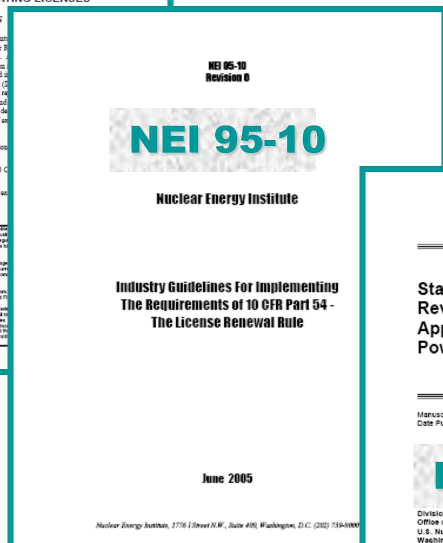
SLR Built Upon Successful LR Programs

License Renewal

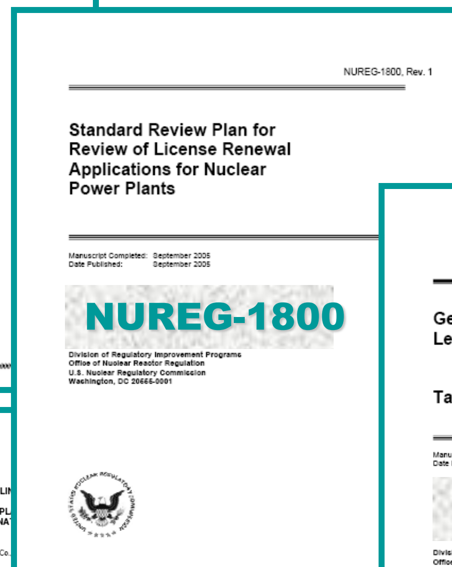
- Atomic Energy Act anticipated and allows for LR and SLR
- NRC process governed by 10 CFR Part 54 and Part 51
  - Original rule issued in 1991, pilot project determined rule was unsuccessful
  - Revised rule issued in 1995, pilot projects successful
- Renewal of original 40 year operating license for additional 20 year terms (i.e., 60, 80, etc. years)
- Aging management for passive, long-lived components and structures; time-limited aging analyses evaluation; environmental impact review

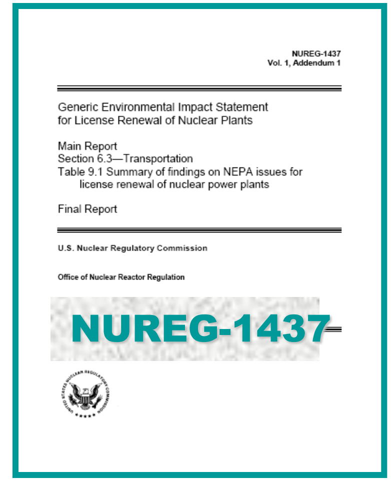
U.S. Regulatory & Industry Guidance

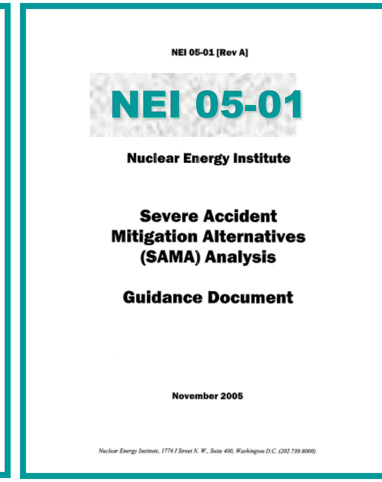


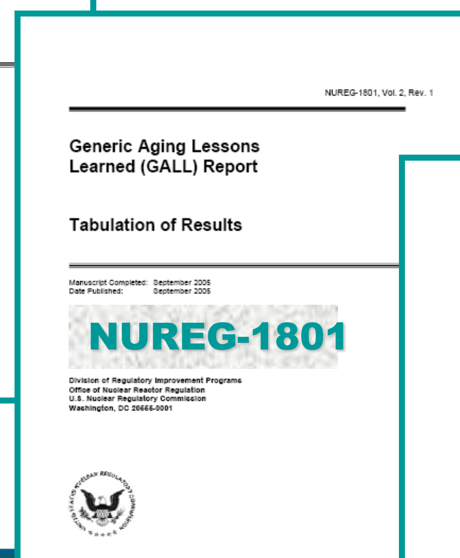


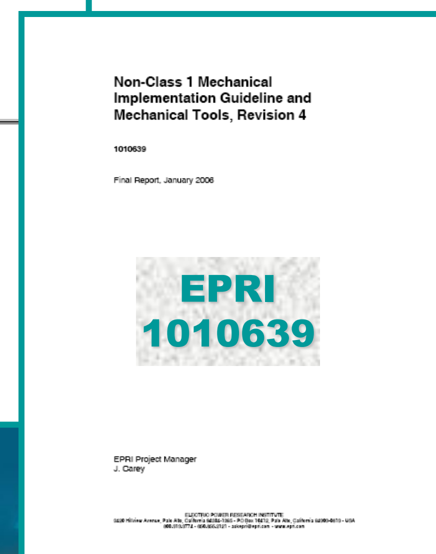
Status – on-going revisions of regulatory & industry guidance based on lessons learned and operating experience

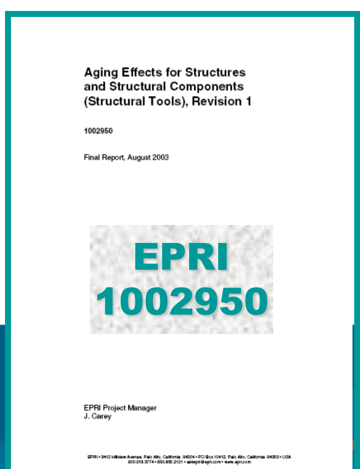


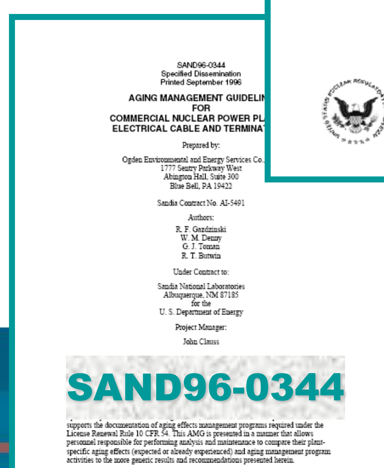








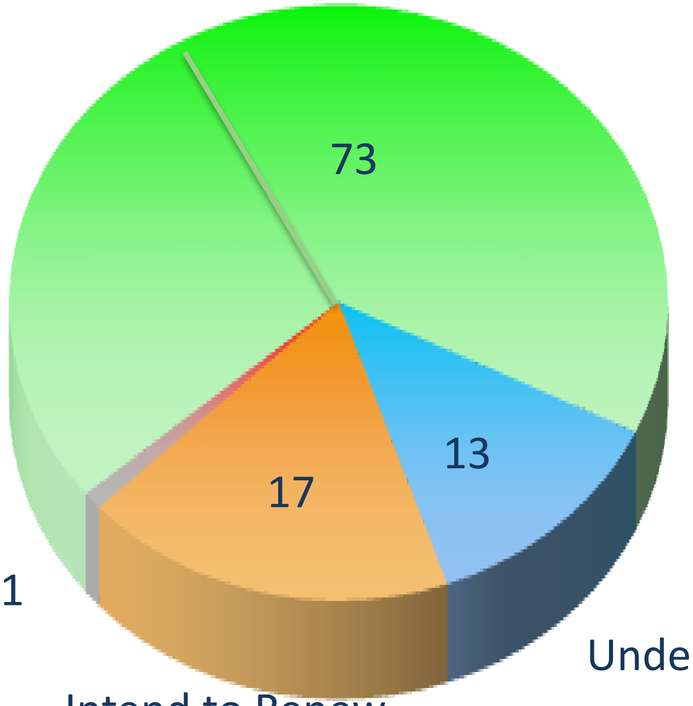




nuclear. clean air energy.

Current Status

27 in period of extended operation

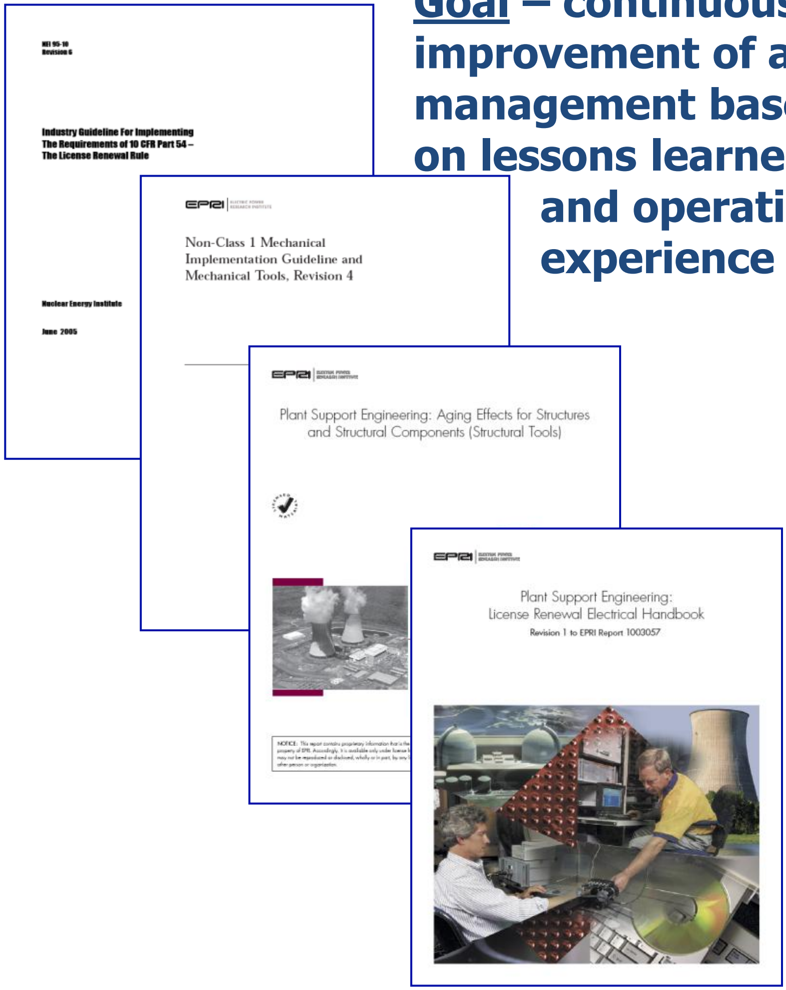


Industry and Government Preparing for SLR and Long Term Operations

U.S. Industry Groups – Supporting SLR

- **NEI LR and SLR Task Force**
  - Regular industry meetings
    - Quarterly industry meetings
    - Quarterly NRC mgmt. meetings
    - SRP & GALL revision recommendations
  - NEI 95-10 industry guidance
  - Industry peer reviews of LRAs
- **NEI License Renewal Working Groups**
  - Mechanical Working Group
    - EPRI Mechanical Tools Doc. Upkeep
  - Electrical Working Group
    - EPRI Electrical Tools Doc. Upkeep
  - Civil/Structural Working Group
    - EPRI Structural Tools Doc. Upkeep
  - Implementation Working Group
    - NRC IP71003, Industry Guidance
  - Subsequent LR Working Group
    - LTO R&D and Licensing Guidance
- **NEI SLR Executive Working Group** [new]
- **ASME Special Working Group – Nuclear Plant Aging Management**

Goal – continuous improvement of aging management based on lessons learned and operating experience



Close Coordination with Research

- ASME Special Working Group
  - Nuclear Plant Aging Management
- EPRI Long Term Operation (LTO) Program
  - EPRI documents identified in GALL in support of first round of LR
  - Subsequent License Renewal
  - Pilot Programs
- Department of Energy's (DOE) Light Water Reactor Sustainability Program (LWRS)
  - Materials Aging and Degradation
  - Advanced Instrumentation, Information, and Control Systems Technologies
  - Risk-Informed Safety Margin Characterization

Current SLR Milestone Schedule

2029 License Expires for 1st LR Plants

2024 5 Year Minimum to Submit SLR for Continued Operation Per Timely Renewal

SLR License Approved 9 Years Before Expiration of Original License

2020 1st SLR License Approved by the NRC

2 Years for NRC Review of SLR Application

2018 1st SLR License Application Submitted

2 Years for SLR Application Preparation

2016 Pilot Plant Selected, Begin SLR Submittal Preparations

R&D Supporting SLR ,EPRI/DOE/NRC

Revise GALL and SRP, NEI 95-10

Current Date

NRC Prepares SECY Paper on SLR

AMP Audits for Nine Mile, Ginna, Robinson by NRC

EPRI AMP Review Complete

NRC SLR Public Meeting Series

2009 1st LR Plants Enter the Period of Extended Operation

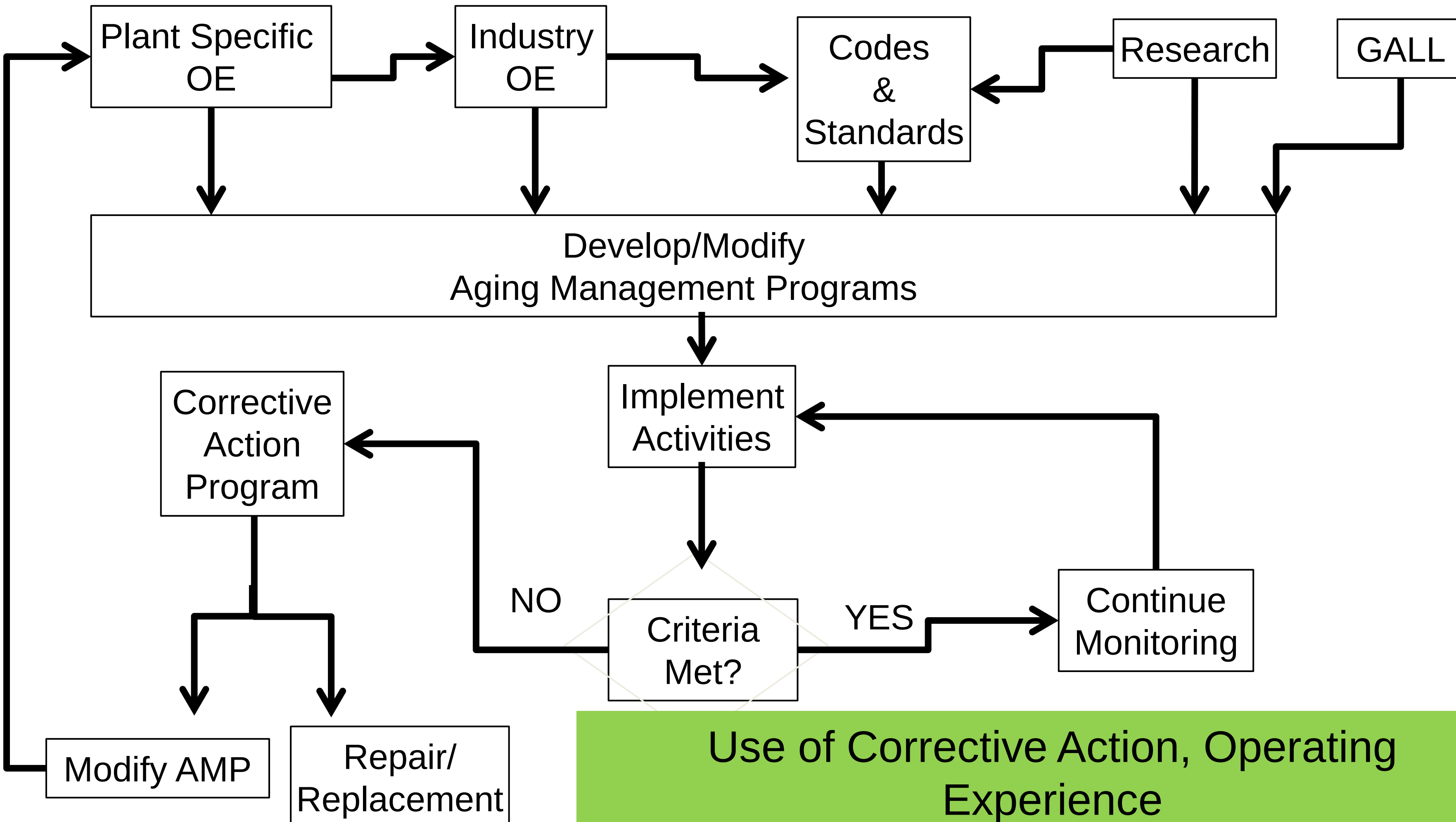
Aging Management – a Living Process

Most AMPs are Based on Mature Plant Programs

XI.M1 ASME Section XI Inservice Inspection,
Subsections IWB, IWC, and IWD
XI.M2 Water Chemistry
XI.M3 Reactor Head Closure Stud Bolting
XI.M4 BWR Vessel ID Attachment Welds
XI.M5 BWR Feedwater Nozzle
XI.M6 BWR Control Rod Drive Return Line Nozzle
XI.M7 BWR Stress Corrosion Cracking
XI.M9 BWR Vessel Internals
XI.M10 Boric Acid Corrosion
XI.M12 Thermal Aging Embrittlement of Cast
Austenitic
Stainless Steel (CASS)
XI.M16A PWR Vessel Internals
XI.M17 Flow-Accelerated Corrosion
XI.M18 Bolting Integrity
XI.M19 Steam Generators
XI.M20 Open-Cycle Cooling Water System
XI.M21A Closed Treated Water Systems .

XI.M22 Boraflex Monitoring
XI.M23 Inspection of Overhead Heavy Load and
Light Load (Related to Refueling)
Handling Systems
XI.M24 Compressed Air Monitoring
XI.M25 BWR Reactor Water Cleanup System
XI.M26 Fire Protection
XI.M27 Fire Water System
XI.M29 Aboveground Metallic Tanks
XI.M30 Fuel Oil Chemistry
XI.M31 Reactor Vessel Surveillance
XI.M32 One-Time Inspection
XI.M33 Selective Leaching
XI.M35 One-time Inspection of ASME Code
Class 1 Small Bore-Piping
XI.M36 External Surfaces Monitoring of
Mechanical Components
XI.M37 Flux Thimble Tube Inspection
XI.M38 Inspection of Internal Surfaces in
Miscellaneous Piping and Ducting
Components
XI.M39 Lubricating Oil Analysis
XI.M40 Monitoring of Neutron-Absorbing
Materials Other than Boraflex
XI.M41 Buried and Underground Piping and
Tanks

Developing & Maintaining
Effective Aging Management Programs (AMP)



Use of Corrective Action, Operating Experience
and ongoing research ensures existing AMPs remain effective for SLR

Plant Inspection for Aging Management

- NRC IP 71002 LR Site Inspections
- NRC IP 71003 Post Approval Inspections
- Aging management part of normal NRC site inspection procedures and included in ROP
- SLR Audits, Nine Mile, Ginna, Robinson
  - No major deficiencies

Detailed Analysis of SECY Paper

Key Principles for License Renewal

- **Current regulatory process** is adequate to ensure that the licensing basis of all operating plants provides and maintains an **acceptable level of safety** so that operation will not be detrimental to public health and safety or common defense and security
- Each plant's licensing basis is required to be **maintained during any renewal term** in the **same manner and to the same extent** as during the original licensing term

Agree with DLR Staff Conclusions for Four Items

- License renewal process and regulations are sound and can support subsequent license renewal
- Environmental issues can be adequately addressed by the existing generic environmental impact statement (GEIS)
- Helpful for the NRC to revise its license renewal guidance (GALL, SRP) but not essential
- No need for applicants to include PRA update because no unique nexus to SLR

Overall Concerns with Rulemaking

- Out of step with "Implementation of the Cumulative Effects of Regulation Process Changes" (SECY-12-0137)
- No significant issue, inspection finding, audit report, implementation difficulty, or operational need to implement rulemaking
- SECY claims of improved efficiency or "more predictable review process" not backed up with any cost-benefit justification or study
- Most changes suggested in SECY not unique to SLR and can be implemented without rulemaking
- For these non-safety significant issues, schedule for rulemaking may impact industry plans and NRC staff resource requirements for SLR application reviews

Summary of SECY Proposed Changes

- NRC Staff Proposed 4 Options (SECY -14-0016):
  - # 1 – No change to existing 10 CFR 54 regulations
  - # 2 – Minor clarifications to 10 CFR 54 for LR and SLR
    - Editorial update to 10 CFR 54.4(a)(3) to Reference 10 CFR 50.61a (PTS)
    - Clarify Intent of 10 CFR 54.37(b) (NRC updates)
  - # 3 – Update 10 CFR 54 for LR and SLR
    - Define expectations of Timely Renewal (10 CFR2.109)
    - Revise 10 CFR 54.4(a)(3) to place 10 CFR 50.54(hh) and FLEX equipment in scope of LR
  - # 4 – Rulemaking for subsequent renewal-specific changes
    - Require that Licensees effectively maintain License Renewal activities and report aging-related degradation after a license is renewed
    - Limit the time during which SLR applications can be filed
    - Require verification of continuing validity of certain original design parameters

Option 1 – 10 CFR 54 is sound

- Part 54 anticipates further rounds of License Renewal
- Existing regulatory processes ensure safe operation
  - 10 CFR 50, Appendix B
  - Aging Management Programs (AMPs)
  - Maintenance Rule – active components
  - ROP process
  - Design basis is maintained
- Process proven through vast experience, 73 renewed licensed, 27 reactor units in PEO
- Reliable, predictable process

Option 2- Unnecessary Editorial Changes

- "These changes alone may not warrant resource allocation to conduct the rulemaking process" (SECY pg. 6)
- 54.37(b) can be further clarified in a Regulatory Issue Summary (RIS) if necessary
- Would apply to current renewals

Option 3 – Unnecessary and No Unique Relevance to SLR

- Timely Renewal – Unnecessary Regulation
  - Rare event – one time
  - NRC Inspection Procedure 71013
  - Addressed through current processes
- Commission considered EP equipment in LR rule not in scope (SOC)
- 50:54(hh)(2) equipment and FLEX equipment managed by plant procedures.
- Would apply to current renewals

Option 4 – Conflicts with Fundamental Regulatory Principles in LR Rule

I. "Explicitly require maintenance of effectiveness … and reporting age-related degradation."

- Existing regulatory guidance, GALL review items
  - **5. *Monitoring and Trending***
  - **10. *Operating Experience***
- Required by 10 CFR 50, Appendix B
  - XVI. Corrective Action

Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

Option 4 – Current Industry Initiatives Underway

- Current industry initiatives underway
  - "Use of Industry Operating Experience for Age-Related Degradation and Aging Management Programs" NEI 14-xx
  - "Aging Management Program Effectiveness" NEI 14-xx
- Not an SLR specific issue – if important, why wait 15 to 20 years to implement

Option 4 – Significant AMP Experience

II. Limit the Time During Which SLR Applications Can Be Filed (<20 Years)

- Many Aging Management Programs in place from beginning of plant operation
  - Program improvements made based on OE and research programs (EPRI, DOE)
  - Industry Initiatives – Buried Piping Program
- Significant AMP experience in PEO will be available across industry before 1st SLR application is submitted (>40 Reactor-years in PEO now)
- Due to significant economic uncertainty, 20 year planning horizon should be maintained

Option 4 – Validate Original Design Parameters

- Undermines the two principles of License Renewal
- Matter of current plant operation and addressed through existing NRC Regulatory Processes
- Wasteful and inefficient to address in the SLR process and adding to cumulative effects of unnecessary regulations

Summary

- The future of US license renewal depends on certainty in the regulatory process
- Existing License Renewal regulation provides a solid foundation for safe operation
- SLR Schedule is tight compared to first round of license renewals and may be compromised by SLR Rulemaking
- Criteria for rulemaking is not supported by increase in safety nor efficiency improvements

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United States Nuclear Regulatory Commission
Protecting People and the Environment

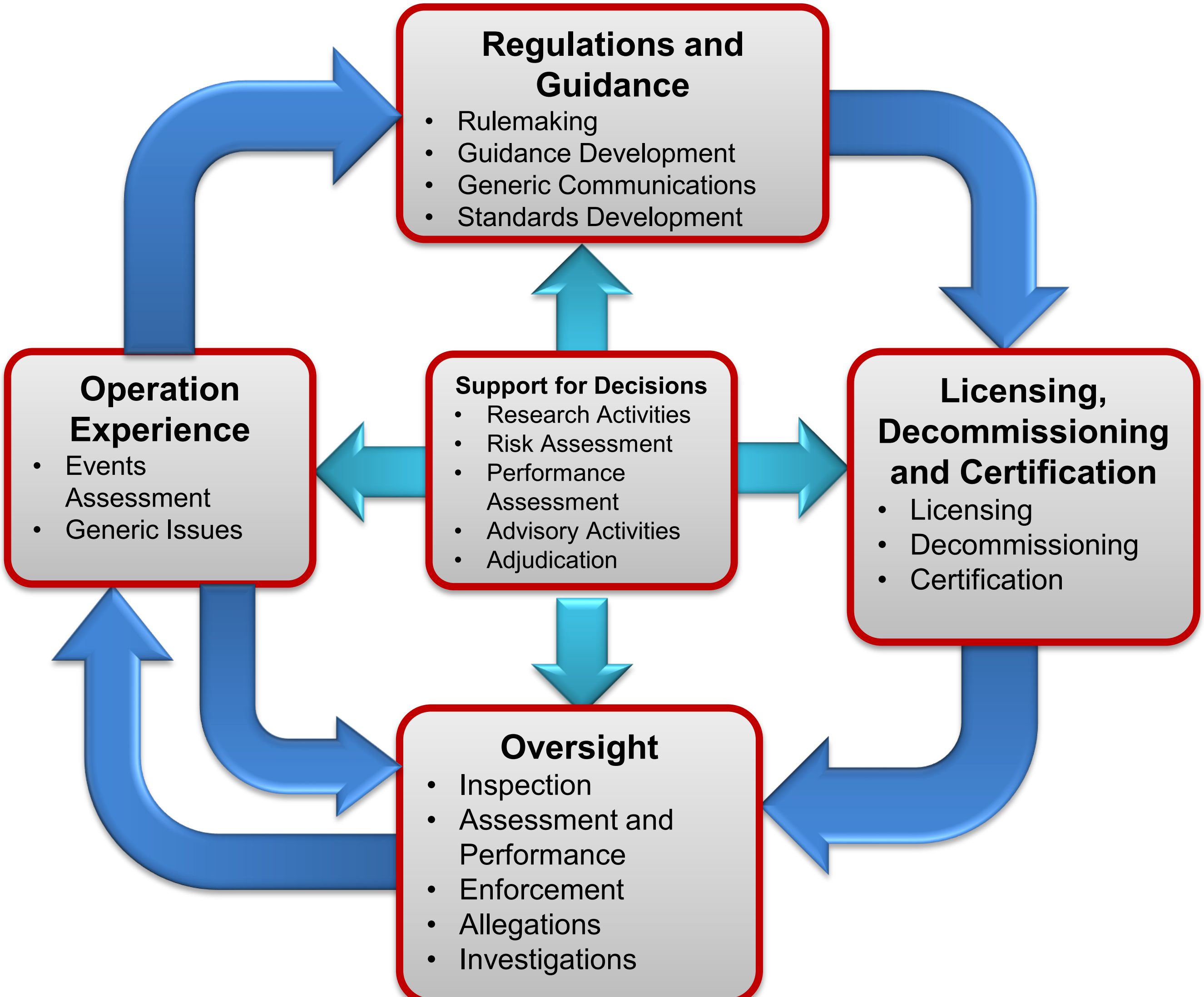
Subsequent License Renewal

Division of License Renewal
Office of Nuclear Reactor Regulation
Division of Engineering
Office of Nuclear Regulatory Research
May 8, 2014

Agenda

- Licensing Overview
- Proposed Regulatory Framework
- Technical Framework
- Summary

Safety is Ensured During the First 40 Years



License Renewal Principles Maintain Safety

- With the exception of the detrimental effects of aging, the existing regulatory process is adequate for safe plant operations

- Each plant's licensing basis must be maintained

Safety Continues to be Maintained Beyond 60 Years

- The principles of license renewal would continue to be effective to ensure safety
- Additional focus on the effectiveness of aging management programs

Enhance Aging Management Program Effectiveness

- Self-assessments
- Aging-related degradation
- Changes to subsequent license renewal activities

Timing of SLR Applications

- Current - subsequent license renewal application concurrent with entering its first period of extended operation

- Revised - rule to require more operating experience

Licensing Basis

- Maintenance of Licensing Basis
  - Changes approved by the staff
  - Changes volunteered by the licensee
  - Changes mandated by the NRC
- Identification and resolution of generic safety issues
- Review of external hazards/site characteristics

Other Rulemaking Considerations

- Recordkeeping requirements
- Timely renewal requirements
- Add additional passive systems, structures, and components

Requiring Probabilistic Risk Assessments Non-Concurrence

- Probabilistic risk assessments are not required to maintain plant safety
- Probabilistic risk assessments are not unique to license renewal
- Applicants can risk-inform aging management programs

Research Activities in Support of SLR

- **Canvas state of knowledge**:
  - Technical workshops
  - International Atomic Energy Agency International Conference on NPP Life Management
  - Nuclear Energy Agency Committee on the Safety of Nuclear Installations Long Term Operations (LTO) activities
  - Periodic safety reviews
- **Periodic interactions through memoranda of understanding:**
  - Department of Energy (DOE)/Light Water Reactor Sustainability Program
  - Electric Power Research Institute/LTO Program
- **Audits of aging management programs**

Extended Materials Degradation Assessment (EMDA)

- Builds on Proactive Materials Degradation Assessment (NUREG/CR 6923, February 2007)
- Joint effort with DOE's Light Water Reactor Sustainability Program
- International experts with diverse affiliations
- Phenomena identification and ranking table techniques

High-Susceptibility Degradation Scenarios

- **Piping and core internals:**
  - High knowledge: primary water stress corrosion cracking
  - Low knowledge: irradiation-induced degradation of core internals
- **Reactor pressure vessel:**
  - High knowledge: neutron irradiation embrittlement
- **Electrical cables:**
  - High knowledge: thermal and irradiation effects
  - Low knowledge: environmental qualification; submergence of low and medium voltage cables
- **Concrete structures:**
  - High knowledge: freeze-thaw damage
  - Low knowledge: alkali silica reaction, irradiation effects

Path Forward

- Commission SRM
- External stakeholder interactions
- Database of technical issues
  - Subject matter expert panels
- Guidance development

Summary

- Principles of license renewal are adequate for ensuring safety for subsequent license renewal
- Regulatory process is effective
- Technical reviews ensure effective aging management

Option for Upgraded PRA in Subsequent License Renewal

Joseph Giitter

Director, Division of Risk Assessment (DRA)

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Why Should PRA be a Consideration for SLR?

Policy Rationale

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PRA Policy Statement : *Use of PRA should be increased in **all** regulatory matters to the extent supported by "**the state of the art**."*

- Regulatory framework for subsequent license renewal is a major "regulatory matter."
- PRA "state of the art" has advanced considerably in the last twenty years.

Why Should PRA be a Consideration for SLR?

Policy Rationale

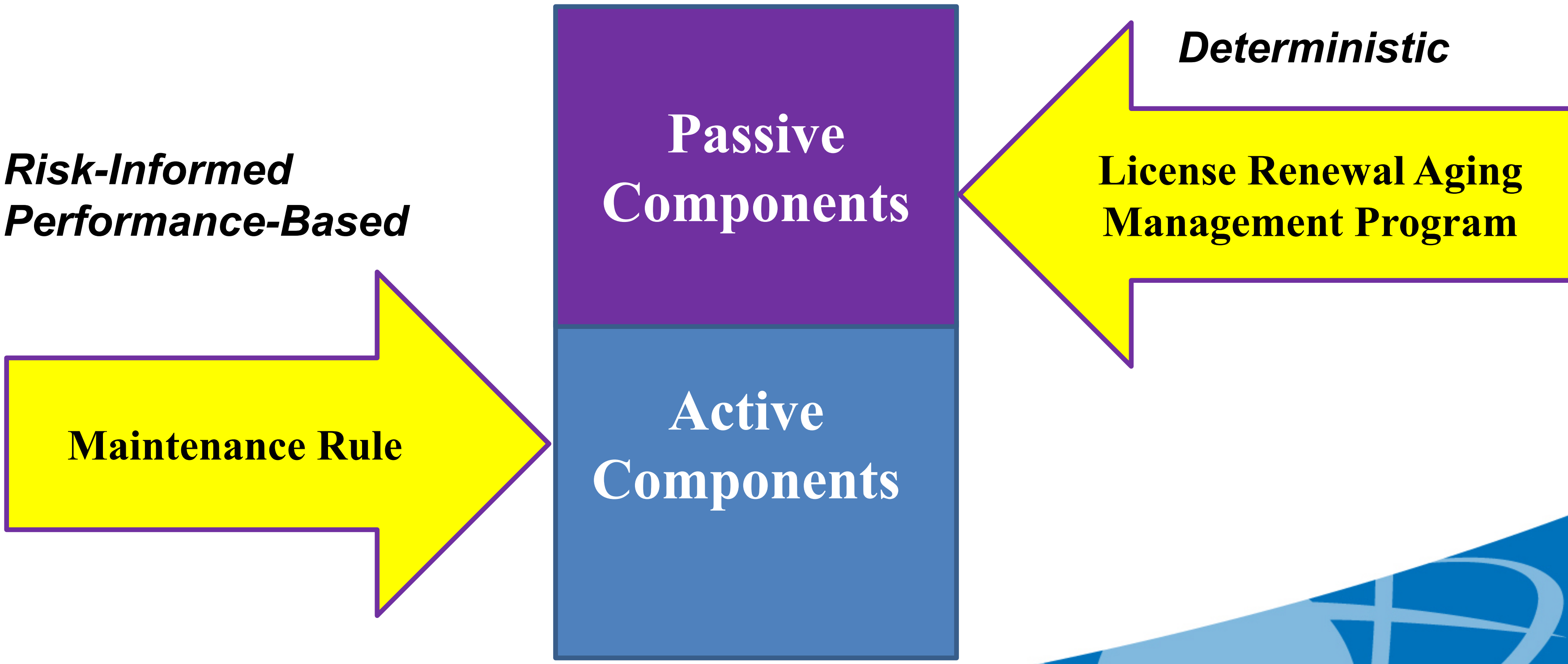
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Provides regulatory consistency for combined operating license holders and the existing reactor fleet
  - 10 CFR 50.71(h)(3) requires Combined Operating License (COL) holders to submit an upgraded PRA (one that covers all modes and initiating events) as part of their license renewal application
  - No PRA requirement for current fleet

- An updated PRA requirement would provide consistency with license renewal regulations for New Reactors

Why Should PRA be a Consideration for SLR?

Safety Rationale



Why Should PRA be a Consideration for SLR?

Safety Rationale

RISK REGIONS HIGH MEDIUM LOW		CONSEQUENCE CATEGORY Core Melt Potential for Limiting Break Size			
		NONE	LOW	MEDIUM	HIGH
DEGRADATION CATEGORY Potential for Large Break/Rupture	HIGH	LOW RISK	MEDIUM RISK	HIGH RISK	HIGH RISK
	MEDIUM	LOW RISK	LOW RISK	MEDIUM RISK	HIGH RISK
	SMALL	LOW RISK	LOW RISK	LOW RISK	MEDIUM RISK

Why Should PRA be a Consideration for SLR?

Safety Rationale

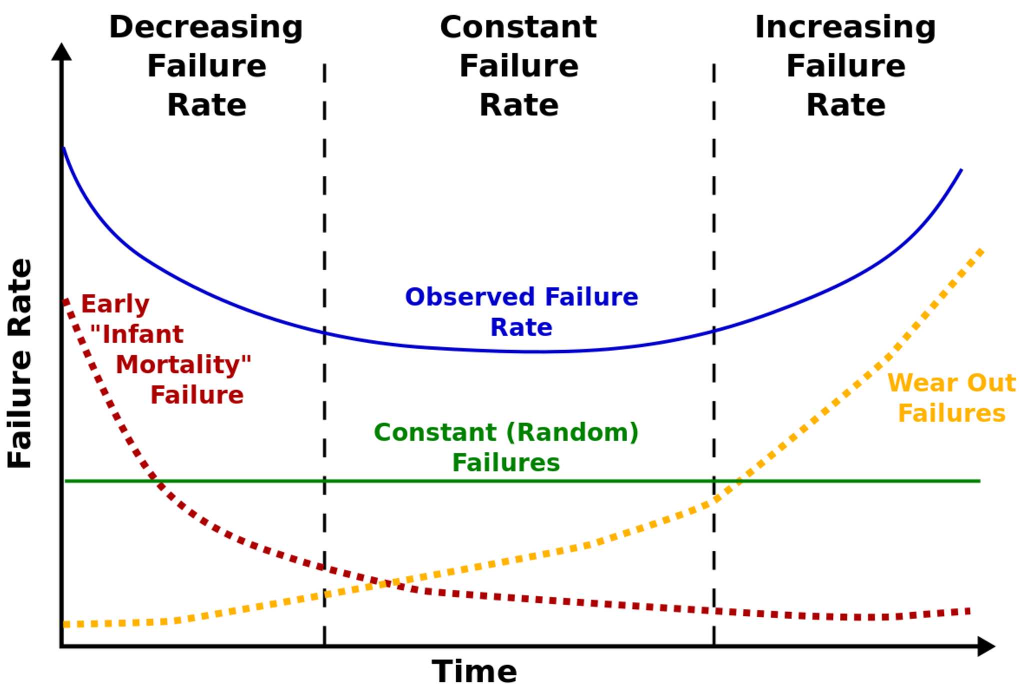
RISC-1: **•Safety Related** **•Safety Significant** **~25%** **~5000 SSCs**	**RISC-2:** **•Non-Safety-Related** **•Safety Significant** **~1%** **~700 SSCs**
RISC-3 **•Safety Related** **•Low Safety Significance** **~75%** **~15,000 SSCs**	**RISC-4** **•Non-Safety-Related** **•Low Safety Significance** **~99%** **~60,000 SSCs**

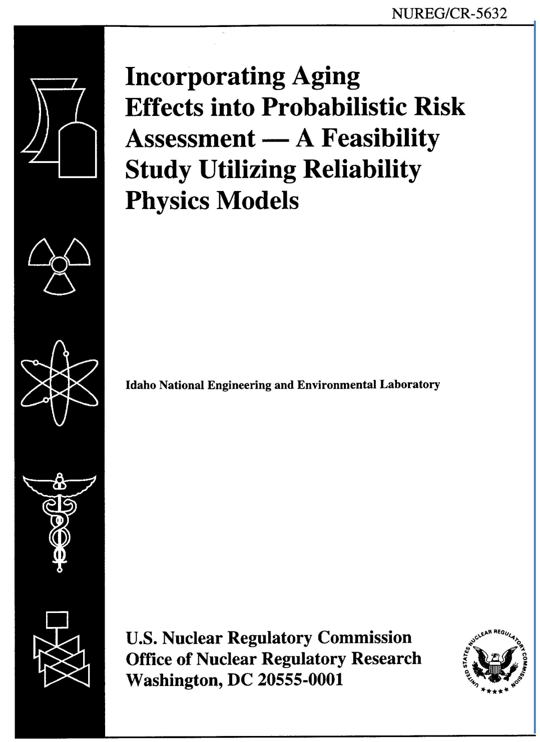
(Numbers are approximate values from South Texas Exemption)

- CLB is based on a stylized scenario that may not represent the greatest risk contributors
- Experience from risk-informed licensing applications
  - 50.69
  - Risk-informed ISI

Why Should PRA be a Consideration for SLR?

Safety Rationale




NUREG/CR-5632

Incorporating Aging Effects into Probabilistic Risk Assessment — A Feasibility Study Utilizing Reliability Physics Models

Idaho National Engineering and Environmental Laboratory

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001

Why Should PRA be a Consideration for SLR?

Safety Rationale

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40-60 Years

Risk insights from one-time SAMA analysis

AMP doesn't differentiate based on risk

High quality risk insights

AMP focuses resources on most risk significant and susceptible SSCs

60-80 years with PRA requirement

No risk insights

AMP doesn't differentiate based on risk

60-80 years without PRA requirement

Why wait for SLR Rulemaking?

- Current PRA quality driven by voluntary initiatives
- Uncertain that current staff initiatives (e.g., RMRF) will result in a PRA requirement
- PRA requirement unlikely to pass the backfit rule
- SLR rulemaking provides a unique opportunity that is justified by both policy and safety considerations.