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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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RELIABILITY AND PRA SUBCOMMITTEE

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WEDNESDAY

JANUARY 15, 2014

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ROCKVILLE, MARYLAND

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

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member

HAROLD B. RAY, Member

JOY REMPE, Member

STEPHEN P. SCHULTZ, Member

DESIGNATED FEDERAL OFFICIAL:

JOHN LAI

ALSO PRESENT:

EDWIN M. HACKETT, Executive Director, ACRS

JAMES CHANG, RES

SUSAN COOPER, RES

RICHARD CORREIA, RES

AMY D'AGOSTINO, RES

ANTHONY DELAMOTTE, RES

DAVID DESAULNIERS, NRO

PATRICK J. FALLON, DTE Energy

CARMEN FRANKLIN, RES

DON HELTON, RES

CHRIS HUNTER, RES

NIAV HUGHES, RES

LAUREN NING, RES

SEAN PETERS, RES

MARY PRESLEY, EPRI*

NATHAN SIU, RES

TOM STEVENS, NEI

APRIL WHALEY, INL*

JING XING, RES

ANTONIOS ZOULIS, NRR

*Present via telephone

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

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.)

CHAIRMAN STETKAR: The meeting will now come to order. This is a meeting of the Reliability and PRA Subcommittee. I'm John Stetkar, Chairman of the Subcommittee meeting.

ACRS members in attendance are Steve Schultz, Harold Ray, Ron Ballinger and Joy Rempe and I am assured that we will be joined later by Dr. Dennis Bley. John Lai of the ACRS staff is the designated federal official for this meeting.

The Subcommittee will hear the latest developments on the HRA methodology and its applications in response to the Commission's SRM-M062010. We will hear presentations from the NRC staff and designated representatives from the Electric Power Research Institute.

There will be a phone bridge line. To preclude the interruption of this meeting, the phone will be placed in a listen-in mode during the presentations and Committee discussions.

We received no written comments or requests for time and make oral statements from members of the public regarding today's meeting. The entire meeting will be open to public attendance.

The Subcommittee will gather information and analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

Therefore we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee. The participants should first identify themselves and speak with sufficient clarity and volume so they may be readily heard.

We'll now proceed with the meeting and I guess, Sean, I'll ask Sean Peters, do you have any opening statements?

MR. PETERS: Yes. I'd like to thank the ACRS for allowing us to come and have our annual presentation on the status of the SRM, HRA model differences.

Our staff has made significant progress this year in development activities and I do appreciate the extended time period to get the draft of the generic methodology forth to the ACRS.

With that in mind, I think Jing and James have done a great job getting this together for you and I'd like to hear what they have to say and I'd like to hear ACRS comments on the work, so with no further ado, Jing.

CHAIRMAN STETKAR: Sean, before we start, the Subcommittee has had a few meetings on this topic over the last two or three years, something like that. The full Committee actually has not yet been briefed on any of this work and I think some of the work products are getting to a point of maturity where it would be beneficial to have a briefing of the full Committee and perhaps if the Committee decides to write a letter sort of documenting our current understanding of the process and feedback.

So if you get a chance, you may want to discuss that with James and Jing, you know, and decide whether and when you feel it's opportune.

I just get the sense that we're getting to a point where it might be useful, both for our purposes and perhaps for your purposes and that's why you may want to discuss it internally.

MR. PETERS: Yes, we have discussed that to a degree. We are receptive to an ACRS meeting.

CHAIRMAN STETKAR: Okay.

MR. PETERS: And the real issue would be since ACRS is kind of a co-bagholder on this project, at what point does the ACRS think it would be beneficial to weigh in on this?

CHAIRMAN STETKAR: Yes. Well, I'm at least throwing out the notion that I think we're getting to a point, at least on some of the work products, where it may be opportune to do that, so --

MR. PETERS: Okay. Yes, I think especially the earlier stuff that we've done, the cognitive basis report and others like that.

CHAIRMAN STETKAR: So you may want to discuss it because at the end of the meeting today I'd like to try to get a little bit of closure on what that might be, what the products might be. We don't need to schedule a meeting date obviously.

MR. PETERS: Sure.

CHAIRMAN STETKAR: We can work through that with our schedule, but if we at least keep that in the back of our mind and try to revisit it at the end of the afternoon.

MR. PETERS: Okay. We will do.

CHAIRMAN STETKAR: Great. Thank you. With that, Jing, it's yours.

MS. XING: Okay. Okay thanks, everyone,

for being here today for our briefing. And, first, I'd like to apologize to the audience sitting in the back. We are missing the handout for this first set of slides, the overview, so this is a demonstration of the error of omission. So even a simple task of making copies, we can missing one set of the copy so but you have the rest of the set. Okay.

So I'm Jing Xing and I'm the project manager for the SRM HRA method differences. Since this SRM started in 2006, even if you have a very good memory for what's been happening over the last six years, I think you wouldn't mind that we have an overview for what in the past we've been through over the last couple years and where we are. So that's the overview section. Okay, we start with a very large team, many participants on this work.

CHAIRMAN STETKAR: Actually, if you think about it, no one on the ACRS side of the table sitting in this meeting room today was even a member of the Committee in 2006, just for some perspective.

MS. XING: Okay, this picture shows you how we look like, the HRA work, back to 2006. We have a number of issues. I put them in these five bubbles of things, so we have issues like we have multiple HRA method. We have issues in use of this method and the method application scope, their scientific basis and the empirical data to support this method. Let's take a close look of each of these.

So as we all know, there are probably about 30 to 40 HRA method around the world and primarily most of these method are for internal procedural events.

These method have different scopes so they do not complementary to each other. And they use the different approaches so you can't simply combine them somehow. They're not always compatible to each other. And also most of them lack of a commonly agreed foundation for modeling human errors. So for a situation like this, we really need an integrated method to reduce the variabilities among this method.

And to have a method, that doesn't mean you can use it as it's supposed to. So we find that many of these method or most of them have inadequate guidance on how to use them. Therefore, quite often there are discrepancies in the way the method was intended to be used and the way it's actually being used.

So and also there's lack of criteria on the level of details and the depth of the analysis when using this method. So people often wonder when's good enough with doing this. So we really need a clear guidance with a good technical basis for analysts to follow and to make judgment on the approved method.

And even we have multiple HRA method there, most of them are for internal procedural event, so when we talk about a broad scope of applications, like lower power/shutdown, external event, Level-2/3 event and fuels, material, nuclear byproducts used.

When we go outside the internal event, we wonder are the existing method applicable? We found that we don't have the right method, for example, for lower power/shutdown or Level-2 HRA.

And the existing method do not cover many situations in the other applications and the many types of human actions are not covered with the existing method.

So that implies we need some more, even we already have many method, it look like we need more method for other applications. But do we really want for every application we need its own method? This is a trade-off issue between the generalizability and the specificity of the method.

So ideally we would like to have a generic methodology for all the applications and, if needed, the generic methodology can be tailored for a specific application so that way we can meet both generalizability and specificity.

And about the scientific basis in the HRA method, HRA is about how human make errors. The good news is most HRA method implicitly use some sparse information of why and how human make errors like show in this diagram.

We know human perform the tasks in this cognitive functions, like you're detecting something, to understand it, then make a decision, put your decision into action and you have teamwork bounded all this together. And there are various performance-influencing factors which affects the performance. So this is the basic model used by most HRA method.

However, we lack a strong scientific basis in this model. Exactly how human make error? You said you can make an error in detection. Why and how? What factor would affect it in what way? So we need a foundation to modeling human error and the effect of the PIFs.

MEMBER SCHULTZ: Jing, just one question at this point. Most methods use this approach. Now, does that mean those that do not are not going to fit the goal of this study and need to be discarded?

In other words, we're just going to set those -- I don't know how many are most and how many are -- of the 30 that you mentioned, you know, roughly 30, some of them do not use this approach from what you've said. Are we going to set those aside in terms of the work here?

MS. XING: I would say even for those ones that did not explicitly use this, they might still have consideration of developing method. I'm sure they have some consideration like this.

MEMBER SCHULTZ: Yes, that's why I ask, because it looks fundamental.

MS. XING: Yes, one example, like NARA. NARA only did use a failure mode of the behavior of actions, like fail to, you can give example, a error failure model, like fail to start a pump or fail to close a valve, but underneath there must be some consideration of this process.

MALE PARTICIPANT: THERP.

MX. XING: Yes, THERP. I'm sure THERP had a consideration of all this but it's just not explicitly shown in the model.

MEMBER SCHULTZ: Okay. I understand. Thank you.

MS. XING: Yes, so I like give credit to all the models on this.

And the data for HRA. Well, the HRA, one purpose for HRA or the ultimate purpose is to estimate human error probability, which is the number of failures out of the number of instance you perform this task.

However, most of the method do not supported by data. The HEPs primarily rely on expert judgment.

And even in the existing data, the denominator data is rare. We have some kind of information like error reports show people made this many error in this instance and other situation but out of how many instance we don't know.

And when we try to use data we find that we don't have a useful HRA database. For example, NRC has a human event database but you can't just go to that database and pull out data for HRA.

And also because the lack of such a database, the data from different sources is not generalizable. We cannot simply combine them to use so we do need a systematic way to collect, generalize and use data to improve the HEP estimation.

So I'm sure the Committee and the commissioner considered all these issues. That's why we had this SRM that directed us to work with the staff and external stakeholders to evaluate the different method, to propose a single method or the combination of several method for the agency to use.

And our staff's response is what's the box in the center. Way back to 2008 we decided to develop a new HRA method to address those issues and meet the need.

So this project has been started for the last five years, and I'd like to point out this project didn't work in a standalone fashion. It's been interacted and supported by other projects in our division, like it takes a lesson learned from the international and the U.S. HRA benchmark studies and it interacted with the HRA database project.

And over the last two years, we have staff work on Level-3 PRA project where there's HRA element with the interaction with that team in the development of the HRA method.

And also we had a relatively new, back to two years ago, a new SRM asked us to develop a guidance for former expert judgment so we've been using the initial guidance to do the expert judgment in our HRA method development and vice versa, the method development was used as a pilot for our guidance of expert judgment.

So let's remind what we want to achieve in this project. The goal for this project for the HRA method development is to develop a new methodology to reduce the variability and apply to all the HRA applications.

So the requirement for this project, what we want to achieve, is, first of all, we wanted the method to conform to the PRA/HRA standards and the HRA Good

Practices. We don't want a dramatic revolution to where we were and we like to retain and integrate the strengths of existing method.

And the new method should have the enhanced capabilities to address the key weaknesses in the current state-of-practice and the new method should have a state-of-the-art technical basis.

And to meet the goal for all HRA applications, we like to create the method generic enough for all the application in nuclear power plant. So by the end of this, you know, we will look at this goal as a requirement to see how far we have achieved.

MEMBER SCHULTZ: So this was the original listing? Because on the previous slide, you mentioned guidance for expert judgment was in a separate SRM but was going to be incorporated in.

MS. XING: That was a separate SRM.

MEMBER SCHULTZ: So that's not on this list?

MS. XING: That's not on this. This is only for the method, HRA method development.

MEMBER SCHULTZ: Okay, so the center box.

MS. XING: Yes, the center box.

MEMBER SCHULTZ: Okay, thank you.

MS. XING: As the strategic approach we had in this project, we start from look at the technical basis so we did a comprehensive review of scientific literature and did a cognitive basis for human error analysis.

Based on that, we tried to develop a generic HRA methodology that can be used for all the HRA applications so this is generic enough and we make a specific, tailored to a particular application.

One is we did develop this IDHEAS method for internal at-power events and the other one was tailored for develop a HRA worksheet, which we think it can be good to use for a Level-3 project which Jim will talk about later on. So in the long run we could tailor from the generic methodology for other specific applications as needed.

So along with our strategy this shows our end product from this project. The first one is a cognitive basis, also called a literature review report, which is NUREG-2114, and this report is intended to use for HRA, general human performance and the human factors engineers.

The second report is generic HRA methodology. It's intended to use for all applications. And third report is the IDHEAS methodology, specific for internal, at-power events.

So I think for today's presentation I will focus on the delta, what we have progressed in 2013. So in the cognitive basis part, we had the report externally reviewed and thoroughly revised the report. We think we are close to the final publication in that report.

The generic methodology is still in the development stage. So for 2013 we made some expansion of the cognitive basis to cover the full applications and the major work was in the development of the quantification model and we also develop an HEP worksheet and piloting with SAMGs.

And for the IDHEAS method, we completed expert elicitation of the basic human error probabilities in the method and the report was also externally reviewed and we revised according to the input from expert elicitation and the external review. We also conducted some initial testing of the method.

MEMBER REMPE: How did you pick your external reviewers? Are they domestic, international or everything?

MS. XING: Yes, we had actually four reviewers, two domestic, two international, and three of those four reviewers have more than ten years' experience in HRA practices.

CHAIRMAN STETKAR: Had they been involved in the project on an ongoing basis or were they completely independent from the project?

MS. XING: They were completely independent. None of them were in the project.

So for the FY14, for the cognitive basis report, as we said, we're close to publish the final report. For the generic methodology, we need to conduct expert elicitation of the HEPs and test it. For the IDHEAS methodology, we did the initial testing but we like do more formal testing of this method.

So this just tried to summarize, to show you we did some work since 2007.

MEMBER SCHULTZ: Jing, excuse me. On the last point there, the external review of the IDHEAS method, is that the same team of external reviewers or is it a separate program to review the last document, the internal events?

MS. XING: You mean compared to the first report?

MEMBER SCHULTZ: Yes.

MS. XING: There were two separate reviews.

MEMBER SCHULTZ: Okay. And both of those reviews were done this year --

MS. XING: Yes.

MEMBER SCHULTZ: Last year.

MS. XING: And actually one reviewer reviewed both.

MEMBER SCHULTZ: Okay. Thank you.

MS. XING: This slide's, I'm not go into the detail. Just tell you, good news. Since 2007 we made progress in every of these boxes. So we have IDHEAS to address the multiple method issue and we have improved the guidance to address the use of method. We have generic methodology to cover the broad application scope. We have cognitive basis report serve as the scientific basis and we have the SACADA and the Halden database in the future hopefully to provide empiric data for HRA. So any questions on the overview?

MEMBER RAY: You list the contributors on the second slide. How has it managed the joint effort?

MS. XING: We have very effective boss there and we work together.

MR. PETERS: I'm not certain I totally understand the question. What was the question exactly?

MEMBER RAY: Well, things can be established so that you have input from various parties or you can bring people together and say we're going to produce a joint product. You know, we have to arrive at consensus to do that and until we do -- whatever we produce is something that we all agree upon rather than just input to the NRC in this case. You know, which of those models are we talking about here?

MR. PETERS: The funny answer is yes. And what happened the beginning stages was they had a team of experts that were working on the international benchmarking study.

Based upon the preliminary results they got from the study back in the 2007/2008 time frame, this large group of international and national stakeholders made a determination that they saw significant weaknesses in all their methodologies.

And with that large team of all those people that were on that board almost, I mean there were a couple that were added there after 2008, they all decided that the particular path forward should be a new methodology which takes bits and pieces from the existing methods, trying to take those strengths and getting rid of the weaknesses.

How the team organized to begin with was that the team as a whole tried to develop a consensus on each of the particular pieces of the methodology as the project progressed. And when you had a team of, I don't know, 15, how many people are on that list? Fifteen people?

MS. XING: I think initially the team started about 20 people.

MR. PETERS: About 20 people. When you try to get a consensus amongst 20 people on every technical detail of an HRA methodology, you pretty much are proceeding very slowly down a path to failure and also you create kind of issues among some of the personalities of the team.

But over time the team actually shrunk significantly down to a group that could work on the issues, and also once Jing took over the project management, she was able to divide out the labor on a particular effort.

So the answer was yes. At the beginning the entire team was trying to reach consensus on each of the pieces of the methodology, which created a very slow process. And towards the end, we actually had to whittle it down and take on bits and pieces for each particular member to tackle.

And so what we've done since then, in the last couple months the actual generic methodology was purely an internal team only because we were on a very tight time frame. We were on about a three- to four-month development window to get this generic methodology out the door so we could split the Level 3 project.

So the generic methodology in itself is only developed from our internal NRC members and the next plan will be for the industry to take a look at it, provide their comments and feedback.

We had to get something on paper now for the Level 3 project and once we do -- we do have that draft methodology now ready for the Level 3 project. Now it's time for the rest of our team members to take a look at it and start poking holes in it and seeing what we need to improve.

MEMBER RAY: Thank you.

MR. PETERS: Sorry for the long-winded explanation.

MEMBER RAY: No, no, that's --

MEMBER SCHULTZ: But just to pursue it one step further, the way I heard you is that these are the individuals that have contributed over the last ten years to the project?

MR. PETERS: Yes, over the last, yes, seven.

MEMBER SCHULTZ: Roughly.

MR. PETERS: Yes.

MEMBER SCHULTZ: Okay. And some subset of them have been working on the different bubbles that we've seen in the slides --

MR. PETERS: That's exactly right.

MEMBER SCHULTZ: -- in 2013 and not everyone is active right now. 2013, not all the contractors were employed on the project that are on the list here, like Sandia and INL.

MR. PETERS: Yes, pretty much the Sandia and Idaho contracts finished here around September 30th of 2013.

MEMBER SCHULTZ: Okay.

MR. PETERS: So all those team members were involved in the development process of the Level 1 at-power IDHEAS method and were partially responsible for the generic methodology. But since September 30th, we've been doing it in-house exclusively.

MEMBER SCHULTZ: But you still consider this as the general team that's pursuing this project going forward?

MR. PETERS: Yes, I mean and we may in the future have more contracting resources. Of course, we've been part of sequestration and everything else too. It's not just that we had too many people on the project. I guess we had too much money so that was taken away too, so --

MEMBER SCHULTZ: Okay, that's fine.

MR. PETERS: So, anyway, more money should be coming here in 2014 and we may be able to get some more --

MEMBER SCHULTZ: And the next presentation is on the review, so the reviewers are not on this list.

MR. PETERS: The reviewers are not on that list. That's correct.

MEMBER SCHULTZ: Thank you.

MS. XING: Thank you, Sean. And I'd also like to make an explanation to the process of how we achieve the consensus. Looking back this project, it was, like, the first two or three years we were using an unconstructive expert elicitation process, which means every individual topic we try to achieve, try to make everyone agree up on something. It was very difficulty because everyone is an expert in his or her own area so we spend lots of time in debating, exploring.

But that time was very valuable because in that process we kind of explored all the possible success and failure paths for where we should go with this method.

And in the later stage of this project, we used more like a more formal expert elicitation process, which means the individual members propose their ideas, their opinions and the team has, several central contributor of the team, the most experienced expert, they work as the integrator to integrate or evaluate all the input from the bigger team and make a decision where we go so that will make the project progress much quicker than for us to stay here.

Any other questions?

MEMBER RAY: While he's doing that, there is a question now. I want to add to the first discussion.

CHAIRMAN STETKAR: They can multitask.

MEMBER RAY: Well, I'm not sure.

(Laughter)

CHAIRMAN STETKAR: I'm sorry. I'll be quiet. You're right.

MEMBER REMPE: Collect more data.

MR. CHANG: There was three data points.

MEMBER RAY: I want to ask a question on what's been presented because I finally recognized it. There's an observation that there's very little data. It was the last bubble on the last slide you had up there. That's why I didn't react to it in time.

MS. XING: Okay, can we use --

MEMBER RAY: No. I'm sorry. It happened to be the slide that you had on the screen just before you moved off. It wasn't that one. There was a bubble over on the right side.

MS. XING: The bubbles? Okay.

MEMBER RAY: Yes, and it said --

MS. XING: Like this one?

MEMBER RAY: -- empirical data and then it said there was very little. Okay? Am I communicating?

(No response)

MEMBER RAY: So the question is that sounds odd although I assume, when I look at that, that that really means very little empirical data that meets the criteria that's required for this work that you're doing.

Of course, there's an enormous amount of empirical data about human reliability. It's just not in the form you need it, with the precision and the rigor and the discipline that you need it to be in.

It happens that we're at this point in time talking with staff generally about research topics, one of which is operational experience. Is there something about the operational experience, which there's tons of and it grows all the time, that ought to be addressed in a way that would make that data more useful to what you're doing?

MS. XING: Yes. Actually we've been working on that from two aspects. One is we had a project, which Jim is the project manager, to develop a database which is to capture the operator simulator data for HRA use.

And we're also working with Halden to develop a Halden human performance database which has more captured the experience and the lesson learned in their simulation.

MEMBER RAY: So this would be simulator derived and I can understand why that --

MS. XING: Yes.

MEMBER RAY: -- would be more useful to what you're doing. I was sort of puzzled by the fact that Halden seems to be the place to go to get these data and it suggests to me that maybe it becomes parochial at some point and not representative of what you're trying to achieve. Well, those are just observations so I guess I'll --

MR. CHANG: Yes, this is Jim Chang, sorry. Let me answer that question. For operation experience, the test and that's primarily that database was going back, looking at the NRC's open inspection report or the licensee report.

And then from there analysts go in to read that report and then try to extract the human performance information into that database and the operation experience for doing that -- in terms of data units quite expensive. We have two INL staff spend one and a half month to put one event report into the data.

MEMBER RAY: Yes. No, I can understand that. No, that's why I understand that using the simulator data might be more accessible --

MR. CHANG: Yes.

MEMBER RAY: -- than trying to reconstruct all the details of some actual operating event.

MR. CHANG: Right, yes. And, okay, so there was -- because operation experience give us not quantitative but qualitative quotient that we know the context.

And then in the past what we tried to do was when there's event that the NRC send the inspection team we'll try to go with the inspection team but that didn't happen. That happened so quick and then that we are not able to accommodate that kind of arrangement.

The other thing that in the simulator data now we more for quantitative purpose, now we are more focused on the simulator data, that we talk about the SACADA data.

Now we work with South Texas Project, for them to know that they are offered training data into the database. And this past year we have five years extension of the agreement with them for them continue to load.

And in the past year we also outreach to the other plants. Nine Mile Point was this fall, going to STP to see how they enter data. They adopted the database so this is the way that we have enough data to give us some statistic indication for some of the things that type of activity. But we can have data that do support certain range of the activity we are analyzing.

MR. PETERS: And I'd like to raise one more item. The operational experience data gives us a decent qualitative level of input. It tells us qualitatively what can happen, how it can happen.

But the one down side is it doesn't give us success. So when you do that HRA, you need the failures and you need the number of successes when you're looking for those human error probabilities and we can't get that from operational experience because people don't document when they successfully perform their actions. And so the only place that we've been able to find to get that is through the simulator trials.

MEMBER RAY: Yes, I understand that.

MR. PETERS: Yes.

CHAIRMAN STETKAR: And that's really important. Yes, we learned that lesson 35 years ago when people spent enormous amounts of time going through LERs to say, well, this failure of that valve was because a bolt was loose so we're going to put it in the loose bolt little box in a spreadsheet and then people made up numbers about what would go in a denominator.

So in terms of quantifying failure rates, the enormous amount of effort that was spent looking at failures without thinking about the ultimate use of or the needs of the data in large part was wasted.

Now, in human reliability you're exactly right, that the real benefits of looking at the operating experience are not in the sense of data, and I don't like to use the word data because that typically implies numerical.

It's looking at the causes for human failures and examining those critically within the context of the psychological framework that's been developed to get a much, much better sense about really under different types of activities what are the most important influences? What does that operating experience show us? That gives you confidence in that psychologic basis. It really doesn't tell you anything about, you know, is it 10^{-2} or 10^{-200}?

So that is an important point, Sean, and that's why at some point, you know, spending whatever you said examining one event and subdividing it and classifying it, you know, you quickly reach the point of diminishing returns there. You're probably well past that point already.

MR. PETERS: And we're more than happy to have Halden spearhead that effort because they have a lot greater resources than we have to go at the problem.

MS. XING: Yes. In fact, in the development of the method, we have used lots of operational experience and lesson learned.

A particular thing I'd like to point out was in our expert elicitation process, although the main purpose for that was to estimate the HEPs, the expert, you know, our group who most of them were either analysts or former operators or trainers, they provided lots of their operational experience, their lesson learned, as the input to support our model so that was a very valuable input.

And I also like to say in term of use and data, one issue that's use in data as we talked earlier, here we have some data but we cannot plug them into the existing HRA measure because the format are different.

So in the recent effort, we have this method development project side-by-side with the database project, so the SACADA database and IDHEAS method were both based on the same cognitive foundation.

So at least we know in the future the data from the SACADA database can directly fold into IDHEAS method to improve the HEPs. That's what we're looking forward to in the next couple years.

CHAIRMAN STETKAR: We do have to be a little bit careful to manage the time because we have a ton of material to get through today and --

MS. XING: Okay.

CHAIRMAN STETKAR: So I know that none of the

Subcommittee members have a life but you don't want to be here 9 o'clock tonight, so be a little bit aware of the time management here so we make sure we cover all of the topics in a reasonable amount of time.

MS. XING: I guess if we run into a time issue we can always jump to the summaries slide.

CHAIRMAN STETKAR: No. No.

(Laughter)

CHAIRMAN STETKAR: That option does not exist.

MS. XING: A quick pass. Okay, so let's move to the next topic. Part 2 is building a cognitive foundation for human reliability analysis, so that's our first product here. And this, actually we have put it in the format of NUREG-2114.

So since we reviewed this project in April 2013, I am confident that you remember literally everything we talked back then, so today I will only give a very quick overview of the structure of the database just to refresh your memory and then give you a summary of our external review.

And if we still have time, I can talk our major revision to the draft report we read before which is the Teamwork chapter. That's where we got most comment from the review and we made a lot of revision to that chapter. Okay, I don't need to talk this again. You know what this means.

So basically this is the structure underlying most of the HRA method. What we tried to do in the cognitive basis is to make the blurred box more explicit, to go inside to find all the mechanisms and each of these cognitive functions and establish the links between the mechanism, PIFs and the task.

That's what we've tried to do in the literature review. So the goal of the literature review, first goal is to identify the cognitive mechanisms underlying those nuclear power plant tasks.

And also we tried to identify the factors that influenced human performance, sorry, there's typo here, and identify the way in which those factors affected failure.

And we put those information together to develop a structured cognitive framework that can serve as a foundation for human error analysis.

So this is a cognitive framework, the high-level framework has been used by all the HRA method. You have the PRA event. You identify the human tasks in that event and those human tasks are achieved by these four major cognitive functions and the teamwork binding the functions together so we're all familiar with this.

And the cognitive basis we are developing is try to get more detailed information to that high-level framework so we try to identify the scope of a cognitive function in the nuclear power plant control room tasks. What objectives the functions try to achieve?

So you talk about detection. What exactly mean by detection? The objective would be, okay, I do monitor. I have that information, so those are what we mean by detection.

And then the cognitive mechanism try to understand how humans perform the function and what make the human reliably achieve the function?

And then look into how the cognitive mechanisms may fail. From there we can look at what performance-influencing factors would lead to these failures.

CHAIRMAN STETKAR: Jing.

MS. XING: And I wouldn't --

CHAIRMAN STETKAR: I was going to ask you on the last slide but, no, bring up the little picture because I like the little picture. I love these pictures.

I wanted to ask you something. I actually read the summary of the review comments and I'll be blunt. Except for the changes that you made in the teamwork area, which I think in general are quite good, I liked the report a year ago better than I like the report today because I find today's report more difficult to understand than the report a year ago.

And people hang up on words and syntax and what I wanted to do is point out the darker blue boxes here. You've now changed something that used to be called a proximate cause to something that's called a cognitive failure.

So if I now read the report, I have many parts of the report that talk about failures, failures, failures, failures which, for me, is really, really confusing.

And then I go to the generic methodology and it uses a different syntax. It talks about failure modes, failures, failures, failure, failure modes, failures, failures. I believe that the original authors of this report developed a specific terminology for a particular purpose.

We suffered from this, again, 35 years ago where people couldn't understand the distinction between functional failures, failure modes, failure causes, failure, failure, failure.

Everything was a failure so everything got dumped into a box of a failure and when people collected information they fought among themselves about what failure box. Well, is this a failure? It's not a failure, but it's called a failure.

So the question is, one question I had as I read through this, why did you change that terminology?

MS. XING: Okay. So we changed that terminology for several reasons and from the peers, the external reviews as well.

CHAIRMAN STETKAR: Okay, I didn't really see that comment in the peer review so I didn't read anywhere that said I don't understand what a proximate cause is. You should call it a failure. So why did you make that change?

MS. XING: Okay, that was a decision made actually before the external review among our team. When we tried to apply these proximate causes into the IDHEAS method --

CHAIRMAN STETKAR: Thank you for putting that on the record. One does not change research to fit a particular proposed model of a process, which is what you've done. One keeps the research as research. If the model is deficient, that's the model's process. Let the modelers adapt to the research, not vice versa. One does not go in and change the results of an experiment in a laboratory to fit someone's goofy model of the way the process should work.

MS. XING: In this case --

CHAIRMAN STETKAR: So and in many cases you've changed subtly this very good research report to make it sound more consistent with this proposed, and I will say proposed, IDHEAS methodology.

And I fundamentally disagree with that as an individual. This is a Subcommittee. That's my opinion. I think it reads a lot worse. I think that you've made many of the points more obscure.

I think that you've introduced much more of this what I'll keep calling procedure-centric view of the world into this really good research report because you're trying to make the research sound like it's more consistent with someone's proposed methodology.

And I would very strongly encourage the staff independently, no one who's been involved in this process because they're all married to a particular goal, to go back and read all of that stuff, and especially the original authors of the report because I think that you've subtly changed some of the technical content to the point where it's actually more confusing than it was a year ago. And I'll stop there.

MS. XING: Yes. First of all, I completely agree with you. You shouldn't --

CHAIRMAN STETKAR: Yes, and part of the

thing is don't be so agreeable to everyone.

MS. XING: I understand.

CHAIRMAN STETKAR: Okay? Don't be so agreeable.

MS. XING: No, I really don't --

(Laughter)

CHAIRMAN STETKAR: You cannot accommodate everybody. You cannot accommodate all of the researchers who will say the research is never complete, is not complete.

You cannot accommodate someone who has a particular world view and a particular methodology that says, well, can't you call this a failure because that will fit my little model and the terminology I've used in my little model? Don't be so accommodating.

MS. XING: Thank you. I appreciate that encouragement. And, in fact, we don't need to stick to this, the particular detail or reason for this term change.

But the overall plan was now we have the three reports and, as we said, the cognitive basis is the foundation. So towards the end of this project, I mean actually before we publish the cognitive basis report, as the project manager I, like, work with some external person, with the discussion. Let's look all this three report together. And first we fix with right terminology we needed in the foundation report there, modify, unify the terminologies of the two reports.

CHAIRMAN STETKAR: And I'm glad you put it that way because I still, I mean the last meeting we had a year ago, I went back through my notes and the transcripts and the meeting minutes and at that time there was, I won't use the word consensus because Subcommittee meetings, we just represent our individual views, but I think we gave you pretty good feedback on the cognitive basis report, that it was nearly ready for prime time. You said you had to do a little bit of work in the teamwork area because that obviously was the area that was still under some development.

And I was surprised as I read through the new version the number of changes. Now, if you look at the changes, there are words here. There was words there. There's parts or paragraphs deleted. But if you look at them in total, they've changed the sense of several of those sections and that's a bit troubling.

MS. XING: Okay. Maybe we can talk more later on the agenda items.

CHAIRMAN STETKAR: Yes, yes. And part of this, the reason I bring it up is the SRM was written to the ACRS so in some sense we're not sitting here as disinterested, I won't say disinterested, interested third parties providing review comments. We're as involved, at least from the Commission's perspective, as the staff is in this whole process and that's another one of the reasons why I think it's important to get the full Committee on board and get some feedback but just take that --

MS. XING: And that perspective is very important because, to myself, regardless what terms we use, I know what they means.

CHAIRMAN STETKAR: Yes. But the problem is the terms are important. The terms are important because you find out as you go forward that, for example, the methodology, which we'll get to, uses a different set of terminology.

So, for example, if I look at the methodology report, I can't understand in many cases where parts of the methodology link into this framework. I honestly can't. I've tried. And if the same terminology was used, an avoidance of the failures of the failures of the failures of the failures, because as soon as you put failure in there, then I don't know where I am on this nice pink-to-purple progression.

MEMBER SCHULTZ: We don't have a color copy.

(Laughter)

CHAIRMAN STETKAR: Yes, but we have it in front of us here.

MEMBER SCHULTZ: I don't mean to make light of it.

CHAIRMAN STETKAR: No, it's --

MEMBER SCHULTZ: I totally agree with what John is saying and this consistency, especially in this area in terminology, the consistency in terminology, it's just extremely important.

CHAIRMAN STETKAR: It's a rigor. It's --

MEMBER SCHULTZ: It is and remember what the team has set out to do, and that is to create a fundamental basis and, in fact, leave behind, I think, you know, many of the other methodologies that have been developed. Leave it behind.

Develop the fundamental concept, develop a fundamental model, a generic model is what we're terming it, a generic model from which other subset models can be developed. Consistency in terminology is fundamental to execute that process.

MS. XING: Thank you. In fact, we received the very same comment from our human factors reviewers of the report --

MEMBER SCHULTZ: Of course.

MS. XING: Amy D'Agostino sitting in the

back. She wrote consistency is critical. Consistent in terminology is critical in this project. And I think that also the way we structure the product of this project provides a good opportunity for us to unify and clarify the confusing terminologies in the field.

CHAIRMAN STETKAR: That's exactly right. You'll receive, and you probably already have, comments from, you know, the world. Everybody has their own notion. They understand in their own mind what a squiggle is. You don't understand what a squiggle is. They understand what that squiggle is.

They don't have the right to introduce the term squiggle into your methodology. They have to explain how a squiggle interfaces with this framework and they have to use your terminology. That's incumbent on them.

If they can't do that, then they haven't thought through either their approach or your approach well enough to have a valid comment, and that's another reason why this consistency in terminology and avoidance of conflicting terminology is really, really important.

As you know, if we took a poll of 1,000 individuals, each one would admit that they know nothing about human reliability but they will all claim that they're an expert. And they all have their own terminology, they all have their own world view so it's important to do that. I'm sorry. We'll go on.

MS. XING: I understand and appreciate the encouragement. So we'll take a quick look at the external review process and the results.

So we have four reviewers completed the review and provided written comment. Initially we identified eight reviewers and four of the reviewers did not have time to give us written comments.

MEMBER REMPE: So your table you sent out prior to the meeting said there were six that you sent the report to and only four turned it in, and I was just wondering, was this a volunteer effort?

MS. XING: It's a volunteer effort.

CHAIRMAN STETKAR: Yes.

MEMBER REMPE: Oh, okay.

MS. XING: Okay.

(Laughter)

MEMBER REMPE: That's a little different then, when you pay a reviewer and what you get back.

MS. XING: So they all used their spare time to do this.

CHAIRMAN STETKAR: Well, and this is not necessarily the easiest document to walk through. I mean it really takes --

MEMBER REMPE: Absolutely, when you volunteer your effort here.

CHAIRMAN STETKAR: It takes a lot of effort and thought to really work your way through this and understand it to the point where you can even provide reasonable feedback, so it's not surprising you only got feedback from four people.

MEMBER REMPE: Sometimes, though, you get what you pay for in life. If it's free effort but, anyhow, just a comment.

MS. XING: Actually, by the time we did the review, we were out of project money so you probably noticed that many figures in this report hadn't changed, mainly because some figures were produced by our contractor. The contractor terminated so I don't at the moment --

MEMBER REMPE: It's illegal for contractors to do things for free.

CHAIRMAN STETKAR: I was going to say thankfully, from my perspectives, the figures didn't get changed.

MEMBER REMPE: Okay.

MS. XING: So I wasn't able to break down those figures to change them so that's the effort we will do later on.

So we have two domestic and two international reviewers. All have 20 years plus experience in cognitive engineering research and applications and three reviewers actually have experience in developing human performance models.

And I have to say these are the top experts in the field and the three reviewers have experience in HRA so we think we got a fairly good representative set of reviewers.

I don't know if you want to read this wordy slide. Because it's a 300-page report and people doing this on the voluntary basis, so we asked them to focus on the knowledge gaps in the report and also focus their review on these key questions, like whether the approach is right and whether the method generate new information or useful information for HRA and, professionally wise, does the approach offer new knowledge which is different from what we have now and how the approach provided, whether it has a coherent strategy to understand human error.

Three reviewers actually answered this question. One reviewer developed his own question and answered his own questions. So --

MALE PARTICIPANT: Geez.

MALE PARTICIPANT: You get what you pay for.

(Laughter)

MS. XING: Should I give you one more minute with the questions?

CHAIRMAN STETKAR: No. No, that's okay.

MEMBER BALLINGER: He had to be a faculty member somewhere.

(Laughter)

CHAIRMAN STETKAR: Yes. Spherical chickens come to mind.

MS. XING: Well, we have lots of comment. I tried to summarize the comment that at least two or three reviewers have in common.

So in general, the report provides a thorough literature review and can serve as a technical foundation for HRA. All the reviewers agreed upon this.

And the literature review conducted for each of the macrocognitive functions provide a broad coverage of relevant literature and a good synthesis of the key points related to human performance and human reliability.

And the review covers the major cognitive mechanisms that can be relevant to the nuclear environment and the links of this mechanism to the performance-shaping factors, so these are the positive side.

And the reviewers also pointed out the report is limited to its intended scope, that is in the very beginning of this literature review we didn't have the generic methodology in mind.

Therefore, the literature review was very strictly focused on the kind of cognitive mechanisms or the kind of tasks needed to support the procedural internal event in the nuclear power plant control room.

CHAIRMAN STETKAR: Let me ask you about that because I'm a bit troubled by that fourth comment and I'm a bit troubled about the way that you tried to address it, I think, in the report.

Did the reviewer have specific examples of why they believed that the framework was limited and focused specifically on these types of activities and do you have those examples?

MS. XING: Yes, I can give example. First, in the last April's meeting I point out those areas where the literature review did not cover the limitation.

And for the current examples the reviewers pointed out, number one is distributed decision making. There's a large amount of literature there we didn't cover. And another example there is in the teamwork area.

CHAIRMAN STETKAR: Kind of a --

MS. XING: Like the leadership, the

cooperation, those things were barely covered in the --

CHAIRMAN STETKAR: Barely? The thing that concerns me is, again, I'll step back and, again, in my personal opinion, I really like the cognitive basis report. And other than the fact that the words that are written in the report, which I believe in many cases were written in the report as a reaction to the proposed model IDHEAS, it's not clear to me that that report is as limited as may be inferred by the words in the report or by that comment.

In other words, the report comes back and says, well, we have good procedures. Well, this applies to nuclear power plant control room activities where the operators are well trained.

The report says that in words but it's not clear to me that the fundamental framework, the performance-influencing factors, the cognitive mechanisms, the proximate causes and the macrocognitive functions, including however you treat teamwork, is necessarily limited to that very focused snapshot of the world.

So I'm looking now, rather than an academic research where you can never do enough research, I'm looking for specific examples that says this methodology or this framework is faulty because it cannot handle these types of cognitive behaviors. And you mentioned distributed decision making. That might be one area. Might be one area.

But many of the other types of activities -- if I think of, for example, ex-control room activities, trying to coordinate a bunch of people running around a nuclear power plant trying to respond to some sort of an event, which is certainly not control room, it might not be procedure driven and it might not necessarily be performed by the best-trained people in the world, at least in terms of licensed nuclear reactor operators, it's not clear to me that I would need a different framework or additions to the framework to handle that.

So I'm a bit curious about that because as I read the report now there have been subtle qualifications inserted into the report, I think in response to this, to say, well, just remember, we're only looking at control room, procedure-driven things. That's all we thought about in the research. And I'm not sure that the researchers actually limited themselves to that.

MEMBER SCHULTZ: I don't think so.

CHAIRMAN STETKAR: I don't think they did.

MEMBER SCHULTZ: Because if you read the first three comments taken as they're stated here, the fourth comment is surprising.

And if the report has been changed to reflect the fourth comment, to solidify the words in the report to reflect the fourth comment, to reinforce the report to meet the fourth comment, I think we're going the wrong way because the original intent, I thought, was to develop the approach that would match up and induce the comments 1, 2 and 3, a thorough review, an approach that is generic and meets up with what one would want to do in evaluating human performance and so forth, not to meet the objectives of general comment 4.

MS. XING: Okay, so let me see if I can answer your curiosity in this. Let's talk about the, give a little bit of history, how we started the literature review.

When we started the literature review, the overall framework was there. You know, we know we are going to, these were cognitive functions. We're not going to change that. Nobody will argue with that.

And for the first function, the detection, it cost our team, a team of five people, spend a half a year, well, they don't full time work on this but, nevertheless, spend six months and wasn't even got into one third, a quarter of all the possible cognitive mechanisms that are in the detection domain.

So the team was very troubled. Like in this, one, we can never complete this literature review. This is just one function. It's been six months. We are still far away to a good coverage. Two, even we had a good enough coverage, there's million pieces of information. How to organize them? We couldn't establish the link.

At that point we made a decision, or strategy let's say. Since our goal at that time was to develop this basis only for the IDHEAS method that was for internal procedural event, we said, okay, before we dive into this million pieces of literature, let's first understand the scope of detection function within the control room.

Like when you talk detection, if you go through cognitive literature, you probably can comfortably identify 20 or 30 generic tasks in the detection domain, for example, monitor and catch information, motion information detection, color detection, weak picture, you know, there's many of these things.

CHAIRMAN STETKAR: Those are tasks though. Come back to terminology. Those are tasks.

MS. XING: Yes.

CHAIRMAN STETKAR: I must recognize that that light flickered. However, noticing is a cognitive mechanism, I believe, that's identified. It's not a task. Don't confuse tasks about how I need to get to that door, I need to move my left foot, my right foot. Sure, you can identify all kinds of tasks.

The question is what about the list of proximate causes, cognitive mechanisms and performance-influencing factors is lacking because of a presumed focus on actions in the control room that are driven by procedures performed only by well-trained people? What did you miss because you focused on that?

MS. XING: Yes. That's cognitive mechanisms. Let's say, suppose we have 20 different type of generic tasks for detection and we could identify totally about 100 cognitive mechanisms in the detection area to support those and in our report we only choosing a subset of cognitive mechanism which would sufficiently cover these tasks related to the control room situation without putting all the 100 or 200 mechanisms there.

So have said that, I would say all the cognitive mechanisms or everything we identified in this literature review is applicable to all human actions, so in this directions it's not like this mechanism only for control room. Doesn't work for all control room.

CHAIRMAN STETKAR: Good.

MS. XING: It's however the limitation is.

The set of the mechanism we put in the literature review is only a subset of everything has been reported in the literature. If we report everything, it will be too much.

CHAIRMAN STETKAR: But, I'll come back to an original. People who get paid to do research will say the research is never finished and that's just a given.

If, indeed, you've subjected this literature review and the framework to a broad set of independent reviewers, qualified independent reviewers, and you receive feedback from, let's say, 100 people and each individual says, well, you didn't consider my pet squiggle, say, well, we think we did if you can explain what a squiggle is. You know, how does your squiggle not fit into this framework? Because each of them have their own terminology, each of them have their own little area of research.

And what I'm asking you is from your understanding of what was done in the literature review, in the development of the framework and your exchanges with reviewers and other people on the project -- the statement that you made that the cognitive mechanisms and performance-influencing factors that are listed in this report, in the framework, would apply beyond the control room is a good statement.

The question is if I now look at someone needing to respond to an event -- let's say it's a firefighting crew, fire brigade that has some operators and some security people and they need to decide what to do out in the plant and the phone lines are down and the radios aren't working.

What about their thought process, about do I put foam or do I put water or do I let the fire burn out or what do I do, what about that process is not handled in this framework? I mean that's my actual -- because that is a scenario that is involved in the PRA. This methodology should be able to handle that scenario.

If you can't handle that scenario, the methodology and, indeed, the literature search is incomplete because we do have fires in PRAs. We do have floods. We have seismic events.

We have conditions where communications have broken down, where you do have people outside of the control room who may not necessarily be as well trained as the licensed operators processing information, making decisions and deciding to implement certain actions, which may or may not be the appropriate actions.

So that's why I'm challenging you, because I think in many cases you may be putting too many caveats in the report to try to make every reviewer happy without challenging either the reviewers or yourselves to understand whether or not a comment is, indeed, valid, especially in the areas of limitations and incompleteness.

As soon as you write a report that says it's incomplete and it's limited, it's very easy for people to say, well, obviously this doesn't apply to my example because I'm not in the control room, I don't have procedures, I don't have necessarily well-trained people. Half of my fire brigade is made of security people or people I grabbed off the street or whoever.

So you need to be really careful about that, and that fourth one is really troubling if it's well grounded. If it's not well grounded, dismiss it.

MS. XING: Yes. Well, thanks for that comment. Good thing we haven't started writing the abstract for this report. I believe I will make this part --

CHAIRMAN STETKAR: Do you understand, Sean? It's --

MR. PETERS: I exactly understand what you're --

CHAIRMAN STETKAR: You can't be arrogant in a research report but you can never satisfy every reviewer either.

MR. PETERS: Exactly. And what I'm hearing from your read is you didn't see major holes where it couldn't be applied in particular areas.

CHAIRMAN STETKAR: You know, but this is not necessarily my area of expertise. I didn't see any. I thought about many, many different conditions that I can think of in a nuclear power plant setting outside of the control room, actions that are coordinated.

I mean, as I said, the fire brigade example is one example and I didn't see any of those examples where I couldn't use the fundamental principles in this document to evaluate performance in those scenarios.

MS. XING: Let me ask --

CHAIRMAN STETKAR: Even the extent of having an emergency operations facility three states away manned by people who have, you know, degrees in law and economics rather than engineering could, indeed, be evaluated, perhaps not as well because that's part of this distributed decision making.

MEMBER SCHULTZ: What bothers me about the fourth statement is the word "limited." I'm just reading it over again and seeing how things followed out.

If the fourth statement had read the report focuses on those mechanisms and factors influencing human tasks in the control room and trained crew, I'd feel comfortable that that's one, two, three, four and does not make a statement that one, two and three are wrong. You've done what you've set out to do. There is no limitation. There is a particular focus.

CHAIRMAN STETKAR: It's not even clear to me that it's focused. Many of the examples --

MEMBER SCHULTZ: That's true.

CHAIRMAN STETKAR: -- in the report are derived from that experience.

MEMBER SCHULTZ: That's right.

CHAIRMAN STETKAR: You know, they're anecdotal phrases that said, well, look, in the control room, here's how operators in the control room do this.

MEMBER SCHULTZ: Demonstrate how the generic and --

CHAIRMAN STETKAR: Fine, you know.

MEMBER SCHULTZ: -- cognitive approach can be utilized.

CHAIRMAN STETKAR: They could have equally put in examples of how people not in the control room do this except it was just easier I think because of the personnel involved in the project to pluck those examples.

MEMBER SCHULTZ: And it doesn't mean it's limited.

CHAIRMAN STETKAR: It does not necessarily mean that it's limited. It doesn't necessarily mean that it's limited. If it is, I'd like to better understand --

MEMBER SCHULTZ: How we got there.

CHAIRMAN STETKAR: -- how it is limited and where it is limited because it's not clear reading if there is a fundamental gap.

MS. XING: Actually I really like your suggestion. I, myself, did some analysis and there, like, we're talking two things. One is not applicability of this knowledge. I think it was wrong to say it's limited to control room only because this knowledge is applicable to general human performance.

But the second issue is the coverage or the completeness, but this knowledge covered all the major things, to all applications.

CHAIRMAN STETKAR: Right. Right.

MS. XING: As the leader for this effort, I know we have some gaps.

CHAIRMAN STETKAR: Those gaps don't necessarily, I think there's a couple of sentences, you know, where, for example, distributed decision making, I think that that is an important message to make very clear in the report.

If there are known gaps, make it very clear to the reader that the presumption is that this is universal except we know very explicitly that it does not address the following issues.

MS. XING: Yes, I agree. We should --

CHAIRMAN STETKAR: It's a much different perspective.

MS. XING: Yes. I added a paragraph in most of these chapters, tried to point out where are that gaps. I think I should make that part more clear elaborated.

CHAIRMAN STETKAR: Well, as I read those, in many cases there was too much emphasis on the words procedure and control room. You know, rather than saying this is a fundamental issue that we did not address, in many cases it's written, it says, well, just remember we focused on procedures in control room and trained operators which is not clear, to me anyway, that that, indeed, was the original intent or is a valid limitation.

Just take it, you know, we need to move on here but think about it from that perspective.

MS. XING: Okay.

CHAIRMAN STETKAR: Because as Steve said, as soon as you say this is limited, which it is. I mean there will not be universal agreement that it's addressed everything.

But the key is what salient features of the cognitive decision-making process are not addressed that might have relevance to the types of activities that we evaluate in a risk assessment of a nuclear power plant? Not personnel performance in the control room for internal events that are driven by procedures, but in a risk assessment for a nuclear power plant.

MS. XING: Okay. Thank you. So I think we have, for the major critiques, we already discussed the first one. Two of the reviewers feel like the limitation they think is the coverage was influenced by the assumption of the IDHEAS method which said for trained operators, fixed team and procedure tasks. So and these are a couple examples the reviewer pointed out as areas that did not covered.

And the second item is about this terminology so we put that as a placeholder. We'll address that later on. This is the failures mechanism, the cognitive failures and a bunch of failures. We try to make better and our team had a problem early with the proximate causes so we change it to cognitive failures.

CHAIRMAN STETKAR: Who on the team?

MS. XING: Our project team, the IDHEAS development team.

CHAIRMAN STETKAR: The modelers.

MS. XING: The modelers, yes. Actually --

CHAIRMAN STETKAR: The modelers should get over their problem with the terminology. That's their problem. It's not the problem of --

MS. XING: In this particular case --

MR. PETERS: I'll quote you on that.

CHAIRMAN STETKAR: You can quote me on that. I'll tell you, you know, I keep coming back to the horrors of simple things like determining what is a failure of a pump?

It took the collective industry years to determine what a failure of a pump was because everybody had a different interpretation of what a failure -- a failure was there was a little bit of leakage from the seal because that was more leakage than was specified in a particular design requirement. So somebody would say that's a failure. You have to count that as failure. Say, well, and you shake your head. You weren't there. I was there.

(Laughter)

CHAIRMAN STETKAR: It took years to develop that and when we finally got people to think about things in a coherent manner, it got a lot easier, okay? Sometimes the people developing a model have to start using terminology that is crisp and consistent with at least a framework.

We face this in a lot of areas. We have another issue where we're looking at digital I&C failure modes. We can't get agreement on what a failure mode is. Once you get agreement on what that thing is, you can now start understanding how to evaluate it. Once the modelers understand what a proximate cause is, then they can probably develop a model that feeds into that thing. Go on.

MS. XING: And in this particular case, the proximate cause was a term generated by our own team. In the very beginning we intended to say, oh, there are so many different causes for failure. Let's group them into a high level called the proximate causes.

Then, as we've done the literature review, we find that, oh, the things we called the proximate causes is not what we intended, a group of the failure cause, but this is the way how this function can fail. So that was the basis and so, okay, it's really not causes. It's describe really how you can fail a function. Thus, we changed it to cognitive failures.

But, again, I realize that creates a new problem. So the best way is we look all the terms separately, try to come up a good scheme and use them consistently.

Okay. So we did some revision, try to

address the comment and some revision good, some worse make it.

So since we're running out of time for this part, I was planning to show you what the major revision would be for the teamwork. I'll probably only talk one slide, give you a sense in that.

So this is the major revision. Earlier we called this chapter is communication and the coordination. When you look at the content, it's mainly talk about teamwork so we realized we didn't have a good definition what is teamwork, how teamwork was related to communication, coordination.

So this part, we went back to the literature, did a lot more extensive literature search on the teamwork region and, in fact, the literature gave a pretty good consensus on what teamwork is.

Teamwork is mainly about these three things, communication, coordination, the collaboration. There large volume of literature from the military research labs which if you do a search you will find that there are three C-model, communication, coordination and the collaboration, so we find a lot of literature in that area.

I forgot to delete this overly complex slide. I just tried to make that simple. So for each of these teamwork aspect, we went through the literature to identify what is the process needed to achieve this, see?

For example, communication is a process. You initiate the communication, exchange information. But that's not the end. You need to confirm the information communicated.

So these are all the new additions we have to the literature review and we identified teamwork mechanisms and this is from the old one.

So, in fact, from this slide you can see every bullet can be a failure mode of teamwork. In the literature review, we only identified these two type of failures, failure of communication and failure of leadership. This was highly driven by the discussion we consider in the internal procedural event.

For example, you don't see much any failure of cooperation here because when we determined the scope one comment was, well, in the control room cooperation's not a problem because they are bounded by procedures.

CHAIRMAN STETKAR: You know, and there -- I'll keep saying this. You say those words. I've been in a control room. No, they're not.

MS. XING: I know they're not.

CHAIRMAN STETKAR: They are not and, in

fact, the literature review addresses that issue. They have procedures. If we look at people who have made errors in the real world, many cases the procedures don't fit or they deviate from the procedures or they need to become creative, at which point cooperation becomes important. Okay?

The operators meeting challenging situations in a control room are not automatons and they do not necessarily follow procedures, nor are the procedures necessarily very well developed for those situations.

So, you know, making statements like, well, we don't need to consider this because the operators in the control room always have perfect information and they always have perfect procedures and they always perfectly follow the procedures, therefore, there's no need for coordination and cooperation, is not true. That's a false statement.

Communication is important obviously and one could, perhaps, infer that part of coordination is embodied in communication. So a taxonomy that includes only communication and leadership, one could probably try to understand how coordination or cooperation, you know, in the sense of distributing tasks among different people could fit into that process, especially in the communication area.

But to just simply say, well, this doesn't apply in the control room because they have procedures is false. I mean we have evidence to show that that doesn't work. H.B. Robinson fire event had procedures. All of the people cooperated very well to miss important information.

MS. XING: So you are giving a perfect example of what we talked early is a limitation of this report. Like, on this slide, this is more generic coverage of what's in the teamwork. And our early literature review end up only a subset of what happened.

CHAIRMAN STETKAR: Right.

MS. XING: So these two things, of course, apply to known procedural severe accident, but there are many things in the process we left out.

CHAIRMAN STETKAR: See, part of the rationale is you can say that you've left something out. We did not address the issues of, it's not very well in this set of bullets but what I'll call collaboration in the sense of Joe adjusts this control while Ralph adjusts a second control while Mary monitors the overall function and they all three of them need to do that in a collaborative method to achieve the overall goal.

You may not have fully captured that in the communication and leadership issues that you have addressed, but the reason you didn't capture it isn't because the people in the control have good procedures. It's you just didn't capture it.

MS. XING: Yes.

CHAIRMAN STETKAR: You follow me? The rationale for why it isn't important is because we're only focusing on the control room and people have procedures is it's a false rationale for that environment also. It's nothing wrong to say we didn't capture this element of team performance, period.

MS. XING: It's not wrong but we should have captured that. That's why we make this, in this chapter we make a revision, try to capture a lot of things that we left out earlier.

In fact, if we have time, I would like do this to every chapter, capture those things that we on purposely left out because our assumption about how the control room works.

CHAIRMAN STETKAR: That --

MS. XING: But this chapter has a major issue. We left out too many things. That's why I made more revision on this.

CHAIRMAN STETKAR: It's not clear to me you left out a lot.

MS. XING: So but at least one thing. If we don't have time to put all those gaps back, at least we, I promise we would clearly point out the gaps at the end of every chapter. Here are some major cognitive elements that we didn't cover in this chapter.

Any questions about this part, or we can go to the --

CHAIRMAN STETKAR: Any members have any questions? If not, I think it's time for a break. So we will recess until 10:25.

(Whereupon, the foregoing matter went off the record at 10:10 a.m. and went back on the record at 10:28 a.m.)

CHAIRMAN STETKAR: We are back in session. We have been joined by the good Dr. Dennis Bley who has finally arrived. If this were Los Angeles, you could use the traffic as the standard --

MEMBER BLEY: I could but it wasn't the traffic but I apologize, everyone, for being late. I do need to put on the record that I have a conflict for some of what's being talked about today from work I perform for the NRC in this area and those areas and make statements of clarification.

MEMBER REMPE: I suppose while we're fessing up our conflicts of interest I have to declare my organizational conflict of interest and I forgot to do that this morning.

CHAIRMAN STETKAR: Should have done that while we were talking about the stuff that your organization was involved in.

MEMBER REMPE: I was quiet during that slide, okay?

CHAIRMAN STETKAR: Okay. We're running a little bit behind schedule but that's okay. Jing, it's back to you on your next issue.

MS. XING: Okay, so we are talking the second part of the product, the generic methodology. Since we are 30 minutes behind schedule, I will not go through every slide in this section but try to give you the main idea of the generic methodology and the progress we did in 2013 but you are welcome to ask questions where you think I need to give more explanation of a particular slide that you would like me to talk. Thank you.

The major requirement we have for the generic methodology is we want it generic enough for all HRA applications.

So this is the HRA process that's defined in the PRA standard and the HRA Good Practices. So the generic methodology was intended to capture every element in the standard practice.

So therefore we have the generic methodology consist of these five parts, a cognitive error-causal tree, guidance for human event analysis, a qualitative analysis structure, a quantification process and integrative analysis. This is how the generic methodology look like at the very high level.

And for today I will talk a little bit about the cognitive error-causal tree, which is the basis of this method, and the quantification process, which is the major progress we made in 2013.

I know we're running into a terminology issue now but let's leave that behind for now. How the cognitive error-causal tree different from the cognitive, the literature review we presented earlier, it basically came from the literature review and we did some expansion in several ways.

One, we did more research to cover some gaps we left in the early literature review. For example, decision making we did more and teamwork, we did more search there.

And also we made the links between the different elements more explicit. For example, in the early literature review, the cognitive basis, we put everything, call everything as the mechanism. So people have been questioning working memory is a mechanism.

Then overload of working memory is also mechanism. So that caused the confusion.

We tried to make a distinction in this error-causal tree if we consider working memory is a mechanism for understanding and detection. Then we identified the error causes to this mechanism, like overload of the working memory. You did not install work memory with sufficient time or working memory faded as time elapsed without being reinforced, so these are the causes so we made that link clear.

And with that link being clear, we can identify the explicit context characteristics that work on those causes so we challenge the cognitive mechanism.

Another addition we made there is we identified the cognitive processes for every cognitive function. When we talk about detection, we identify the source of the literature. How a detection function is performed? What are the basic steps in performing cognitive function? That is important because that is the foundation for the failure model we have later on in IDHEAS. So, again, it's the same high-level framework that works for everything.

CHAIRMAN STETKAR: Jing, let me ask on detection because it's typically the easiest one to talk about, and if you have a slide that addresses this later, then just tell me that.

MS. XING: I don't have a slide showing detection here but you can ask question.

CHAIRMAN STETKAR: In the document, where I keep getting confused and where I lose the flow from the framework is that under the, I'll come back to the framework, under the detection and noticing macrocognitive function which, that you call detection, you've identified five cognitive subtasks, to be aware of information to be required, identify sources of information, perceive information, verify, confirm information acquired and communicate the acquired information.

I understand the communication part is part of the teamwork macrocognitive function there, so we'll set that aside.

It's not clear to me nor can I understand the link among the first four of those subtasks and how they relate to the proximate causes and cognitive mechanisms in the framework.

Was there an attempt to be a linkage or was this just something that you thought, well, these are things people need to do? Because I can think of other things people need to do.

For, you know, perception, there are three proximate causes that relate to perception. They're proximate causes. They're not cognitive mechanisms. It's misperceived, not perceived, and there's a third one that I can't find in my notes here.

I'm not sure what being aware of information to be acquired means. Well, sure, if I have a PRA model and I know that my model says the operator has to do bleed and feed I know that the operator needs to look for certain things. But that's my little model of that thing. That isn't a methodology. So I'm not sure what being aware of the information to be acquired means as a subtask.

Typically if I'm in the control room, I'm sitting there. I'm vigilant maybe. Maybe I'm not. I'm looking around. Sometimes alarms are going off. Sometimes alarms are not going off.

MS. XING: Something --

CHAIRMAN STETKAR: You know, so what information am I aware of that needs to be required? It's just an example of where I'm not clear on how this generic methodology aligns with the framework.

MS. XING: The --

CHAIRMAN STETKAR: Could explain that. I mean maybe have a better example for one of the other macrocognitive functions but --

MS. XING: The quick answer for that, we

tried to establish the links, like for each step in the process, what mechanisms support this process. At this stage I did not choose to put that information into the report because there's a lot of individual subjectivity there so I don't feel it's mature enough to put it there, to put it, like for --

CHAIRMAN STETKAR: How should we treat, then, this 199-page report on the generic methodology?

MS. XING: I do not get that question.

CHAIRMAN STETKAR: You said, well, you decided that you haven't put it in there, that linkage, because there might be some subjectivity involved. The implication might be that, well, it should be in there but I decided not to put it in there quite yet.

If it's not in there, I'm saying that as someone who is working from this notion of a framework to a generic methodology to specialized applications of that generic methodology in that overall hierarchy that you've established, I think it's really important that the generic methodology document provide that linkage to the framework.

Yes, indeed, here's where this element of the methodology addresses these elements of the framework. I'm specifically using element because that word is not used in either document very well.

And here's where in our generic methodology we either decided actively to ignore something in the framework and here's why or here is part of the generic methodology where we thought that the framework was lacking and we added something and here's why. I just didn't get that. I just had these lists of here's a list of subtasks.

MS. XING: Okay, the draft of the report we have now for the generic method is a working draft report which will be very different from the final report. There's a lot of information, a lot of stuff that we are working on which still is not mature enough so we did not put it in this report.

For example, there should be detailed explanation and a real-world example for each step of this cognitive process. Using your example, be aware of the information need to be acquired.

Earlier, like when we thought about in the procedure events, we always assumed, well, you always work in a responsive way. You're seeing a cue or you hear an alarm and you start to go to get information, so you always know what you need to detect. Consider in a severe --

CHAIRMAN STETKAR: You ever thought about a fire? You don't know what you need to --

MS. XING: Yes, that's exact --

CHAIRMAN STETKAR: Because you can have a storm of information, some of which is valid, some of which is invalid, all of which the operators need to process. You don't necessarily know what you need to know.

MS. XING: Yes. That's why in the first step, when you start in a fire situation, first thing, before you actually do a detection, you need to know what you are looking for. You are not try to examine every corner of the control room. You have to start with some mental model in order do detection.

Earlier when you asked me what's the gaps, the left out, that was one knowledge gap we didn't have in the literature review, is when you --

CHAIRMAN STETKAR: Why is it not in the literature review?

MS. XING: We can talk that later I think.

CHAIRMAN STETKAR: Okay.

MS. XING: We don't want to for your time. Because at that time we always start with the assumption, yes, you always respond to an alarm but in reality, like you say, in fire, you -- have a question?

CHAIRMAN STETKAR: I think we have a comment.

MR. FALLON: Yes, if I'm on.

CHAIRMAN STETKAR: Just make sure you identify yourself. You're on.

MR. FALLON: Yes, my name is Patrick Fallon. I'm a SRO from Fermi 2 and I was wondering if your literature search also looked at items like the INPO operator fundamentals because your cognitive function looks pretty close to what they have in terms of monitoring, control and other things like that.

And that's an ongoing program at pretty much every nuclear plant in the U.S., where we gather with our observation programs daily information on gaps to these types of events and monitor that.

Typically in our organization at Fermi, we'll pick up 100 of these observations a week for gaps to proper detection, understanding, decision making and things like that.

It's probably a tremendous source of input for your model if you haven't already done that. It just would involve working with INPO and with the plants to get that sort of data. Just a point for you.

MS. XING: Thank you. I would very much appreciate that line of information because my plan for this report, for the development, we plan to collect a bunch of example for each of these steps in the process.

When we talk monitor, here is an operational example showing what is a different kind of monitor, so help people, so I like talk to you later on that. That will be a wonderful help. Thank you.

MEMBER BLEY: I'd like to make a point of clarification and maybe it won't clarify anything at all.

(Laughter)

MEMBER BLEY: And Jing can correct me on this. She's mentioned a couple times that it's a draft and the final might be different.

Two points to that. One is the trials I've seen of the methodology, the links back there are in the head of the person using it, which needs to get systematized if they get to where they wanted to.

But they had a little diversion a few years ago when this opportunity came up to get into the plants, at least one of the plants, and actually look at simulator data.

They built a very interesting computer code to help the people put the data in and the plants were heavily involved. And in that process, they made a lot of links back to the lowest levels and it keeps asking you to dig and identify what exactly is going on.

I suspect, I don't know this for sure, but the vision might be to have something similar to that to assist people trying to apply the method and that might be something that's better in a system such as that rather than trying to do it all in a hard copy in a manual.

CHAIRMAN STETKAR: You weren't here for the first part of the session but one of my observations was that I like very much the psychological framework report. I think it hangs together quite well.

We had quite a bit of discussion. I personally think it's more complete than the authors might lead you to believe from some of the words in there.

When I then pick up the generic methodology report and try to understand how it relates to that framework, I don't get it. Now that might be my --

MEMBER BLEY: As far as I know, nobody's tried to use it yet and it might be a real learning experience.

CHAIRMAN STETKAR: -- my boneheaded approach but I see part of it is differences in terminology. Part of it is different constructs.

So, for example, this example that I mentioned in a sense, out of the blue, the generic methodology reports says, well, we've defined five subtasks for the detection macrocognitive function and here they are. And, well, number five relates to teamwork so we're going to push that away and we're going to focus on one through four.

And, okay, I can read those words but I could define, you know, 12 subtasks if I were led to believe that and if I don't have the discipline to relate those subtasks back to the overall framework, we're then just promulgating this notion of you sit in your room and develop your methodology and you will defend that to the death and I sit in my room and I'll develop my methodology and defend it to the death, and we're trying to get away from that.

So there needs to be a discipline. If people are going to use this and understand the generic methodology in this hierarchical process, there needs to be those links.

Someone needs to understand the grounding of everything you say in that generic methodology report, how it relates back to the fundamental concepts, and if it doesn't, there should be a rationale of why it doesn't.

MALE PARTICIPANT: That's right. Yes.

CHAIRMAN STETKAR: I, today, made this decision because, not just here's what we used, table of tables.

MR. PETERS: And, John, I think we wholeheartedly agree with you and we're going to go back and look at developing those linkages. And what you guys are seeing right now is an earlier report based on the time crunch. We did not have the time --

CHAIRMAN STETKAR: Yes.

MR. PETERS: -- given the time frame to go back and create those linkages, but we will in the future.

CHAIRMAN STETKAR: The reason I asked about the 199 pages, that becomes more clear as you go further on in the report, where there are caveats saying, well, we're still kind of working on this.

Up in the front, though, where some of these basic principles are developed in terms of listings of these subtasks because they then develop the framework within the context of this methodology that the numbers eventually feed into, the linkages aren't there either and I'm assuming that the front end of the report is a lot more mature than the back end.

MR. PETERS: Yes, probably a good month older, yes.

CHAIRMAN STETKAR: Oh, okay. Okay.

(Simultaneous speaking)

MR. PETERS: As we did our office report, I was thinking about a three-month time frame to get that together.

CHAIRMAN STETKAR: Oh, okay. Okay.

MS. XING: Yes, and later on we should really systematically look at these things. For example, the five subtasks you just mentioned for detection, you could find them in the literature review report in the later models may only talk one element.

CHAIRMAN STETKAR: And I did that. I actually went back --

MS. XING: Did that. Okay.

CHAIRMAN STETKAR: -- and I can see all of those words scattered. Well, Joe and Ralph said that these are important things and Tom and Mary said that these are important things.

MS. XING: Yes. And we need to put those together.

CHAIRMAN STETKAR: But the fact of the matter is you already have a framework where you've identified proximate causes, cognitive mechanisms and performance-influencing factors.

In some sense I don't care what everybody else has said in the literature review. You've distilled all of that information into the framework that you've developed in NUREG-2114. That is now the governing document.

So I need to understand how elements of this methodology relate to not some paper that you read as part of the literature review or that somebody said that this is a subtask that people do to collect information.

I need to understand how it fits into your framework, the framework that you're owning in NUREG-2114. Not you're owning. We're owning because ACRS is on the hook for this as much as you are.

MS. XING: Yes. I'm on board with that. I'll take that recommendation in the next state of our --

CHAIRMAN STETKAR: Even if you feel uncomfortable, as I said, that linkage is important and places where you deviate you need to justify why, why it's necessary either to omit something or to add something to resolve some incompleteness and that just doesn't, to me anyway, it didn't come through.

MEMBER SCHULTZ: And that's a --

MS. XING: Yes. I would say we did not deviate from the basic structure and we added lots of things but results in the report gave you the justification why we added this thing, so.

CHAIRMAN STETKAR: Okay. Go on.

MEMBER SCHULTZ: I was just going to comment following John's remark about identifying as you're going through this because there have been already many challenges to what is being developed here and will continue to be and if you look any further you'll find more things that need to be dispositioned.

Doesn't mean it has to be incorporated in the documentation, but somewhere it would be very useful when you ask and answer a question and you go into the why, why is this not being considered or where is it considered and how is it considered, that that be documented in some files so that the literature review is complete.

Doesn't have to be incorporated in a 1,000-page document but it has to be there somewhere to demonstrate that all of these considerations, in fact, have been included and documented as to how they are treated in the document because, as we've discussed this morning so far, there's a very complete process that's being developed.

It's a challenging approach, especially now that you've got a philosophical approach in a fairly detailed functional model and in the middle you have a methodology and the front end and the back end are more developed than the middle methodology.

So you've got to go through that process of A, B and C and document how it fits together and it doesn't have to be, I mean, you could do it as you described. You keep revising the documentation so it all fits together but as you try to move in that direction you've got to document in the file, the work file, what you're determining and how you're dispositioning information and approaches.

MS. XING: Thank you. That's very important to remember in the project.

So the basic concept here was based on we've taken from the early literature review to construct this error-causal tree and the changes, why we make some revision like this, the cognitive processes and the distinction from the cognitive mechanism and error causes, we didn't put a justification in the current document but we have reasons for doing this. Because, like, in the early practice when we apply for ideas we try to use the cognitive basis report or we find, okay, couple places we couldn't use the knowledge there. That's why we evolved further into a clean structure of this error-causal tree.

So we can just give you a look of the cognitive process for decision making we put there. I wish I had the attachment, which would be easier.

CHAIRMAN STETKAR: That's okay. Decision making is fine.

MS. XING: Yes. For most of the decision-making models, every model have assumption so we try to synthesize the general assumption for decision making which when people develop decision-making models they always assume the information needed for decision making is already there and the situation is well assessed and there are existing decision goals and criteria so this is basic assumption.

CHAIRMAN STETKAR: Okay. I understand the information. I understand the situation is assessed because those are the two preceding macrocognitive functions if you think of these as a serial process. When you say decision goals and criteria exist, what does that mean?

MS. XING: Okay, for the decision-making models, you could find it in the literature. They all assumed, you know what's --

CHAIRMAN STETKAR: No, no. I don't care about the literature. I mean I'm asking you today in the framework of the cognitive framework that we've established, what does that mean? I know exactly what I'm supposed to do? I know that I'm supposed to go to bleed and feed and that I'm not supposed to try to get feed water back?

MS. XING: You know you try to get feed and bleed for this --

CHAIRMAN STETKAR: Why?

MS. XING: -- feed water.

CHAIRMAN STETKAR: Why do I know that? I know that I want to get emergency feed water back. So I need to understand what this bullet, this presumption, because that's an assumption. You say that decision goals and criteria exist and I don't understand what that means.

MS. XING: You won't make a decision whether or not you should start feed and bleed and your goal, primary goal, is to protect the reactor.

CHAIRMAN STETKAR: I can protect the reactor by getting emergency feed water back. I can get it by main feed water back. I can get it by blowing down the secondary system and getting condensate in there. I can get it by doing a lot of different things.

MS. XING: Yes, so you need to choose one strategy from that but you need --

CHAIRMAN STETKAR: What I'm saying is that I understand as a precondition assumption that, indeed, I've successfully accomplished my detection macrocognitive function and that I've successfully accomplished my understanding macrocognitive function. Those are the first two bullets.

What I don't understand is what the assumption regarding decision goals and criteria exist means when I now do the evaluation of decision making.

MR. CHANG: If I can, the decision criteria, my interpretation is that, okay, procedure based on some idea --

CHAIRMAN STETKAR: Don't use the word, procedures.

MR. CHANG: Okay, well, --

CHAIRMAN STETKAR: Don't use the word, procedures. I'm in the control room.

MR. CHANG: Right.

CHAIRMAN STETKAR: The procedures say, try as you might to get feed water back and I have somebody yelling at me on the phone saying, we're going to get it back any second now. Any second now, hold off, hold off. There are criteria in a procedure that says go to bleed and feed under this. I have conflict here. So don't say procedures. I don't want to hear procedures.

I want to hear what you mean by the assumption that decision goals and criteria exist. Does that mean they're unambiguous and absolutely black and white so therefore I take it as a given and I do not evaluate the quality of those criteria and goals in the context of decision making. Or, as in the framework, I evaluate the quality and goals in the context of a scenario?

I'm trying to understand this. Honestly, I'm trying to understand this. So I need to understand what that assumption means.

MS. XING: Okay. Whenever you make a decision, you make a decision for a reason. That reason could, what you want with this decision for, that's the goal.

CHAIRMAN STETKAR: Hey, Xing, I'm asking that I'm going to do an analysis, okay. If I read the Cognitive Basis document, the Cognitive Basis document says, in many cases, we've observed that there are confusing elements of the goals. In some cases, conflicting elements of the goals and that the criteria may not be well specified for a particular scenario.

For another scenario, push a button, eat a banana. The red light goes off, I push this button I get a banana. Great, I understand that. Most of the scenarios that we're concerned about in risk assessment are not push a button, eat a banana. They're complex scenarios.

And in those cases, the literature review, and indeed the framework, says that I need to actively evaluate, in the context of a scenario, whether or not the goals and the criteria for the particular action that I'm focusing on in my little model here, are clear enough to enforce an appropriate decision. Or whether there's something that might be fuzzy. But if you're assuming that they exist and they're clear as a precondition, I don't get a chance to evaluate those attributes.

MS. XING: Yes, we assume they existed. Whether or not they're clear, that's the first step in the process, in the management. First and second step. You have multiple goals. Probably have conflict in goals. You try to manage this goal by prioritize them or use of criteria to evaluate them and come up with the right mental model for making decision.

So but if you don't have, that's like whenever you make, all this decision making model we took our goal directives. In the literature, they call the goal directive decision making. So you always start from some goal, but in the process you are going to evaluate these goals. You are going to evaluate the criteria. But it's not like you start from nothing.

CHAIRMAN STETKAR: Okay.

MEMBER SCHULTZ: I see a scenario where the terminology is not really clear me. Manage the goals doesn't mean --

CHAIRMAN STETKAR: That's right. This is a case where --

MEMBER SCHULTZ: I don't know how to interpret that, manage the goals. Establish a decision model to meet the goals and objectives when I've got an assumption that I've got decision goals and criteria already in place. There's a misfit here that --

MS. XING: Yes, this is --

MEMBER SCHULTZ: -- I'm not understanding and I don't know if it's important we clarify it today, but it's not clear to me how these will fit together.

MS. XING: No, I agree, it's not clear and this is the part that I would say is in the early stage of the working process, like we just heard from INPO. Ultimate plan for this part we will provide a definition for each of these items and attach to this at least one or several examples.

Factor from a real example. Why are they clamped? James and I we will talk this. We can pull these things from the SAMGs, pull several examples in SAMGs. This is where they need the manager's goal. This is where the criteria exist, but not clear. So those are the things we are planning to do, so what we're showing now, it's immature product.

CHAIRMAN STETKAR: Part of, Xing, what I suggest, and what's helped me an awful lot, is that the problem that you have is, and it sounds like you've thought through this process, which is good, but you now have on this slide and in the report, you have seven bullets. You don't have six, you don't have 12, you have seven. You are now married to seven bullets.

You will now, if you start to elaborate the report, you will try to retain this nice crisp set of seven and rationalize how things might fit into this seven. Rather than if you were starting with a clean sheet of paper, transitioning from the framework to salient features of the decision making, after cognitive function. You might come up with two, you might come up with 20, but there would be a progressive rationale for the derivation of these things. Follow me?

So I'm a bit troubled by saying, yes, we need to go back and flush out things to feed into this, because that's sort of rationalizing a preconceived notion already. Unless you've done that process? The question is, if you did the process, why didn't you write it down?

MS. XING: We did that. Good news for you is that we did that process.

CHAIRMAN STETKAR: Good.

MS. XING: And let's see, from all the literature we got, we probably identified like 30 or 40 all seems to belong to the company to process here. And also search in 40 and you will find some of the same thing, but they use different term. Some like this we could really group them as one would be better. There must be a reason for why it is this way.

Like anyone of these step, if you go to literature, you will find some literature will break down the manager's role into multiple processes.

MEMBER BLEY: Let me ask you a question. I actually didn't work on this part. It's caused a lot of confusion, these assumptions. I'm not sure what having these assumptions is doing for you. I mean, John went back and sited some description from the framework that really makes a lot sense.

And when I first looked at this, I said, well, you know, the whole thing we did on ATHENA years ago was to look for cases where the goals and criteria that don't exist, or are so confused they may as well not exist. And I guess what you mean by situation is assessed, there has been an assessment, whether it's right or wrong, is up for grabs. And it seems more important to layout, well, I guess that's covered somewhere else, but when you get here, I'm not sure what the third assumption does for you.

CHAIRMAN STETKAR: Well, I'm not sure what the third assumption does. I could rationalize the first two, somehow. But I'm not sure about the tasks, because I keep coming back to these, I love these pictures, the purple pictures, from the framework document. And in our framework, I will start owning this framework if nobody else will. I like this framework.

In our framework, we identify three cognitive mechanisms. I'm sorry, three proximate causes. I have to be clear on my terminology too. Three proximate causes that contribute to failure of decision making. That's incorrect goals or priorities set, incorrect internal pattern matching, incorrect mental simulation or evaluation of options.

There are then a number of cognitive mechanisms that contribute to each of those proximate causes. And then performance influencing factors that affect each of the cognitive mechanisms. The question is now in this framework, how do these seven tasks relate to those proximate causes? It's not clear to me.

I can kind of try to divine, maybe, how some of them do, but I don't know why we, why do we need to do this? Why do we need to have these seven? Why do we need to make the assumption that decision goals and criteria exist? Why do we need to do that? What about the methodology is there that requires this step?

MS. XING: This is exactly where we tried to make up the gaps in the literature review. In the literature review for the decision making, you just read three proximate causes. And because we limited some scope of the literature review, those three are corresponding to like the first one, goals not prioritized, that relates to this first manager's goal. So because you need to do this and you didn't do it, so you fail.

And what are the other two proximate causes?

CHAIRMAN STETKAR: Incorrect internal pattern matching and incorrect mental simulation or evaluation of options.

MS. XING: So that's related to --

CHAIRMAN STETKAR: Now I, DM4 is make the decision.

MS. XING: Yes, okay.

MEMBER SCHULTZ: Then implement it.

CHAIRMAN STETKAR: Yes, okay, I push the button, you know, the banana came out, good. But I don't understand what DM4, how that relates to these proximate causes. That's the ultimate thing that I'm supposed to do. I'm supposed to make the decision. It might be right or wrong depending on those other influencing factors.

Plan action scripts. Well, incorrect mental simulation or evaluation of options. That's part of planning scripts. It's also part of establishing a decision model to meet decision goals. I don't know why we need this bullet, bullet, bullet. I don't know why we need it. I don't know what it's doing that the fundamental framework fails to do.

MEMBER SCHULTZ: In one step rather than three or however many.

CHAIRMAN STETKAR: In one step rather than, yes, or three steps rather than seven, or something like that. I just don't understand.

MS. XING: Okay, first of all --

CHAIRMAN STETKAR: Honestly I don't, I --

MS. XING: Yes, first of all, this is a working, this part is still your working stage, like as you point out, some two steps should really group into one. And if we find that that's a better way to group, we have better justification for that, we would do it.

CHAIRMAN STETKAR: Xing, my challenge is why didn't you start with the three --

MS. XING: Because --

CHAIRMAN STETKAR: -- and work from there?

MS. XING: -- those were not complete. You could think those three are subset of this.

CHAIRMAN STETKAR: No, well, tell me what part of those three, which of these seven fill in a gap that's missing in those three? Those three do not address communicate and implement, because that's the --

MS. XING: Plan action scripts. That was missing --

CHAIRMAN STETKAR: Plan action scripts.

MS. XING: -- in those three, if I can remember.

CHAIRMAN STETKAR: Okay. I have to get the right page here.

MEMBER BLEY: There was something like it.

CHAIRMAN STETKAR: Incorrect mental simulation or evaluation of options. If I'm evaluating my options, am I not planning the script?

MS. XING: At least that that's what when we did the literature review, that's what we --

CHAIRMAN STETKAR: You did the literature review. The literature review is embodied in the framework.

MS. XING: Yes, the literature review did not consider any working process, company to process --

CHAIRMAN STETKAR: Incorrect inclusion of alternatives. Inaccurate portrayal of the system response to the proposed action. Inaccurate portrayal of the action. I mean, I don't, maybe I don't understand the results of the literature review then?

I don't understand why the things that I've just read are not all part of evaluating pros and cons, planning the action scripts, and simulating evaluate the decision plan, which I don't quite understand what it means anyway.

MEMBER SCHULTZ: In other words, it appears you're creating a new terminology here. You already have it in the document. You need to potentially map one to other, but you don't have to create a new set.

MS. XING: Yes, eventually --

MEMBER SCHULTZ: Perhaps adds one or two or takes away one or two elements that are already established.

MS. XING: Yes. Right now we're still in work in process phase. That's why I didn't put the mapping part into the report, because that's we're still working on. And even we're still trying to give to our best knowledge a good rationale for these seven steps. Maybe eventually you will find that two of them should be combined or one doesn't need to be there.

So all your comments I will take and work --

CHAIRMAN STETKAR: Xing, I'm challenging you to delete this slide and start the three and find out where something's lacking.

MEMBER BLEY: This whole bit comes from Chapter 2, which is the cognitive basis in which they tried to lay out the process people go through as operators. And then one would hope you would link that back to the ways you could fail in carrying out this process.

The things John's looking at of viewing with the ways we fail and it seems to me this slide, and the section it's part of, is really laying out what people do to get into situations where they might fail. And maybe it's that link is what you didn't find in reading the report.

But to me, laying out as a background for what you ought to know when you start thinking about modeling cognitive processes, what people do when they're successful or unsuccessful is an important bit of the background in doing this work. And I think that's what this is trying to do.

But somewhere then you need to make the link between what people do and where they can fail, that ought to tie back very soundly to the framework, I would think.

CHAIRMAN STETKAR: And that's what I was missing.

MEMBER SCHULTZ: Thank you, yes.

MS. XING: Yes, exact Dennis, thanks for explaining that. That was exact purpose why we did this, because those proximate causes, we got challenged why, are these all the proximate causes? Where they came from? We didn't have that explicitly in the literature review.

So we just, the team think, okay, from the literature review that we think these are the three major proximate causes, but are there others? Later on, that problem occurred all the way to the development of the IDHEAS method, because the failure mode, you know, the IDHEAS methods are based on the proximate causes.

And the one we got challenges it. Are these all the proximate causes, are these all the full set of failure modes. Are there other failure modes that you didn't cover? We didn't have a good basis to offer that. I think you guys challenged us in the previous meetings it also was, well, these are what we think is the best, good enough to cover.

Here we laid out the complimenting process and we can actually point it out which failure mode, if we talk about a failure mode, which one it means. Where in the process it breaks and what part of the process we did not identify failure mode, because we don't believe people will ever fail there.

So the main purpose for this part is to lay out a basis in the future for us to build up, you have to build to the success phase first, then to build up the failures phase.

CHAIRMAN STETKAR: Okay.

MS. XING: So fortunately, this part doesn't affect what Jim's going to present here today, because we deal with the failure mode there at the high level, we only talk about failure decision making. We start talking failure, what part of the decision making process.

So this is, I think, not sure if I want talk this, but that's the point I want to mention. Why we went to identify this assumptions is a process. We look at, when we talk about failure modes, we often see very different kind of failure modes. You can talk of failure modes like THERP. It takes a failure mode based on the observable human actions, classifies the type of human action as a failure mode.

And the other mode like a MEMORS would talk, they consider each test objective as like you failed monitoring, you failed to prioritize your goals. They talk that as a failure mode. Like SPAR-H talk failure mode at the very high level, the cognitive function level. Even at the cognitive function level they combine to some common functions.

So SPAR-H only has two failure mode, cognitive and action. Where ATHENA really considers failure in detection and standard decision making. SPAR-H combine all these three together. And CBDT and the IDHEAS actually, they're failure mode are based on the cognitive process like we talked here.

So just by laying off the cognitive process, which if you want you can decide at which level you want to model your failure mode. You want to model them at a high level, at the cognitive function or you want to model your failure space in a much detailed level, look at the cognitive processes.

So what we will present today later on we'll show you two methods. Like IDHEAS actually models the failure at the cognitive process space. And the HEP worksheet Jim's developed models the failure at the cognitive function level.

And there's really no universal rule on deciding failure mode. It just depends from which aspect you want to break down, look at the tasks or break down tasks. And by laying off of the cognitive process, it allows us to examine whether our failure mode sufficiently cover the cognitive, what is need to be done.

So have said that, I will give --. So that's when we come to the quantification part of this method. We actually have this to implementation. The first implementation isn't, we called it the HEP worksheet, which we estimated the HEP of each cognitive function. Like we break down a critical task into these four functions and estimate the failure of each function.

And in IDHEAS we actually break down further for every cognitive function. Like for detection we have five failure mode, each of those failure modes corresponding to one step, or one assumption, in the cognitive process. So we evaluate at the much detailed level.

So next I will have, Jim will talk about the top value, estimate HEP at the cognitive function level. And in the afternoon I will talk about how we estimate HEP at the detailed failure mode level. That's the IDHEAS.

So I'll give James for the next part.

MEMBER BLEY: Can you back up one slide, please? Oh, maybe not. You're going to go through the second one this afternoon?

MS. XING: This afternoon, yes.

MEMBER BLEY: Okay, then I won't mention it here.

MS. XING: Next James will go through the top one.

MEMBER BLEY: Okay, I'll wait until later, never mind.

MR. CHANG: This is Jim Chang. I'm going to present this HEP quantification method, we call it HEP worksheet. One question to the committees. I saw that next one is 11:30, that I have less than ten minutes. I think if I present all information here in ten minutes I will cause more problems than I want to solve. Not sure that was the decision here that --

CHAIRMAN STETKAR: Just do what you need to do. We only have one constraint. We do need to break at noon because I have another meeting that I need to go to, but we'll take as much time as necessary.

MR. CHANG: Okay, yes, thank you. This figure showing the current high level flow tasks of these HEP quantification. On the upper left we have in the IE event tree that has a human failure event identified. And then in the IDHEAS methodology qualitative and then is the portion there that tried to decompose going to analyze these few human failure event.

And then that we present in the Crew Response Tree so that's from what is transferred here. It was kind of telling a more detailed story of the scenarios. From this Crew Response Tree there identified these critical subtasks. We see that human failure event itself as a task. So the bottom half here was a list of the critical subtasks was identified.

And now coming to this HRA worksheet method here. For each subcritical we ask, that's okay, what's the macrocognitive function of this subtask. Is that detecting, understanding, deciding, or actions? So we let the guidance that, IDHEAS methodology already provided guidance on how distinguish these four different macrocognitive actions.

So that analysis will check, okay, this subtask I think that's involved with detecting and understanding macrocognitive function. And then there's a corresponding worksheet for detecting, for example. And that's the worksheet there that we calculate the detecting independent error. And that's down the flow that there also has dependent analysis and minimum HEP that coming to, and then, the total HEP of this HFE will be backward.

Now we calculate each pieces, small pieces of the, alpha, beta, and then that's aggregate back to the, adding this HEP together and back to the HEP of the HFE.

CHAIRMAN STETKAR: James?

MR. CHANG: Yes?

CHAIRMAN STETKAR: One of the things that I'd like you to keep in mind, and perhaps you kind of address this as you go through this process, I read through this. I grew up with THERP.

MR. CHANG: Yes.

CHAIRMAN STETKAR: I believe that there's general consensus that THERP is silly and I want to understand how this is different from THERP. Because a lot of things that I read are suddenly devolving into THERP.

MR. CHANG: Yes.

CHAIRMAN STETKAR: I'm suddenly developing critical subtasks, procedure steps that I'm evaluating the critical subtasks. I'm developing a basic human error probability, adjusting that human error probability by some performance influencing factors. And I seem to be disassociating that whole process from the context of the scenario and kind of a higher level perspective accumulative performance.

So if you can sort of address that comment. Maybe I'm getting the wrong impression, but I see suddenly going back to 35 years ago saying, well, THERP is okay. That whole process of assigning things to little boxes and each box has a number associated with it and then I add a bunch of stuff together and I multiply it by a couple of other factors and viola I have a human error probability.

MR. CHANG: Yes, yes.

CHAIRMAN STETKAR: Okay.

MEMBER BLEY: Just a question for from the last time you folks were here. I don't recall that there was always a quantification flow sheet and something like the cause based decision tree in the methodology. Has that always been there? Two separate ways to quantify? Or is this something new that was just added since last time we saw you?

MR. CHANG: Quantification, this is new thing.

CHAIRMAN STETKAR: This is new.

MEMBER BLEY: Okay, it looked like it was all new material in there.

MR. CHANG: Yes. Well, the upper portion is not new, that's been presented in the IDHEAS methodology. The bottom half is the new thing that we added.

MEMBER BLEY: Okay.

MR. CHANG: So in looking this, let's go back just looking at what's the element, or component, that's in quantifying the HEP. Just looking at these HRA as a whole. The first thing was that the basic HEP units, like the ultimate unit we want to estimate is the HFE, human failure event. But is this human failure event defined in the PIF as like units or need to be break down to a more appropriate unit from the human performance perspective, okay. That's a thing there.

Most of these SPAR-H, CBDT typical are HRT defined PIF as a unit that do not do a spreadsheet. And then mention like THERP, they go into more and more detail activity. So this, that pretty much depends on, that's a method, method that's how find, how to use this HFE.

And then the second was a basic HEP. This tries to get people, again, what's a generic kind of type task, what a type of task? Like a SPAR-H, it define two things, diagnosis and actions, okay. And that's giving that diagnosis has one E minus two, action has one E minus three.

And some other method, like NARA, it defined around 14, 15 basic, generic tasks. And each task has, HEP for example, like there's a simple action with immediate system feedback. That's one generic task described in NARA. And this type we see it quite common. And then same thing with the THERP, like turning a switch. That provides a basic HEP. So that's kind of element --

CHAIRMAN STETKAR: James?

MR. CHANG: Yes?

CHAIRMAN STETKAR: We're going to spend a little time on this because it is new and it's kind of key to making that transition from the framework to getting numbers into a model.

MR. CHANG: Yes.

CHAIRMAN STETKAR: You mentioned SPAR-H.

MR. CHANG: Yes.

CHAIRMAN STETKAR: You mentioned THERP.

MR. CHANG: Yes.

CHAIRMAN STETKAR: First of all, SPAR-H, is that a human reliability analysis methodology, in your view?

MR. CHANG: It's a quantification methodology.

CHAIRMAN STETKAR: Okay, I thought that the intent was to provide some quick and dirty numbers for resident inspectors and people out in the region to develop sort of a gut feel for how important a particular event might be. That maybe I'm misrepresenting it, but it doesn't quite seem to be what I would call a state of the practice human reliability analysis methodology.

So the numbers that are in there, --

MR. CHANG: Right.

CHAIRMAN STETKAR: -- you know, it's kind of like around 2,500 miles sort of maybe to Los Angeles if I put a straight line across the U.S., but that's not something that I would use for planning a route.

MR. CHANG: Right, yes. The reason mentioned about SPAR-H, mention of THERP, this method is not trying to talk about this detail, this method or the numbering, or why this method, but instead what's the element they use to quantify HEP. So these are the things we are looking for here.

CHAIRMAN STETKAR: Okay.

MR. CHANG: The third one was a performance influencing factor. These I think we don't need to do much explanation here. And then the fourth one was error recovery. That's in the team framework. Errors here, it's kind of what's the principal responder that will fail that task and then in the team framework, that's people, the other team member could recover that error in time.

CHAIRMAN STETKAR: Is there any chance that the team can make things worse?

MR. CHANG: It could, but --

CHAIRMAN STETKAR: Not according to your methodology. Your methodology says the team always makes things better. The team is always assessed as a recovery factor.

MS. XING: May I answer this question?

CHAIRMAN STETKAR: Yes, sure.

MS. XING: Yes, there are many chances the team can make it worse.

CHAIRMAN STETKAR: Okay.

MS. XING: Remember the ask/re-ask teamwork aspect, communication, collaboration, coordination. And any of those elements, the team can make it --

CHAIRMAN STETKAR: Why doesn't the methodology allow that then?

MS. XING: Yes, and so how it can make it worse was identified in the PIFs. Like the part the team make worse is already covered in the PIFs we identified.

CHAIRMAN STETKAR: Yes, well, I certainly didn't read it that way, because the PIFs are assessed at the individual level to adjust the basic AGP. I mean, and all of the words says, well, will the affects, I can read words. I'd have to find them in my notes. The effect of the team is to look at recovery to improve the situation.

That's certainly an opinion of some people. I don't think it's supported necessarily by actual operating experience where teams have collectively decided that the world is working in a certain way and have responded that way and they've been wrong.

MR. CHANG: Okay.

CHAIRMAN STETKAR: Group think sometimes helps, often helps. Group think sometimes doesn't help.

(Simultaneous speaking)

CHAIRMAN STETKAR: Methodology does not --

MEMBER BLEY: Negative context.

CHAIRMAN STETKAR: If the methodology does not acknowledge the fact that teamwork, under certain circumstances, either because of poor communication, autocratic leadership, whatever, you know, I'll just keep it focused on your communication and leadership that you've identified and the teamwork macrocognitive function, it can be detrimental to overall performance. And it's not clear to me that the methodology accounts for that.

MR. CHANG: Yes, if we say the principal responder that doing the things to say finally just a success or fail. In the success path now, if I can take it correct from you, look, it failed that the team cannot make it worse, but is only success fails and then you are saying that the team will make it fail?

CHAIRMAN STETKAR: Yes.

MR. CHANG: Okay, we haven't considered that.

MS. XING: In fact, a list on the table last year I got from French EDF, the MOMARS method, and they identify a very good list of how a teamwork, what aspect teamwork can actually be causing, be negatively affect performance. And while supplies, right now we have that in the appendix as a list of the PIF characteristics. And next we will try to incorporate some of the French work, the EDF work, into that list.

CHAIRMAN STETKAR: But in some sense, Xing, I'll bring it back to that psychologic basis. NUREG-2114 does discuss those things. It discusses it. I evaluate the effectiveness of communication. I evaluate the effectiveness of leadership, both in a positive and a negative sense, in the context of a scenario.

And that's at least the message that I took away. Perhaps I'm reading too much in there. And yet, as I see the translation of that into a particular proposed methodology, I only see the fact that teamwork can make things better, because everybody always checks things and communicates and makes things better.

And that kind of bothers me. It says that we're not necessarily learning from what seems to be written in the framework document. We're developing our separate model of the way we think the world works and kind of ignoring these things.

MS. XING: Yes, 2114 identified the two failure modes of proximate causes, failure of communication and failure of leadership.

CHAIRMAN STETKAR: Yes.

MS. XING: So failure of communication was actually later transferred in the model in IDHEAS. And we had a lot of problem about that failure mode. That's one failure mode the expert couldn't reach a consensus, because we feel the impact of failure of communication already being modeled in other failure mode.

And failure of leadership we didn't model that at all in IDHEAS. So that's where we said 2114 had some limitations and we try in this generic methodology goes beyond what is said in 2114. Tried to model many other aspects of teamwork, which we haven't got that part completely done yet.

CHAIRMAN STETKAR: Go on, continue.

MR. CHANG: Okay. The first one, the task dependency, now that we, as practiced now is mostly a model in the PIF event tree that these are at HFE level. That's one task failure that will have a factor at performance level subsequence. And then that there's a minimum (joint) HEP requirement.

CHAIRMAN STETKAR: James?

MR. CHANG: Yes.

CHAIRMAN STETKAR: Two questions. I was going to wait until we got to that last. How exactly, there's statements in the methodology, there are two sentences, that's the justification. It says that the minimum HEP accounts for epistemic uncertainty. How does it do that?

MR. CHANG: No, no, this was two reports that the EPRI, that's in 2010, that has a report that's written by Gareth Parry and talk about these minimum HEP --

CHAIRMAN STETKAR: No, I'm talking about this is your report, your name is on this report.

MR. CHANG: Oh, yes.

CHAIRMAN STETKAR: So I'm asking you about how the minimum HEP accounts for the effects of epistemic uncertainty in our human reliability analysis. How does it do that?

MR. CHANG: How does it --

CHAIRMAN STETKAR: Right, I don't understand why just saying the minimum number ought to be 10-5 that so we've addressed epistemic uncertainty because we put a 10-5 in there? I don't understand that. Why shouldn't it be 10-2, or 10-200?

MR. CHANG: Well, this was not my work, okay. That was quoted from Barry Kirwan that, he was saying that data, even that aspect, it seems like the minimum, there's some threshold that might have the uncertainty bound, but that's what, no matter how good the situation is, how simple the task is, okay, there's always some failure. And then that in his report, he even provided even more conservative numbers.

So in my report, I similarly state, saying that, okay, here that we haven't spent effort on this item that we --

CHAIRMAN STETKAR: Well, the point is that uncertainty is not addressed anywhere in this methodology.

MR. CHANG: Right.

CHAIRMAN STETKAR: Except for this simple statement that says, well, we put a minimum number in there and that addresses epistemic uncertainty. Since that's the only reference to uncertainty, other than there is a discussion in time lines about how you address the uncertainty, perhaps, in available time and time required to perform an action.

But in terms of the quantification, there's no discussion of uncertainty except this simple statement. And I honestly do not understand how assigning a 10-5 number address the whole issue of epistemic uncertainty.

MR. CHANG: It won't.

MR. CHANG: Okay, well, why does it say it does?

MS. XING: We haven't started work on that yet, but the part --

CHAIRMAN STETKAR: But yet, but see things are in writing already. So if you haven't started work on it, don't make statements.

MS. XING: We made those statement there, we take from the existing state of practice, which that's what in EPRI's report. That's what in the prior HRA. So we say since we didn't do additional work, we just grab whatever in the current state of practice.

Doesn't mean we completed. Think is correct, but that's what --

MR. PETERS: As I understand, James is flying out this evening to meet with EPRI and they're having a workshop and evolving this minimum human error probability and --

CHAIRMAN STETKAR: They're going to fight over numbers. I'm fighting over a concept. And EPRI doesn't understand the concept either. They're just trying to use things as a crutch. We criticize EPRI reports on this also.

But that's an EPRI report, this is a staff report. This is a staff document.

MR. PETERS: I understand that and as such, this is also a very interesting topic as I understand the NRR, and we are beginning discussions with NRR about whether or not we need to do more research into this minimum human error probability. So there will be more to come on this, what as we get to culture the final document, but we did get your comment, John.

CHAIRMAN STETKAR: Be careful of what you put in, once you put something in writing it starts to take a life of its own. You say, well, this was said before by somebody else and you now own this. You now own this.

It doesn't say we did some research and this other organization claimed this and we have questions about it. This is a simple statement in your report, so you now own it.

MR. CHANG: Okay, thank you. We'll talk about it from this actual worksheet. That's how we address these elements. The basic HEP is this one qualitative that's from the IDHEAS flow tree that fall under to identify what's the critical subtasks.

And then we use context factors to address the basic HEP performance shaping factor and error recovery. And then also the task dependence. This occurred preliminary thought used in the context factor to address task dependency. Not having much thoughts put on that area yet. And minimum HEP --

(Simultaneous speaking)

CHAIRMAN STETKAR: James, help me out.

MR. CHANG: Yes.

CHAIRMAN STETKAR: When you say the words context factors, --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- should I think in the framework as performance influencing factors? Or is it different?

MR. CHANG: Later I have a concrete example --

CHAIRMAN STETKAR: Okay, thanks, that'll help.

MR. CHANG: -- helps you understand, yes. So the way that context factors, again the error causes, but in the operational perspective it's still pretty different. For example, in the literature report we would say that the salience of information, we take an alarm for example here. And then in context factor here we characterize, okay, what's an Alarm 4 situation when that's alarm needs to be detected, okay.

The second bullet talk about it. We divide this into three classes, okay. Alarm board is only showing a single alarm, or there's a pattern of alarm that's very strange to recognize that pattern of alarms knowing that what's the problem. Okay, that's one class.

The second class is short, few alarms, but none have clear patterns. And then the third one, third level, is overwhelming number of alarms showing on the alarm board to take. So this is a context factor, just showing the context, the situation. This is very consistent with the SACADA, a database approach. And then I talk about benefit, we'll talk about it.

This benefit, this from my perspective, is repeatability. This context factor that we are, okay, this method coming to the end will be HRA or the PIF analyst to use. This term that we define is quite objective. They can note this and they can create it knowing which class to go.

Data support means mention about this. Very consistent with SACADA data and then the scale data that we have been approved that you can use in the correct in the simulate operation later training, practice. That's together a large number of data to support statistic indications.

The models are comprehensive. This was, the use this term was, it had been several iterations of revising the context factors. But the basic was I took Jean's set, his set of the causal factor and then look in it, okay. Well, there's all these causal factors covered by these context factors and then there's been an iteration I did not keep checking that, okay, come to the end.

We should have covered that, but now at least because now we are still in the process of refining this context factor that we'll in one of the appendix profiling mapping. Once that we come to the iterative process come to the end, we will have a appendix for part of mapping of that literature review at those causal factor and then what's corresponding that context factor cover that.

Now we have to think about this context factor with the causal factor. And then from the Xing earlier presentation, the cognitive causal tree there, that we can, okay, I'll show it. We can link, bring the link that's coming, trace back, come from the what's the context of the HRA analyst and then trace back, okay, what's likely causal factor and then what's likely error mechanism, or error modes, completely in that situation. Later I have, once I talk about these points.

So another example decision in the decision making, this one of context factors, what type of decision is it making? Okay, we defined the three type of decision. And then that circle, we intend in the future become the sole application for the HRA analyst to doing this thing. And then so leave the complex calculation of quantification and then the logics behind, that's all we'll deal with. But now I just provided.

So we have three classes decision, okay, standard decisions. Like one, there's a procedure they train you on that's clear criteria to make the decision. And then the second one was a competing goal, with concrete Go versus No-Go criteria. And this was a question that earlier you comment that in that example. Yes, I know that while in current situation, yes, I lost all the feed water, but I'm starting restoring the emergency feed.

But while I can take chance that emergency feed will back to work so that I save the day. But with our situation we might be way too late. That's a situation that we do not desire. And for this type of situation I think we expect the prime procedure or training that has set of criteria when that's okay, that you can wait until when? After that point that you should do what?

Okay, but at least then this decision that has kind of action that's with high economical consequence, things -- so this type of decision --

CHAIRMAN STETKAR: You've used in a few places I've noticed, you use this term, well, decision making is important only if there is high economic consequences. I don't quite understand why that qualification applies.

You used it here on slide --

MR. CHANG: Well, this is a --

(Simultaneous speaking)

CHAIRMAN STETKAR: I highlighted it several places in the plan. It says, while decision making is important if there are high economic consequences involved. Decision making is, I mean, I don't know what to make of that.

MR. CHANG: Yes, that's, yes, well, okay, probably we need to broaden that. There's a competing goal. And then we need to identify down here that's, okay, no production, and the safety is a balance. We might need to think about the other dimension.

CHAIRMAN STETKAR: But let me understand this a little bit. The intent of this methodology is I as an analyst will come in and say, well, in the context of this scenario, I either satisfy bullet number one, bullet number two, or bullet number three. So I press bullet number two and that automatically applies a multiplying factor. Is that right?

MR. CHANG: No, not a multiply factor.

CHAIRMAN STETKAR: Okay.

MR. CHANG: It's just one of the factor characterized situation. We calculated the final HEP is looking for all these factors that group our factor together.

CHAIRMAN STETKAR: Okay.

MR. CHANG: And then the third one was, this was in the level two PIF here. This is a competing goal without concrete Go versus No-Go criteria. This in Westinghouse Severe Accident Guideline, SAGs, okay. When there's a SAG that depends on the prime, there's seven or eight SAG goals.

For example, the inject into steam generator. So that when all the steam generator that's level, they're engine level below 40 percent, you enter this procedure. And then the procedure come to the end, okay, you check later this afternoon I more detailed discussion about example.

Again though this procedure was, okay, the first thing you check is that you have a mean to inject, okay. And then the second you say, okay, you check that inject into a steam generator there's a set could have some side effect. Evaluate these side effect. And then the next step is decide if you want to inject or not.

So this kind of guidance that's for decision maker that a way, okay, I have benefits, I have this advantage of injection and then that is decision maker's decision to do or not do. And the good, the good thing in the SHE was, the SHE without action is acceptable. So do or no do, there's no correct actually right or wrong. That's what we saw that's kind of different type of decision.

So this also kind of reason that we put this three different type of decision here as one of these context factors affecting this to characterize the decision probability. One thing I wanted to say is these context factor here that all that SACADA type. We used the works, of few words to highlight it. And each item has a longer description or even a why example to relay what's the things that we are talking about in that.

So this one is kind of example that we mapping IDHEAS of casual factor with the context factors. And this just postulates. So IDHEAS causal factor in the detection state, information change over time and that requires a standard attention over a period of time. Is determining a trend. Okay, that's a causal factor in identifying in the IDHEAS.

And then how do you present to these context factors here. In a context factors that we have a display type. Okay, what type of display? It seems here that reading determining a trend some kind of like a recorder. That type of thing.

And then also have another factor catch attention. Three different options there for catching attention to do the activity. And maybe there's more corresponding related context factors that I did not list here.

And then the second one that's understanding the system behavior may be unexpected and unexplained. And in the understanding that we have a one context factors code familiarity and then has three options, standard, anomaly, and novel. Each one has an explanation associated with it.

So that works, it just tries to show the committee that the work we found it try to say, okay, there's a causal factor in IDHEAS and then now we translate to context factors. We do not lost the coverage.

CHAIRMAN STETKAR: I didn't, by the way, and I read through, I think that's Appendix D, where you try to make the link, I didn't understand that at all. I know it's a work in progress, but you need to work on that.

MR. CHANG: Yes, yes. Yes, and then that's also, I say it in a way that we modify context factors. I did not go back to modify the things, because expecting that we'll continue to modify. Then when to do that work, come to the final stage instead of now.

CHAIRMAN STETKAR: Okay.

MR. CHANG: So what we do is HRA, that worksheet, is that each macrocognitive function has a set of context factors. And in these context factors was in the worksheet. And this worksheet that we talk about is, in terms of, you can look as a set of context factors, but in terms of calculation of HEP, dividing based on how HEP is calculated. Dividing into four groups.

The first thing is the basic HEP. Basic

issue group. This means I'm performing this task. Okay, for example, identifying the broken steam generator example. These factors associated with identifying the broken steam generator it's a constant, the same. The measure is a simple steam generator that he brought you. Or that you have a combination, multiple failure of the steam generator.

These factors status should be sent. And then the second one is HEP modifier. Okay, basic HEP, this group based on this three or four factors together and then that's coming to the one basic HEP number.

And then the second was modified group. These are the situations that were less than optimal that could increase the HEP. And currently that we only taken from the IDHEAS the experience. These HEP model only increase failure probability, not decrease.

And then the third group was error recovery group. That's because there's additional mechanisms that can reduce the HEP like team recovery we mentioned.

And then the fourth group was a dependence group that how the situation, but this need to look into the scenario that's how the previous variable will come into effect at this task failure that's in the systematic amendement.

CHAIRMAN STETKAR: I think, let's see,

where's a good, you're going to have to tell me where a good stopping point is. Whether it's right here and it might be.

MR. CHANG: Well, we can --

CHAIRMAN STETKAR: You have, let me give you a hint. You have two and a half minutes to the stopping point. So we either introduce the equation now or we stop here.

MR. CHANG: Yes, equation, yes, equation. Got to talk about equation.

CHAIRMAN STETKAR: Now certainly don't want to get into more of the details after this.

MR. CHANG: Yes, so let me finish this equation slide. Okay, that we first calculate independent HEP and then from independent HEP calculate dependent HEP and then that final minimum. That if we have want to impose that threshold. So this is kind of three phases of HEP calculation.

And then independent HEP is a function of basic HEP, multiplier, and error recovery. In the multiplier here that's even there's a set of factors. Depends on what's the situation that an analyst would set.

That each factor now in that report we say, okay, there's multiple factors of two or five, but that doesn't means that it combined the factor. It would be just minimal modification. We still haven't figured out how to this combined factors effect.

And then same thing as error recovery. And then dependent HEP is a, that is not direct multiplication. Look at the current HRA practice. There's a function between the independent HEP and the dependent's effect. So we still taking the generic form of the effects into here.

So, yes, in the presentation that I will talk about the current of what we thought about the dependents and then ask for committee's feedback. But today that we'll probably talk about these minimum HEP, because we haven't spent time, spent effort on it.

CHAIRMAN STETKAR: Let's at least enter those as the basic format that you've set up for the quantification. And then after lunch we can finish up the slides that you do have on the quantification process. And I know we have a slide in for EPRI. I'm sure they're out there chomping at the bit.

We will do that. We may run a little bit long this afternoon, but that's okay. So with that we will break for lunch and reconvene at 1 o'clock.

(Whereupon, the proceedings went off the record at 11:59 a.m. and resumed at 1:05 p.m.)

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

(1:05 p.m.)

CHAIRMAN STETKAR: We are back in session. And as I understand it the Staff has proposed, and I do think it will help flow a little bit, for those following on your agenda sheets we're going to move line Item Number 11 up to the discussion following James's conclusion of the material that we were talking about before lunch.

I am going to ask, for those of you on the bridge line listening in, we had slotted at 11:30 till noon input from EPRI and I want to try to keep us a little bit on schedule in case people have problems out there on the West coast or wherever EPRI is calling in from. So what I'll do is we'll finish, James will finish the material that you were presenting before lunch then we'll take the time to get EPRI's feedback and then go into the demonstration.

MR. CHANG: Okay, thank you.

CHAIRMAN STETKAR: Okay. And with that we're back on the record. With blank screens.

MEMBER BALLINGER: Where's Smiley when you need him?

CHAIRMAN STETKAR: There we go.

MR. CHANG: The very first slides show that the current set of the contacts factors for detecting this cognitive function. The screen shown here, the first screen, is the factor for basic HEP factor.

The first one, catch attention, that we divided into three crisis. Likely, less likely, unlikely. This information there that's uploaded, notice that information, that aspect.

And then the second factor is display type. That was, okay, know that there's -- take the information from in terms of reading the information wrong. So these two represent intuitive in type of failure mode.

And catch attention here that occurs, there's the three different levels. The likely was that, meaning that we, for example say that, notice an alarm or there's alarm patterns stated that we, yes, notice alarm or notice a plant status from the offsite emergency phone calls so that information is called from the emergency phone call so that, okay, operate will be likely to take their call and then get the information.

Or it's directed by procedures. They check that piece of information so that, so this type of, we going to the likely crisis.

Again, for either description in the less likely situation here, that may be something like same monitoring. Monitoring the parameter in the full operation.

Okay, these are the parameter that you need to monitor. Okay, so that could be one of the situation in the less likely situation.

For display type we've got, so essentially take these seven different instrumentation from the table. That's, in the row we may need to update, modify these.

Information familiarity, that was stretching one of the things that earlier that causal factor basic characteristic information they need to know that information.

Okay, in most situation that's certain they would know the situation, but maybe in some certain situation the person detecting information, information presented there, then they know what that information means. So that's, we put an option here, familiar or not familiar.

And then the communication. To apply this information, what's the communication scope needed for applying this information.

Normal, just is this individual inside a controlling type of setup. Extended, that control on sight.

And offsite that means, offsite this would get me to, offsite fire brigade, they have a set agreement and then has joined exercise in an annual basis. So they have communication that, for his cooperation.

And then offsite extended, that means that something is beyond. There's no agreement of statute but need to bring in the people. So that's why we divided these communication scope into these four crisis.

And these four contextual factors, characters, belong to the basic HEP factors. And then come to the HEP multiplier factor here.

CHAIRMAN STETKAR: James?

MR. CHANG: Yes.

CHAIRMAN STETKAR: Let me, I'm still struggling with those whole process. In the report there's a Figure 9, and I was looking to see if you're going to get to it but you're not, so I'll ask you about it now.

Figure 9 is a little logic structure that for the detecting macrocognitive function and it's got your catch attention, it's got information familiarity and it has communication scope with the attributes that you listed here. It doesn't have display type. So apparently --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- the display type actually does not affect things?

MR. CHANG: No, it's putting the modifier.

That factor that's here, that's --

CHAIRMAN STETKAR: Oh, okay. So it's not a contributor to the basic HEP?

MR. CHANG: Well I was saying it's more based on the disciplination, this here it's a process.

CHAIRMAN STETKAR: Well no, honestly --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- this is a really complex process and if I see something in a presentation today that says these are the things that I should think about as contributors to the, what you're calling the basic HEP, and yet in the report I see a different logical construct that leads me to real uncertainty about how this whole process works. Even more than I had trying to work my way through the report.

MR. CHANG: Okay.

CHAIRMAN STETKAR: So I hate to keep bringing this up but I'm trying to understand. I read through the report, I didn't try to study every word in the report because quite honestly I got lost a lot. And now I'm not sure how I'm, to interpret the report you keep saying, well it's a work in progress. But it's difficult for me to now understand how much in progress it is versus what's final.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And when in see figures and logic structure and numbers and then at presentation I see kind of a different construct, that starts to get me foundering about not understanding where we are in the development of this whole methodology. Follow my problem?

MR. CHANG: Yes, but, yes. Yes I think I understand. I trying to think about what's the figure you're mentioning in --

CHAIRMAN STETKAR: Well Figure 9 is actually, it looks like a little event tree.

MR. CHANG: Okay.

CHAIRMAN STETKAR: And then across the top in the caption is, the basic HEPs of the detecting macrocognitive function.

MR. CHANG: Yes.

CHAIRMAN STETKAR: Okay. And across the top there are three things listed and they are called catch attention --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- information familiarity and communication scope.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And under those catch attention has three possibilities.

MR. CHANG: Yes.

CHAIRMAN STETKAR: Information familiarity has two and communication has four.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And depending on the combinations of things there's a number.

MR. CHANG: Oh, okay. Yes.

CHAIRMAN STETKAR: But here you've identified display type as something that also effects the basic HEP. So does it or doesn't it?

MR. CHANG: It does.

CHAIRMAN STETKAR: It does?

MR. CHANG: Yes it does. Yes this, sorry that, ones that we reported as acting, I took down the reports and then prepared the slides.

When I think about it, what's the principle? We say that basic HEP was the principle. We indicate when these are modified.

And then one principle was that this, in the basic HEP the states should not change from scenario to scenario for the same task.

So if I'm detecting that the steam generator has ruptured, has broken, okay, the communicator there, it is a simple steam generator rupture scenario. That indication should be the same.

It's the distinction of water level that radiation indication can, these things shall stay the same. So in the report I predicted that I put a piece of pipe in the modifier and then when I prepared the presentation I said, oh no, this should be in the basic HEP so that I can move it here.

MEMBER BLEY: So this is changing every day?

MR. CHANG: Yes.

MEMBER BLEY: The amount reporting on what's in the report, you're reporting on your most recent ideas since the report of a month ago?

MS. XING: Yes, that's, at this stage I would rather say there was presenting here. On these slides is a mock-up to demonstrate how we are going to work on these.

To plan for the project is, after we dump, we had a mock-up version it may not be accurate but we try out, in SAMGs examples as James did.

And the eight phases are the right way to go. If we fill this the right way to go. So the plan for 2014, since we're going to have expert elicitation for the HEP, we will use the expert group to do these kind of a classification.

Say if James thinks these critical paths should be, belong to the basic HEP, we'd like for us to operate on other knowledge of experts, what they think based on the principle that they described, should they be here or be at a different category.

MEMBER BLEY: So we're pretty far away from a --

CHAIRMAN STETKAR: Yes, and I think some of, so let me just take this at face value, what we're starring at now on the screen and put it into the context of the report. In the report there's this little tree that gives me all of the logical combinations of catch attention --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- information familiarity --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- communication type and scope. And there are 24 combinations and each of those combinations is assigned a basic HEP value.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And some of them have the same basic HEP but let's just say there's 24 combinations. Now if each of the display types now effects the basic HEP, we now have 168 different combinations because there are one, two, three, four, five, six, seven times 24 is a 168.

So you're proposing to have a 168 different basic HEPs in principle?

MR. CHANG: Yes, principle yes.

CHAIRMAN STETKAR: Does that make sense?

MR. CHANG: Coming to the end maybe you see there's a certain way, this is just a, provided these are the factors we considering in this basic HEP group. And then well yes, based on the, each has a number that's coming to the 170.

But down the road we are coming to the expert elicitation and the process may be merged into a less crisis --

CHAIRMAN STETKAR: But in principle you'd start off, as I would say, that this Figure 9 as an expert I would be asked to think about 24 different discreet combinations. You'd ask an expert to now think about 168 discreet combinations and then decide which ones were, where the differences were not different enough to combine them or assign the same basic HEP.

Is that, am I interpreting that correctly or am I misinterpreting something?

MR. CHANG: Well yes, if we do it with just the process that would be the case, but the other way would be coming, if stereotype was the meaning, the detecting while reading. Maybe we can shrink these seven into two, three, I don't know.

CHAIRMAN STETKAR: All right, go on.

MR. CHANG: Yes. So indeed these are four factors forming that their basic HEP. And then coming to the second here, we have two slides talking about HEP multiple factors.

The first one is amount of information. This was, depends on what's the subtask we find, that's a maybe. But on our info sheets shows that there's several, detected several pieces or parameter.

And maybe, it's a simple that's a one, allowing them coming in, detecting that piece. So that's just a mound of information need to be detected in these subtask.

And then information appearance. These squares means that there's multiple choice could happen. So there's, no mimic of information, similar displays, information filter.

That's something like smoke between the individual and that indicator. That kind of information filter.

And masking information. That's a, the LOCA in free water coming in and then you have sometimes a steam generator rupture. So that's water level that did not really indicate a distinction to plot a scenario.

Now poor label quality or delay of

information. This happen often in the simulator training. They feed into the operator about it, the information they need.

And then the second category is about information content and display. That's striation that's, say that's one, two, detect --

Apprentice explains state of RPV water level that can be detected from the same multiple way to indicate. And then this operator was trying to find what's the most, the primary default parameter to do that.

And then finally parameter may not be available in that situation and then would they be, rely on that primary parameter or to be able to check the redundant information to come out to the right conclusion.

And then there's unreliable indication and then faulted indication. Faulted indication here, that was explained in a different model. Varied that there's separate switch on and off.

And then for it, it should be on but it's not displayed. And so this, detecting this, because operators are trained not just to rely on a single parameter, single indicator to come to the conclusion and they need to check the redound auto to associate information.

So that's about, this is showing you, you say, well if that one pieces of information they could go rely on is not, is that wrong state or they be coming, would rely on this auto association information come to the right conclusion of detecting.

The second setup after here is some kind, we call this kind of overarching factors. This --

MEMBER BLEY: James?

MR. CHANG: Yes.

MEMBER BLEY: Let me ask you a kind of large conceptual thing because I've been having a little trouble with this too.

This idea of a basic HEP, it seems to me what you've done is really borrow a concept from NARA where NARA has its general task types. But each of those tasks types, some of them have a lot of context embedded into them.

MR. CHANG: Yes, yes.

MEMBER BLEY: And then following that there's another multiplier to extend the context in some ways.

MR. CHANG: Yes.

MEMBER BLEY: When I look at Figure 9, which is, I hate calling it an event tree because it isn't, it's really a context tree that defines 24 different contexts.

MR. CHANG: Yes.

MEMBER BLEY: That are really defined elsewhere. And I think this causes everybody a little trouble, that idea of the qualitative analysis and how it generates the context such that when I come to Table 9 I know the catch attention is less likely and information familiarity is familiar and communication scope is extended.

That's one, that defines one context of this most straightforward type. Most straightforward based on these three characteristics.

MR. CHANG: Yes.

MEMBER BLEY: And we're calling each of those a basic HEP even though it's got a great deal of context imbedded into each one of them.

MR. CHANG: Yes.

MEMBER BLEY: And then you have another multiplier to cover a separate set of things that you decided for some reason not to build into that tree structure.

CHAIRMAN STETKAR: Which are also part of the context.

MR. CHANG: Yes.

MEMBER BLEY: Which are also part of the context.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And another multiplier to, or a divider if you want, to account for things called recovery which are also part of the context.

MEMBER BLEY: Yes.

MR. CHANG: Yes. All these are context factors, yes. But the, that's right. But in terms of actually calculating the HEP for us we have different roles.

MEMBER BLEY: Yes, I guess it's the roles that aren't clear to me. It seems that we've got a jumble of a whole bunch of things that most of which, we need to change, maybe not everything, most of which were talked about in the framework and for some purpose it's not transparent to me broken them into these different categories.

CHAIRMAN STETKAR: When I read through it I harkened back to the days where analysts sat in a room and kind of lost the sense of the context but searched through THERP and said, oh, here's a number from table 20-13 that sounds like throwing a switch and I have to throw a switch so I'll use that number for throwing the switch.

MEMBER BLEY: But this seems much different is much of, almost everything we're looking at our contextual issues that are set in these HEPs. They're not simple, turn a switch, start a pump, follow procedure steps.

CHAIRMAN STETKAR: They're cast that way. The problem is, in practice I'm concerned about people trying to use this methodology and falling back into the trap of, check off a box and look up a number in the table.

MEMBER BLEY: That's how we --

CHAIRMAN STETKAR: And losing that.

MR. CHANG: Yes.

CHAIRMAN STETKAR: We're trying to avoid that.

MEMBER BLEY: We would like to avoid that.

CHAIRMAN STETKAR: We would like to avoid that.

MEMBER BLEY: I think, I'm sorry for my little soliloquy here, but the thing that's kind of slipped form the focus and to me is the number one focus is that part of the qualitative analysis and development of those crew response trees that really allows you to define, to search for and identify all these things we're now sticking into a quantification machine.

And if you don't do that part really well and thoroughly then none of the rest of this matters much. It is, as John says, just plucking things out of the air kind of. And maybe that's to come, but it's, it doesn't jump out at you when you read the document.

MR. CHANG: Okay, yes.

MEMBER BLEY: How important that is.

MR. CHANG: That means probably there's --

MEMBER BLEY: And then those workshops that you're going to talk about later, we had trouble, people would look at trees like, this Figure 9 tree, and think about how likely it is. And they had real trouble divorcing that because they didn't have that basic structure of how you build the qualitative part of the model first.

MR. CHANG: Right.

MEMBER BLEY: So it's a serious problem and I think it could lead to the kind of thing John's worried about.

MR. CHANG: Yes. Let me back up a little bit. The reason we have this contractual factor, okay, they was trying to find in region that, come to the end that we had HRA answer, okay.

Who will be the issuer that PI partition or HRA partition? And then or even our regions, that's things that we try to say, okay, given this situation here that, okay, the weight, can we use the language that's you either use to identify okay, so should be Option 1, Option 2 or Options 3, okay.

The way that the language reads they always think that it's more intuitive to learn. And the second that's, we mentioned that Appendix D that had been standards, okay, that's cause effective referring in the IDHEAS method. And then that's a way to identify these sort of, there's different terms that contractual factors.

We try to see that, okay, how will all these factors cause effect in this contractual factor. That's what we tried. But we need to do a update of Appendix D but that's way after we get, assuming we need to update.

And then the third one was okay. Now here we are considering look at this factor here. We will consider that there's probably 20, 30 factor. Each factor has -- at least find the mistakes

And in terms of the more practical, to capture HEP as can ask the experts, say okay, there's a two times 20, that's a 2,000 whatever combination. And then let's asked them to achieve HEP. Well I'm not sure that's practical.

So we come up, we need to make this process more practical. The NARA that uses this as basic HEP and modifier and then recover this. We thought, okay, wow, without these type, we get approximate there's a, make this thing become a more practical for use.

So that's kind of the reasoning behind it coming to this set that we are grouping these extra contractual factors in these four groups.

CHAIRMAN STETKAR: Okay.

MEMBER SCHULTZ: I think you need to have your meeting because the way you've described it and the way this is developing is very complex. The level of detail that is being established to present to experts for elicitation is overwhelming already.

MR. CHANG: Um-huh.

MEMBER SCHULTZ: Just based on three slides. To me.

MR. CHANG: Yes.

MEMBER SCHULTZ: I just don't understand how that's going to happen or how one would bifurcate all the information and put it into some summation tool.

MR. CHANG: Um-huh, um-huh.

MEMBER SCHULTZ: Because I think, well you'll find that out I think when you go to the meeting and have, talk to the experts about, what do you think this would, how would you quantify this and --

CHAIRMAN STETKAR: Well the problem is, if he talks to experts who grew up using THERP --

MEMBER SCHULTZ: Yes.

CHAIRMAN STETKAR: -- they're really comfortable thumbing through pages of things or they've even automated stuff where you check off little boxes and bam, a number gets put in and things get added and multiplied --

MEMBER SCHULTZ: That would also be my concern.

CHAIRMAN STETKAR: -- and you've divorced yourself from actually thinking.

MEMBER SCHULTZ: Right.

CHAIRMAN STETKAR: People are really happy with that. I don't have to think, I don't have to --

MEMBER SCHULTZ: Well on each of these slides there's a completeness issue. You've got a list of four or five things on this one. Five large boxes and there are things missing. Could argue about that.

There are things here that, there's no priority associated with either of those elements. That's what you have to identify for that.

MR. CHANG: Right. These are no priority --

MEMBER SCHULTZ: Yes.

MR. CHANG: Yes, there's no priority. Depends on their situation. And then the things we tried to do was, okay, these are coming to the end, there's 20, 30 factors and then check out the status of each factor and then look at this, okay, holistically doing, okay, now these are combined status, what's the 1:31:41.

That will be argument situation. But if that's, because the down role combination we cannot deal with that, how we are going to the more approximate practical way.

MEMBER REMPE: I have to go to a meeting at 2:00 and so I may not be here late but I, and I fully appreciate that I don't understand a lot of what I'm hearing because this is not my area. But aren't we supposed to be using this method for the Level 3 assessment?

CHAIRMAN STETKAR: This is the generic methodology that should apply for any type of human action that can be defined in Level 1, Level 2, Level 3, internal, external events, low power shutdown, full power, you name it. Yes.

MEMBER REMPE: Yes, but isn't this method supposed to be ready to use for the Level 3 assessment that the staff is doing?

MEMBER BLEY: Originally that was a --

CHAIRMAN STETKAR: That's a scheduling issue, that's not a technical methodology issue.

MEMBER REMPE: Well I am curious, is that's still the guidance that was --

CHAIRMAN STETKAR: The Staff has to figure out what they're going to do in the Level 3 --

MR. PETERS: Yes, the Level 3 Staff is still determining how they are going to progress with their analysis. But what our driving factor was, we were trying to get this methodology in a state where it can be used for Level 3 if it's the one Level 3 team chooses.

MEMBER REMPE: And is that still your hope?

MR. PETERS: It is my hope yes, because we have a commissioner who most likely on March 3rd that will probably ask that same question.

MEMBER BLEY: Just an aside, that has two implications that are potentially troublesome. One is if the Level 3 folks decide, oh, we won't need to use the HRA method for two years, that gives you more time to turn this into a operational method.

On the other hand if whoever is doing the HRA is not involved in the PRA as it's developed, that leads to maybe even more significant problems later. But that's not for you, we'll talk to the Level 3 folks about that at some point.

CHAIRMAN STETKAR: That's more, I mean in some sense then if the qualitative part of this, in terms of defining the HFEs and the scenario context is in better shape, that alleviates a little bit of a concern.

MEMBER BLEY: It does. It's certainly not in terms of guidance you see in the methodology document. I don't think.

CHAIRMAN STETKAR: Not completely, that's true.

MEMBER BLEY: I mean I would have trouble handing this document to a third party and say, go do the qualitative part of the HRA to support PRA, given the way it is right now.

CHAIRMAN STETKAR: Certainly in getting to the point where you define coherent human failure events that then need to be quantified somehow.

MEMBER BLEY: An associated context --

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: -- of various places in event trees. Yes.

CHAIRMAN STETKAR: Yes.

MR. CHANG: Okay. So this slide talk about context factor. That has a peer checklist, first and behind the individual, the principal respondent and supervisors presence.

And then the other was the redundant information. Says that this indication that maybe coming to a different pieces of information in the time of sequence they are, the individual maybe miss the first one but was detected in the second piece of information and then leading to the detection.

Fresh mind, that's means a different person but the same cue. Same information there but just because of different people coming in has fresh mind to detect that. And then, so each of these has a different weight of performing and recovery.

Okay, now here's the contractual factor that's, they can see that name down at the very bottom label. And then at the top there's four labels. There's a cognitive causal tree.

Now this is a contractual factor we can link to the context characters. And then that's a link from a causal factor, and then this link is the one that we have a difficult support and then.

So based on what's the contact, the situation that our analysts check, okay. This relation link already made there, that represented the relation indicated in the cognitive causal tree and then it's the brown arrow line that, again, the phase on the check that we can systematically trace back.

Trace back, identifying what given is the situation, what's the likely error that they would made, what's the likely causes is there.

A lot of decision, one thing that we talked about is, decision was that we talked about Go and No-Go result, concrete decision. This was the type of decision we did not see in the situation.

The difference is that no explicit reference or correct or incorrect decision. And then that branch probability, this we are not going to, we talk about SAGs, severe accident guidance, go into that procedure that there's no requirement needed to action. So that's an action or no action, there's no correct or incorrect reference in terms of procedure.

So that's a probability. It did not represent a human error probability. It just represented probability effort, choose do that or not do that. Okay.

So this type of decision that's considered a factor is different from the sets that we are presented, that's most likely you have a right or wrong references. And later I will present, in my example I will present this type of position and the all current statements are false.

Just example here that's, for example, Severe Accident Guidance 1 that's injecting into a steam generator, that's PWR. So that procedure say that, okay, well if you now enter into this procedure that all steam generator water labeled, never reach below 40 percent.

So if the procedure tells, the guideline tell us, operators say okay, don't inject into the, what's the possible length of impact, the steam generator will not be a heat sink for RCS. Steam generator tube integrity may be threatened.

Steam Generator cannot be used to depressurize the RCS. And then the scrubbing the fission products from any steam generator tube leak will not occur.

So procedure identified at this level, to this level, okay, for although to know that okay, that's a possible consequent if not inject into the steam generator. And procedure also provided that if you inject into a steam generator, what's possible side effect.

And that's okay. If you are feeding into a hot dry steam generator then it could cause the thermal shock in the steam generator, cause the tube rupture.

If feeding into a ruptured steam generator or leaking steam generator, then fission products would be released. And then the other, if the pressurized steam generator with low water level, the steam generator tubes creep rupture may occur.

So the procedure, most of the procedure provides example, more concrete, say okay, how do you determine if it's hot and dry steam generator, okay, that has the same parameter? Our figure has the parameter associated with a number.

So that's coming, our first strictly follow the guidance, okay, that's temperature exceeding this point and then that's, if the steam generator is dry and hot. So that could cause a thermal shock.

But the procedure didn't, the guidance didn't say it was okay, now you have this information. Whether you should inject or not inject.

That's leaves this decision to the operator -- I'm sorry, to a decision maker. And this, so we see this as a different kind of decision different from the Level 1 type of practice.

Okay, Jing suggested to me to skip the dependence.

MS. XING: Yes, given the time we have for today maybe it's ready for, the next part Jim was planning to talk about, dependency. So --

CHAIRMAN STETKAR: Let's skip that. I think that's probably --

MS. XING: I mean it's entirely --

CHAIRMAN STETKAR: In the interest of time --

MS. XING: -- in the early stage, it's just some thought. So I think for the time --

CHAIRMAN STETKAR: Unless some of the members really want to hear about that?

MEMBER BLEY: No, but I don't know where all you've looked, but there is quite a few places where there's a lot of available material on the different kinds of dependence. You need to track through this analysts.

MR. CHANG: Yes.

MEMBER BLEY: I trust you'll be consulting those.

MR. CHANG: Yes. I would suggest that the next time we go back, come back to the committee to present a more mature subject on dependence. And, well I think I will skip the minimum joint HEP as well.

MEMBER BLEY: Let me ask you one last question though.

MR. CHANG: Yes.

MEMBER BLEY: This NARA like thing you have in your basic HEPs and then these multipliers for a catalog of different things that could be there, NARA gives a big warning to be extremely careful if you get cases where you would have a multiple multiplier factors going on, maybe even get absurd results pretty soon.

MR. CHANG: Yes.

MEMBER BLEY: Your document doesn't hint at that. It's something to think about.

CHAIRMAN STETKAR: I found that --

MR. CHANG: Right.

CHAIRMAN STETKAR: The sentence does appear in there somewhere.

MEMBER BLEY: Does it?

CHAIRMAN STETKAR: It does, yes.

MEMBER BLEY: I apologize.

CHAIRMAN STETKAR: I remember reading it.

MR. CHANG: No, it --

MEMBER BLEY: In any case there's a --

CHAIRMAN STETKAR: I don't remember where.

MEMBER BLEY: -- there's a lot of factors and all of a sudden this could --

MR. CHANG: Yes. It's now, we now have this response, problem that all our staff using this and try to avoid double counts.

So that's, when that's like a stress and then the time constraint. This kind of activity is associated together so they have conscious awareness when that situation occurred, which one they use to prevent double count.

And generally we talk about using, that how we --

MEMBER BLEY: But there's nothing in here like that.

MR. CHANG: No.

MEMBER BLEY: I mean you don't link any of these --

MR. CHANG: Oh.

MEMBER BLEY: -- the ideas that lead the multipliers back to the framework and --

CHAIRMAN STETKAR: As best as I can, there is, you know --

MEMBER BLEY: A warning.

CHAIRMAN STETKAR: There is a statement that parrots the words that you said and that James mentioned in the text, but I couldn't see how the actual implementation of the proposed addition multiplication stuff really accounts for that in practice. Because it just seems to be, you get a 1.4 from this and you get a 2.7 from that and you get a 6 from this and you multiple them all together and they come out to be, you know, 136 or whatever.

MR. CHANG: Right. As I mentioned earlier, that not all of these factors we put in here is kind of, in the first folder, and then how they combined integrated effects. That we haven't developed yet. Any questions?

MEMBER BLEY: There's a lot of multiplier factors.

CHAIRMAN STETKAR: There's a lot of factors.

MEMBER BLEY: Yes.

CHAIRMAN STETKAR: Now I guess in closing on this topic I'll just come back to, my personal on ease is that we're very rapidly developing something that pays lip service to context but indeed sounds and practice an awful lot like THERP. Check off a box and pick a number out of a table and if you have to multiple 15 numbers together then the numbers get multiplied together.

Whereas there may be a different way of addressing the problem that retains the analysts focus on the context without subdividing it into so many small partitions that the analyst basically forgets that context. And I think Dennis was saying, and I feel the same way is, I don't see that guidance in that methodology that keeps bringing the analyst back to that scenario context.

You know, it's not so important that I have a gauge that's got an orange pointer that looks vertically or I have a strip chart that prints with blue ink and yellow ink that goes vertically, it's more important to understand that there's a heck of a lot of other stuff going on in the control that could divert everybody's attention to something else. And that's a scenario context, it has nothing to do with the particular indicator that I'm looking for in the very narrow focus of this particular number that I'm trying to derive.

MR. CHANG: If I, the analysts, when they did the process there that from the event tree come to the crew response tree that we inspected, detecting the crew response tree there that the analysts are, qualitative analysts is knowing that what's the situation leading to there. And now these are coming to assume, assuming they have, we are assuming that they already have that scenario in mind and then they communicate here, say okay, based on the understanding of the scenario sequence leading to that point that what's these contacts fractures.

CHAIRMAN STETKAR: I think that --

MR. CHANG: What the striation looks like.

CHAIRMAN STETKAR: I think that, I hear what you're saying. I also read these reports in the hierarchy that I'd like to think of them. The psychological basis framework, the generic methodology and specific applications of the generic methodology.

The generic methodology report right now just says, well yes, we're going to use the crew response tree and go look at the internal event procedure driven in the control room application report to understand what that means. There's no crew response trees in here, there's no, if I'm going to use this methodology for evaluating a seismic event that breaks pipes and floods the basement of a power plant and disables all DC power, for example, I don't understand how that crew response tree construct keeps me focused on that type of scenario in a generic methodology.

Because I'll I have is a reference that says, oh, go look at this thing that's been specialized to procedure driven in control room internal event responses for the way to think about that.

MS. XING: In the generic methodology in the qualitative analysis structure we have two elements that were not in the IDHEAS report for internal procedure to handle this situation.

The two elements, one was a cognitive test analysts, the other is a work load and that timing analysts which specifically asks you. Even if you define a success task in the CRT fashion, which are the tasks that you have to do to do Task A then follow by Task B, you still need to look at what are other things going on when you do Task A.

Like there's a distraction, there's other things and finish the things from the previous task from the previous event. You identify all this and they will be counted as the number of the simultaneous tasks, the number of amount of distractions and also time pressure because if you're doing these other things, it takes your time away.

So this would be all to the basic HEP calculation. That's how we tried to capture this context. So even you are look at this individual task, you look at all these other things happen, how to extrapolate this task. That is a part in the work and workload analysis guidance.

CHAIRMAN STETKAR: Okay, well we're running, I mean my comment is that's a different construct than those crew response trees. These again are just simply telling people to think about this stuff.

MEMBER BLEY: One of the unifying thoughts that came out of the International and U.S. benchmark, you called them something else right, bench marking studies, was that one of the biggest gaps in most of the methods that were out there, before this, was really clear guidance on how to do, in fact, qualitative analysis. Told a story of things affecting the scenarios in the event tree that can lead you to the crew response tree and that wasn't part of the discussion.

And I think we're still in that same boat. That's a place we haven't put the effort in. Unless I'm missing it somewhere, it's in the document that slide off in my radar.

And the quality of everything that comes out of it is really hinged at doing that part well. If that guidance is around I'd like to get pointed to it because I'm not sure where it is.

I mean there was a lot more of it in ATHENA then I found in here. And I think we need it.

MS. XING: Okay, yes.

CHAIRMAN STETKAR: Let's, any members have any more comments from this? What I would like to do, John, can we get the ---

MEMBER BLEY: Sure.

CHAIRMAN STETKAR: I'm assuming EPRI is still out there. We have a line item on our agenda for EPRIs perspective and I, in fairness to them they're now two and a half hours later than what they were originally planning and --

MEMBER BLEY: It's lunch time.

CHAIRMAN STETKAR: No, it's 11:00 on the West coast. If they're West coast.

MEMBER BLEY: 10:52.

CHAIRMAN STETKAR: And if they're in Charlotte it's after lunch, so.

MR. CHANG: Yes, EPRI people are now in Florida.

CHAIRMAN STETKAR: They're in Florida?

MR. CHANG: EPRI, yes.

CHAIRMAN STETKAR: So they're on our time zone.

MEMBER BLEY: Oh, they're in a meeting --

MEMBER SCHULTZ: They've got other committees.

MEMBER BLEY: Was the mic open?

CHAIRMAN STETKAR: We're getting it open. They may have given up. I hope not. Hold on, here we go.

MS. PRESLEY: Hi, this is Mary.

CHAIRMAN STETKAR: Okay. Who's on from EPRI?

MS. PRESLEY: Hi, this is Mary Presley.

CHAIRMAN STETKAR: Hi, Mary.

MS. PRESLEY: Hello.

CHAIRMAN STETKAR: We really apologize we're, if you've been listening in you followed how we got to where we are, if you haven't been listening in I apologize for being two and a half hours late, but if you could we'll give you your time to give us EPRI's perspective so that in case you do indeed want to hang up the phone and run away you can do that for the rest of, what's left with the afternoon.

MS. PRESLEY: Yes and I only have one slide so it will be pretty quick. We have been involved, as you know, in the, guess the IDHEAS technical basis report but not in the generic methodology.

So I can't comment on the generic methodology at all because we haven't seen it. We got our copy of it last week and we haven't had a chance to look at it yet.

CHAIRMAN STETKAR: Okay.

MS. PRESLEY: But we believe there's a lot value in the ideas technical basis document. And there's a couple things I want to cover so I'll just go straight to the slide.

We tried to socialize this with our members, let me clarify. Our membership includes all the U.S. utilities and a handful of International utilities.

So we tried to socialize this method a little bit and it's come up in a couple places where we thought particularly this method would be useful to fill the gap where other methods don't quite look at the things that we needed to look at. And we found a couple barriers that we believe the method could actually use to do any analysis or informal piloting of the message.

And three kind of major barriers. One is that the message isn't complete. Some of the decisions trees don't have numbers associated with them. And full on control actions, we still don't have a great way to model those.

The second is that there's this except that there's not consensus, can you guys hear me?

CHAIRMAN STETKAR: After the word consensus you sort of dropped off the line, so.

MS. PRESLEY: Oh, okay. Let me take you off --

MEMBER BLEY: That's good now, we can hear you well.

MS. PRESLEY: Okay. There's a perception that there's not consensus to be, within the NRC, on acceptance of ideas. So there's not that emphasis from the utilities perspective to apply it if it's not going to be accepted anyways.

And then the third, just in terms of piloting the message, a lot of the utilities are already very consumed with their existing workload so without a strong motivating factor like, they know the NRC's going to accept it --

CHAIRMAN STETKAR: Yes.

MS. PRESLEY: -- analysis is studied in this method. It's another barrier I guess to having the industry test or pilot the method.

So those are the three reasons we haven't really used IDHEAS as much. So that's the bad news.

The good news, on the other side they said we are starting to look at how we can apply the insights into the existing methodology, so we're already using the qualitative analysis, pull that into our training of how you do a qualitative analysis.

We're starting to look at the questions that were defined and the definitions that were used in the branch point and figure out where those are applicable and what we're doing now and provide additional guidance. And then we have a task to look at IDHEAS as a way to see how, I guess, mental model problems or areas in general.

The topic is, is part of the analysis. So the good news side is there's been a lot of work done in the IDHEAS project but we're trying to capitalize on them in what we're already doing knowing that there's a barrier to actually changing methods.

In terms of path forward where we see our role or trying to be helpful, there's a big TBD there based on kind of our funding and new priorities. But there's three areas here we're sort of already doing work and would probably mesh with what the NRC is working on.

One is participation and testing in the user's guide, the other is the generic guidance that the NRC has put together. The generic methodology which we haven't reviewed, we have to peer review that.

And then also we have been listing EPRI projects in various areas of external flooding to see how what we're doing there does or does not against the generic guidance and generic methodology that they are providing. Part of that, we have a proposed project, which isn't permanent whether we're going to do it or not, is to do a gap analysis of low power shutdown set for Parking Level 2 event against current methods.

So, Steve, what parts of those, the actions in those areas are handled with current methods and what parts of those actions aren't handled with current methods? And I think the decision making portion, which the generic item is getting at, is what's those areas.

And then to see, I guess, if the generic methodology does actually cover that. And then the third bullet point is dependency, including minimum joint HEP.

I did want to comment that the EPRI report that's out there is published as a technical update, which means it was put out as kind of a straw man to initiate this topic and is not a final decision.

And the 1E and a 6 number, we don't advertise that we have a strong technical basis for that. The reasons the 1E-5, 1E-6 numbers where in there as a basis for discussion is because other industry documents have been using those numbers.

And so I think somebody mentioned we seem to carry things forward and they just become gospel. It's not intended to be gospel it's intended to be a point of discussion.

And we tackle in that document that there is ways to show independents. So the minimum joint HEP, again, I'm not that familiar with the generic methodology because I have not been able to read it yet. We don't want to see hard lines where the hard lines aren't justified.

And then finally, the last bullet, our recommendations NRC passed forward. Particularly in the quantification of the remaining trees because that's where they're going. We believe that --

CHAIRMAN STETKAR: And this --

MS. PRESLEY: -- whatever, I'm sorry?

CHAIRMAN STETKAR: Mary, just to make sure that I understand, when you say, quantification for the remaining trees, those are the remaining decision trees within the context of the internal events analysis --

MS. PRESLEY: Yes.

CHAIRMAN STETKAR: -- right? Okay, thanks.

MS. PRESLEY: Again, we got the generic methodology --

CHAIRMAN STETKAR: Right.

MS. PRESLEY: -- last week so we haven't reviewed it yet. I don't know what's in there, I apologize.

CHAIRMAN STETKAR: Yes, okay, thanks. I just wanted to make sure I understood that, that last bullet there.

MS. PRESLEY: There was the idea, I think, that we wouldn't use an expert elicitation process but use a different process by which to get those numbers. And we just want to stress --

MEMBER BLEY: Well --

MS. PRESLEY: -- what the process that's used to get those final numbers that we have a good testing process by defining some representative use cases and assure that the output is reasonable. Because we have 14 different decision trees, we don't want to get into a point where we have an aggravation issue because we've been conservative in our quantification of the individual trees.

So we just want to emphasis that point and then also bring up this link to SACADA or other simulation data collection. What can we do to make sure in the future we can justify or improve the quantification values that we have?

Because right now, you know, most of the quantifications that are used in the industry are based on judgments. And the more that we can validate that in a practical way the less arguments they'll be.

So I know SACADA is doing good work, I don't know exactly what the link is between what they're doing in the quantification portion and IDHEAS. But it would be very nice to see that link be linked.

MEMBER BLEY: Mary?

MS. PRESLEY: Yes.

MEMBER BLEY: This is Dennis Bley, what have you folks been thinking about as an alternative to expert judgment for dealing with those decision trees?

MS. PRESLEY: I heard a proposal, it's not from us because we haven't been involved in that, we haven't really been involved in this project after the report that went to ACRS to be completed, but there was that are just to this, a proposal that's doing some sort of comparison between the decision tree and existing methods and trying to extrapolate numbers.

Jing, I'll let you speak to that one.

MS. XING: Thanks, Mary. Actually I don't have much to say on that. When, at the end of our IDHEAS development project we had two decision trees that we couldn't, our team couldn't agree on and we couldn't get an expert to agree on what this tree really means.

One tree was miscommunication, the other was choose the appropriate strategy. So we didn't have any information, we didn't have much solid information of those two trees, we don't know what to do with these two trees. That's the situation that still remains now.

And they are a couple other trees, I don't remember how many of them, we couldn't get the final HEP number because we, either the information from the expert was incomplete, insufficient or they're too diverse to resolve the strong technical basis for their number. So we couldn't get them.

MEMBER BLEY: Well here's the place I was involved so I can just offer clarification.

MS. XING: Yes, go ahead.

MEMBER BLEY: In those workshops we ran out of funding essentially before we got through all those so I think those places where there were disagreements and the places were there weren't estimates could be done if you got a group together to do it.

MS. XING: Yes.

MEMBER BLEY: It's just they ran out of time. We tried to do an awful lot in a couple short, not so short, couple week long meetings.

But that thing, you said, deals with this issue of coming up with an alternative to expert elicitation to fill in those fairly complex combinations of contextual factors in the decision trees.

MS. XING: Yes.

MEMBER BLEY: Is there anything, for the --

MS. XING: That's what we think --

MEMBER BLEY: -- life of me I don't know what it would be?

MS. XING: -- the worksheet is in the more or less ready shape where we start an expert elicitation for those. But until we, as you see from Jim's presentation, that part is still in the developmental stage.

MEMBER BLEY: Okay.

MS. XING: And if we don't, we only have limited resource for expert elicitation so we won't save till the end. Therefore for the IDHEAS for those trees that no number, we think the alternative strategy is, in standard to having a, like levels recheck are very formal expert elicitation process which means brings expert together for a couple workshops.

We might use the information we got from the two workshops previously and the work in the way like a remotely work with some expert to see if we can come up with some number. That's an alternative strategy.

MEMBER BLEY: Okay, thanks.

MS. XING: And the way IDHEAS team did not, we didn't reach that decision mainly because some members on our team strongly, basically did that approach. Think that means some members are good.

Not say good but have the better basis with this formal expert elicitation process. Now if you put some numbers that did, that are not generated in the same manner which would degraded the quality of the entire method.

So however we have to consider our very limited resource we, our current plan for 2014 we just hand wise and establish a validated, we just couldn't afford another round of expert elicitation.

CHAIRMAN STETKAR: Jing, and this is, I'll just throw it out there because we do not involve ourselves in staff schedule or resource issues but I just make the observation that if, this is an important project. I mean it's our collective opportunity to accomplish something that people have been trying to accomplish for decades and a lot of people are looking to us collectively to try to accomplish that.

If we don't have the resources to accomplish it in a consistent coherent manner, we ought not to just throw something out there to say, well this is all we could do in the 15 minutes with the nickel that we had available because people will then interpret that outside of that context going forward to say, well this now is the coherent methodology developed jointly by the industry, at least on the internal events and the NRC staff going forward.

So, you know, it's a real resource issue that we can't accomplish this work, maybe we need to table it. I'll just throw that out there that it's --

MR. PETERS: Tabling is not really our decision.

CHAIRMAN STETKAR: Oh, I understand that.

MR. PETERS: Because --

CHAIRMAN STETKAR: And it's not our decision either in terms of ACRS, but --

MR. PETERS: And as far as resources go we, the one thing that we don't have here is a time limit or a timeline and we do have some resources. So at the time we didn't have in the fiscal year, in FY13, we do have resources here in '14 to pick up testing --

CHAIRMAN STETKAR: Okay, it's just, again, we don't get involve.

MR. PETERS: Right.

CHAIRMAN STETKAR: We're typically technical people. But from a technical perspective I think there's a real danger in saying, well we're so resource constraint that we constrained that we just had to do something on an add hawk basis so that we could check off a box that we had to report out. And that isn't going to fly --

MR. PETERS: I don't think Jing's proposing anything to ad hoc anyway, just to say. But I think that we are proposing that we can pick this up at any, maybe a more efficient manner, in the future.

CHAIRMAN STETKAR: Okay.

MR. PETERS: So we have been pretty creative, as you see, when you look at going through the free resources and peer reviews of my order. So we have ways of working around that resource issue.

CHAIRMAN STETKAR: Okay.

MEMBER SCHULTZ: Mary, this is Steve Schultz. It looks like you've got a fairly nicely prioritized list of barriers to industry testing or piloting.

With respect to the perception that there's not consensus within the NRC on the acceptance of that method, is that something you can elaborate on as to who has this perception and how was it developed? Is it resource, I mean I don't want to put words in your mouth but is it the progress of the task or the resources that seem to be applied to it, or something different?

MS. PRESLEY: I think it's, well the, without getting into details, I think it's still, that within the NRC different methods are used and there doesn't seem to be a leadership from the NRC's perspective of trying to implement the method or receptiveness from some of the other branches that's in the NRC.

So that probably is where the perception comes from the most. And just in interactions, there doesn't seem to be a lot of advocating from the unified message from the NRC that yes, we should try to use these methods in certain applications.

MEMBER SCHULTZ: That's fine --

MR. PETERS: I think that's actually --

MEMBER SCHULTZ: -- I appreciate that.

MR. PETERS: -- a comment that's probably best from the NRC Staff itself to create a comment on where the disagreements may lie or there may be some type of nonacceptance of the methodology.

And what we've experience on our staff is, you know, human reliability analysis. Just like John was hinting at is that there, everybody is an expert in it but nobody is an expert on it. And there are a ton of different ideas on how you can progress in doing a nature array.

And most of the backlash we've had or disagreement we've had internal to the NRC on this particular methodology stems from the fact that it has not been a completed methodology. Has not been tested, has not been peer reviewed up to that point.

And that backlash, people will not go forth through the agency and use a methodology that's not complete or tested or validated. They're comfortable with their existing methodologies and indefinitely have been using them for years.

So at the point we get this to a state where we have tested it, we have, you know, we have it in a complete format, I don't see us overcoming those internal barriers until people get to kick the tires. Because basically what you're telling the rest of the agency is, yes, you have a house, but we bought you a new one, don't worry about it, we'll be good when we get it to you.

And you've got to get them that complete house where they can go in, tour it, take it, make modifications. And at that point then I think you'll get a lot more acceptance from the agency.

And as far as the industries acceptance of it, my experience, and I talked to Mary about this a couple days ago, but my experience with methodology is, if the NRC accepts it and we start we using it for a significance determination process in our ASPEN analysis, at some point people in the industry will also look at that when they're at least debating those particular issues. So I think at some point, what my hope is that we can collaborate with EPRI on all the particular portions of the methodology and get them all in there into like the EPRI HRA calculator or something like that.

But if not, even if they can't collaborate or don't have the resources available to collaborate on all the particular aspects, the parts that we end up using will most likely make its way into the EPRI HRA calculator anyway because industry will want to be able to discuss particular findings and want to be able to discuss the actual modeling of the findings with us in our methodology that we use.

MEMBER SCHULTZ: Yes, I understand that but, and I appreciate that, that's very helpful, but I thought that one of the key elements moving forward was industry testing and piloting associated with providing information that could be used to feed into and build the quantification of the method.

MR. PETERS: Industries, what my understanding is, and I'm a little bit removed from the internal discussions with industry on it, but my impressions that industries saw the most use out of a

Level 1 model. And we have been thrown a curve ball within the last couple years inside the NRC with the Level 3 project.

And so the NRC's biggest need at the moment was to define some type of method for analyzing the Level 2 portion of a PRA or an external events and whatnot whereas industries may drive as a Level 1. So within the last few months we had to kind of curtail our Level 1 efforts and really hammer on this generic methodology.

So at some point in the future we hope can get realigned with industries and NRC's needs and finalize this Level 1 model.

MS. PRESLEY: I do want to mention that the Level 1 model, we did, it wasn't thorough testing what I recall but we did a, it was probably called check level testing and published it as part of the, as like appendix, I don't remember which Appendix, A or B, to the report. So we've done a little poking at it but in terms of getting industry utilities to pick it up and use it on their own, that part we haven't successfully elicit a lot of volunteers.

MR. PETERS: Yes.

MS. PRESLEY: So --

MR. PETERS: And I don't think they will until we get something complete.

CHAIRMAN STETKAR: I think the only, you know, we have another example that's somewhat analogist to this where I hope we've learned how not to do it and that's the fire methodology, NUREG/CR-6850, that people now are saying both, within the staff and the industry, that we really should have done a thorough piloting on, not just kick the tires to see whether or not they're under the car, but actually do some real pilot example analysis, real world analysis to work the bugs out because the devil is always in the details.

And we didn't do that when CR-6850 was initially issued. There was an attempt to do that, it fell apart and now people are complaining bitterly on, from all sides that we should have done that. So we should learn that lesson here. Somehow.

MR. PETERS: Yes, you see some slides later meeting if we get to it that show our plans --

CHAIRMAN STETKAR: Okay, good.

MR. PETERS: -- testing and all that. And we do plan to kick the tires for our analysis, STP analysis and for, we're hoping to do it on a Level 3 PRA.

Either with the project or released on our teams effort to remodel the Level 3 PRA internally. And we'll need to discuss with EPRI what they're plans are, if they want to kick the, or I'm not going to use the kick the tire, if they want to use the, if they want to test out the methodology in their own right.

CHAIRMAN STETKAR: Okay. Anything more for Mary, among the members? If not, Mary, again, thanks for your input and again, I'll apologize for the scheduling problem. It's largely due to my rambling.

We're going to close the mic so that, we get a lot of feedback and noise and clicking in here when we keep the mic open. If you want to stay on the line, certainly do that.

Before we end the meeting I'll open up the mics again and ask for other public comments and if you have anything, if you're still there, you'd like to contribute something we'd appreciate that. Other than that, again, thanks a lot and sorry for the delay. James, it's back to you.

MR. CHANG: Okay. So this presentation I will use the SAG as an example to demonstrate how it's planned to use this worksheet in to quantify the HEPs.

So the process is a work in progress and so we emphasize, I'm more here asking for the Committee's comments more on process and the prospective data than the number put in here. Numbers that will be refined by expert elicitation download as V&V process.

I'm not sure that are familiar with, the

Committee, with the SAMG so my presentation is provided to overview of and then to talk about using the Severe Accident Guide 3, Injection into RCS, this particular guidance has examples in how we use the attribute worksheet into a quantification.

We talk about this HEP quantification elements that test dependence and the minimal HEP was not discussed in this presentation. So we already talked this process in morning.

So now we'll talk about the Westinghouse SMGs. Entry into the SMG is based on the EOP, that's typically based on the core exit temperature that's greater than 1,200 degree Fahrenheit and that keep increasing. That's kind of the general principle going there.

So these are three or four EOP procedure, it's basically say okay enter SAMG. And then in the SAMG it contain the following guidance, 2 Severe Accident Control Room Guidance and SACRG. The one was controlled use before the TSC establish it. And then the second one was when TSC, Technical Support Center, already established it and monitoring the situation.

And there's two diagnostic guideline. One is the Diagnosis Flow Chart. The other is Severe Challenge Status Tree. When the TSC establish -- I'm talking about the Westinghouse scenario. My illustration, the diagnosis flow chart is the first procedure they would go to that would provide them to monitor the plant's status.

And there is two diagnosis guide in this so the decision maker enter into, there's 11 or 12 mitigating guidance, that guideline. That TSC diagnosis flow chart direct into the severe accident guidance. That's the example that we'll talk about SAMG-3. And then there's four severe accident guidelines that there's four Severe Challenging Guideline, that's direct entered by the SCST.

And then there's also two Severe Accident Exit Guidelines. The long term monitoring was providing the guidance for the plant status, to monitoring the plant status especially for the mitigation strategy in place and then seeing if they are effective and if there is a side effect caused by implementing this mitigation action.

And then there's SAMG termination, that SAEG-2 is the one, SMG that's usually the procedure that the plant staff will use to monitor the trends long-term, this status. And then there's several computer calculation aids that provide in this situation that information may be not available that all the guidance for determining what's the things, that precalculate the information that are for to assist in the decision making.

This was done by Don Helton, it's kind of a figure showing that entering into this SAMG that's the concern, and they were using the SACRGs during the transition procedure, okay. Depends on whether TSC is monitoring the situation.

And then the second layer, when TSC was monitoring the situation data simultaneously using the diagnosis flow chart and the severe challenges status tree. And then this diagnosis tree lead them to enter status of severe accident guidelines, or the SCGs.

And during the implementation, during the process of SAG-1, that's guide the plant staff to see what's the, talk about the strategy effective or is there any arising side effect need to be deal with.

So now let's going into the diagnosis flow chart. Entry condition is that's when TSC established, that's the first procedure they into. And then the first thing was to monitor the SCST, so that's simultaneous monitoring the two diagnosis guideline.

MEMBER BLEY: What you're doing here is just a copy of -

MR. CHANG: No this is my simplified. It's not --

MEMBER BLEY: Oh, okay.

MR. CHANG: Yes simplified, otherwise need a few pages.

And then the thought was something like this. Asking that the first, these are seven or eight SAG is prioritizer. Okay. First thing looking at the dealing with the steam generator level. Okay, if the situation merits going to SAG-1, okay if not keep on next to check the RCS pressure. So these are the seven or eight, depends on plant, the sequence diagnosis flow chart. So that's the second portion.

And once these come to the bottom of the sequence, after checking each individual SAG is going to perform SAEG-1. As I said SAEG-1, these are -- In a situation maybe there's a multiple mitigation strategy is in place. So these try to give a operators to check around, that's okay. Okay. And then is there any rising side effects that need to be deal as well, so that's coming to fruition.

And then the last one was checking if the SAG should be exit. And that's provide for error. That's all these need to be a match in order to exit the SAG. So that's a core temperature less than about 700 degree and then site release. Site release is different. I'm not sure that's consistent. But the release that they provided is based on site release criteria.

And then, based on the pressure and hydrogen level, so once all these four condition met and then perform the SAEG-2 to long-term monitoring the plant status. If not go back to the diagnosis approach again, through the loop checking the guidelines.

So the example we are talking about is the third one, the core temperature less than 708 degree Fahrenheit. Given the situation we'll enter into the SAG-3, that's inject into RCS.

So the SAGs have the same flow, same step. This is the biggest guidance that has 12 step. But almost that it's got ten step, provide a similar flow.

The first one we have entry condition as the diagnosis approach here, set greater than 708 degree Fahrenheit. And then Step 1 was okay, now inject into the RCS. Provided instruction, okay, go check is there any mean. Do you have the pump available. Do you have the water source available. Do you have injection path available. So lead into the path to inject into the RCS. Okay, that's what steps identify the option available to inject into the RCS.

The Step 2 was the same. Okay, given that this provided our calculation ends here. So based on the plant status now, what minimal injection do I need to enter. Later I have go into this in more detail. But now I just kind of provide an overview of this step. So Step 2 was okay. Now the amount is available so okay what do I need to inject.

And then Step 3 was identify any negative impacts. So now based on the plant's data. So earlier this morning we talk about there is a condition if the injection into a dry and process steam generator tube rupture, creep rupture. Okay that type of information provided in the Step 3, you say okay. Now you're going to inject into RCS, these are possible negative impact you need to consider.

Step 4 is okay. We're going to decide if RCS injection should be initiated. If you're injecting into the RCS, what possible side effect that are already identified in Step 3 and then Step 4 would say if you don't inject into RCS, what's the side effect. What's the negative consequences. And then Step 4 that issues you may need to decide should injection into RCS, should we do or not do.

Step 5 was identify the preferred RCS injection path. And, you know, among the options that's, okay what I need to do.

And Step 6 was identify injection limitation. Limitation was kind of cautious, okay. Now injection, you don't inject too fast. Okay, otherwise could make the generator a large amount of hydrogen. And then the other consideration would be say okay now what are the water source is RWST okay, that's the water level come to a certain level, you know, consider is depleted. So this kind of consideration in Step 6.

And so Step 7, now assume that TSC decide to inject into the RCS, Step 7 is simply ask directly the control room to implement the strategy. And the past information was okay, what's the consideration. Now there's a situation here that I just check one plant that the STP was asking that, on training safe, how to train operators on the inference to the SAMG.

The answer was, well the SAMG would be implement by the manager, that they train operator to only come to the SAEG one. That's transferring the responsibility to the TSC. So operator was not very trained on this decision.

And then I'm not sure -- But because the action here is in the EOP or the regular training they are training in doubting this path. So these are just talking about this training aspect.

Step 8, pretty much is kind of verify, the action was performed by the main control room. And TSC was a monitor situation that Step 8 was check like implementation by monitoring the appropriate parameter.

So the guideline here that's provided this the parameter to monitor. That's what checking the effectiveness or not.

And in Step 9, determine additional mitigation action needed. So interesting here that the mitigation action here was during the performing of the injection into RCS the side effect concern may arise. So here the mitigation action would say, okay, do I need to do something to deal with the side effect.

Step 10 was determining if another RCS injection path is needed to refill the core. So now the path I identify in Step 5 may then show the effectiveness of the cool down the core. That's we may need to add in additional injection paths into the RCS.

And this Step 11 says identify long term concern due to injection into the RCS. So that this becomes another type of check, that say okay there's a pump that needs to continue longer and they need to at least need to have sufficient water. And then that also monitoring. And the staff simply monitor the effect if arise in the situation. And then throughout this we turn back to the diagnosis flow chart.

So this kind of provide the same thing. The first half is try to determine do I have the mean to inject. Okay and then to decide whether I should inject or not.

If decided to inject and then to choose a path and then direct the main control to implement action and then monitoring how action was performed by the parameter providing the SAMGs.

So now we come into, because we identify the devil in the details. That's coming to say okay, what's the macrocognitive function in this step here. We would try to do this Step 1, Identify the available RCS injection path. The SAMG data design is, in my impression, was try to make the decision as simple as possible based on the data.

Look at the diagnosis flow chart entering into the particular procedures sequence based on one parameter, two parameter maximum, and then provide a exceed number that's 708 degree Fahrenheit.

The sentence here that's, Step 1, identify the available RCS path, okay, in the procedure, this is a copy from the procedure. That's the charging pump, set injection pumps, RH pump, makeup system. And then each one has, say okay, charging pump see info provided section. Charging pump A or B and then the water source here for the plant staff to check water availability. And then even coming to this charging pump that's A or B here -- In the attachment we'll find more details there, okay.

In terms of the charging pump A status, I'm looking at the left-hand side, the first column. Okay you need to bus to energize the 241 energize and pump function. So this kind of provide a very detailed check this, okay. Once a plant check this data is assumed okay well the charging pump one option is available using whatever the sources are identified.

Step 2, calculation. One, that's actually is injection. So this based on the RCS pressure and the access and then the injection flow rate of water. So based on what's my RCS pressure and then that what's the situation on the injection tube. Is that going to the yellow range or red range, that's something that is insufficient injection. That's wide area, that means that's a sufficient injection. So that plant staff, this information can provide a first guidance that based on the amount available option here, what's the options. What's appropriate or current status.

And Step 3, identify and evaluate any negative impact. So for this injection RCS is identified potential negative impacts of the containment severe challenge from the hydrogen burn. Creep rupture of steam generator tube. Containment flooding. Auxiliary building habitability, that's because of radiation release. And then RCS seal degradation.

And for each of them they provide a

condition, what each event containment severe challenge from hydrogen burn could be challenging. So for that information, I think -- Okay, yes.

So let me take this as example here. This table also provided in the attachment of the guidance. So calculating this also provides step-by-step guidance for the plant staff to calculate what's the status based on the containment pressure, okay, assuming that's available.

And then measure the containment hydrogen concentration, if that measurement is available go to C, D and E to calculate the number. If not, that's use this calculation A-3 to come out with approximation.

And this is calculation 3 here. So either based on the reading, hydrogen concentration reading available or not, and then could either way come here with more precise kind of estimation. An estimation or more precise calculation of the flood or plant status here. And then there's an arrow in the red area that we present could be hydrogen burn or hydrogen severe challenges consideration.

Okay. And then Step 4 is determining if RCS injection path should be initiated. So this basically on the positive impact and the negative impact coming into the 4c here, determine action -- Decision is made to inject into RCS okay. If not return under the Response Not Obtained, we would return to the Diagnosis Flow Chart, where this come from. If decided to inject then continue with the step.

So then we see that -- We mention that there is no especially right or wrong thing in the guidance for our Rev 2, that all decision is decided -- Well plant status is decided well we're going to inject or not.

This is additionally, I draft these two plants procedure. And this has discretion in Step 4 in terms of information provide for the plant staff to make the decision. In one of the plan that, before turning back to the DFC instruct the plant staff to deal with the negative impact. The decision not to inject into the RCS because there is a side effect impact considered.

So that this plan say okay go and deal with that negative impact and then we jump back to the Diagnosis Flow Chart. But this plan is simply say, we jump back to the Diagnosis Flow Chart without talking about the negative impact, dealing with the negative impact.

So assume their decision is to go to inject the RCS, now let's identify this injection path. The reason I show the Committee this level in details, we see that the way the implementation level of detail here is quite detailed -- If there is a crew the scenario mentioned to the procedure. They have a specific detailed instructions to do the job. The guidance -- that's pretty much that give the plant staff leeway to do that. That's not a situation, based on the guideline we received.

And then I think that RCS when they initiate communication talk about the flow rate if there's a hydrogen concern. That cannot put all of the flow rate in at once, maybe gradually increase the flow rate and then duration of injection too.

And then also that the implementation of the water sources from our RWST or the VCT what's the indication for the long term operation perspective. This provided the kind of notes to remind the decision maker, okay this are the things that you need to pay attention so that this pump can keep running, that the water can keep injecting into the RCS.

And then there's direct control room to implement strategy. One thing I emphasize was this is a Westinghouse guideline. That's once enter the SAMG that decision making is -- responsibility is in the TSC not in the main control room. Control room become the action taker. But this is not in PWR or the CE type plant. They could also feel that to continue, but the main control room still making the decision. And the TSC establishing they provide recommendation instead of direct to the mitigation strategy.

Step 8 here, that's verify the strategy is effective. So here I think are the status of this monitoring. This including that the water has been going to the RCS and then is there any side effects that arise because of these mitigation actions. And something here that these things that are provided very specific.

For example, they say how do we determine that the injection is effective. Okay. That's in the procedure that's attachment provided, okay, these are parameter. And then you see that the water level is increasing or not.

Assuming that indication is available, that will be done to determine that the water that's injection is effective or non-effective.

And then talk about this, okay. Now it's injecting into RCS, that could cause a side effect. And then decide, okay, if the side effect arise the situation, like the containment situation from a hydrogen burn, become a concern. Okay, that's what they need to do, and they take action. That's mitigate the action to eliminate the concern.

Now I want so say here that the information show that that calculation A, that's figure provided, even it's the plant status that is provided guidance that the operator does not know this decision and then probably would rely on that information to decide, okay, whether containment situation is a concern or not based on the figure.

While determining if another RCS injection path is needed to refill the core. I just want to mention about, checking the effective like in the procedure it says check if the RCS pressure is stable or decreasing. Check core exit, stable or decreasing. These are the parameter they check in order to determine whether to add another injection path into the RCS or not.

Identify long term concern due to injection into RCS. This is kind of a reminder again that because injection in RCS could cause the side effect, this is again that's, okay, just remind operator -- the decision maker to look at if these side effects that's been arise become a concern.

Okay. So providing this information, so first thing is once you have the Committee knowing what the information provided in the SAMG. One thing we concerned is SAMG procedure is like EOP has a simulator exercise. And then that to find out what's the scenario procedure inconsistency and then refine the procedure.

MEMBER BLEY: I didn't quite understand. Could you repeat that?

MR. CHANG: Okay.

MEMBER BLEY: You said unlike the EOPs these are never verified on the simulator, is that what you're saying?

MR. CHANG: Simulator, yes. EOP we have further training on the simulator, capability able to handle the EOP scenario.

MEMBER BLEY: And we've verified the EOPs by using the simulator.

MR. CHANG: Yes. Yes.

MEMBER BLEY: And found a lot of problems that had to get fixed. But go ahead.

MR. CHANG: Right. And then the continued training that --

CHAIRMAN STETKAR: Of scenarios that they ran. They didn't find the problems for the scenarios that they didn't run.

MEMBER BLEY: So go ahead.

MR. CHANG: Yes and also at the end of the training they found out that the procedure is not something that the current EOP constantly, it was modified to make the crew use it. The EOP is a constant process of modifying to improve EOP. But SAMG probably not have that privilege. We're fairly certain it has a good basis, but that the advantage of EOP that continually modified based on the exercise, that's probably not in the SAMGs.

So now we back to this crew response tree. Now looking at this procedure I assume that in the EOP event tree that is a defense aid to inject into the RCS. That's a human failure event. And now I want to go to understand well what's the action here that basically there on these 12 steps, including the entry condition.

So this table trying to say that if crew is wrong in this step, what's the consequence. For example, let's say the DFC entry to, the first one, miss the DFC entry to the SAG-3, didn't detect a temperature greater than 708 degree. Well this procedure would be not entered. And that likely situation may be what both indication, like Fukushima, you know the DFC don't have a indication and that could be a situation, likely situation, leading to that not detecting the cooling issue.

So here that I've said okay, what's the constant here that are -- The problem here is to identify what's the critical step. What's the critical step I really want to model, certainly it's the best things and I model everything. But coming to the end when to -- Well and then also the logical, these different steps, how they affect each other. Not every step has a equal weight.

Well the first thing is the SAG-3 is not entered. And then the second is that well there's a available path, injection path, but I somehow say well there's no available injection path and then exit the DFC.

And the third one is come to the decision, okay, based on the similar relation we may say well in this situation they should better that to inject into the RCS instead of not injecting. So maybe operator made a different decision at that Step 4.

And then they directed the control room to implement action. Well control room may implement the action in correct way, okay, all the necessary indication that injection should be gradually increased until the flow rate is stable, of injection, that kind of indication did not communicate so control room carry out the injection not as expected, okay, that could be that action.

And then after that is monitoring, if there's something wrong to correct the previous decision. So this is where we go here to identify this, what's the consequence, the possible consequence of the each step is do we know what's the consequence. And then this tries to provide the justifications. Okay, what's the three steps that we want to monitor in the crew response tree.

So I come, myself, come out to the is then. The Step 1, that's doing wrong that could, you know, access the DFC. And then 5, decide not to inject. Okay, so I can -- Assume that the situation is that injecting the RCS is the right decision but now there's a five, item five, wrong decision where they decide not to inject.

And then 6 was, 6 is the kind of monitoring. I think, yes, 6 was okay. We are still with the negative impacts. Now I inject into the RCS, there's a negative impact arise. 6, is direct the decision maker to make -- detected that this is negative impact. So if that's been detect there's, later on in the step, 8, 9, 11, that's also dealing with this negative impact situation.

And 7, was dealing with insufficient injection and the first choice they select is insufficient to cool down the RCS. And then but that data has 8, 10, 11, these step to provide a kind of check again and then maybe correct the previous to make the injection more sufficient.

So this is my version of the crew response tree.

CHAIRMAN STETKAR: Hey, James.

MR. CHANG: Yes.

CHAIRMAN STETKAR: I'm not, I've never drawn a crew response tree in my life so I don't quite understand this process. So let me ask you, what happened to 2, 3 and 4 in your crew response tree?

MR. CHANG: 2, 3 and 4 is identified -- Let me see. Okay.

CHAIRMAN STETKAR: 3 is, if I go back to your Slide 26 there. Identify and evaluate any negative impacts and determine if RCS injection should be initiated.

MR. CHANG: Right.

CHAIRMAN STETKAR: Who does that and how long do they need to make those decisions and what criteria do they use?

MR. CHANG: So can you repeat again? The question?

CHAIRMAN STETKAR: Who does that?

MR. CHANG: Does which one?

CHAIRMAN STETKAR: 2, 3 and 4.

MR. CHANG: 3 and 4.

CHAIRMAN STETKAR: People, some human beings must evaluate the situation and say, gee, based on everything we know we ought to decide to do this. And I'm assuming that it isn't one all-knowing all-seeing individual who makes that decision. It's a group of people.

MR. CHANG: No, right.

CHAIRMAN STETKAR: And it takes some time to do that and there might be discussions about whether or not it's prudent to do that right now or whether we should wait or --

MEMBER BLEY: And even beyond the folks in the TSC at least the --

CHAIRMAN STETKAR: Might call the Prime Minister.

MEMBER SCHULTZ: And the resources available.

MEMBER BLEY: -- and the vendors and the engineering.

CHAIRMAN STETKAR: So the question is how do we evaluate that process in this crew response tree?

MR. CHANG: This decision maker that has this step, supporting step, one equipment and one have operating experience and then the other maintenance. And that's a procedure, that's one procedure specified as what the expertise that a manager needs to be in the decision, discuss, forming the decision.

And how exactly this is done, so sorry I cannot answer that question.

CHAIRMAN STETKAR: I'm simply asking you, if I'm going to be filling in boxes somehow, why there's not box to fill in to address those issues in your crew response tree. I see no consideration of evaluating that process in your crew response tree.

MEMBER BLEY: Let me put it another way if I could.

CHAIRMAN STETKAR: Okay.

MEMBER BLEY: Because, I've looked ahead and you had this -- The salient things that are easy, like is this a chart recorder or --

CHAIRMAN STETKAR: Sure.

MEMBER BLEY: -- that you check the boxes, you see that. But the part of this analysis, be it for SAMGs or anything else, right about here where you draw that crew response tree, somewhere in there you've got to think about the context that's been set up by the events that got you to this point.

MR. CHANG: Yes.

MEMBER BLEY: By all the other factors that could push you in one way or the other, that show up in your decision trees. But I don't, in your analysis, none of that's laid out. And maybe the reason is that in the guidance it's not laid out how to do that.

CHAIRMAN STETKAR: I was going to ask --

MR. CHANG: -- check with the status of factors, but --

MEMBER BLEY: Well there aren't check marks. This is a situation that has evolved that leads to a context that can put all of those different stressors on the operators that are discussed in the framework.

MR. CHANG: Yes.

CHAIRMAN STETKAR: In the decision.

MEMBER BLEY: You haven't identified any of those at this point. And here I am just guessing, maybe the reason you didn't put that all together is because our methodology doesn't tell you how to do that.

CHAIRMAN STETKAR: Or doesn't stress --

MEMBER BLEY: John brought up one particular place where there's context here that's --

CHAIRMAN STETKAR: Yes I was going to wait. I was just curious why there was the hole there, then I was going to get into the other part of the context. But I --

MR. CHANG: Yes I agree. That 3 and 4 could --

CHAIRMAN STETKAR: It's not as simple as a black and white failure though. It's perhaps we don't know. Perhaps there is so much discussion that, dang, we should have done that an hour ago. We just didn't realize it.

MEMBER BLEY: But you can't even address

those things until you know what got you to this point.

CHAIRMAN STETKAR: That's right. That's right. Until you know the scenario progression and evaluate those systematically within the context of that scenario progression. We'll come back to -- I like this really.

I mentioned that I like this framework document. Misinterpretation of procedure, inaccurate portrayal of the system response to the proposed action, incorrect inclusion of alternatives. Time load, knowledge, experience. Things like that. This thing tells me that I need to think about that kind of stuff.

Your crew response tree tells me that I don't need to think about that kind of stuff. Or if it tells me that I need to think about it, I don't see where I'm thinking about it.

MR. CHANG: I won't say that -- that's not the purpose of this crew response tree. It was given that the task, okay, they are in the procedure in the guideline.

CHAIRMAN STETKAR: This is a generic methodology. Stop talking about procedures and guidelines. If I wanted to do that I'd turn the clock back 35 years and follow THERP. It's clear that looking at steps and procedures do not allow us to understand how people make mistakes. Period. So stay away from the procedures.

I'm trying to understand how the methodology and this construct prompts me as an analyst to evaluate the integrated response of the people within the context of this scenario. And part of that integrated response are the actions -- I'm going to call them actions, are the understanding, sense making, decision making process that's involved in the 3 and 4 items in your list here.

MEMBER SCHULTZ: Evaluating and making decisions.

CHAIRMAN STETKAR: Evaluating and making decisions.

MEMBER SCHULTZ: Because that's what's happening in 2, 3, 4 and 5.

CHAIRMAN STETKAR: In a timely manner given the context of the scenario and the resources available. Both people resources and hardware resources. And information resources and knowledge resources. And by leaving those out I'm not sure how we're capturing that kind of contribution to human errors. To errors in the overall process. I don't know how we're capturing them because I've not been forced to ask those questions here.

MR. CHANG: Okay, if I understand right here, that yes procedure might be -- I want to say. But procedure is in the guidance that the crew when they went through the SAG so we assume that they are doing the procedure. Their training, their engineering this is still a process guiding what the things that they will do.

When they are going through this series of things, that's okay. Now we come to look into each individual element. Same the detection, okay deciding to enter into this SAG-3, very simple. Okay? That's simple. Based on the core exit water temperature, that parameter, okay. That despite, yes that parameter may not be available, you know, directly, but --

CHAIRMAN STETKAR: James, stop --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- for a moment if you would.

You keep bringing this back to gauges and steps in the procedure. I'm trying to pull you back and think about the whole context of the scenario and all elements of finally making the decision to inject water with enough flow in enough time to not melt the core, or to recover core cooling in this case.

MR. CHANG: Yes.

CHAIRMAN STETKAR: Okay. I don't care about steps and procedures. I don't care about vertical versus orange versus things like that.

MR. CHANG: Right.

CHAIRMAN STETKAR: So I'm asking you in your logic model, this crew response tree, that you're going to use as part of your tool for quantification, why does that logic model omit the types of process that are embodied in items number 3 and 4 in this list?

MR. CHANG: Oh. Okay, yes.

CHAIRMAN STETKAR: That's what I'm asking. It has nothing to do with core exit thermocouples or step number 37 in procedure XAG, whatever. It has to do, why does this logic model that you've created, as an aid to quantification, omit those functions.

MR. CHANG: Right. Kind of my reasoning when I developing the crew response tree was in the Step 2 here was identify available injection path. Okay. Now this is the think point, I say okay if they identify the injection path they come into this, this 3 here will determine what's their --

CHAIRMAN STETKAR: Okay. Let me, instead of being really precise, let me call it 234 together, 2, 3 and 4 all together.

MR. CHANG: Yes.

CHAIRMAN STETKAR: Don't parse it up into little bits and pieces.

MR. CHANG: Yes.

CHAIRMAN STETKAR: Why does 234 all together not appear as part of your logic model to help me in the quantification? I see 0, 1, 5, 6, 7, 8, 9, 10, 11, all of which I can parse up neatly into a step in a procedure and this gauge and all of that other kind of silliness. I don't see 2, 3 and 4. And 2, 3 and 4 are really difficult.

MEMBER SCHULTZ: These are where the decisions are made.

CHAIRMAN STETKAR: And they depend on the context in the scenario.

MEMBER BLEY: For the decision.

CHAIRMAN STETKAR: That's where the decision is made. That's where the understanding of the decision process is. And it's not there.

MR. CHANG: Oh that's a labeling mistake. Okay. Let me start -- Starting from 0 -- Sorry. 5 here actually means 4 in that, yes. Coming to the end of 5 was deciding not to inject into the RCS, that was the 4 here. I'm sorry that I didn't check that the numbering consistent. But it --

MS. XING: So are you suggesting that 5 is --

MEMBER SCHULTZ: But that's not the question John is asking. He's asking why elements are omitted in the crew response tree. Elements that are shown in this list, the steps in the list.

MEMBER BLEY: Which really this list doesn't align with what the numbers mean on your chart.

CHAIRMAN STETKAR: Well I thought I understood what 5 was and now maybe I don't understand what 5 is. But it's --

MEMBER BLEY: On the tree it says you decide not to inject.

CHAIRMAN STETKAR: It says you decide not to inject.

MR. CHANG: Right, that's --

MS. XING: Yes. James, as I remember of our discussion you decided to group 2, 3, 4, 5 together as a single test. That's what 5 in your tree for. And the Number 5 in the tree actually represent four steps, Step 2, 3, 4, 5. I remember that was --

MEMBER BLEY: And then the consequence would be as described on the tree.

MS. XING: Yes.

MEMBER BLEY: Okay.

CHAIRMAN STETKAR: Okay.

MS. XING: And at one point we talked, like the end of Step 3, identify and evaluate negative impact. That's not the end of the test until you've come to --

CHAIRMAN STETKAR: Now part of this is, again, it's language. It's context. It's trying to understand what all of this means. But the implication of 5 down in your little crew response tree, it says decide not to inject into RCS and exit SAG because of negative concerns.

Part of my concern, as I originally cast it was, maybe they just take too long. It's not an active decision not to do it because I'm concerned about the negative impacts. It's because I'm trying to do this by committee and we've never really thought about that before and it takes too long to get all of the votes in from everybody concerned.

And by the time we decide that it's a good idea to inject it's too late. We should have made the decision earlier. That's not an active decision not to do it. It's part of the understanding, sense making, decision making process that caused an inordinate delay given the context of the developing scenario, which obviously depends on the context.

Let me -- We've got somebody standing here patiently.

MR. STEVENS: Tom Stevens with NEI. My colleague who was here is an SRO at Detroit Edison, which happens to be a BWR so he would not necessarily have been involved in this particular scenario James picked.

But I would offer that if you want context and what may be going on in a control room when these kinds of events are unfolding, I'll offer, and I think we can make good on it, to have some SRO, or more than one SRO, come in and talk you through all this.

It occurs to me that that context that you're asking about might be most available by that kind of thing. And I believe we've done some of that with James already but maybe not on this particular scenario. So I'd be glad to respond if either the Committee or the NRC were to want to pursue that.

MEMBER BLEY: I think that's a nice offer and you folks ought to think about it. But the place that's bothering me is the methodology, as written, doesn't push you to develop that. And the examples haven't pushed to develop that. And that seems a problem.

MR. CHANG: The example --

MEMBER BLEY: This example you're walking through.

MR. CHANG: I think I missed -- The demand on the cognitive portion that's --

MEMBER BLEY: Yes, the context that would affect the people that are trying to making that decision. What are the things that could make that difficult.

MR. CHANG: Right.

MEMBER BLEY: And they're the kind of things that are in the framework.

CHAIRMAN STETKAR: Let's go on a little bit. Because I think as you go on to the quantification we'll be even more, because I see in the worksheet here, detecting, detecting, detecting, detecting. I don't see anything that's listed in your -- If you go back to Slide Number 28, the macrocognitive function that's associated with 4 and 5 anyway, at least right here, is understanding and deciding.

In the quantification I don't --

MR. CHANG: It's in the backup slides. I think. Yes. I can show --

CHAIRMAN STETKAR: Oh the backup.

MEMBER SCHULTZ: What we have in this package seem to aim at whether one enters into SAG-3 or not.

CHAIRMAN STETKAR: I see. Okay.

MEMBER SCHULTZ: -- on the functional step-by-step features is what happens after you enter.

MR. CHANG: Right.

MEMBER SCHULTZ: And that's all human errors or human factors and evaluation of what happens in terms of the decision making and the direction given back to the control room which is critical for the event and success of ameliorating the event. So it has to be part of the process.

CHAIRMAN STETKAR: I misinterpreted what I was seeing. I was trying to read ahead too quickly.

MEMBER SCHULTZ: Well maybe I did too. James, if you'd go through that.

CHAIRMAN STETKAR: Don is standing up here patiently chomping at the bit.

MR. HELTON: I was just going to offer, I'm not that involved so tell me if I'm off base here. This is Don Helton, Office of Research. One of the ongoing projects that Susan and myself and James and Xing are all involved in has prompted us to obtain a licensee's characterization of one of their EP drills that included entrance into the SAMGs and looking at the EDMGs.

And the documentation is rather coarse but it gives us the opportunity to go in and get at the first cut at some of these issues that you're bringing up in terms of how long is it taking them to make a decision from the time they enter the SAMGs to the time that the control room has a strategy that they're supposed to be acting on.

And I think at its most basic what you're trying to convey is that you're not seeing something in the guidance here that forces you to do things like that to develop what I would call some of the more systemic biases in terms of decision making and execution.

CHAIRMAN STETKAR: Yes, I think that's a different way of saying the thing that Dennis and I, and I think all of us, have been troubled a bit by the methodology, at least as presented, seems to perhaps gloss over those difficult issues. And some of the operating experience, you know, that you've mentioned and we've heard from NEI and Fermi people, can help to highlight the importance of those elements of the whole process.

You know, it's not something that's done I think in 15 seconds by an autocrat who says, yes verily go do this. It's indeed a thoughtful process that people go through. And, depending on the progression of the scenario, can lead to not a simple situation where it is a black and white decision.

MEMBER SCHULTZ: But your methodology has a place in here to capture all of this. But in this example, at least as we've seen it so far --

MR. CHANG: So far. Not yet, not yet. Didn't come to a worksheet yet.

(Simultaneous speaking)

MEMBER SCHULTZ: But your worksheet doesn't seem to say you've caught it but maybe you have.

MR. CHANG: So this is -- Okay. The first one -- The previous was try to identify what was a clinical subtask. Okay. That's entering into the SAGs, the first clinical subtask.

And this checkmark just I put in here without thinking that's really some specific situations. Probably now I would say okay. So here let's assume, that okay that's a wire that is coming in here. But the DC power indication is available. And then the tube, that is what I was saying, the most simple situation so characterize this situation.

They are detecting whether SAG-3 should be entered or not. That's simply based on the particular temperature, RCS temperature. Okay. So given this situation here, they would say well what is the procedure tree, the guidance tree so that's one likely thing.

And then display, let's assume that the situation there that the meter is -- pressure is available, so that's an analog meter that they will use. And then do they know the mean, yes. Okay. And also communication. This is kind of a check of the basic situation.

And now, okay, what's the additional contextual information. And then they check one. Is there information of the situation that met -- When they check this, okay, the parameter is not available, okay. They need to rely on other indication. Like looking at information content and display, in the second half, bottom here. Primary parameter not available. Is that indication that's come to the operator that would say okay that's unreliable.

Like in the TSC here that -- Like in the H.B. Robinson example. In the computer display, when the numbers become not reliable they show in a different color. I think they show in a state of green and then that's when it's not reliable showing in a white color. And then in that situation that happened.

STA instead rely on that parameter showing on the monitor and going to the main control panel to look at individual parameter. That kind of a situation that's unreliable indication. And then you've got 40 indication in this particular scenario. So these are the things that the entities need to check. What are these showing in the detecting, the deciding to go into this, to enter into SAG.

Take an example here, if they lost the DC power without indication, okay, there's no indication and then these are the complexity of the issue and need to reflect on these corresponding contextual factors.

That's correctly characterize the difficulty of the situation in detecting this particular parameter.

And then in this situation, in this hypothetical thing, okay, that's the second, it has parallel task and distraction happened here. And now it's lost control. The core is melting. It's melting. They have a sense of loss of control of the situation.

That's a high psychological stress that we may apply. So these are the things the entities need to take into the sequence and then check this contextual factor applied to the situation. Which here when I say that the worksheet is the provided tool for the entities to use.

MEMBER SCHULTZ: James, are you still -- Are you describing the decision flow chart that leads the decision maker into do I go into SAG-3? Or do I not go into it? That's what I want to know.

MR. CHANG: Okay. Okay, so here -- That's coming to here this worksheet, because this guidance has a clear rule that say okay, temperature greater than 708, going to --

MEMBER SCHULTZ: Yes --

(Simultaneous speaking)

MR. CHANG: -- was based on the situation that we're come out to the error probability say not going into SAG-3.

MEMBER SCHULTZ: Does it affect the decision flow chart elements?

MR. CHANG: Yes.

MEMBER SCHULTZ: Okay. I guess, I know you are but you haven't gone into SAG-3 yet. You're making the determination.

MR. CHANG: Right. Right. Now this is --

MEMBER SCHULTZ: Someone is making a determination. I'm sorry to put you in the picture, but go ahead.

MR. CHANG: And then there's a peer check.

MEMBER SCHULTZ: Yes. So this gets to what we were saying before. What we were talking about before was your line diagram for the steps. 1, 2, 3, 4, 5.

MR. CHANG: Yes.

MEMBER SCHULTZ: That's very important human performance evaluation.

MR. CHANG: Yes.

MEMBER SCHULTZ: But you haven't addressed that here in this example.

MR. CHANG: If I can use, that is, because there is a decision. Okay so let's go to deciding, it's backup slides. We do have slides too many.

MEMBER SCHULTZ: I didn't get there because

I was following the paper as well.

MR. CHANG: Okay. So let's make this decision. Assume that the crew comes, okay, they have injection paths. Okay. And then that they have evaluated this and negative consequence and now come to the decision. So that's the decision, that's evaluating negative consequence and deciding Go or No Go, that's the same packages.

So here, okay, the first decision here we ask them what's the type of decision. Okay. Now there's competing goals, GO versus NO-GO. Okay, this is the type of the decision.

And familiarity, the crew dealing with this situation, one here says is novel situation coming to not training -- How I say. That's better for the HR analysts to make the decision. But now this will make it. And communication type. Now it's checking, okay, let's just assume it's between the TSC and main control room and maybe onsite people. So this is kind of the extended communication scope.

And now who make the decision? Okay, is it the operating staff or the plant management. Is this done by the plant management. And then the third on was this outside stakeholder maybe have a different interest that can influence the decision making.

Decision criteria is that clear criteria or that's guided criteria, that's just like this. Okay? Like provide you this thing to consider and then leave you to make decision. And on the scene that means that, well they make the engineering judgments that Go or No Go decision. And then conflict. That is the decision that's a policy, there is policy, and then procedure maybe and some conflict instruction. That's another type of decision criteria they need to make.

And then information quality here that they check that do they have sufficient information to make a decision. Is information uncertain or confident. In making a decision here, after a decision is done, does that system provide feedback to correct the decision. Okay.

And, oh, this change in response plan was now I make the decision and then down the road that was based on because of scenario I need to change the response plan. Now I go to a steam tube rupture event and then there's data I need to change to a LOCA event. LOCA procedure. That's kind of response plan, just is better illustration.

And then here scenario and environment factors. Okay, these are kind of the generic overarching factors. That's parallel task and distraction and high psychological stress. And then there's work environment, assume that what is normal.

And there's a miscellaneous item, that's information was mixed level of importance. That's maybe a factor in their decision. And require close coordination with control room crew or the onsite staff. And then there's information ergonomics, which what is exactly mean. And then there's a feedback.

Now there's a thing here that we talk about, it's a Go versus No Go Decision. Because the decision was decided what the positive impact and negative impact and then come to a decision. We haven't come up to how to evaluate the probability that the decision maker would do that. But this is kind of first start with looking into this SAG and SCG and the positive and negative things they identify and they would try to summarize, okay, there's several categories.

One is a release, the active release. And something about containment integrity, RCS integrity, core cooling and the criticality of the core and scrubbing of the radioactive release. And then equipment damage and habitation.

This kind of at high level cover all the information in the SAG/SCG. And so this -- What we need to do is --

CHAIRMAN STETKAR: James, let me ask you something.

MR. CHANG: Yes.

CHAIRMAN STETKAR: I'm still, honestly I'm so doggone confused I can't follow this.

MR. CHANG: Okay.

CHAIRMAN STETKAR: This is a nice construct for this particular example. But you say this is a deciding worksheet. Well I can't find a worksheet that's got all of this stuff on, this is something you made up for this particular example. This is not in the generic methodology. I can't find this anywhere.

If you could point me to a place in your generic methodology report that has this set of check boxes on it I'd be happy.

MR. CHANG: It's in the -- I guess not.

CHAIRMAN STETKAR: Check boxes? No. Other check boxes that I can find under decision making, but not these check boxes.

MR. CHANG: Okay, yes, in the appendix. Okay, this is SAG-1 to SAG-8 specific say that if containment injecting into a steam generator, a dry, hot steam generator and that could have a creep, creeping crack rupture, okay.

And this has a table, this is that especially and then there's a kind of -- The right-hand column, there's says the category that's maybe related to release and the scrubbing. This factor is showing in that table is probably not in this format.

CHAIRMAN STETKAR: Probably not in this format.

MEMBER SCHULTZ: So this is not a generic worksheet that you've incorporated into the methodology?

MR. CHANG: Well because this, we say this -- We need to do more -- Oh, wait. Actually there was, it's there. In the decision, that you go to the decision worksheet, that's Section 3. And then in the Go-No Go decision without criteria and that is one of these for positive, one for negative.

CHAIRMAN STETKAR: Section 3. Okay. I can search here.

MR. CHANG: Yes.

CHAIRMAN STETKAR: The point that I was trying to make is that you can't do this on the fly. If we're going to have a generic methodology that works for any type of action we can't do it on the fly.

MR. CHANG: Right.

CHAIRMAN STETKAR: We can't. Well for this particular thing I need to think about this.

MR. CHANG: Right. This has path for it and it has a specific mind for implementing into a Level 3 project and making that type of decision. And that's one hard decision, that's how do we calculate probability. Because there's no correct right and wrong criteria that's lead, you know, stress, may not really affect the probability of the decision. And then how do we provide a structure, method, so the analysts today will be able to take it from the thermal hydraulic information to coming to the probability. That's something that I tried to do here.

MEMBER SCHULTZ: But how does this relate to evaluating human performance?

MR. CHANG: As I said this is not a human error probability. So there's no -- It's just decision probability. So that's what I'm trying to do here, okay, in making this decision to inject into RCS or not, okay now I have a positive and negative and then I know that positive maybe has weight associated with them. Say that my positive -- in not inject I have three negative impact and that would be --

MEMBER SCHULTZ: And core cooling would be checked also. There's nothing checked.

MR. CHANG: Yes.

MEMBER SCHULTZ: But we're not going to count one column versus another, checkmarks, and say well, I mean, what that demonstrates to me is that this is a very stressful decision and needs to be made, timing has got to be appropriate as John indicated before and the stresses that come with hit.

CHAIRMAN STETKAR: And there might be quite a large amount of uncertainty about personnel behavior under this. Not a specific number.

And by the way I did find that table. You're right, it's not formatted this way and I didn't quite appreciate what the table was trying to tell me. But the table does exist in the report. It's table, I think the one, it is Table 16 in Chapter 6 actually.

MR. CHANG: Yes. Okay, so this table is, so just I try to put more focus on it. That fall under how to characterize this SAGs that are based on positive and negative potential factor and then come to the probability of making a decision.

And then what we have here, that we have a worksheet for detecting that's presented. And then there's a worksheet for understanding, deciding and actions.

CHAIRMAN STETKAR: But ultimately the goal, if I understand it, of this process is I check off a bunch of boxes. And by checking off those boxes I'm directed to specific numbers analogously to the detecting example that you have that we haven't quite worked our way through yet. Is that right? I mean that's the division?

MR. CHANG: Yes.

CHAIRMAN STETKAR: Can we go back? Anybody want to probe this set of check boxes more? Then let's go back to detecting. Okay. And this is detecting particularly -- And go back to your Slide 28.

The example that you've developed that eventually gets to a number is for the failure of detecting for Item 0 here, is that right?

MR. CHANG: Yes.

CHAIRMAN STETKAR: Now I notice the detecting affects, also 1, what I'll now characterize as 2345, 6, 8, 9, 10 and 11. Do I evaluate those detectings now independently of the detecting that affects 0? So I go through the same tick boxes and go through the same table look-ups and come up with numbers for each of those detecting?

MR. CHANG: In the Step 0, they go through detecting incorrect, that's these assumptions they were not going to SAG-3.

CHAIRMAN STETKAR: I understand that. But if they do the detecting correctly in 0, then do I evaluate them separately for each of the other ones?

MR. CHANG: Yes. You have each worksheet.

CHAIRMAN STETKAR: How do I account for the fact that there's coupling among those detectings? I'm the same person. I have the same scenario context in terms of what's available, in terms of distracting information.

MR. CHANG: Yes.

CHAIRMAN STETKAR: How do I handle that?

MR. CHANG: This thing is a model in dependency here. That's --

CHAIRMAN STETKAR: Dependencies are on the fail-fail paths. I'm talking about I succeeded on 0.

MR. CHANG: Yes.

CHAIRMAN STETKAR: But there are dependencies -- I can still succeed, you know, I have a 99.56 percent chance of succeeding on 0, despite some things that might cause me concerns. They weren't bad enough to make it guaranteed that I would fail. I'm 99.56 percent chance of being successful.

The question is the things that are detrimental to 0, but not causing it to absolutely fail, still may exist in every other line item that I see detecting, detecting, detecting there. How do I handle that?

That's a scenario dependency. It's not the type of dependency that you're thinking about in terms of fail-fail type branch points. It's something that exists in the world that affects every detecting, or some number of those detectings, and I don't know what they are, throughout that model, doesn't it?

MR. CHANG: Because, we're pretty cautious about the dependence. May I bring up one slide that's missed in the morning time discussion that's about dependency that maybe help our discussion here.

Because the way we talk about it really dependency really depends on severity has a certain model in mind. That's something in my model, I model in an independent HFE. So that's the other thing that I model in a dependent.

So look at this, what's the type of dependence we are talking about. Now there's LOCA then in the scenario, so that's one HFE, one HFE so that LOCA, that's create a high stress. That's common PSF affect both to them. Okay. That's one type of dependence.

And then the second one was direct dependency sort of start here. Okay. It was talking about the successful or failure of the previous task would affect the line, okay. It jeopardizes the previous task, it complicates the performing of the second task. Or to make the time available for the second task become shorter than normal. Okay, that's kind of the consequence of the result of one HFE affecting the downstream HFEs.

And then the third one in direct dependence, this is quite confusing. It's not so clear there. In third, they say okay, in a situation now the operating crew, junior operator or senior operator, okay, even a high stress situation for a junior operator maybe become more listening to the senior operator command. This crew configuration. But then there was something that was not clear about it.

Here we talk about resource sharing. So if there's two HFE that implement in a single time overlap and then they share the same resource, that's including staff or the equipment and maybe have something effect to each other. That kind of resource sharing dependent.

Trust a redundancy of trust is to say okay, I know this person is good so even on peer checker that I don't do that because I know that he is good, that's kind of trust dependency.

And then the other one event tree cutset, this was because these different resolutions, the things that we modeled in the top event, or at the cutset level.

One example was this eventually function one, if function one could be followed by human error or other component variable and that actually lead to probability, would somebody depend on what exact equipment failure or the human cause of fail, the previous one. And that now this thing is coming to the cutset level, that's to avoid this confusion.

And the last one is more of the things we tried to tackle. I call it fixation. I have some mentality that say well I calibrate this wrong and then I calibrate ten of the instrumentation based on the fixation, the attention, my mental mind, I just maybe incorrectly categorized all of the rest of the indication.

This are something in here that's what, okay, what type of the dependence the people talk about. We try to list them expressly. And then say okay what are the things that we model in the independent or contextual factor, this for independent HFE. And then what are the things that we want to model in the dependence contextual factors there.

So we have the problem of model that's what we're looking for the dependency. That is my answer to your question. Because, yes, we cannot say well, yes always a action test so there must be dependence maybe. But do we cover that dependence in our independent factors. Or that we want to say that it's not covered as we went to separate in the model in the dependence context factor. That's something that we need to clarify.

CHAIRMAN STETKAR: I guess we're not -- I need to take a break. And I'd ask you, I want to return to this because it's something that's bothering me. And maybe you can think about it during the break.

The concern that I have, I'll give you a specific example. Suppose the scenario, suppose they have a two train plant and the scenario disables half my indications. It's gone, half. Not all of it, exactly half of it. I have one of two of everything in the world that I need to communicate with the status of the plant. That's what I have. The scenario did that to me. I'll call it the station DC power was failed, half of it. That's something that would effect, uniformly, detection for every line item in the list on 28.

It doesn't reset when you get to the second step. It doesn't reset when you get to the third step. It doesn't reset when you get to the seventh step. It's there, all the time. It affects it uniformly. And I want to understand how that uniform scenario context is treated in the way that you quantify now the contribution from failure to detect in each one of those little boxes on your crew response tree.

So if you think about an answer to that. And it's not the type of dependence that you're talking about with this diagram here. It's a different dependence.

If we can do that then, as I said, since I have the gavel I can take a break. Let's recess until 3:55 please.

(Whereupon, the foregoing matter went off the record at 3:41 p.m. and went back on the record at 3:55 p.m.)

CHAIRMAN STETKAR: Let's come back to session. We are running late, obviously. So what I'd like to do is ask the staff if there's anything that you feel that, from your planned presentation, you can skip or go through quickly it's up to you. I mean, we're willing to stay as late as reasonable to go through everything.

MS. XING: Yes. Okay, we scheduled the two hour slot for like the one part of the talk about our external review, expert elicitation for ideas. We could squeeze that into 20 minutes.

CHAIRMAN STETKAR: Okay.

MS. XING: And there's an initial testing or piloting of the method. We planned it for one hour. Again, I prepared for being running late, so I can talk better from five minutes to any time longer than one hour depends on --

CHAIRMAN STETKAR: What I'd like to do is see if we can finish by about, no later than 6:00 and --

MS. XING: Oh, absolutely we'll finish before 6:00.

CHAIRMAN STETKAR: -- even earlier --

CHAIRMAN STETKAR: -- than that would be appreciated. But let's target, and we'll try to, when I say we that's a royal we, I'll try to be more constrained here. Now, with that, James, do you have anything to react to --

MR. CHANG: Yes. But I understand the Chairman's question is that, now I have a rough indication.

Okay. In all places that this, each of this activities has a worksheet, okay. And seems that's this order detecting hub activity. So these are defective worksheets.

Okay, so for the first activity here that's in this then, depends on the draw at least that that's an indication, how that's in to here.

It may be coming to, Chuck said, in the second bottom half, information coming in this right here. Maybe that's a primary parameter, not available. If that's affecting the activity of that, and maybe it's a faulty indication. Okay, that's an indication there.

And then they need to check what type of fault that is. So if this, assume that's a basic effect, that some indication that for subsequent activity. So each activity has this worksheet. And then every worksheet has at least a contextual factor check.

CHAIRMAN STETKAR: Okay. I understand that. But if we go to, if we follow thorough this example, you eventually, by checking the boxes and going through the worksheets for the particular activity of entry into SAG-3 which is driven by detection --

MR. CHANG: Yes.

CHAIRMAN STETKAR: -- you quantify a human error probability of 4.4 times ten to the minus three, however you do that.

MR. CHANG: Yes, sir.

CHAIRMAN STETKAR: If that succeeds, I now get a chance to fail at the next point.

MR. CHANG: Yes.

CHAIRMAN STETKAR: And if I had 1,000 of these, and if I had 4.4 times ten to the minus three for each one, my overall human error probability would be 4.4.

MR. CHANG: Yes.

CHAIRMAN STETKAR: In other words, I can fail 4.4 times every time I'm challenged to do this.

MR. CHANG: Yes.

CHAIRMAN STETKAR: That type of dependence that I'm talking about affects that success path, that conditional success path, human error probability, not the dependence on the failure path.

And I don't see how the methodology, even if I understand what this approach is doing, I don't see how it accounts for that, the fact that it's a, even though I can check off those boxes that you showed there, I don't see in practice how that overriding contextual factor is not compounded by the addition and multiplication in your particular little logic model in your quantification construct. Follow me?

MR. CHANG: Yes, agreed. But the way that I identified these lists become the framing that how we tried to identify this one, if I understand, all right.

So let's look at this, coming to this, Step 1 example. If we make it, just assume any one in this parameter, this checkered part of this parameter, if we assume that it's only one in this parameter would, we could run wrong decision in this step.

Okay, and how our parameter go into capture less. Well, one thing it says here that one subtask we did to a specific goal, injection path.

And so in terms of, because this is so many parameter to check in the detection here that we come to this one parameter, the first one, a number information.

How many pieces of information I need to check. But I try to trust that, just for that particular goal, making decision do I have or not. I'm not sure this address your question.

CHAIRMAN STETKAR: It does not.

MR. CHANG: It does not, okay.

CHAIRMAN STETKAR: And we're apparently not communicating very well here. And in the interest of time, we should probably just press on. But I don't see how the, what I'm concerned about is a compounding effect on the errors.

As I said, in principal if I had 1,000 line items in your list here, each of which had detection and each of which independently, by checking off these boxes, was evaluated at 4.4 times ten to the minus three, I would have an overall human error probability of 4.4 which obviously is pretty wrong. It's pretty conservative.

That's an example of not accounting for a scenario based context that indeed would keep the human error probability lower than you would quantify.

There could equally be scenario-based context that would make the human error probability higher because of these compounding effects, the multiplication and addition that's presumed in this logical construct.

And it was always a problem with THERP when people went through the procedure steps. And if you had the procedure that had 100 steps in it, and there was, you know, 1.5 times ten to the minus 1 you could infer that people would fail one and a half times every time they were challenged.

Fortunately, not many of the procedures had that many steps in it. But it was an issue that's been raised often in terms of excessive conservatism. And it comes back to this notion of maintaining that overall scenario perspective rather than parsing things up into these little bits and pieces that you then quantify as if they're separate.

MS. XING: Yes. I'd like to comment on this a little bit. We haven't addressed this or write this in the generic methodology. But we gained some experience from highlighting the IDHEAS method.

In the IDHEAS method we had the same situation like when you break down the task to the two details, and so that means we have many subtasks. And you end up have probably, each subtask have, Subtask A had this failure mode detection, B had its result end up many such detection.

So when that add up, you will produce a higher probability than what you should be without breaking this level of detail.

That was a concern we had with the method. And we didn't know how to treat it. But from the initial piloting or tasking, I see some good stand there which I'll probably talk later.

Two tasking teams, like they break down the task at a different level of detail. But it end up, when you break down to the, the one break down into multiple subtasks, and so you identify the more failure mode there.

However the failure modes that, addition of failure mode quite often end up in the lower path of the decision tree. And therefore, they do not significantly contribute to the overall probability.

Again, if you break down this into 1,000 small tasks, you will still bring up. So the strategy we talked in IDHEAS was if you go to the lowest path of the decision tree, it means what really the probability is low.

You stand to put a number there. You put the HEP as negligible. Therefore the HEP, the very small HEPs, say if you go to the lowest path the HEP would presumably you may put a 10E-5 there. But you stand to put a 10E-5, you said, like zero.

Therefore, these things do not add up. So we still haven't fully decided if that's one thing we want to try out in tasking to see how these things work out.

CHAIRMAN STETKAR: Let's go on with this. Because we do need to, and especially if you have a couple of examples of how you've grappled with that, at least in the internal event stuff, and we can see that.

(Off microphone discussion)

MS. XING: Okay, so the next part of the presentation, we going to come to the IDHEAS method for internal at-power events. And this is the method that you've been briefed a couple of times before. And we has addressed the report updated.

So for this part I will mainly focus on the new progress we made since last year. So I will give you, well, with all of the methods, just to refresh your memory how this method would look like, so a summary of the external review. And if you're interested, we may talk about some part of the expert elicitation process.

So here are some elements in the method which I would like to refresh in your memory. It's almost like a dictionary. So the method helps the element authentication and definition of human failure events, feasibility assessment, task analysis and development of crew response tree, CRT.

And we have a crew failure mode to describe the failure of a critical task, a decision tree to assess the contextual impact on the HEP of the failure mode.

Then we have the quantification part as we combine these HEPs of the individual failure mode to generate the HEP for the event.

Finally, we have integrative analysis which the intention was to fix dependency and uncertainty. But we didn't do any work there. So we just take from the existing practice.

CHAIRMAN STETKAR: The existing practice typically does not treat uncertainty which is a fundamental flaw in inner methodology. And if you do not treat uncertainty explicitly in this methodology, this methodology is fundamentally flawed.

MS. XING: I'll take that comment back to our team.

CHAIRMAN STETKAR: You must account for uncertainties, and not as an afterthought or a patch at the end but throughout the process. That's something that the Agency needs to have the same discipline as the Agency requires of their licensees.

MS. XING: I'd like to show the process, how the statement part works. Basically, it's a work flow starting from understanding PRA scenario, identify HFE, identify critical tasks in the HFE. Well, probably better say it from this diagram.

So if an HFE is feasible, you go to one task analysis to identify those critical tasks you want to analyze. You put them in a crew response tree format, then go to quantification.

In the quantification model, for each critical task you identify the failure mode. We have both your failure modes there. Once the failure mode is identified, there's a decision tree to decide which, to determine the effect of the performance implementing factors that will allow you to determine a decision tree path.

So at the end of each decision tree path, there's an HEP number associated with the ending process. So this is how the method look like.

And here's the refresh of the crew failure mode. We have 15 crew failure modes. So the first column, the failure mode corresponding to detection and understanding in our cognitive framework, and we used the term plant status assessment to make it consistent with the operation.

Then the next one is the next column of the failure mode for response planning which accompanies the framework that's for the decision part and then the action execution.

We also have two failure modes throughout all this phases which is misread or skip steps in the procedure and critical data and miscommunication.

So for quantification, for each crew failure mode that we identified, those most relevant performance safety factors, every decision point in the tree is related to existence of those factors if the factor exists in those up branch. If not, you go to the lower branch.

And the decision tree, each task represents a different crew failure scenario and a probability assigned to the end point of a task.

So then once you identify the crew failure, assess the crew failure mode, you combine them basically, you sub them together which I didn't put it in the slide. It's what I just said.

If you always go to the lowest task, you don't add them together. You just computed that to zero. We don't know if that's a good decision or not. We want to try out in the testing stage.

So on that part of the model, so next we go to the external review. For the report we gave to you which was dated on October 28th, 2013, sets up the external review. And then we made a modification.

MEMBER BLEY: That review was out of the generic methodology document?

MS. XING: No. That was IDHEAS, that report that we gave to the committee in last December.

MEMBER BLEY: Okay.

MS. XING: It was the December 16th, 2013, version. That's the version we gave.

MEMBER BLEY: Okay.

CHAIRMAN STETKAR: Jing, you mentioned two domestic, two international, all have ten plus years, yata, yata, yata. This slide sounds a lot like the slide that you mentioned for review of the cognitive framework, the cycle. Did the same people review both documents?

MS. XING: Only one person reviewed both documents.

CHAIRMAN STETKAR: Only one person.

MS. XING: He reviewed both documents. And in the report we have the names for these external reviewers.

CHAIRMAN STETKAR: You basically had feedback from one person regarding consistency between the psychological framework and the focused implementation for internal event at-power modeling.

MS. XING: Yes. That was, they said because for the first one, the literature one. They want to find the people who are really experienced in the cognitive domain. Those people are not necessarily familiar with HRA. Fortunately, two of them have some knowledge in HRA.

CHAIRMAN STETKAR: And they decided not to, or you didn't ask them to review the HRA, or they decided not to?

MS. XING: We did not ask them to. Because already they, on a voluntary basis already too much work. However, we did give them the six report. But we didn't ask them to review it. We'll say, hey, here's the report if you like to take a look and, if you like, tell us what you think.

MEMBER REMPE: So before you went to the external review did it go through internal review too?

MS. XING: Which one, this one?

MEMBER REMPE: This report?

MS. XING: Yes. Oh, yes. Because average progress, it's been through many rounds of internal review of different versions. Like this project has been going on for five years. Over time we produced many versions of the report. Pretty much every version of the report we gave to our internal stakeholder.

MEMBER REMPE: And, again, I apologize, but I had another staff thing I needed to do. But the EPRI geograph said something about that there was not internal consensus. And, in your opinion, there is internal consensus with the staff? Or did I misunderstand what was on the EPRI --

MEMBER BLEY: There was a long discussion about that earlier. And --

MEMBER REMPE: I missed it.

MEMBER BLEY: Yes. They need a lot of work to get internal consistency. They need, I think, the way they put it was they need a complete method. That's where they're going to get internal agreement. This is not yet complete.

MEMBER REMPE: Okay. And that's being approached and trying to get done? Okay.

MS. XING: Yes. And the one thing I can speak about the internal consistency is our immediate use of the other branches for the PRA. Once you've read the report, the major remark was this method was too complex to use. Nobody would be able to use it.

That would possibly show in the initial testing next. It's not as bad as we'd formed the report. So we haven't given the testing results to our internal stakeholder yet. Hopefully, that might help bring better consensus on this matter.

MEMBER REMPE: Okay.

MS. XING: And again, we have some guiding questions for the reviewers to think about. And we didn't say you have to answer all these questions. But these are just some guidance for them to think about.

We asked them to think about this is general methodology and the research aspect. And we also asked to put a list of this, basically these are the elements of the method we want them to comment on, each part of the method, see what their opinion on this.

So I tried to summarize the comments from the reviewers, but it was a very difficult task. Because the comments are very diverse, almost out of the copy/paste the entire. So I tried to give some just major comments of here.

See, like the first question asking if this method improved the HRA modeling and the treatment or the major common themes. The measure doesn't demonstrate the new aspects in the understanding in error. And however, it provides the steps forward in HRA series and applications.

To me, it just seems to be contradicting. But I just want to show you how these are some comments where the same people have different perspectives.

And so modeling how well we did in modeling human performance for HRA purposes, the comment was the method that produced good models for human performance and improve HRA practices.

And, really, if you look at the comments, there are internal reviewer differences. And even for the same reviewer, the comments can be contradicting. So I don't know how, to what level we took these general comments.

And for offer new knowledge, they think the method provide a better description of how to apply the existing HRA technology and the process of reducing the HRA subjectivity and the variability. Too, you would think it should, because it provided more systematics and a robust approach. And two other reviewers said, well, this needs to be tested before we see if it will really reduce the variability.

But one of the things that everybody agree on is the method is consistent with the known HRA good practice. Everybody said yes.

So the comments are on the individual part of the method. I think we want to go through all these comments. But basically, the comments are like there are positive comments on this. Yes, this part has some advantage as a really useful part of our team is they pointed out how the method can be enhanced or improved.

Let me give you what this example. Let's look at Item A, the concept of failure mode that's tied to crew's cognitive activities. Part of the comment is that this is a good feature. It makes the whole analysis more closely linked with operational issues.

And the things we need to make improvements of these things, there's lots of uncertainty in that we have, whether we have a complete set of crew failure mode in the model.

So just to give you a flavor, how the comments look like, so what our team did, we basically put every comment in the table and they discuss how we treated every comment.

And the objective from comments, the majority of comments about doing some work with this idea, we reconstruct the format of the report for conciseness and clarification. And we made the revisions as information like other example of how to divulge the CRT, how to document the test analysis and how to estimate the HEP.

You see the major expansion, I think, of a previous report was like around 200 page. Now it goes to 300 page, because we added the last example. It shows how this method can be used.

And also, as my report, we added the documentation of exercising the full process of the method in the Appendix. And the Step 7 reviewer find that that's quite useful to see how we accessed this method that we used.

And then we didn't make any change to the main structure of the method. Like for example, one reviewer proposed, he didn't feel comfortable with using expert judgment for the HEP of each ending point of the decision tree.

He would rather say like a SPAR-H like approach. Why don't you make each PIF as a multiplier. That means entirely change the philosophy of this method for both parts they actually are.

And we made some revisions to address the specific comment on the crew failure mode definition, decision tree and the PIF definition. For every PIF we had a list of questions. He helped decide to help evaluate the PIF. And we made a lot of changes on both question lists.

I would say this Item 5, it's not just based on the comments from the reviewer. We got lots good input from our expert elicitation. So a lot of changes on the CFM definition and the PIF question came from the expert elicitation.

And there were some comments we didn't address. And lots of the comments were regarded to the practical use of method. So we decided to keep those in the future and use it as documentation. Because they were not related to the fundamental aspect of the method. It's really how you can make it easy to use. Any questions on this?

(Pause)

MS. XING: Okay, so here's the question to the committee. Do you like to have a walk through of the expert elicitation process, or we can skip?

CHAIRMAN STETKAR: No. The answer is yes, we would.

MS. XING: Okay. The objectives of the expert elicitation process, the major objective is to estimate the HEP of the decision tree path for every crew failure mode. And in addition to that, we also want to identify if there are additional factors that contribute to the CFM.

And that's almost like a verification or validation to validate our decision tree. And also we like to elicit the expert's opinion about the effect of the PIFs on the crew failure mode.

And we used a formal expert elicitation process which we called the SSHAC method. SSHAC is the formal structured interactive process for eliciting expert judgment on complex technical issues.

By formal, it means the full cycle of expert elicitation is well planned and managed by the project team, a different type of expert with well-defined rules and responsibilities. This is who reviews the biases.

And the most important part he check is it's emphasized in correcting process. So you use workshops for the expert to come schedule face to face, to interact and integrate their judgment.

MEMBER REMPE: So this is a planned activity in the future you're going --

MS. XING: No, this with HEP.

MEMBER REMPE: Okay, so were the experts paid? Or was this also voluntary, or how did that occur?

MS. XING: Some were volunteer while some are paid. I think the majority of them are paid.

MEMBER REMPE: Okay. Thank you.

MS. XING: Yes. We had some experts, we have the resource expert or the main expert from the power plant, from several nuclear power plants. They are trainers, and some are current SROs. They were paid for a per diem, but not for the hours they spent.

MEMBER REMPE: So they were volunteers, basically.

MEMBER BLEY: Volunteers from their industry.

MEMBER REMPE: Yes.

MEMBER BALLINGER: That's called being voluntold.

MEMBER REMPE: Yes.

CHAIRMAN STETKAR: They were being paid by their time as part of their normal pay.

MS. XING: Yes. And actually the plant considers that's plenty opportunity for their, I mean, expert elicitation. Those experts all expressed that this is very good training for that.

CHAIRMAN STETKAR: Good.

MS. XING: So it's a win/win.

MEMBER REMPE: That's typically how all these other methods did their quantification too, that they had similar types of processes occurring? I'm not an expert in HRA.

MEMBER BLEY: They're all different.

CHAIRMAN STETKAR: They're all different. Most of the people made up numbers that seemed to make sense at the time.

MEMBER REMPE: Back room?

CHAIRMAN STETKAR: It's my number, it seems to make sense at the time. That's cynical, but a lot of them --

MEMBER REMPE: In the back room. So this is more transparent than prior methods, the way it was done in prior methods, maybe? Is that a fair characterization?

(Pause)

MEMBER BLEY: The intent, I would say, is that it will be. I participated in this expert elicitation. We gathered lots of information, the experts prepared ideas forward and tried to justify them.

The documentation is a little bit sketchy. Not everything was done. But that was all identified. Those kind of details are not yet published, are they? I don't think they are.

MS. XING: I don't know.

MEMBER BLEY: I expect that the intent is that it will be transparent. But right now they've had one exercise in doing this.

MEMBER REMPE: So there will be more workshops in the future --

MEMBER BLEY: It depends on, they talked about that earlier, on what they do. The workshop that was done through the decision trees that were available, two of them, they didn't do for a variety of reasons. For all of them it did some things.

You know, there was an information gathering week workshop, and then there was an evaluation week workshop. And there were a zillion reasons to evaluate. And out of a zillion, a few were done very thoroughly and well documented.

A fair number were well documented by the individual people. And the consensus wasn't as well documented. And for some, the individuals either didn't have time to do the mail or did the remaining ones too quickly to be of content.

So if they want a well-documented set of these for all of the decision trees, they're going to have to do something more. And that's to come, I guess. We'll see.

If they get where they were trying to head with the first set of workshops, yes, I think they've been better documented than most other methods that have numbers in them.

Not all methods have numbers. Some methods tell you how to evaluate, and you generate your numbers. Most of the ones that have numbers in them, the pedigree in the numbers is pretty hard to come by.

MS. XING: Yes. I have like several hundred pages of documents, thousands. I think will be very valuable to put those documentation in a formal format. It can be a very useful document.

For example, one thing we gained from this workshop, for every crew failure mode we had the intense discussion, exactly what this failure mode means in operation.

So the experts come up to various operations always. And the first study can be very useful to understand the method and also to guide the people in future if they want they want to actually use the method. It's this crew study model. So it would be really valuable to have those information.

MEMBER BLEY: The problem I think Jing has is that information, some of it was written down by the individuals. Some of it was in discussions in the meeting. Some of that is, you know, audio recordings that are pretty hard to parse.

And two people in the meeting tried to keep notes. Those sets of notes are pretty clear. But they didn't catch everything. And a lot of the participants kept their own notes which I believe Jing has.

MS. XING: Yes.

MEMBER BLEY: But they're in all different formats. So to turn, all of this diverse collection of documentation into something that's coherent and I think would be very valuable, but it's a lot of work for somebody.

MS. XING: Yes. It's just that, it's not in my priority of 2014. And after 2014, I'm afraid that it decayed from my memory, that picture.

MEMBER BLEY: That's the other thing, tying together these pieces requires some memory of where they came from and why. So you're in a bit of a tough spot.

MS. XING: On the other hand, this exercise is also used as a pilot in our guidance for expert elicitation. That's another SRM. So we've already documented at least some high level information, the lessons learned from this exercise into our guidance for expert elicitation.

Okay, so we have different type of expert as instructed by the shared process. We have data experts to compile data, research experts to provide the experience and the judgment of those failure modes.

And we have evaluators, or called the proponents. These are the HRA analysts that integrate input from the resource expert and who gives HEP estimation.

And we have a technical integrated either here to propose the drafting of elicitation and the result of the technical workshop and the project manager manages the entire project. And we have peer reviewers where he has to provide the peers to the process.

So this is the overall process of the elicitation. So we have the preparation stage which normally to compile whatever data we could find in the literature and to prepare the procedures in the worksheet and training of the pilot user procedure.

Then we have Workshop 1 which is for the resource expert to come up to rank the decision trees classes and to provide some preliminary input of how likely the failure probability would be.

Then in Workshop 2, it's for the HRA analysts to estimate his HEP and to come up estimation. So after Workshop 2, at the end, we have taken the last spot, the technical integrator with the HEPs based on the input from the proponents to come communicate distribution of the HEP number.

MEMBER SCHULTZ: Proponent experts are, what's their characteristic, the proponent expert?

MS. XING: Which group?

MEMBER SCHULTZ: No, the definition of the proponent expert, what is that?

MS. XING: Proponent expert, they are HRA analysts.

MEMBER SCHULTZ: Okay.

MS. XING: So these are the people who're familiar with probability, have experience that you get from after probability. And the people for the research expert, those are the active raters in Workshop 1. Those are the operators or planners.

I'd like to show you my example of each one. I think there's some interesting information in this that they have compiled.

So this is what was done from the literature or from the existing HRA method. Like we found some literature for this particular failure mode, the failure mode of this one is the misread or skip data procedure.

And the interesting thing, when we plot all the information together, we're not that diverse. Like this actually happened to most of the failure mode that we find.

CHAIRMAN STETKAR: What sort of interbreeding is there in those different estimates? If you just do this in generic data, I made up a bunch of generic data back in 1980, and you'd see it published in a lot of different references. And it was amazing. They were all the same value. I made them up. There's a common source.

So the question is, perhaps it's not surprising that the estimates are all comparable if everybody picked a number out of a table in THERP and used it in their own report.

MEMBER BLEY: If I could offer clarification, one of the experts thought this in this information for the team before we went through anything.

Some members said that's interesting, and some others raised the point no raisement. Some identified some linkages, and some said, you know, the exact thing really is being, it isn't exactly the same across these.

So I think probably this was background for people. But I don't know that anybody, one person did use it to directly, but the rest did not use this as part of their background.

CHAIRMAN STETKAR: Good, thanks. Because having too much confidence in this, in terms of lack of variability, in terms of different estimates, I would be very skeptical of that conclusion.

MS. XING: This is the worksheet we used for Workshop 1. So we have this decision tree paths. And we have the expert to rate, but from very low to high, how these different paths.

And we gave them some anchors. Well, what do you mean by very low? What do you mean by high? And some expert actually asked, we asked them, try to use your best estimation. You can mock out, like for the ones you choose as your high, where likely there will be so they have some marks, so based on the information provided to the HRA analyst, for them to come up with their judgment.

CHAIRMAN STETKAR: Just out of curiosity, did you mostly have the experts just put an H, or an L, or an M, or a VL? Or did most of your experts put in numerical values?

MEMBER BLEY: This was Workshop 1 which was primarily the people from the plants giving their thoughts to the folks who were going to actually do the expert elicitation values at the second workshop.

So these were kind of guidance --

CHAIRMAN STETKAR: Okay.

MEMBER BLEY: -- from what the people in the plants thought that was part of the information set that the actual people doing the estimates did later. The people doing the estimates put numbers in and put ranges in.

CHAIRMAN STETKAR: Okay.

MS. XING: Yes. And I can think, we have six experts in this group, as I remember. About three of them actually provide a number.

MEMBER BLEY: That's right. Some put numbers, some --

CHAIRMAN STETKAR: But ultimately, those numbers were not considered by the expert of experts --

MEMBER BLEY: I won't say that. The folks who did the estimating were at the first workshop. And after these people gave their VLs, or actually put numbers on it, they got to question them and ask what drove them to that.

So it provided part of that layer of information that they used in the following workshop to actually put their numbers in. And some did it in between and actually made their original estimates before they came to the workshop, with this as background.

And they did get, those folks were there to provide a common level of information to the folks who would do the estimates later. So they got to ask plenty of questions to make sure they understood what was driving them before in doing this.

MS. XING: And at the workshop, every expert had to defend his reason why I put this high, why I put this low. That's, I think, the real valuable information. We hopefully can document them.

MEMBER SCHULTZ: In Workshop 1 and 2?

MS. XING: Both. They have to give the justification. And then they are allowed to, you can make a modification to your initial judgment, so you have to write down what was your reason. Say, previously I put a high, now I put a low, because this basic information we got from them.

MEMBER BLEY: Just an aside, one interesting thing happened at Workshop 1, especially, and a little bit in Workshop 2, but mostly in Workshop 1. Those people who were doing this, they started saying, gee, we're so

-- this contract's represented by Path 4. Something's wrong about the definitions of these.

And actually, a number of the decision trees ended up being revised. And quite a few of the definitions of what it meant to go up or down on that event tree were reworked during that session because of what the people brought to the process from their own experience and from HRAs they'd done before and that sort of thing.

So it really refined the models, the trees, quite a bit, and the definitions of things in the trees and how to interpret it up branches and down branches in those trees.

MS. XING: Thanks, Dennis.

MEMBER BLEY: It remained, which I don't care about this. I'm not sure if everybody, what remained for a particular, what do we call those, talks in the, clearing holes or whatever they are.

If it was good, it meant it was very good. If it was bad, it meant it wasn't very good. So if that same area of gray that you might evaluate got turned in to switch us a bit, and in a few cases it led to expanding from an up or down to multiple --

CHAIRMAN STETKAR: Yes, okay.

MEMBER BLEY: -- three or maybe even four in same cases.

CHAIRMAN STETKAR: Three or four attributes, yes.

MEMBER BLEY: -- where people weren't comfortable with that.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: That also means when we came to Workshop 2, it was pretty hard for some people to --

CHAIRMAN STETKAR: You know, multiple attributes, it was more difficult for people or when there was a --

MEMBER BLEY: No.

CHAIRMAN STETKAR: -- some goal, one level, up or down?

MEMBER BLEY: They'd say, gee, I think for that particular characteristic it could cover a wider range. And I don't want to say up is perfect, and everything else is failed. Because that'll really bias the outcome.

So there is redefinition of those talks in agreed form which I think most people stayed with, you know, we had to keep talking about it.

And when people would justify, in the second one, sorry, when people would justify their evaluations in the second workshop, all of a sudden they'd start explaining one of these. And they'd say, oh, I didn't treat that as we defined it. And they'd have to revise their estimates.

So it took a fair amount of time to do these. Our managers were not quite happy after the second day that we were only through three of them or four of them.

CHAIRMAN STETKAR: I've been through a few of, not this particular thing, but what I've found is, yes, in this type of process it typically takes what seems like a horrendous amount of time to get through the first --

MEMBER BLEY: The next few days went much faster.

CHAIRMAN STETKAR: Yes. I was going to say, and after that people sort of understand the process. They understand they've got the mental models. And you get consistency. But the first couple of days are horrendous, which is why it's troubling that this whole process wasn't carried through to the end.

MEMBER BLEY: But it's been very nice.

CHAIRMAN STETKAR: Because you have to teach people to relearn what they've already forgotten.

MEMBER BLEY: We had those --

CHAIRMAN STETKAR: I think you had the same people.

MEMBER BLEY: -- consultants, well, members of the NRC staff, consultants to the NRC staff, and consultants to EPR and two different funding streams, they ended at different times for different people. So that really constricted that.

The one thing I would say, primarily for people who have done kind of quickie PRA work out at the plants, the one thing a number of our experts in Workshop 2 had trouble getting there was that this isn't eventually that we don't have a probability of an up branch and a down branch, so that when they got to evaluating what the HEP was, they'd make it artificially low because it's really unlikely that --

CHAIRMAN STETKAR: Down, down, down, down and still.

MEMBER BLEY: And, no, the other part of the analysis tells you it's actually guaranteed to be there.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: We worked on that a lot. I think there's still a bias in our results from that, for the lower branches, that drives them down. Because people couldn't diverse this tree from something that has probabilities on it.

CHAIRMAN STETKAR: Yes, yes.

MEMBER BLEY: And that's in the notes that

I --

(Simultaneous speaking)

MS. XING: Yes. That is actually my reason and later, the team, they said for the layers to pass through the decision tree, there was a lot of numbers there.

CHAIRMAN STETKAR: Well, but that's why in my experience, I'd conclude a different construct. But similar, I very quickly got away from any kind of logic structure.

I told a story, you know. I would have seven paths there. I would have seven stories, please evaluate the story. Now, I'd get feedback from people saying, well, this can't happen. I said, well, no, this is the story. Evaluate this story. Let somebody else worry about how likely it is --

MEMBER BLEY: We had the same thing. I don't know if it would have been better, you know, we made it pretty clear. But they kept coming back. And we're very 4:51:18 in too, kept coming back. All of this can't happen.

CHAIRMAN STETKAR: That's right.

MEMBER BLEY: Yes.

(Simultaneous speaking)

CHAIRMAN STETKAR: It did happen.

MEMBER BLEY: Yes.

MS. XING: That's the failure part.

MEMBER BLEY: It's a hard concept for people. It's a harder concept than I thought it would be for the kind of people we had at the workshop, some of which --

CHAIRMAN STETKAR: Well, I think part of it is just the way it's, as soon as you present it, if they had modeling background or quantification, as soon as you put that sort of branching logic --

MEMBER BLEY: Into our sequences.

CHAIRMAN STETKAR: Yes.

(Simultaneous speaking)

MEMBER BLEY: It might have been better if we just did a table and said these are the conditions coming in.

CHAIRMAN STETKAR: Yes. That's what I have going --

MEMBER BLEY: I think I would do that the next time. But you still have the question.

CHAIRMAN STETKAR: Yes, still have the question. You have the bias on some of them.

MEMBER BLEY: Yes.

MS. XING: And so the worksheet for Workshop 2 is relatively easy. This is the HRA analyst to put, to evaluate the distribution of the HEP instead investigate the means. You have to give all these persons help.

MEMBER BLEY: Just an aside, they let them do this anyway they wanted. They didn't force them to put in every percentile.

CHAIRMAN STETKAR: I was going to say.

MEMBER BLEY: Two of the people in the beginning said I can't do it at all. I'll give a standard or a multiplier kind of thing.

By the time we were on the second day, they were all at least putting a mean and an upper bound value at the minimum.

CHAIRMAN STETKAR: Okay.

MEMBER BLEY: So we had a variety of results. And what we did was build a consensus out of each one and turned it into a log normal, as I remember. But we did get some measure of uncertainty from everybody. And they got better at it as they went along, even, I won't say his name --

(Simultaneous speaking)

MEMBER BLEY: By the end we went back and --

CHAIRMAN STETKAR: Yes. That's what I found also, that eventually people sort of get it.

MEMBER BLEY: Sorry to keep adding to this, but I was the facilitator. So I feel okay doing it.

CHAIRMAN STETKAR: Very helpful. So in principle, although if I look at that, you know, Number 3 on here, and I won't call it a sequence. If I look at Number 3 on here, and it's got a 6.5 times ten to the minus two, that actually has an uncertainty distribution on it.

MEMBER BLEY: Assuming that Jing took this from the report I gave her, yes.

(Laughter)

MS. XING: I did. I took numbers from the report they gave me.

MEMBER BLEY: It's the mean. I ended up getting a mean and a parameter for a log normal on all of them which was --

CHAIRMAN STETKAR: But there is an uncertainty there.

MEMBER BLEY: And the ones that we didn't, I mentioned it, but I didn't, after everybody did their own estimate, we put all those down. We each defended our own estimate.

And then we came up with a consensus that everyone agreed represented the knowledge of the team. So some of those were pretty broad.

CHAIRMAN STETKAR: I was going to say, you didn't take each individual and rate them equally and just merge them --

MEMBER BLEY: No, sir.

CHAIRMAN STETKAR: Okay.

MEMBER BLEY: Did not do that. We came up with a consensus.

CHAIRMAN STETKAR: With a consensus.

MEMBER BLEY: And we had a couple of places where they were very diverse. And as soon as we started talking about it, I know one of them, it came down to definitions.

And we had to redo the tree to allow for what Group 1 was thinking and what Group 2, they were both reasonable things to do. And they weren't fully represented in the tree. So we adapted the tree. And then we had more coherent results.

MS. XING: And we did have three trees. We couldn't reach a consensus during the workshop.

MEMBER BLEY: Even on the trees themselves, that's right.

MS. XING: Even on the trees, so those are --

MEMBER BLEY: What they meant and how to use them. And part of it was how to you use them, like the communication one. None of this is good. What do we do with it? How do we put it back into --

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: -- and use it. We need to better define it so when we --

CHAIRMAN STETKAR: Which is, right.

MEMBER BLEY: Does it apply over and over? Does it apply once and for all? There were things we couldn't resolve during that short time. It seemed a long time when we were doing it, but a fairly short time.

MS. XING: I think we're ready to talk about this.

MEMBER BLEY: Go ahead.

MS. XING: So the project already finds, and we modified the CFM and the PIF decision trees. And we were unable to estimate a HEP for these two trees, because we couldn't come to --

MEMBER BLEY: I don't think you mentioned it, but our source experts from Workshop 1 came to Workshop 2 as well and were available to provide comments and to respond to questions from our evaluators.

MS. XING: Yes, we did. In that diagram there's a process, basically Workshop 1, the main expert, he did the work. And the PRA analyst and other people challenge them. Workshop 2 is just the opposite. PRA analysts do the work, and the research expert challenges them.

MEMBER BLEY: But we also used the resource experts in Workshop 2 if we got to a place, how does this really happen in your plant?

MS. XING: Yes.

MEMBER BLEY: How do you deal with this?

CHAIRMAN STETKAR: Yes, in terms of context and at least their understanding of the context.

MEMBER BLEY: And they came from a wide enough variety of thinking from the different plants that it was very helpful in that we got ideas from a memory that grew. We've played on each other. So that was very helpful.

MS. XING: Overall, we found the modified basis process works reasonably well. And this last sentence I copied from the report Dennis gave me and also from our peers.

The quality of the results were limited by two major factors. One was the experts full understanding of the methodology. Even before the workshop, we gave them training. We thought they understood, but once we come to the workshop face to face we find, oh, you know, everybody has a different story of IDHEAS.

MEMBER BLEY: But that's the whole methodology, not the just a little piece of it. So my understanding how this is used in the rest of the methodology was what became a bit of a problem.

CHAIRMAN STETKAR: Well, and you can understand, you know, the example you brought up about communications or something like that. It's how does that fit into the process?

MS. XING: And also the time resources, like we have three days workshop on each one. Still, that's not enough to --

MEMBER BLEY: Yes, I --

MS. XING: -- do any workshop at all.

CHAIRMAN STETKAR: One can always say that. But my experience, three days is probably too short, you know, 30 days is certainly too long. I think we've reached the point of diminishing returns --

MEMBER BLEY: But what has been good --

CHAIRMAN STETKAR: -- on some of these things.

MEMBER BLEY: -- we needed the face to face. We couldn't have given them more money and had people come in with their own estimates better. Because they didn't know quite how to do it.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: And so we needed the three days. A lot of people did come in with things prepared ahead of time. But after those three days, they thought about it differently.

And then they could have gone home and done all the rest of them and then come back together and worked out the differences.

Two people had estimates for almost everything. But one of them acknowledged he was just coming from the numbers. And the other one had a method that was a little, that hadn't been strong in the consensus. So there's cases where we only had those two or one of those two. We didn't use them, you know. Because there wasn't enough there.

MS. XING: So anyway, based on what we have, the external review and the feedback from expert elicitation, we did think to check how well we did with our mission, recommending one method.

This is the one single method, the variability is to be tested. And it's conformed to the, we achieved the first requirement. It's conformed to the current practice. And we retained the strength of the existing method.

Whether or not it had the enhanced capability to address the current weaknesses, we directly say yes. And from peer review, we got a lot of yes. But how well it works, really needs to be tested out.

CHAIRMAN STETKAR: I have to say this. It's just interesting to look at this slide with very, very positive and assertive yes, yes, yes, yes, yes, yes and harken back to a discussion that we had this morning about all of the negative caveats on the research report.

Oh well, we didn't really do this. No, we need to look more at this. And I would say this is one opinion about how far along you are, especially right there, the last bottom line there.

MS. XING: Since this morning we primarily talked about generic methodology. I would put a note probably to most of these boxes, because that's still developing.

CHAIRMAN STETKAR: It's just, again, I think we have to be very careful that there has been and continues to be the cart before the horse in some sense.

If generic methodology cannot, I have to be careful, if generic methodology should be a generic methodology, this particular application should be a specialization of the generic methodology.

In other words, there shouldn't be anything diametrically opposed or orthogonal in this part of the application compared to the generic methodology.

I don't think we've seen anything yet, at least, to give me the indication that it is. But I don't think we've seen enough about the generic methodology to understand that in the business they focused application of that and not something that's off by itself somewhere. But the flow isn't there yet.

MS. XING: Okay, any questions on this part? I didn't do my promise for get this done in 20 minutes. But I will keep my promise, and we'll get up to leave before 6 o'clock.

MEMBER BLEY: I'm sure you're going to expand it, but I just have to ask a question ahead of time. I've read this testing manual. I don't know whether it has to do with testing. So as you go through it, tell me what it has to do with testing.

MS. XING: Oh, okay.

MEMBER BLEY: It's written like almost a user's guide or something to the --

MS. XING: Well, user's guide is our ultimate goal. Like, eventually after we accumulate enough experience from testing, we want to develop a user's guide.

The first item, this is again, it's a horse or cart first question. Before we get to user's guide, we need testing. So in order to do the testing, people feel like our 300-plus page report is too difficult to use for testing. So we want to convert what's in this

300 page report.

MEMBER BLEY: So it is kind of a user's guide for people to use --

MS. XING: For people to use only for testing.

MEMBER BLEY: Oh.

MS. XING: Yes. So we put it in base format, just for easy to use for people doing the testing. Like the technical aspects, there's no difference from the report you are reading. We just put that, converted the report into a template format so it can be easily used.

CHAIRMAN STETKAR: Can I offer a worry?

MS. XING: Yes.

MEMBER BLEY: The worry is that people will use that document as the handbook and will ignore all of the background knowledge and information that's in the methodology to make, can't say you'd do it right.

(Laughter)

MEMBER BLEY: Is the methodology document work fully complete?

CHAIRMAN STETKAR: As always, yes.

MEMBER BLEY: Okay.

MS. XING: I appreciate that opinion. And I can also share, you know, what I heard from one potential tester. I tried to solicit people in the Agency to volunteer for testing.

And this gentleman told me, well, your methods are too complicated. I don't want to give you a report. I said, okay, how we make a manual for you. I promise manual will be less than 100 pages. And he said, oh, I will only use anything less than 50 pages. So I will try to --

CHAIRMAN STETKAR: Tell him thank you very much, get his resume up to date and don't do this kind of work. It's not a push a button, eat a banana type of analysis. If somebody doesn't want to invest the time to understand the basic technology, one ought not to be doing this, quite honestly.

MS. XING: But taking the experience we learned from expert elicitation, I would think when we, before we do any formal testing, we like to have a good face to face training session for these people. Even if they don't read the full report, we make sure they fully understand the manual.

MEMBER BLEY: Of course.

MS. XING: Everybody on the same one, how the method should be used. That's kind of compromises, but they don't want to read a 300-plus pages.

Okay. The initial testing, so the purpose of this testing, I want to call it more like a piloting, because it's not a formal testing process. We want first to demonstrate how the method works and to verify the functionality and stability of the method elements.

Are they able to really use the guidance with the CRT? Are they able to use the guidance to identify failure modes, things like that. And I think there are areas for improvement.

Initial insight into analyst variability, because we only had three teams, and again, some lesson of how we should develop the future user's guide and user's manual.

Also we have, directly we have three tester teams. Team 1 is the real team, has three analysts, and one of them is an IDHEAS developer and two HRA practitioners. This is what Mary mentioned, Mary Garrisey, an HRA analyst, take this exercise. It was documented in the Appendix A of the report.

MEMBER BLEY: Are these efforts that have already been done, some of them already done? Or are these all planned?

MS. XING: All these, we are done.

MEMBER BLEY: These are finished?

MS. XING: Yes. So this one's documented in Appendix A of the report.

MEMBER BLEY: Okay.

MS. XING: And the second is, because I call it a team, it's only one analyst. But this analyst, April Whaley, who previously worked with this team on the scenarios they tested. And the results she had was fully documented, has a 100-plus pages documentation.

MEMBER SCHULTZ: But not in the report, it's not included in the report?

MS. XING: I think the report covers SRM Volume 3.4. It's a separate, because it's over 100 pages, we didn't put in the method report. It's a separate report. And Team 3 is also analyst, Harry Liao. He previously worked on the U.S. simulator study report. So he is familiar with this scenario.

MEMBER BLEY: Now, I notice you or somebody, no, it was April, I think --

MS. XING: April, April --

MEMBER BLEY: -- tried to apply this methodology that's earlier staged in the benchmark.

MS. XING: Yes.

MEMBER BLEY: So are you saying it doesn't matter who did it? It's another method.

MS. XING: No, Harry did it. He was involved in that earlier, after piloting an early version of the report which he used by real event of Indian Point. And the first one, because after that testing, the method changes a lot. So I do not consider that as a test. It was just --

MEMBER BLEY: No, I was just wondering if Harry was involved in that. But he --

MS. XING: No, Harry didn't involve that.

MEMBER BLEY: Okay.

MS. XING: And they just let him work completely independently. So they didn't with the other people's report.

I told you I will jump to the summary. So the most information we got out from these three testing reports, the most has more or less worked. All the parts worked as they are intended.

The testers provided the comments on where the weakness of the method and made a suggestion for improvement. And the book has 1,000 pages. So I'm the evaluator for this testing result. I personally considered. They provide a thorough group transparency and traceability compared to the documentation I saw in the U.S. benchmark, in the U.S. empirical study and the international benchmark study.

This is too early to say the inter-analyst variability, at least from the several HFEs they tested. We see some good consistency there. And the testing team commented they're very labor consuming. But to be in a template it's a constancy for the timing their deliberation.

MEMBER BLEY: But these are all hand-done analyses, right? You don't have a computer code that they're trying to use?

MS. XING: Yes, this all hand writing methods.

MEMBER BLEY: Okay.

MS. XING: So that's a good point to make. I, for one, have made a comment. I found that I frequently make, in the method, I identify some information like in the quality of analysis. And later on, I need to identify the same information again. So if we have this method computerized, it could save lots of time.

MEMBER SCHULTZ: So just in that bullet, there was some discussion about how time consuming the process was. And what I take from the whole statement is, if the templates had not been as good as they were, it would have been intractable but --

MS. XING: Yes, it could be --

MEMBER SCHULTZ: -- based on the --

MS. XING: -- dramatically.

MEMBER SCHULTZ: Yes.

MS. XING: Taking my personal experience, I was in the SPAR-H team for the U.S. study. And I didn't do a full analysis. But I kind of tried out of this same event.

I'm not a good tester, because I'm too familiar with this method. To me, I didn't find I had to spend too much more time than using SPAR-H. Because I was in the SPAR-H team.

We had two SPAR-H team in the U.S. study. I was in the team. We spent a lot of time to do a slow task analysis which wasn't in the SPAR-H guidance compared to other teams. They didn't do a full test analysis. They pretty much just jumped into the worksheet, check the boxes.

So in our exercise, because SPAR-H didn't have a guidance or test analysis or qualitative analysis, we had lots of deliberation. Should this be a test or not, what we should document for this test.

This is what I tried out in this method. It has the tables, a template. Oh, okay. It meets the criteria for being a critical task. I consider it's a critical task. But then, it's just a test. I had this six or eight dimensions information and literature, the contact information for this test. So end up, it's much easier in that way. But this is just one person's personal experience.

So I think we want to go through the, here

I just provide some examples, the comments provided by this tester say how you can improve the different part of the method.

Okay, the next part I didn't intend to walk you through this. That is too complicated. Just to give you an idea, you can find all these tables in Harry's document. I think that's the report, Volume 3.5.

And so Harry did it different from April. What April did, the primary goal I gave to her was to try to see whether each part of the method would work. What's the strength and weakness of the different part of the method?

That's what she considered. So she wrote, her documentation is full of the task, writing, paragraph writing.

So Harry, because Harry dated this test at a later stage of the development. And I asked him to consider what he thinks the future user's guide would be. So he didn't have to document the same way as in the U.S. study.

And you could document the information in the kind of the template format that would be easy to use. Therefore, if you look at his report, and he primarily used this template to document his findings. So for every part, he developed a table to document the information.

So I want to talk, take a detailed look of any basic particular elements part.

(Off microphone discussion)

MS. XING: And I compared this report to try to get a sense of the inter-analyst variability. And this is how CRT looked like from three teams.

And like each box in there represents one critical task. And you can see, these teams are not quite, or Team 1, the EPRI team, only identified the three major tasks in this loss of feed water scenario which is the transfer to ES-01, diagnose the loss of heat and enter the feed and bleed procedure and implement bleed and feed.

And for Team 2 and 3, their CRT are identical but because they both were in the U.S. study. So I wouldn't call this a high consistency.

CHAIRMAN STETKAR: Right, yes.

MS. XING: So when I look at the CRT, if you look at it you would think the Team 1, Team 2 had very different CRTs. However, once they identified the critical task, they come up fairly similar critical tasks.

The Team 1 had an additional task. Team 1 thinks the transfer the ES-01 and the start monitoring CSFTs, this is a critical task.

Team 2 and Team 3 did not consider this as a critical task. Because they think this would be naturally done. There's no way that you can fail this task. It's in the procedure.

So that's what part of it pointed out. We really need a better guidance on what do you mean by a critical task. And they all had the same on Task 2 which is enter --

CHAIRMAN STETKAR: It's also interesting, Jing, that --

MS. XING: -- feed water and the enter to FR-H1.

CHAIRMAN STETKAR: He said they didn't identify the transfer to that particular ES-01 because, how could you do that, because it's in the procedures. That, to me, says the guidance in the methodology needs to educate people to the fact that just because it's in the procedures doesn't guarantee that it's going to happen.

MS. XING: Yes. I think we had probably too strong assumption in this --

MS. XING: Which again comes back to some of the comments I've had about the subtle way the reports are written in the sense of if I, this is a lot of subtleties in the text of the reports that leads one to conclude that if I have good indications and I have good procedures I will win.

And part of educating people to systematically develop this type of logic structure, you need to make sure they're challenged to think about that.

MS. XING: Yes. And to tell them it's not just in our method, it's in our PRA practice. And somewhere in the, I'm not too familiar with the PRA, but this is from one of our team members' comments. So if the procedure does not match the scenario, the PRA standards there, just put HEP would be one.

CHAIRMAN STETKAR: It's probably somewhere between zero and one. I've seen people to try to say as long as I have a procedure the people are guaranteed to be success, and it's zero which is smaller than 10^{-90th}.

MS. XING: Yes.

CHAIRMAN STETKAR: It probably is somewhere between zero and one. I can almost guarantee that.

MS. XING: Yes. Actually, once the tester made a comment on that. Say like when you, in your failure mode procedure you didn't have a failure mode to cover the situation. The scenario, the procedure, doesn't fit to cover the scenario.

CHAIRMAN STETKAR: You know, in the real world, most of the time it doesn't fit precisely correct nor does it not fit at all.

MEMBER BLEY: What's missing is the task analysis and the story of how you got here. LOCA's a big box. Which LOCA you have can really change the way these things go, and timing. And the story and the task analysis are precursors. And they don't seem to be important enough to be there. This leads you to some inconsistencies.

CHAIRMAN STETKAR: But I mean, if you are getting feedback from people saying, well gee, I didn't think about that, because the procedures are so good and everybody always follows the procedures, that should be a cue to you to say there's something in the methodology that's allowing someone to make that erroneous assumption.

MEMBER SCHULTZ: Or they didn't understand the assignment.

CHAIRMAN STETKAR: Or they didn't understand the assignment.

MEMBER SCHULTZ: Yes. I thought I was only to look at what happened after entry.

CHAIRMAN STETKAR: That could be, perhaps. We don't know.

MS. XING: And in the early version of this report, we actually have, in the qualitative analysis guidance, we actually asked people for each of these mode in the CRT. Also, look at what other tasks they might be doing. But then, at the end we delete that part of --

CHAIRMAN STETKAR: But the problem is this is a plain vanilla loss of feed water event. So it's really difficult for me to understand what other tasks I might be doing on an ill-defined, plain vanilla loss of feed water event.

You know, was it because one of the main feed water turbines exploded and threw, you know, blades into the other turbine which glanced off and killed the motor-driven pump? That's a different world.

MS. XING: And here, we state this would be an example, like in Task 3, decide to start bleed and feed. So two teams put this as one task, decided to start it and actually executed, implemented. And one team breaks down into two parts, two tasks.

So the recommendation here is we need a better guidance on the level of detail, how to break down the task, once detailed enough. But on the other hand, look at the failure mode they identified.

So this Team 1 has this task, it has for the first task enter ES-01. They identify a failure mode of data misperceived. And however, see, the other two teams did not have that task.

And also, the decision path of the lowest one, so the HEP is negligible. So it doesn't, even they identified one more critical task here. It doesn't affect the final HEP.

That was kind of behind that these analysts' mental model of all these tasks, because they will get it. So I'm not put that at the, I'm not going to analyze it.

And for Task 2, these two teams come to same failure mode and the same, I was surprised, they come to the identical decision tree path. And same for Task 3.

See, Team 1 had this as one task, identify the three failure modes. Team 3 break that task into Task 3 and Task 4. But if you look at the failure modes, they got the same failure modes. And they got almost identical decision tree paths, except this one is Number 15 and Number 14. The HFE really had no difference in these two tasks.

And some of this is different from the results, but I think to believe every HEP, every team, everything will come up like as good as this.

And I did not compare the crew failure modes for Team 2 that April Whaley did. Because April used an early version of this report. And the other two teams used a later version of this report. The difference is between these two versions.

We made the last modification on the CFM detonation. That's, as you said, these two teams did not identify the one, miscommunication. Wherein the early version, April had miscommunication in every task. Because there's always a communication there. There's always a chance they miscommunicated.

This is just to give you a flavor of how it's look like, the tasking. And obviously, the preliminary observation is that they didn't demonstrate the major differences in the result. It was a very high failure.

For the crew failure mode there's a high probability that all items have results. So the difference is within the lower end, some CFM not important.

And some analysts say, well regardless, it's highly likely or not, as long as there's a chance, I put it there. That's what April did. So she had more failure modes.

But the other two teams, if you look at their justification they say, oh, this failure mode is unlikely happen because of the so and so. So they did not identify.

That means we really need to give a better guidance on how to choose those failure modes. You should factor all the failure modes that's likely. You will probably get too many failure modes. You only choose the ones that you think it's likely. Then you might miss some importance then. We want to understand that better through the next phase of testing.

So that's some preliminary thinking for what we are going to test, the formal testing we want to conduct in 2014. First of all, I will have to make sure we find the volunteers to do the tests. That's going to be a challenge.

And we've got this challenge from our internal users, say what do you want to test for? So we say we're going to do a test. A test against what? So we have some start on that also.

We will test on the, in the early stage of this work we evaluated the different method offered from the U.S. benchmark study there. We thought about the weaknesses in the current HRA method, like what listed here.

We could test how well this method making advances to those, to addressing those weaknesses. And also, we would like to test this method specific weakness for some, for SPAR-H. Because that's what the Agency is using for our current PRA model.

One comment we got from the users who were using SPAR-H would say, well, unless you demonstrate this new method, improve the weakness in SPAR-H, we will not use this new method. Why bother?

So we want to do some tests against the SPAR-H, okay, using both methods for the same event to see how well it works. And that's my last slide for today.

CHAIRMAN STETKAR: You know, using both methods for the same event, I think you have to be very careful about what that event is. If that event is a, if it's initiating bleed and feed cooling, that may not be a very valid test.

If it's responding to a fire, well, the problem is your IDHEAS method doesn't respond to fires. Because by definition it's only internal events in the control room and yata, yata, yata.

I think you'll see more weaknesses in SPAR-H in terms of scenarios that get further away from this procedure centered focus in the main control room and out into a broader spectrum of real PRA scenarios.

MEMBER BLEY: You could look at some degraded support system initiators. That would be a --

CHAIRMAN STETKAR: That's right.

MEMBER BLEY: You can get the same kind of stuff you get in the fires from those.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: Not loss of, not degraded.

CHAIRMAN STETKAR: Not loss of, degraded.

MS. XING: Yes.

CHAIRMAN STETKAR: Degraded, loss of half of the plant with perhaps something out of service or --

MEMBER BLEY: Gradually falling instrument air.

CHAIRMAN STETKAR: That's a good one.

MEMBER BLEY: Partial losses of cooling water systems.

CHAIRMAN STETKAR: Cooling water, you know, two train plant, cooling water that's aligned to the charging, the normally operating cooling water trains aligned to charging pumps, for example, gets into pretty subtle types of dependencies that don't fit things very well.

So I think if you're going to do that comparison, you know, to address critics who say, well, as long as SPAR-H is giving me a quick and dirty decent number for things, why should I try something else, you need to design your tests a little bit to probe that type of process.

Because if it's just evaluating a push a button, eat a banana type of action, pretty much anything you can think of, those will work.

MEMBER BLEY: Those will work.

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: In the uses of SPAR-H I've seen, there's a built in bias that, you know, you could find some scenarios that will challenge that. And the built in bias is that you only have to strongly justify negative PSFs.

If you don't have any information, which could mean anything is going on, they tend to pick the nominal. And that might not be true at all. And I think some of the things you've built into, where we are so far on this would, on certain scenarios, would really emphasize that difference.

CHAIRMAN STETKAR: Some of the things we've challenged on fires, for example, that if you only focus on the things that the PRA model has told you is important, like do I have feed water, when the entire secondary side of the plant is going nuts on you, people will say, well, I don't care about that.

Because my PRA action only focuses on this particular indication. And James is, I only care about core exit thermocouples. Oh, I'm sorry. The entire world is falling apart. Maybe I remember that I should look at core exit thermocouples, but I'm really busy with --

MEMBER BLEY: And you're busy with --

CHAIRMAN STETKAR: -- everything else that's going on over here. Because operators don't drop back to, oh, let's just look at the parts of the procedures that I use that are dealing with what's in the PRA. They operate the plant. So there's scenarios that put a burden on them from the secondary side.

MR. CHANG: That's just where we have contextual factor of this interrupting task. And either situation in detecting the meters.

CHAIRMAN STETKAR: But I think what Dennis is saying is that that notion may not exist as well in the SPAR-H approach to life where I think you tend to focus more on that particular action that they're evaluating.

MS. XING: Yes. In SPAR-H, the one factor, it has eight PIFs. Two PIFs are address the task aspect. One is the time, like how long, if you have enough time to do the work. Because the other is the test complexity. Text complexity is too general.

CHAIRMAN STETKAR: That's too general.

MS. XING: Yes, because for some people who have a good understanding of operation, he can put a lot of stuff into the test complexity.

For some people who are not experienced, you just don't know when it's complex and when it's not. So because of that, you can really miss things like real performance drivers. And you use the generic methodology.

We try to address that be call out explicitly is the task demanding. It's not because you have, you're fatigued, or you're tired or you have stress.

The test itself is just too complicated. Like this workload factor, so you have this test is unfamiliar, this test you've got multiple tasks you have to do. And if you only have one primary test, but you have a lot of these distractions, and your story the operator gave to you.

So to confirm, we had some thing going on. And they tried to fix something. At that point, an event happened.

According to the normal work process, the operators should have stopped there, to focus ahead of this event. And after this, oh, we were in a hurry of that. We want to finish that first. Then they got into event because there wasn't enough time to do this.

So we tried to capture that kind of thing in the generic methodology. And that's something I personally think is not explicit in SPAR-H so we could give you better improvement in that.

So in short, so far we have had a lot of interaction with our internal staff who work on SPAR-H.

And we look at the event analysis in SPAR-H. They already identified a bunch of weakness areas in SPAR-H. So in the testing we want to pay attention to those weaknesses, see if this method made it matter to those.

MEMBER SCHULTZ: So I think that's reasonable and fair. I would think you'd also want to have your own explicit write-up that would answer that question for those individuals that are familiar with SPAR-H to say why should I use the new method. Well, here are the ten reasons that the new model will address. These are reasons that we know are deficiencies. And the new model addresses those.

MEMBER BLEY: And you can tie them to some actual events that have occurred in the real world.

MEMBER SCHULTZ: And that's even more important.

MS. XING: Our staff who are working on the, who use SPAR-H, we talked. And they said they were planning, well, this is their plan last year. I think may still valid. They were planning to analyze every event using SPAR-H, including the Robinson one.

And so we would like to work with them to select the testing scenario. We probably want to choose some simple one, not as simple as just push a button. Because now we want to, we also want to select some more basic sort of one, like the Robinson one, see how the two method they will capture that.

MEMBER BLEY: You know, one trouble with actually analyzing a real world event, like Robinson, is everybody knows how it turned out.

CHAIRMAN STETKAR: Right.

MEMBER BLEY: So their answers are going to fit what happened.

CHAIRMAN STETKAR: Somehow.

MEMBER BLEY: So taking some scenarios maybe from the benchmark studies and people who were involved in those might be better. Because --

CHAIRMAN STETKAR: I mean, if you read April's, she said was involved in some of the benchmark stuff and had to, sort of tried to divorce herself from the things she knew about and --

MEMBER BLEY: That's really hard.

CHAIRMAN STETKAR: It is.

MEMBER BLEY: I can take THERP to Robinson and get the right answer.

CHAIRMAN STETKAR: I'm sure you can.

(Laughter)

MEMBER BLEY: Now that I know the right answer.

MR. CHANG: You understand, think about it is a PI. I think it's a basic PI, like a stop, sorry, make it a Level 3 PI. They said that the typical one going to this level of the information, the one that's just more like, first time with the analysis, in fact.

And now we have a methodology. That is better. I see that HRA, the way they say that generic methodology or HRA worksheet, it's a quantification of opinions.

And the factor here that they're able to, for the analyst, a portrait is captured of the situation. And then sort of that second one, if I'm in this situation, the key captured, all these key factors in the second situation, second place, there was one here. That's going to the HEP.

MEMBER SCHULTZ: Right. That's another argument that you can make from this methodology versus what has currently existed.

MEMBER BALLINGER: This is a steep curve, man.

CHAIRMAN STETKAR: Yes. Any of the members have anything more for James and Jing? I sure hope not.

Sean, I could carry a couple of summary slides here. Do you still want to go through those?

MR. PETERS: Yes. You can go through them. But I do have a couple of summarizing points from when

I heard from the HRS today, from the subcommittee.

So many pieces that are going to be heard from the particular comments was that if you're going to provide clarification, the cognitive basis report right now is that, as the methodology has been developed, it's not the entirety of the foundation of the generic methodology.

As Jing already, since she was an author of the cognitive basis report, it's not all encompassing. There are pieces of the generic methodology that they had to build without that foundation in the cognitive basis report.

So we will try to identify those particular areas where the cognitive basis report was lacking. And we will explicitly call out those pieces that we had to build upon for the generic methodology. So that's one clear finding on there.

There seemed to be a debate as to how to go about a quantification process. And as you saw in the two presentations here, one was more of a performance influencing factor based on SPAR-H's worksheet where you have a PIF for say whatever method, we may believe the Level 1 was more of an expert elicitation methodology.

We did kind of come to some type of consensus or agreement into is that a deal breaking method to use either one of those? Or is there exclusives in that you should be using one type versus another?

And especially given the applications that we can apply it to, when we apply it for NRC use, we apply it for the STP analysis. And I guess in those particular scenarios, there are a lot of novel failure paths. And actually, doing expert elicitation may become a challenging scenario for at least in these quick cut HRAs you guys are talking about.

CHAIRMAN STETKAR: And, Sean, I think that's one of the keys. As I looked at SPAR-H, for example, I think that inspectors and people in the region need a general framework and some quick and dirty numbers which are, you know, is it ten to the minus three, is it 0.5, to give them some perspective about whether or not they should raise a flag for more detailed evaluation using more sophisticated approaches. Or does a particular event not merit that type of scrutiny?

And so some sort of simplified approach certainly is needed in that arena. But that's not real human reliability analysis. That's not doing a human reliability analysis to support a full scope probabilistic risk assessment.

So that trying to be responsive to somebody who says I need a quick and dirty number to do my job, yes, they do, for their job.

But their job is not doing the whole scope human reliability analysis for a PRA. They're simply out in the field using these things. If they can't reach a conclusion, it's their job also to kick things upstairs and say I need to do a more detailed analysis of this, I think.

MR. PETERS: From that perspective, well, here's one that indicates that we either have a method or several methods for the Agency. And given my six or seven years here in this particular position, what I see of how the Agency uses HRA, and I'm going to put out a number since we've been throwing up numbers all day, is that 90 percent of the time we use it for just these quick and dirty items.

From the Agency's perspective, at times we get a new, and do a novel HRA methods where we go and do novel HRA applications where we go through the, we build up a complete story, as James did in the spent fuel pool scoping study where he had to come in and create kind of a new practical HRA for that.

CHAIRMAN STETKAR: But see, that's part of the problem. Because we see a new, novel HRA method for the spent fuel pool scoping study. And we'll see a NUREG written on a new, novel way of doing HRA for fire events.

And if we're giving people the opportunity, we see yet a different new and novel way of doing HRA for seismic events with no flooding, and for seismic events with flooding and for aircraft crashes but that are not catastrophic, you know --

MEMBER BLEY: Exactly.

CHAIRMAN STETKAR: And I think that's part of the concern of the SRM.

MEMBER BLEY: Back to your 90 percent though, too. When things crop up in the rate, STP, and aren't normal, then they've got to do a more thorough analysis.

And they've got to defend it and deal with folks at the plant who are not wanting to get stuck in a higher category. And that doesn't happen every day. But it happens enough that it's truly an important place to use this.

But one thing you mentioned that troubled me a little, if in fact this method works the way one is hoping it'll work, we have a rather complete set of decision trees. And that's where you need really thorough expert elicitation kind of once and for all.

Now, sometime in the future we'll find, now you'll probably find a few cases when we start applying it. But in the future you'll find some more. But you don't expect to have to do a big expert elicitation every time you apply the method. You've kind of done that.

Now you have to apply it correctly and get to the right --

MEMBER SCHULTZ: Path into --

MEMBER BLEY: -- path in those trees. So it's not that every time they do an analysis they're going to have to go do an expert elicitation.

MR. PETERS: Yes, it's a good point. But in the generic methodology, we haven't elaborated those decision trees out into those other scenarios, like real power shutdown scenarios or whatnot. And giving those decision trees their particular scenario, we can use the methodology to do that and --

MEMBER BLEY: Do you have any reason to expect that when you look at low power in shutdown you're going to need new decision trees?

MR. PETERS: I'll have to punt that question over to our technical team.

MEMBER BLEY: You're going to have to look. But --

MR. PETERS: Yes.

MEMBER BLEY: -- I don't think you are.

MR. PETERS: You don't think we are.

MEMBER BLEY: If I was going to need a new set of decision trees, you really shouldn't. We should have picked up the factors that affect human performance such that, when you do the qualitative analysis for those things, you identify the human characteristics that you need to quantify. And those should already be in those trees.

But if you use this one more, you're going to find cases where originally we didn't think of that. You're going to have to add a new tree --

MR. PETERS: Yes.

MEMBER BLEY: -- or revise the tree. But that's not going to happen every day.

MEMBER SCHULTZ: But that's the huge benefit of approaching the methodology in this way.

CHAIRMAN STETKAR: In terms of your original question about, gee, it looks like we have ideas for internal, at-power, in the control room, procedure related events that have used this expert elicitation methodology with the framework of CRTs and decision trees.

And now, over in the generic methodology, we have this kind of tick box, pick a number out of the table. My personal opinion is that the approach used in the at-power procedure related stuff is the approach, the methodology that ought to apply. Because it tends to keep, I hope, people more focused on the scenario and forces them into those paths in the decision tree.

So my own personal opinion would advocate away from the tick box, pick a number out the table, and more toward organizing the generic methodology in the same way that the focused application is organized. And as Dennis said, if you thought it that way, you might see a need to develop some number of additional --

MEMBER BLEY: But logic --

CHAIRMAN STETKAR: But I don't know.

MEMBER BLEY: One thing that comes to mind, well, you probably won't. For each of those three failure modes or whatever you call them, for each of the trees, the tops, that are the characteristics that are affecting the people, and I forget our language now, whatever those are, the factors that influence performance, well, there's a list of ten, say, I forget how many.

But for each one of those trees, there were reasons why they said, oh, we only need to consider two of these. Or we only need to consider five of them. And when you get to low power and shutdown you might say, oh, we need to consider one more of them. So you might have to expand that tree a little bit.

But, you know, that isn't going to happen a lot. And in principal that's why, I think, the biggest thing will be is you'll find that you've closed off some of the factors that are important, that might turn up to be important. And you might have to add another talk event to those trees.

MS. XING: Yes. But then, when you two decide of which factors are important, that's also an application. It will vary from application to application. But what we have is the generic methodology for, let's say, for each failure mode, just give an example, we identified 20 to 30 effects, characteristics, would affect that failure mode.

However, in the IDHEAS method, we only picked up the top three or four which means we left out the majority of them. Because either those do not apply to the control room kind of events or they'll unlikely happen.

If you move this to a lower power shutdown which, you know, for us probably the PIFs we selected for internal, for at-power event become less important. And the other set now becomes --

MEMBER BLEY: Probably not. But you will get some where you'll add some.

MS. XING: Yes. So that's something, that's the, so the generic methodology initially, as the last resort, let's try to identify all the potential characteristics. That's why we have a long list of the characteristics. I think last time I counted 104.

CHAIRMAN STETKAR: But see, you've created those. And it's not clear to me that there's a need to create the large number of things that you've created if you accept the psychological basis document as your framework.

In other words, you know, we had a long discussion this morning about why did you pick these additional. You said, well, we're concerned about maybe the framework document not being complete.

And that gets back a little bit, Sean, to what you were saying. If indeed there are real gaps in that document, we should better understand where they are. Because I personally don't, for the most part, understand where they are. You can always put more items in a list.

MS. XING: That's the part which is not in the documents. See, for every PIF or characteristic we had in that list, on one side we could link to the cognitive literature what is based this fact on the effect of this error cost and would affect this mechanism, would affect the basic step of the cognitive process. We had that linkage there.

On the other side, for every factor we put there, we had a list of why it's not multiple. Real operational stories showed, okay, this factor has appeared either in this nuclear power plant event or human event in mechanical plant or in the event.

So we have this basis for those characteristics on both sides. But still, it end up a very long list. So we had to find some practical way to treat this long list. If you only pick up the most important ones, then you might leave off some big fish. If you have everything, then it's a problem how you quantify so many.

MEMBER BLEY: Well, and you tried to strike a balance. And Mother Nature will tell us sometime in the future that we missed some that we should have included. And we'll say, oh, we could go at them. You know, that'll happen. You can't have it perfect until you've used it and tried it.

MS. XING: So the worksheet is one mockup. We multiply up. If this could be a balance in the meter it may or may not go with, we need to think about it more. I think we've got lots of good input from today.

CHAIRMAN STETKAR: I think we all promised ourselves we'd try to finish by 6:00 which gives me three and a half minutes here.

MR. PETERS: I've got one more question for you guys. I'd ask plenty of others, but the lesson here that I have on the list is how can we more effectively collaborate on this project, given that we --

CHAIRMAN STETKAR: What sequence interactions?

MR. PETERS: Is there a way, because how we do it now is we schedule four or five months out in advance, you know, an ACRS meeting or a subcommittee meeting and discuss particular issues of reports that we're able to put forth at that time.

And it's hard for us to predict where we're going to make progress and what we're going to make progress on these particular documents in resolving the litany of issues that are here.

Is there a way we can send documents straight over to the ACRS as we get them in a state to where we think that is acceptable and add like bubbled comments or something --

CHAIRMAN STETKAR: No, no. We ought to do it in the context of a subcommittee meeting for a variety of reasons. A lot of the, you know, you might hear me ranting, but indeed there's a lot of exchange that goes on in a subcommittee meeting that, in fairness to you, you need to hear and you need to have on the record.

I think that expending a lot of time and effort to develop documents that you say, okay, we're ready to now send this document to the subcommittee and have them read it and give us feedback on it, I think that's the place where we could gain some efficiency where --

MEMBER BLEY: There might be another. I keep going back to the technology neutral framework. When that was going on, we scheduled a number of subcommittee meetings, I was working for you guys at the time.

We wouldn't bring in slides. We'd provide some material to read. And then we'd come in and just have an open discussion about it. And I mean, it takes me a lot of time to put together a set of slides.

Most of the stuff on the slides, except in a few cases, are already in the report. So we've got two. So if you sent us the part you were talking about you could even, I don't know if you guys want to do this, but you even schedule at a certain time interval, try to get some media set ---

MR. PETERS: Okay.

MEMBER BLEY: And just send up some stuff to read and come and we can talk about.

CHAIRMAN STETKAR: Right, see where you are. We are, in this case the SRM is written to us. So we're as heavily invested as you are in this process. And feedback, if it goes, the last meeting we had was April. And that's too long.

Because the problem is, if there's a drift for us to try to process the information on a drift and give you feedback that, at least from our perspective, the drift might be heading off in the wrong direction, you've now spent nine months where a minor course correction in June, for example, might have changed things a little bit.

And I don't know, you know, when these reports were dated. So I think that, I agree that a more regular exchange, and less formal perhaps --

MEMBER BLEY: It could be a half a day or even a few hours.

CHAIRMAN STETKAR: Right, right. But we can't do it informally, we can't do it on a one-by-one basis. We need to do it in the context of a subcommittee meeting. We can close the subcommittee meetings if it's, you know, preliminary information or whatever. We have no problem doing that in the subcommittee. But I think that type of model going forward might be a lot more effective for all of us.

MR. PETERS: Okay. We'll talk offline about the frequency of the meetings with John here.

MS. XING: I like that more frequent interim meeting, except I have one issue with the report. Like, you know, if I can state, this report, like the one we give you, as you have seen we already changed something. So it's in the working process. Something in the report we are 90 percent sure about it. Something is just an initial idea.

CHAIRMAN STETKAR: And that's fine as long as we mutually recognize the fact that the nature of those meetings is different from you submitting a report to us and us reviewing that report under the presumption that it's some nearly final or final work product.

MS. XING: Okay. I would mark them like a working document --

CHAIRMAN STETKAR: That's --

MS. XING: -- rather than call them report.

CHAIRMAN STETKAR: That's fine.

MEMBER BLEY: Don't do it across the page. Do it in the heading.

(Laughter)

CHAIRMAN STETKAR: Let me, we're going to break 6 o'clock. But I have to get one administrative thing out of the way here.

If there's anybody out there who's still on the bridge line, could you say something please? Because we'd like to open the bridge line and ask if there's any comments from anyone who's had the stamina to stay with us.

MS. WHALEY: I'm here.

CHAIRMAN STETKAR: Good. Is that Mary?

MS. WHALEY: This is April Whaley.

CHAIRMAN STETKAR: Oh. Hi, April. So at least we know the bridge line is open. Given that, does anybody have anything to add or any comments that you'd like to make?

MS. WHALEY: I would like to say that I've listened to most of the meeting today. I've been kind of in and out. But I tried to be here for the section in which you were talking about work that I was involved in which includes the NUREG-2114 and the testing of the IDHEAS method.

And I just want to say that I think that the conversation's been very constructive. I really appreciate many of your comments, John. And I am looking forward to working with Jean on getting the NUREG ready, you know, finally out the door.

And I look forward to being involved in this project in the future if the NRC can manage to have a contract with INL, that I can be a part of it.

And I wanted to, if anybody had any questions about any of the work that I did, I'd be happy to answer them.

CHAIRMAN STETKAR: I don't think so, April, thanks. And thanks for the feedback. That's, you know, from my particular perspective, this is John Stetkar, I think that we're very close to issuing that NUREG, you know, subject to some of the comments that you probably heard this morning and taking another quick look at it.

And I think that's an important milestone for this whole process to come to finality, issue that. Some of the other documents, I'm not so clear about. So thank you. Is there anyone else out there who has any comments?

(No response)

CHAIRMAN STETKAR: If not, thank you. And anyone left in the room who has any comments?

MALE PARTICIPANT: A couple.

CHAIRMAN STETKAR: All right. I've satisfied that requirement. Sean, do you have anything else in terms of close out?

MR. PETERS: Yes. I'm going to provide my vision for the future.

CHAIRMAN STETKAR: That's fine, I think, given the time, that's appropriate. And as we usually do in subcommittee meetings, what I have to do is go around the table and see if any of the members have any final comments that they'd like to make. Joy?

MEMBER REMPE: I need to apologize, because I had some other things going on. And so my comments probably are coming at an inopportune time, because I've missed part of the discussion.

But I guess I'm puzzled still a little bit about, well, we're starting out with this new methodology. Your beginning slide said we're going to put this in the Level 3 PRA. And then I kind of got the impression from a response back from the two of you that the Level 3 activities are going to be delayed. So there is still time to apply this. Or they will not do this?

MEMBER BLEY: That was a hypothetical discussion I put forward.

MEMBER REMPE: Okay. So it will not be used in the Level 3?

MR. PETERS: The decision hasn't been made yet. But we are trying to get this ready in a time line so that it can be one of the options --

MEMBER REMPE: Get that time line, because in your slides you didn't present I didn't see that in there.

MR. PETERS: I don't know the time line. But we do have somebody in the audience who could speak to the time line for all three PRAs.

CHAIRMAN STETKAR: Why don't we wait. We're having a Level 3 PRA meeting in three weeks.

MEMBER REMPE: Yes.

CHAIRMAN STETKAR: We'll hear a lot more about that schedule at that time.

MEMBER REMPE: Or, I'm just kind of wondering. Because I hear, well, there's a shortage of money. And is this thing going to become a workable method?

CHAIRMAN STETKAR: Everybody's --

MEMBER REMPE: That's not clear in my mind.

(Simultaneous speaking)

MEMBER REMPE: -- the parts of the meeting I was here for.

CHAIRMAN STETKAR: In my understanding, one of the challenges of the Level 3 PRA is that they are, no matter how they choose to go forward, there will have to be some form of construction of a method to do that.

The current methods aren't built for that domain. So this is one of the ones we started earlier, doing it for one domain. But the choice is still with the Level 3 team on how to proceed.

MEMBER REMPE: Well, I appreciate the presentations and your continued efforts to try and educate us, some of us like me, in this area. And so I apologize if some of the questions seem a little puzzled. But it's a lot of material to try and understand.

And so I'm looking forward to additional interactions. I like something that's a little less formal and more focused on a smaller amount of material. Because, oh, the other question I wanted to bring up was you had mentioned in the beginning of this meeting about taking this to the full committee.

CHAIRMAN STETKAR: Yes.

MEMBER REMPE: And I think that's, there's been a lot of work since 2006. And even if we're not maybe where we'd like to be, I think it's time to have a broader group listen to a two hour, not more, presentation which I don't know how you're going to do. But --

MR. PETERS: Let me say, we're going to have a very short presentation to the Commission. The Commission hasn't officially voted on it yet. But all signs are pointing to a March 3rd date where we'll be presenting the status of this development. And I don't know if ACRS actually attends or listens in to those meetings, but that could be formal way to get --

MEMBER REMPE: No, I wanted to come --

(Simultaneous speaking)

MEMBER REMPE: -- come to the ACRS, irrespective of what you present to the Commission.

MR. PETERS: Okay.

MEMBER REMPE: And sometimes it's better to go to ACRS before you go to the Commission.

MR. PETERS: Yes. We were given very short notice on this meeting. So it's still not official.

CHAIRMAN STETKAR: But I'm coming in in February. We're not going to write a letter in February in time for a March briefing if you have that. So that will not happen.

MEMBER REMPE: So those were the things I kind of wanted to highlight at the end of this.

CHAIRMAN STETKAR: That would be useful. But to schedule a full committee briefing in, you know, we can decide on it. I think sooner than later is a good, you know, fourth quarter some time. But I'll let you work with John to --

MR. PETERS: My quarters are long. Because first quarter ended in September.

CHAIRMAN STETKAR: I'm sorry.

(Simultaneous speaking)

CHAIRMAN STETKAR: March, April, some sort of time frame. And, yes, you can never predict what the committee will decide in terms of writing the letter.

MR. PETERS: Sure.

CHAIRMAN STETKAR: But I think it will be useful.

MR. PETERS: In fact, I don't, since we have so many outstanding issues we've been trying to work through, I don't even have a vision for what we would want out of the letter.

CHAIRMAN STETKAR: We could just, you know, I can never say the committee will not write a letter. Because it's up the committee's decision on whether they feel strongly enough about writing a letter.

And an information brief at times turns into a letter even if you don't want one. If you do want a letter on something that, we certainly take that under advisement, you know, as a specific desire to have some formal feedback.

MEMBER REMPE: But if there are some issues where a letter could help, if there's a funding situation and maybe that, you know, additional emphasis needs to be in one place versus another. So it might be worthwhile.

CHAIRMAN STETKAR: Thank you. Let's open up the dialogue on it.

MR. CHANG: Excuse me, Chairman.

CHAIRMAN STETKAR: Sure.

MR. CHANG: I have 8 o'clock, fly on 8 o'clock flight.

CHAIRMAN STETKAR: Yes --

(Simultaneous speaking)

CHAIRMAN STETKAR: We'll finish real quickly if you can just turn around in case you cover --

MEMBER BALLINGER: Thank you very much for the presentation. I'm new at this. And I've spent about 16 hours reading all this stuff.

MS. XING: Thank you. I appreciate that.

MR. CHANG: So do I.

MEMBER BALLINGER: The next time I'll probably be able to make an intelligent comment. But Steve --

CHAIRMAN STETKAR: Thank you.

MEMBER BLEY: Nothing additional.

CHAIRMAN STETKAR: Thank you. Steve?

MEMBER SCHULTZ: Well, I appreciate the presentations today. They were quite well prepared and delivered.

I come away with the conclusion that, in fact, as we've just talked about in the last 45 minutes, that this is the right approach and tool to use for all three PRAs. So I hope that the schedules coincide appropriately. I don't think what is existing would be a right way to go, so try to do something different.

Sean, I would recommend that we do dialogue associated with the going forward plan. I think that would be the first thing to do. Because, I think, on your last page, if you just take a review of what we've discussed in the last half hour, I think you'd have better things to put forward --

MR. PETERS: Yes.

MEMBER SCHULTZ: -- in terms of a bullet list of things that ought to be accomplished in 2014.

MR. PETERS: Yes. I think given our dialogue and where, you know, the feedback, some of the schedule's probably not accurate in getting more, we were trying to accomplish so many things in 2014, and it does take time to accomplish those things.

MEMBER SCHULTZ: Yes. I liked your first slide very much in terms of that layout. I'm thinking about the Commission meeting, if you do have to have it in March.

CHAIRMAN STETKAR: Anything else, Steve?

MEMBER SCHULTZ: No, that's it.

CHAIRMAN STETKAR: If not, I don't have anything more to add. Thanks, as always, for the time and effort you put in on preparing all of that and also getting the material to us well in advance. I mean, it helped a lot.

MALE PARTICIPANT: It helped me a lot.

CHAIRMAN STETKAR: And with that, thanks to all and especially for staying so late. We are adjourned.

(Whereupon, the meeting in the above-entitled matter was concluded at 6:12 p.m.)

Overview of Staff's response to the SRM "HRA Method Differences"

Jing Xing
NRC/RES/DRA/HFRB

Prepared for 1/15/2014 ACRS Subcommittee meeting

A Collaboration of U.S. NRC Office of Nuclear Regulatory Research (RES) & Electric Power Research Institute (EPRI)

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HRA in 2006

Multiple methods

- Variation in methods
- Variability in results

Use of methods

- Inadequate guidance
- Inappropriate use
- Inter-analyst Variability

Application scope

- Lack of methods for external, non-procedural, Level 2/3 events

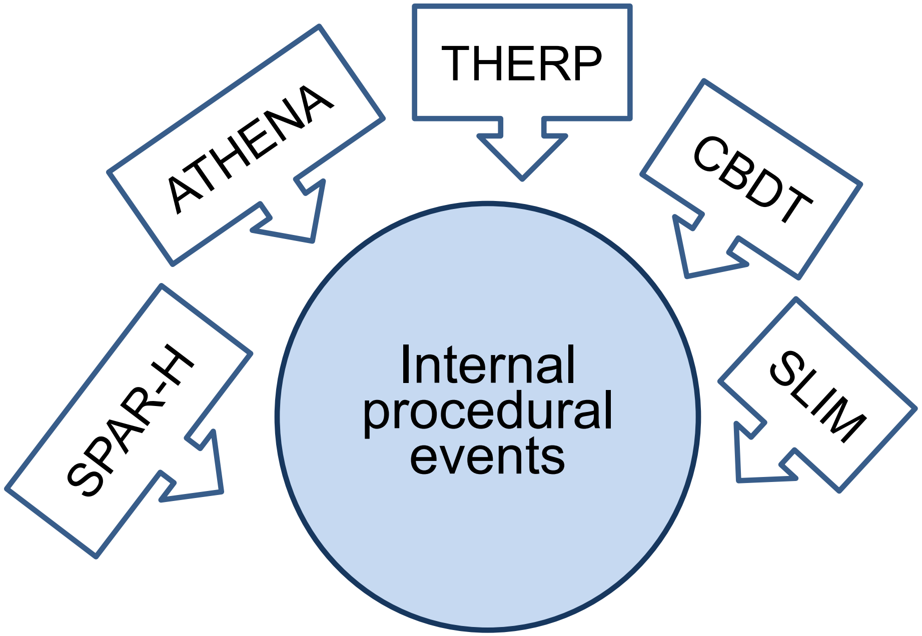
Scientific basis

- Not systematic
- Focused on behaviors not “Why”
- Inference-based

Empirical data

- Very little data
- Lack of useful database

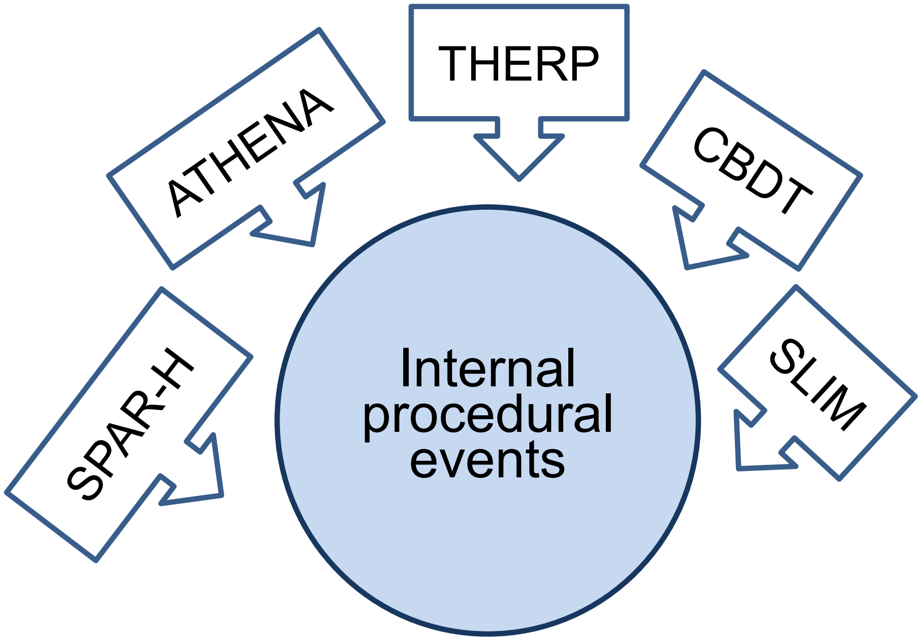
Multiple HRA Methods for Internal Procedural Events



- Different scopes – not complementary
- Different approaches – not compatible
- Lack of a commonly agreed upon foundation for modeling human errors

Need an integrated method to reduce variability

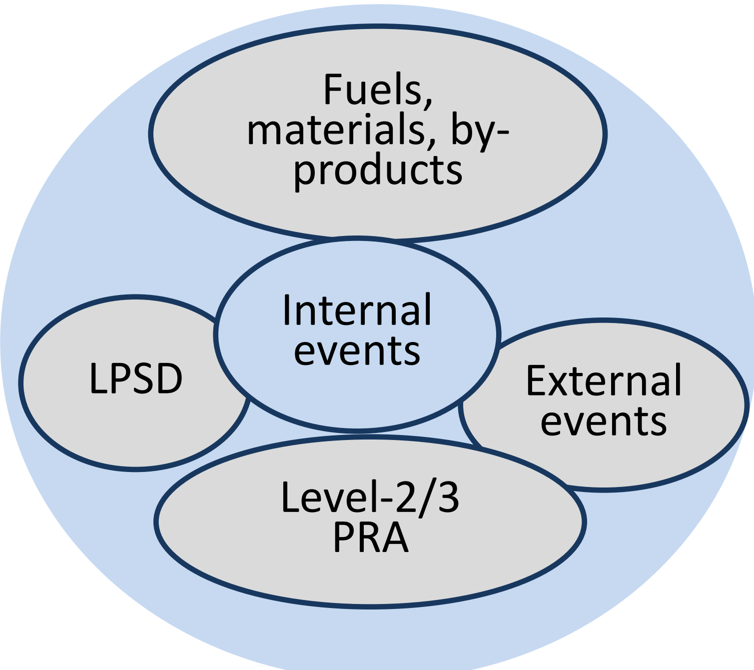
Use of HRA Methods



- Inadequate guidance
- Discrepancies in intended use, scope and actual practices
- Lack of criteria on level of detail and depth of analysis (“When is it good enough?”)

Need clear guidance with technical basis for analysts to follow and make judgment

Multiple HRA Methods

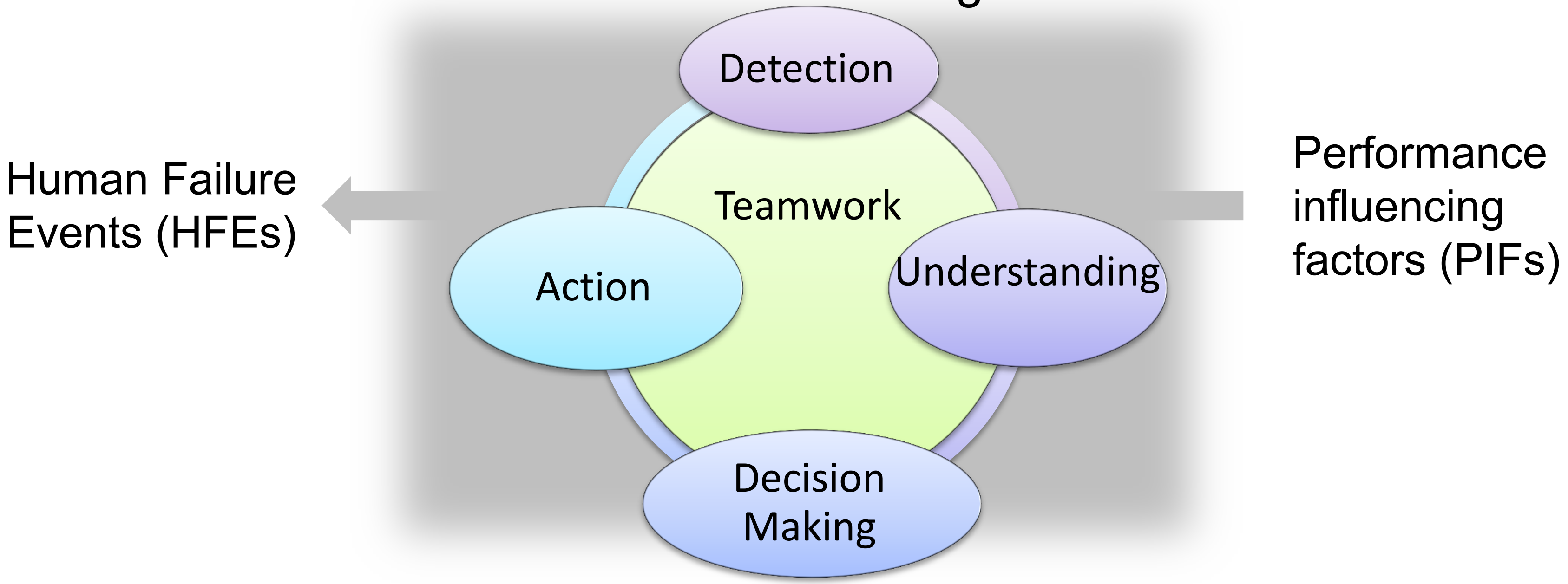


- Are the existing methods applicable?
  - External events, Level-2/3, LPSD
- Are the existing methods adequate?
  - Many situational factors are not considered
  - Many types of human actions are not covered
- Does each application need to have its own method?
  - There is a trade-off between generalizability and specificity

Need a generic methodology for all applications, that is able to be tailored for a specific application

Scientific Basis Used in HRA Methods

- Most HRA methods implicitly use sparse information of why and how human makes errors
- Lack of a strong scientific basis in modeling human errors
- Lack of scientific foundation in modeling the effects of PIFs



Need a cognitive foundation for modeling human errors and the effects of PIFs

Data for HRA

Human Error Probability (HEP) =
# of Failures / # of Instances

- Lack of data – HEPs rely on expert judgment
- Denominator data is rare
- Lack of useful HRA database – data from different sources is not generalizable.

Need a systematic way to collect, generalize, and use data to improve HEP estimation.

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"

HRA Research Activities at the NRC

International and US HRA benchmarking studies

HRA applications (Level-3 PRA, spent-fuel pool, fire HRA, etc)

HRA method development

HRA database (SACADA)

Guidance for expert judgment

HRA Method Development: Goal and Requirements

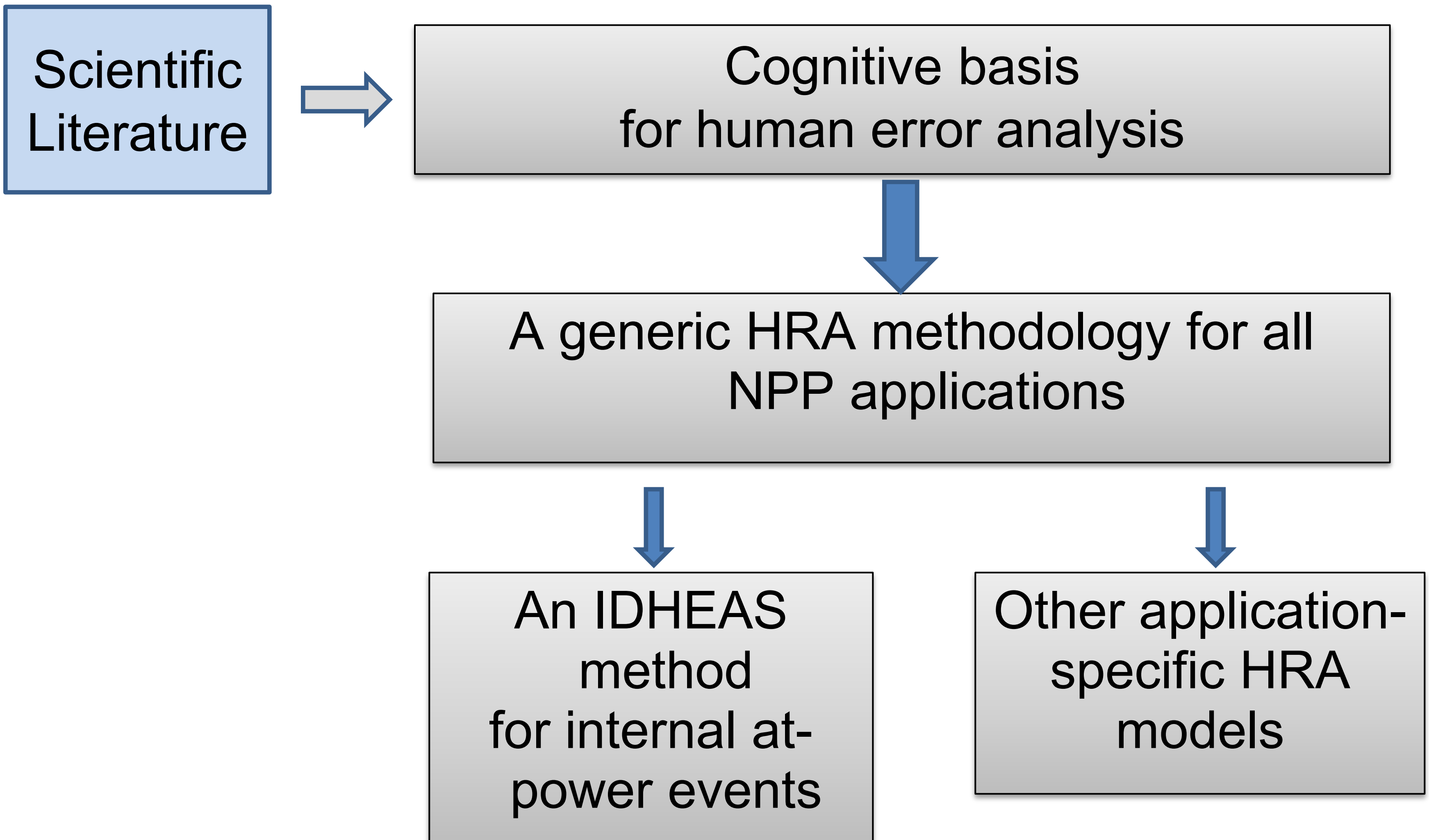
<u>Goal</u>

Develop a new HRA methodology to reduce variability and apply to all HRA applications.

<u>Requirements</u>

- Conform to the PRA/HRA standards and HRA Good Practices
- Retain and integrate the strengths of existing methods
- Have enhanced capabilities to address the key weaknesses in current state-of-practice.
- Have a state-of-the-art technical basis
- Create method generic enough for all HRA applications in NPPs

Strategic approach



Products

Product	Intended applications
Cognitive basis for human error analysis	• HRA • Human performance • Human factors engineering
Generic HRA methodology for NPP applications	• HRA for all kinds of human events in NPP (Level-3 PRA, LPSD, external events, etc.)
An IDHEAS method for internal, at-power events	• Internal, at-power event PRA (PRA models, SDP, ASP, etc.)

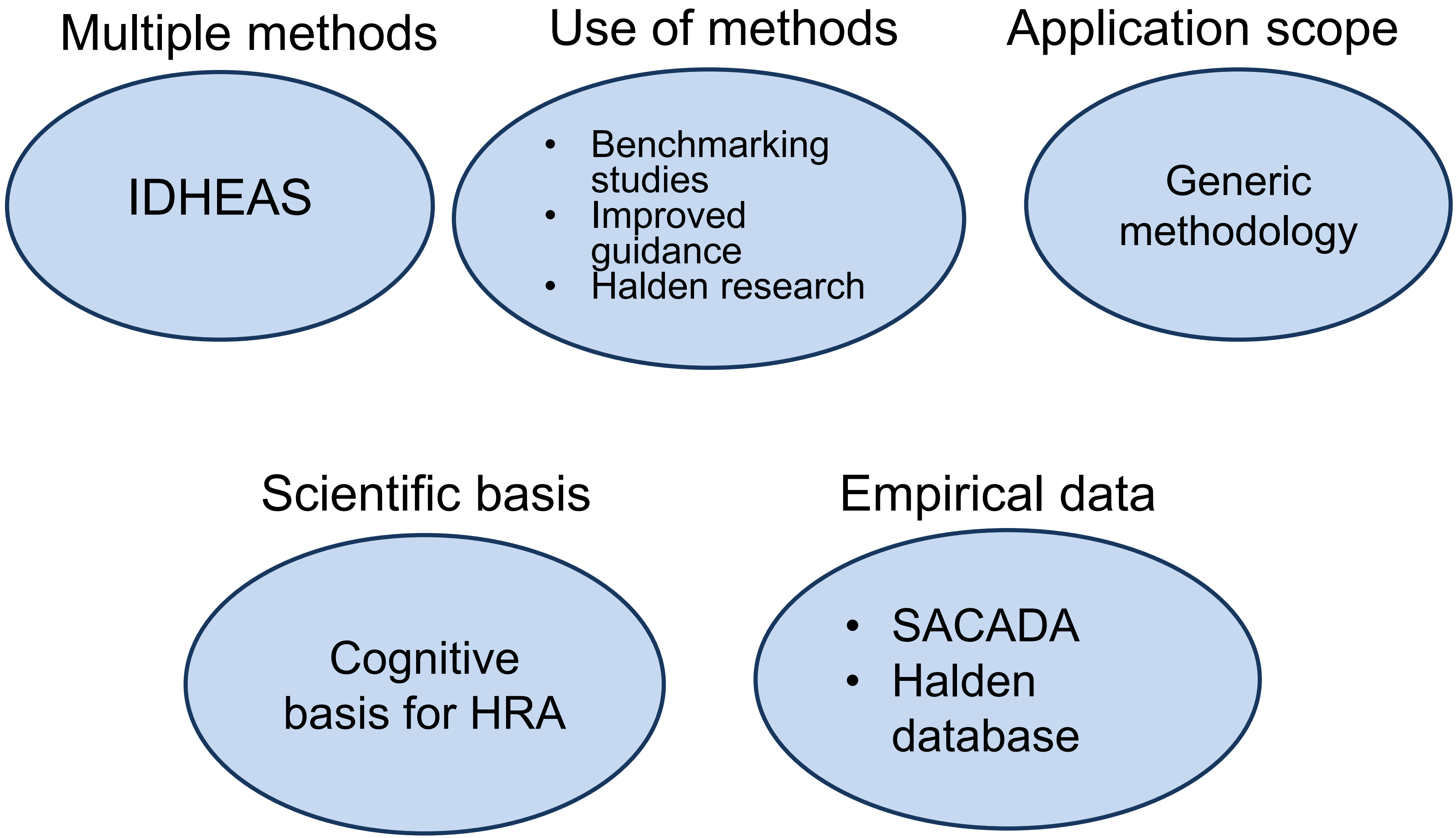
2013 progress

Product	2013 progress
Cognitive basis for human error analysis	• Externally reviewed • Revised for final publication
Generic methodology for NPP applications	• Expansion of the cognitive basis • Development of the quantification model • Development of the HEP worksheet and piloting with SAMGs
An IDHEAS method for internal, at-power events	• Expert elicitation of HEPs • Externally reviewed • Initial test / validation

IDHEAS Status and Planning

Product	Status	FY14 plan
Cognitive basis for human error analysis	• Completed	• Publish final report
Generic methodology for NPP applications	• Draft report • Initial piloting explored in Level-3 PRA	• Expert elicitation of HEPs • Test in Level-3 PRA
IDHEAS method for internal, at-power events	• Externally reviewed • Initially tested	• Test the method

Work Completed Since 2007 …



Path-forward

Product	• **Long-term path -forward**
Cognitive basis for human error analysis	• Update the cognitive basis • Apply the cognitive basis to NRC's human factors engineering and HRA practices
Generic methodology for NPP applications	• Validate and calibrate the methodology • Support Level-3 PRA • Develop HRA models for specific applications
IDHEAS method specific for internal at-power events	• Roll out to HRA applications • Data-referenced HEP estimation • Improve usability

Additional information / backup slides

HRA application areas

Dimension	Specifics
Plant Mode	• At-power • Low power and shutdown
Event Type	• Internal • Spatial (e.g., fire, flood, and seismic)
PRA Phases	• Level 1 • Levels 2 & 3
Radiation Source	• Reactor • Spent fuel pool • Dry cast storage
New/Existing Reactors	• Existing reactors • New & advanced reactors
Temporal Phase	• Pre-initiator • Initiator • Post-initiator
Actor	• Control room • Control room and local combination • Local
Risk-Informed Program	• SPAR • ASP • SDP (of RASP)
Level of analysis	• Detailed • Bounding (screen and scoping)

IDHEAS validation plan

Validation method	Scheme	Validation scope	Pre-Condition	When (tentative)	Who
HRA test battery	Develop a task/event/scenario battery for HRA method validation/testing			FY12	INL
Scientific validation	1) Team and peers to fill out the questionnaire 2) External review of the reports	Integrated method	IDHEAS method development completed and Report II & III draft ready	FY13	INL
Content validation	1) Team develops content statement/description and peers to fill out questionnaire 2) Check compliance to HRA standard/Good Practices	Integrated method	IDHEAS method development completed and Report II & III draft ready	FY 12-13	Team
Demonstration of working (testing)	Apply the parts and integrated method to selected events/scenarios	All the parts and integrated method	As soon as individual parts are ready for piloting	FY12-14	Self-piloting, EPRI, and NRC staff

IDHEAS validation plan (continued)

Validation method	Scheme	Validation scope	Pre-Condition	When (tentative)	Who
Item validation 1	Perform confirmatory factor analysis to load plant/task/human characteristics to CFM/DTs	CFMs, DT, HEPs	CFMs and DTs are ready for testing; Expert elicitation for HEPs completed	FY13	SNL
Item validation 2	Confirm/modify/calibrate CFMs/DTs/HEPs with the data in the NRC's Simulator Data for HRA	CFM, DT, and HEP	Simulator Data is available	Outside IDHEAS project, Long-term activity	NRC
Benchmarking	Benchmarking the completed method using Halden or US empirical study settings	Integrated method	IDHEAS is completed and the above four validation approaches are completed.	FY13	NRC initiates a new task.
Experimental testing	Experimentally tests the effects of task and PIF characteristics on human performance	DTs and HEPs	1) NRC simulator is ready or 2) agreement with Halden	Outside IDHEAS project, Long-term activity	NRC

Building a Cognitive Foundation for Human Reliability Analysis

Presented by Jing Xing
RES/DRA/HFRB

United States Nuclear Regulatory Commission
Protecting People and the Environment

IDHEAS Products

Product	Intended applications	Status
Cognitive basis for human error analysis	• Technical basis for HRA and human factors engineering	• Completed • Publish in FY14
Generic HRA methodology for NPP applications	• Risk-informed HRA applications of all hazards and scopes	• In development • Testing in FY14
An IDHEAS method for internal, at-power, procedural events	• Risk-informed HRA of Internal, at-power, procedural event	• Testing in FY14

Contributors

Building a Cognitive Foundation for Human Reliability Analysis

NUREG-2114
INL/EXT-11-23898

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Outline

I. Overview of the structure of the cognitive basis

II. Summary of the external review

III. Major revision to the draft report: *Teamwork* (previously referred to as *Communication* and *Coordination*)

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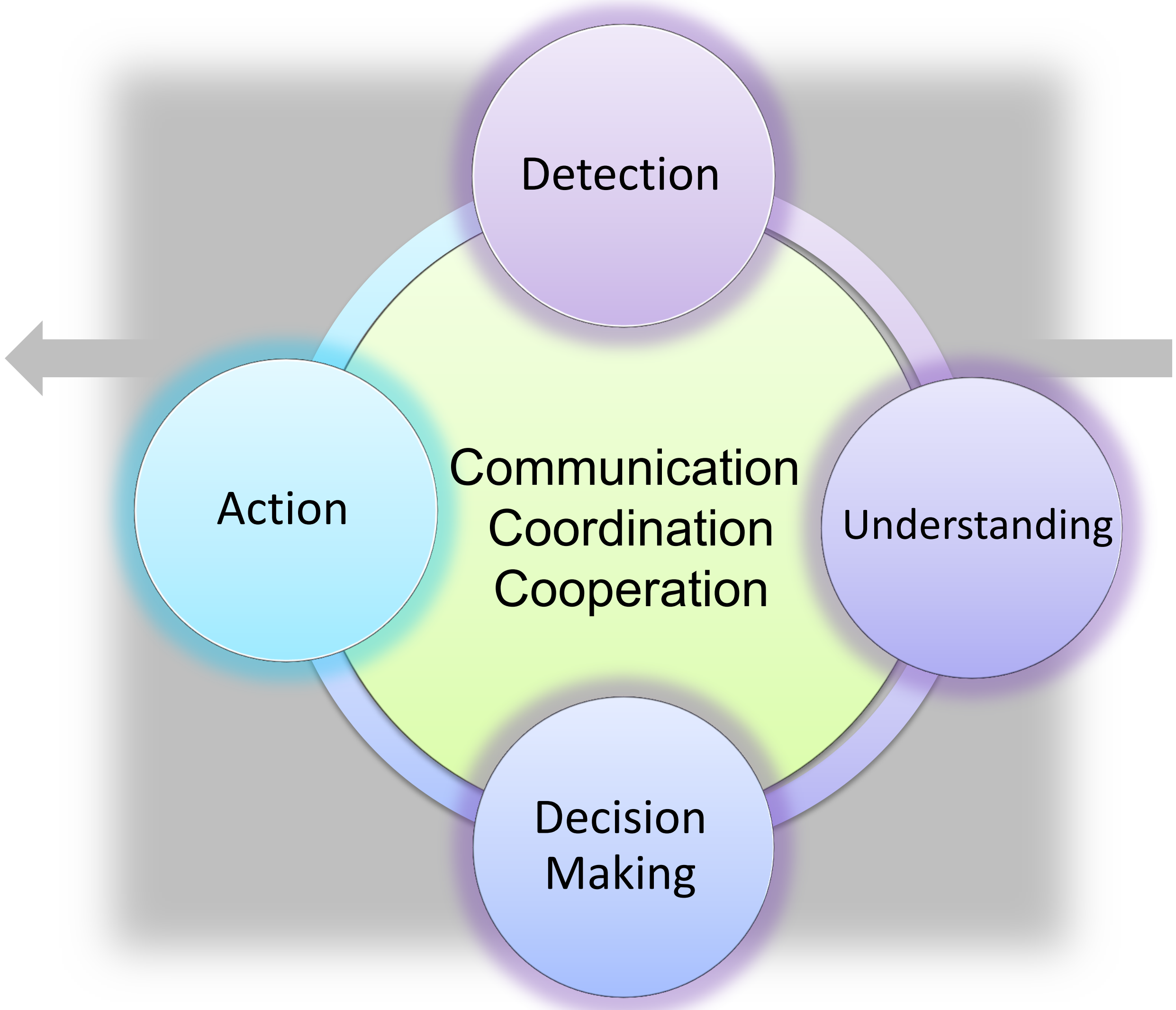
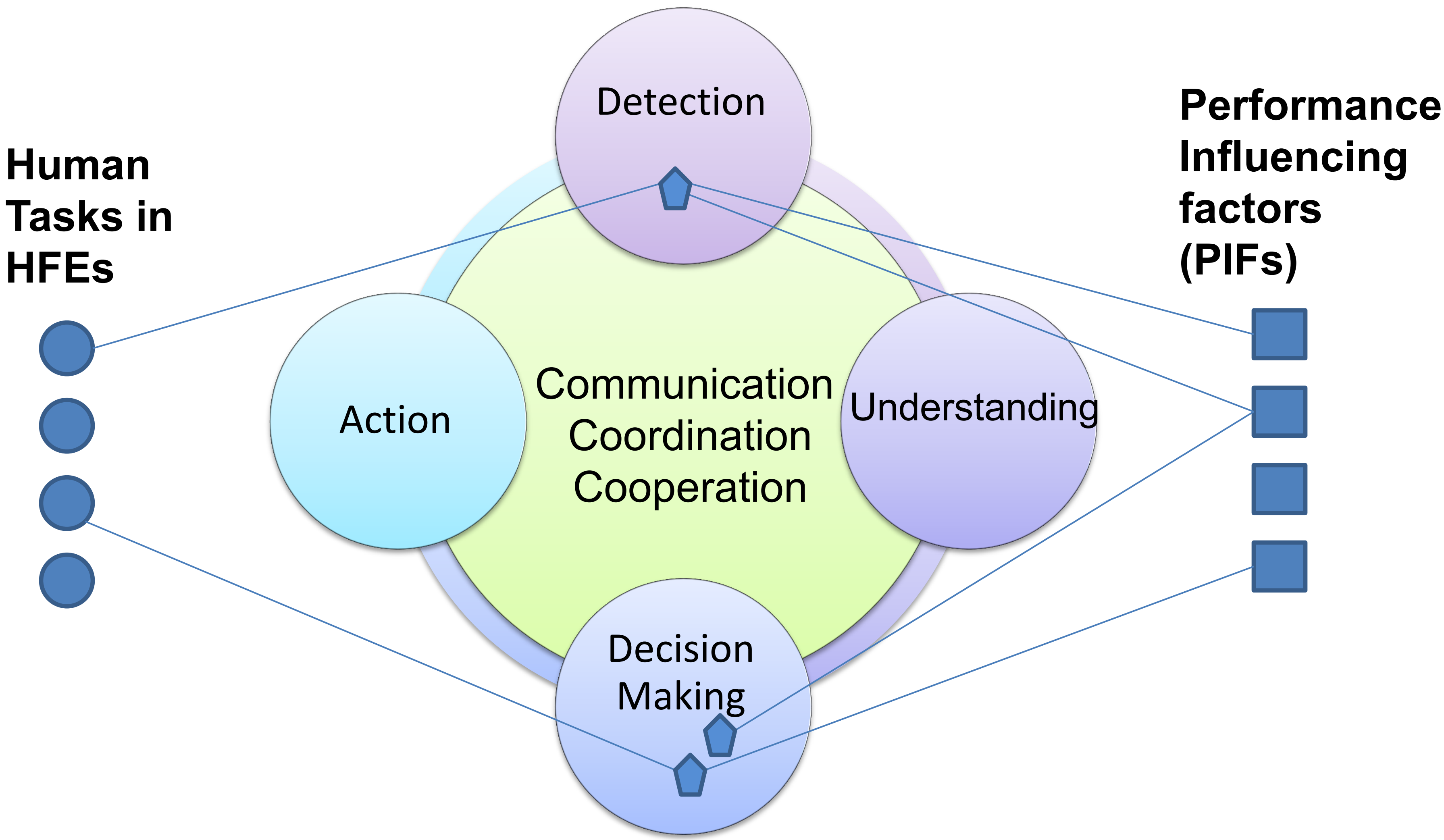
Cognitive Basis used in HRA methods

Human Failure Events (HFEs)



Performance influencing factors (PIFs)

Enhance the Cognitive Basis for HRA

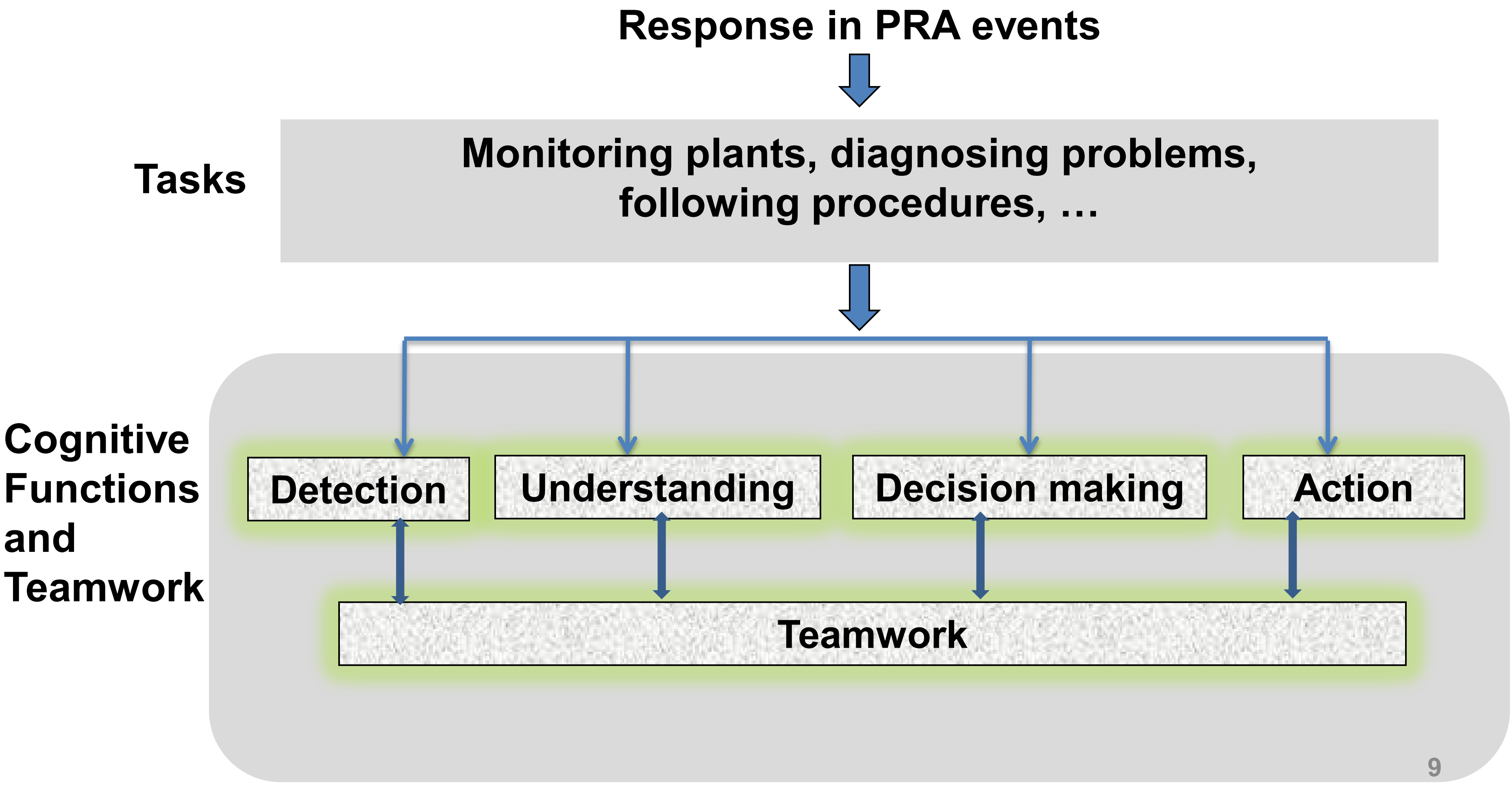


Goals of the Literature Review

- 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 that can serve as a foundation for human error analysis

Cognitive Functions Underlying Human Performance

Human tasks are achieved through four cognitive functions (*Detection, Understanding, Decision-making, Action execution)* and *Teamwork.*



Approach to Developing the Cognitive Basis

The cognitive basis is to elucidate the following:

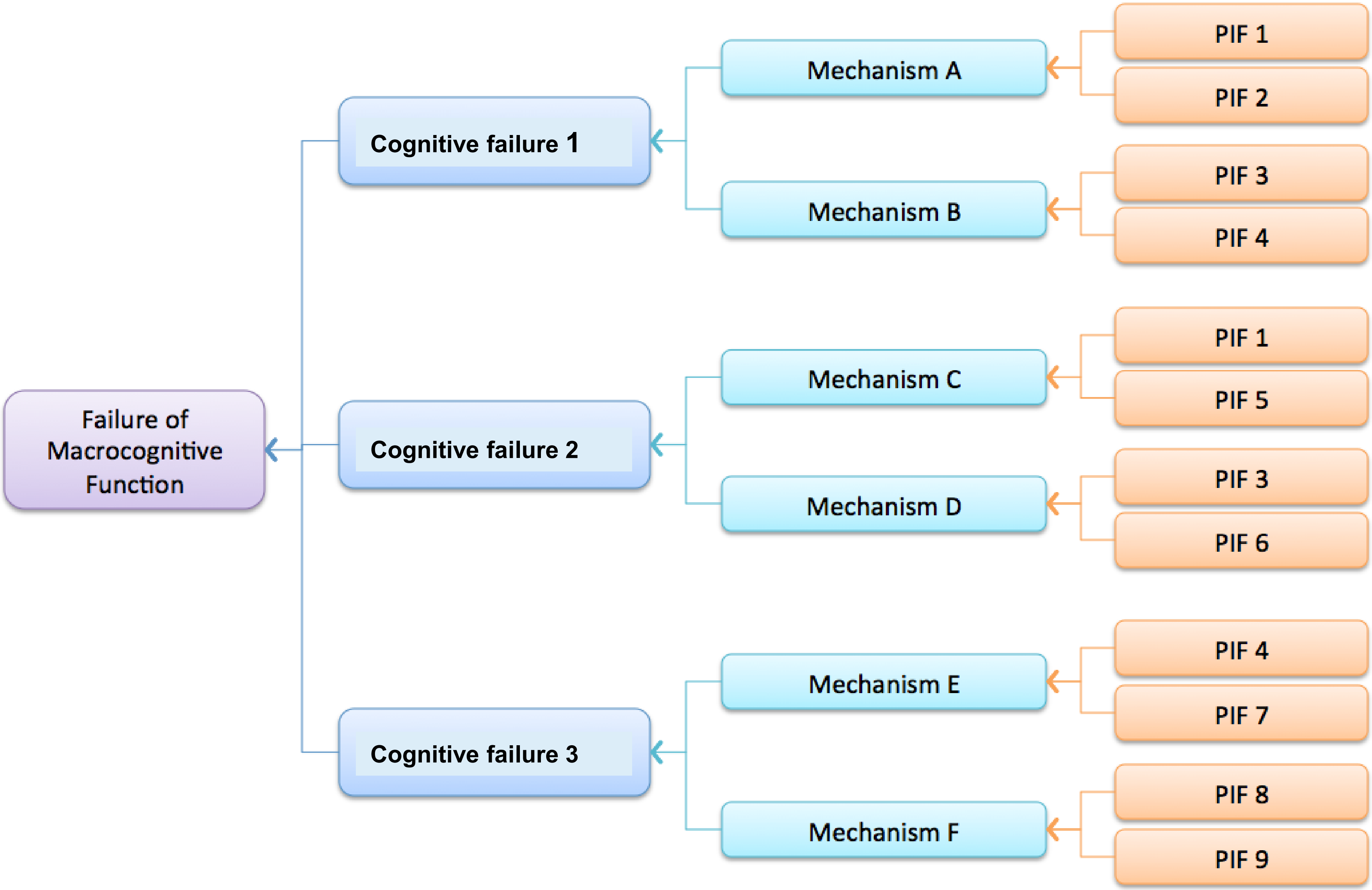
I. Scope of a cognitive function in NPP control room tasks
   - What objectives the function is to achieve?

II. Cognitive Mechanisms
   - How humans perform the function and what makes humans reliably achieve the function?

III. Cognitive Failures
   - How the cognitive mechanisms may fail?

IV. Effect of PIFs
   - What PIFs lead to error causes?

Outcome: The Cognitive Basis



Outline

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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

Scope of the Review

The reviewers were asked to identify knowledge gaps in the report and focus the review on the following aspects:

Philosophical Aspect:
- Does the approach have clearly defined areas of enquiry, application and research?
- Does the approach demonstrate knowledge and competence within the field of cognition?

Methodological Aspect:
- Do the methods specific to this approach generate developments in the theory of HRA, or demonstrate new aspects in the understanding of human errors to improve HRA?
- Does the approach include clearly defined strategies to enable users to develop new organization of experience and practices?

Professional Aspect:
- Does the approach offer new knowledge, which is different and distinctive, in the domain of HRA?
- Is the approach capable of being integrated with other approaches so they can be seen to share areas of common ground?

Research Aspect:
- Does the approach provide a coherent strategy to understand human errors?

General Comments

1) The report provides a thorough literature review and technical foundation HRA.

2) The literature review conducted for each of the macrocognitive functions provides broad coverage of the relevant literature and a good synthesis of the key points relative to the factors influencing human performance and human reliability.

3) The literature review covers the major cognitive mechanisms that may be relevant to the nuclear environment and links these to a comprehensive list of performance influencing factors.

4) The report is limited to its intended scope, i.e., mechanisms and factors influencing human tasks in NPP control room procedural events, performed by well-trained crew.

Major Critiques

1) The literature review was strongly influenced by the assumptions of the IDHEAS method. Research that do not fit one or more assumptions have not been covered or are only marginally integrated into the framework (e.g., team decision making, distributed cognition).

2) There are differences in the types of failure mechanisms and cognitive failures (proximate causes) for the different macrocognitive functions. In some cases they are close to operational level, others are theoretical and distant from the operational level.

3) The chapter on team communication / coordination could benefit from expansion of the literature review and more extensive discussion of the role of teams in a control room.

Revisions to Address the Comments

1) Addressed all the comments
   - Comments from the IDHEAS team
   - Comments from NRC and Idaho National Lab staff received after the previous revision.
   - All the general comments from the reviewers
   - The 77 specific comments from one reviewer

2) Made minor modifications to the structure of the cognitive basis to address the general critiques

3) Performed additional literature review on teamwork and expanded the teamwork chapter.

Modifications to the structure of the Cognitive Basis

Several modifications were made to the structure of the Cognitive Basis:

1) The term “Proximate cause” was changed to “Cognitive failure.” The term refers to different ways that a cognitive function may fail. Therefore “cognitive failure” is a more accurate description..

2) The term “Failure mechanism” in the early version used to refer to sometimes the causes of failure and other times the mechanisms of a cognitive function. In the revision, we separated “Cognitive mechanisms” from “Causes to the failure of cognitive functions.”

3) “Communication and coordination” was changed to “teamwork.” Teamwork is not a macrocognitive function, it binds together individual’s macrocognitive functions to achieve the tasks.

Outline

I. Overview the structure of the cognitive basis

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III. Major revision to the draft report: *Teamwork* (previously referred to as *Communication* and *Coordination*)

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

Collaboration

Coordination

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:

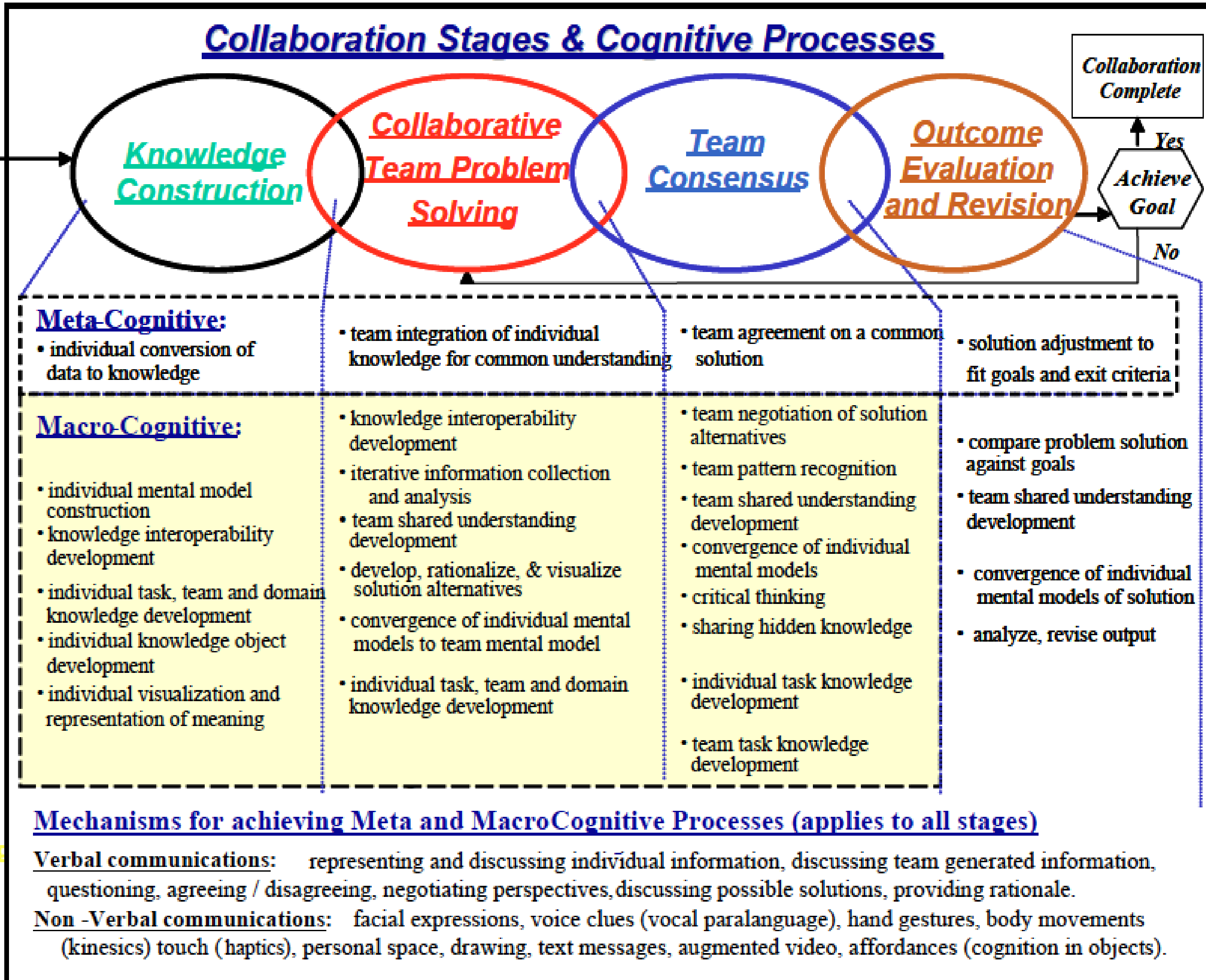
- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
- human-agent interface complexity

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

Conclusions

- 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 procedural tasks and it is not inclusive covering all the relevant information for out-of-scope tasks
- The Cognitive Basis should be dynamically updated to incorporate new relevant knowledge as it becomes available

Backup slides

The cognitive basis –

- Detection
- Understanding
- Decision-making
- Action execution

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

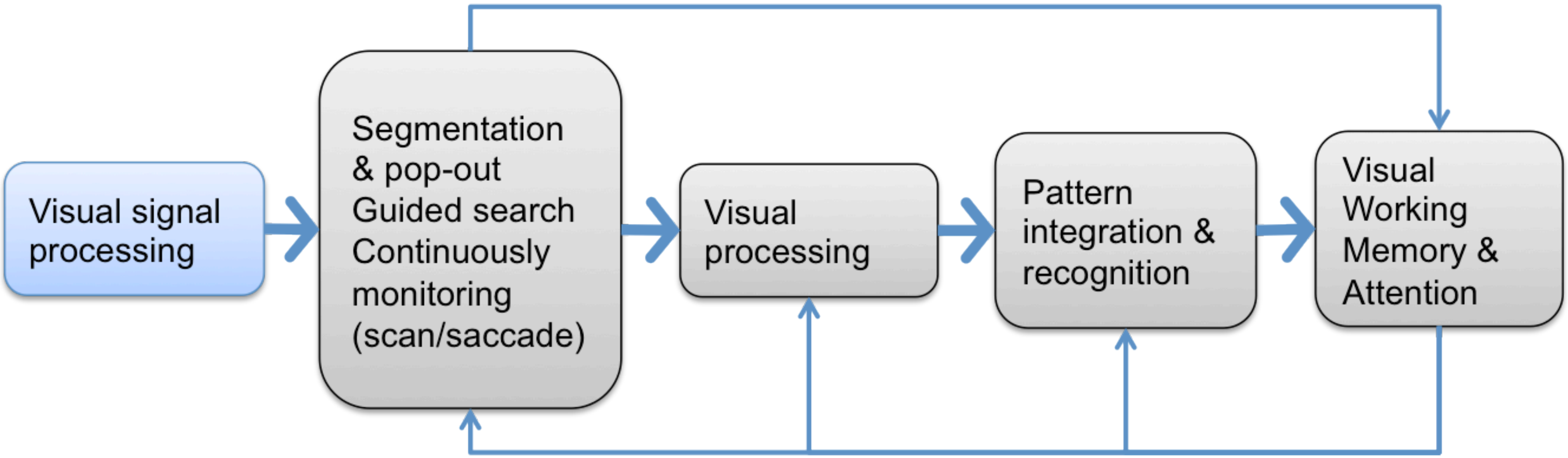
Pursue motion targets

Visual discrimination

Weak signal detection

…

Detection – How the objectives are achieved



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

Understanding - Scope in NPP internal procedural events

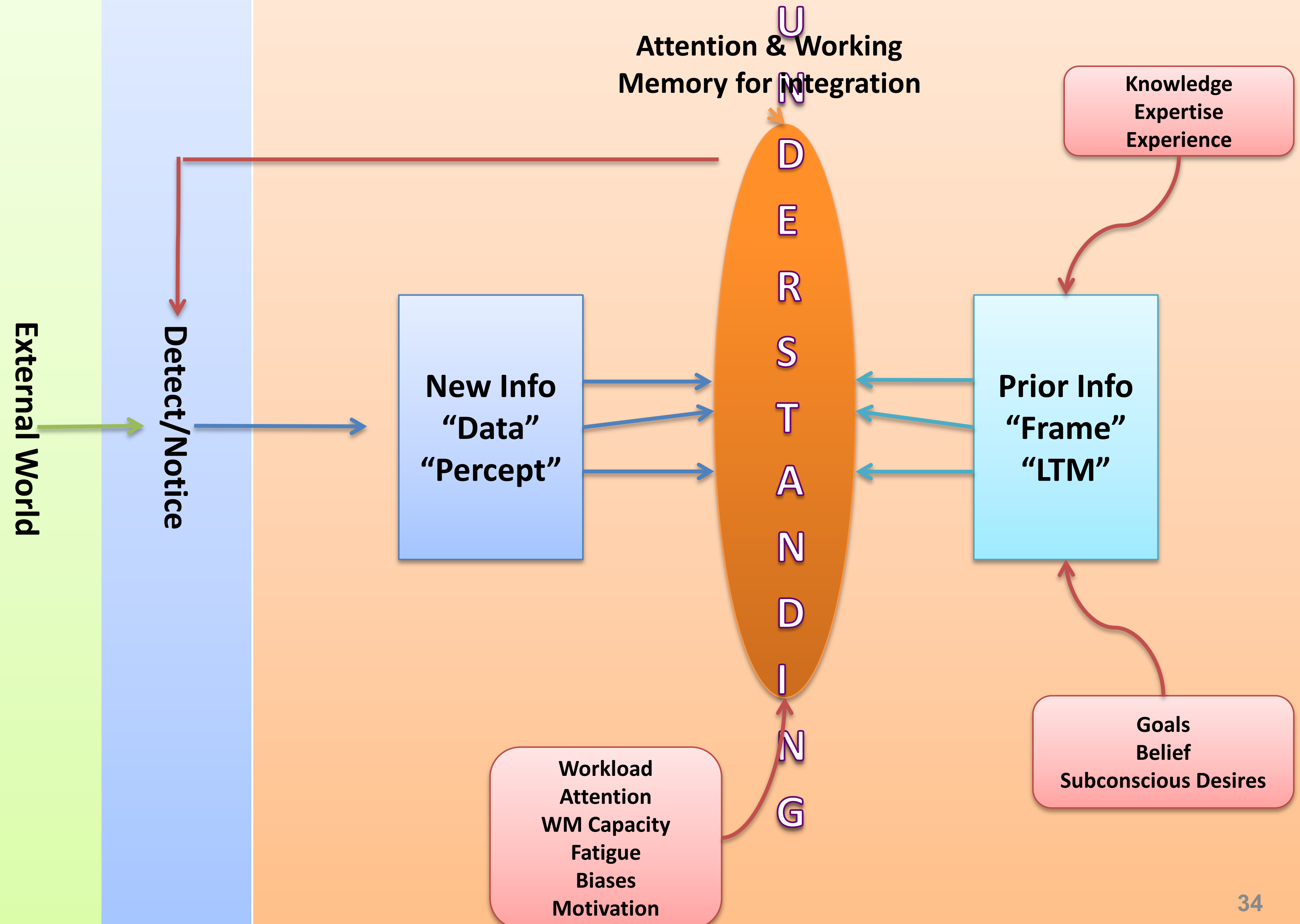
Understanding is the evaluation of current conditions to assess the plant status or to diagnose the underlying causes of any abnormalities.

Scope of *Understanding* in NPP internal procedural events

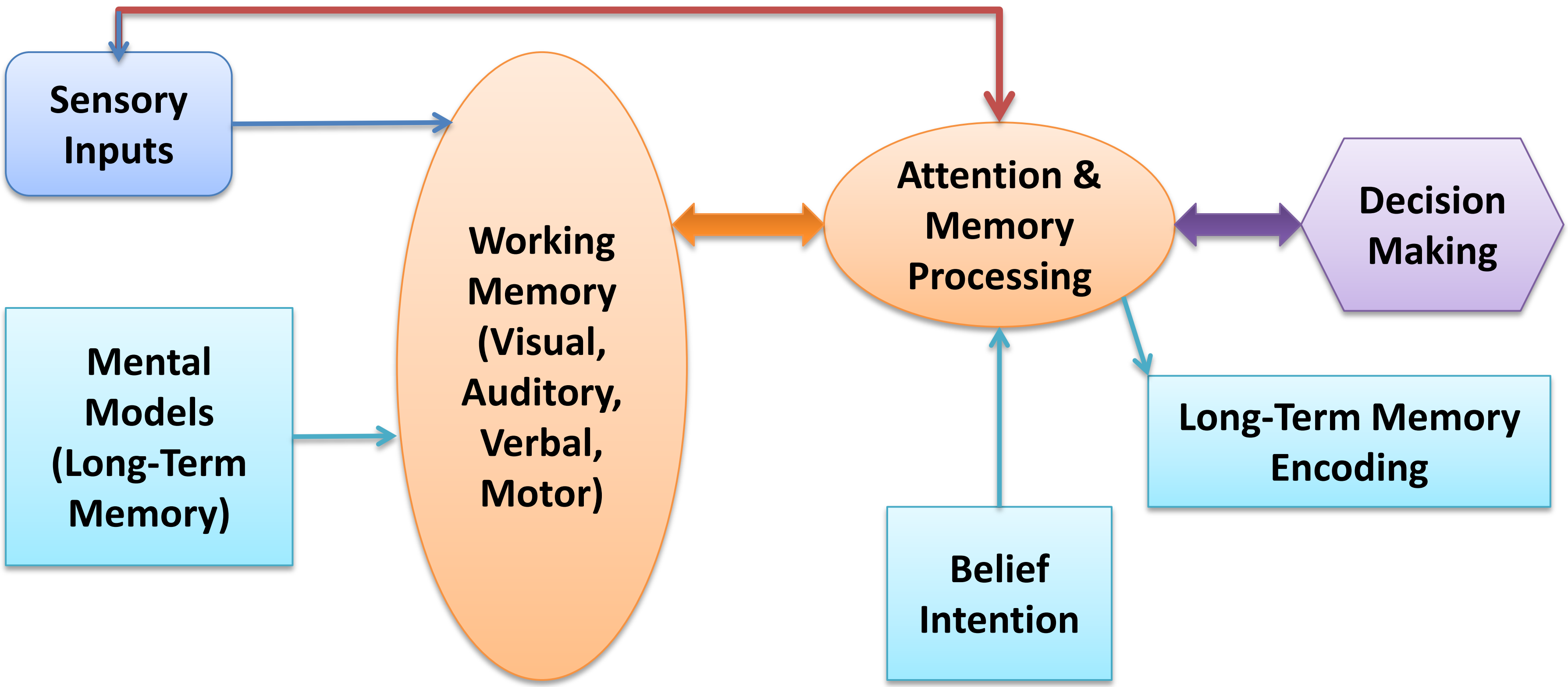
- Assess and verify information
- Develop a coherent representation
- Maintain situational awareness
- Diagnose abnormalities

...

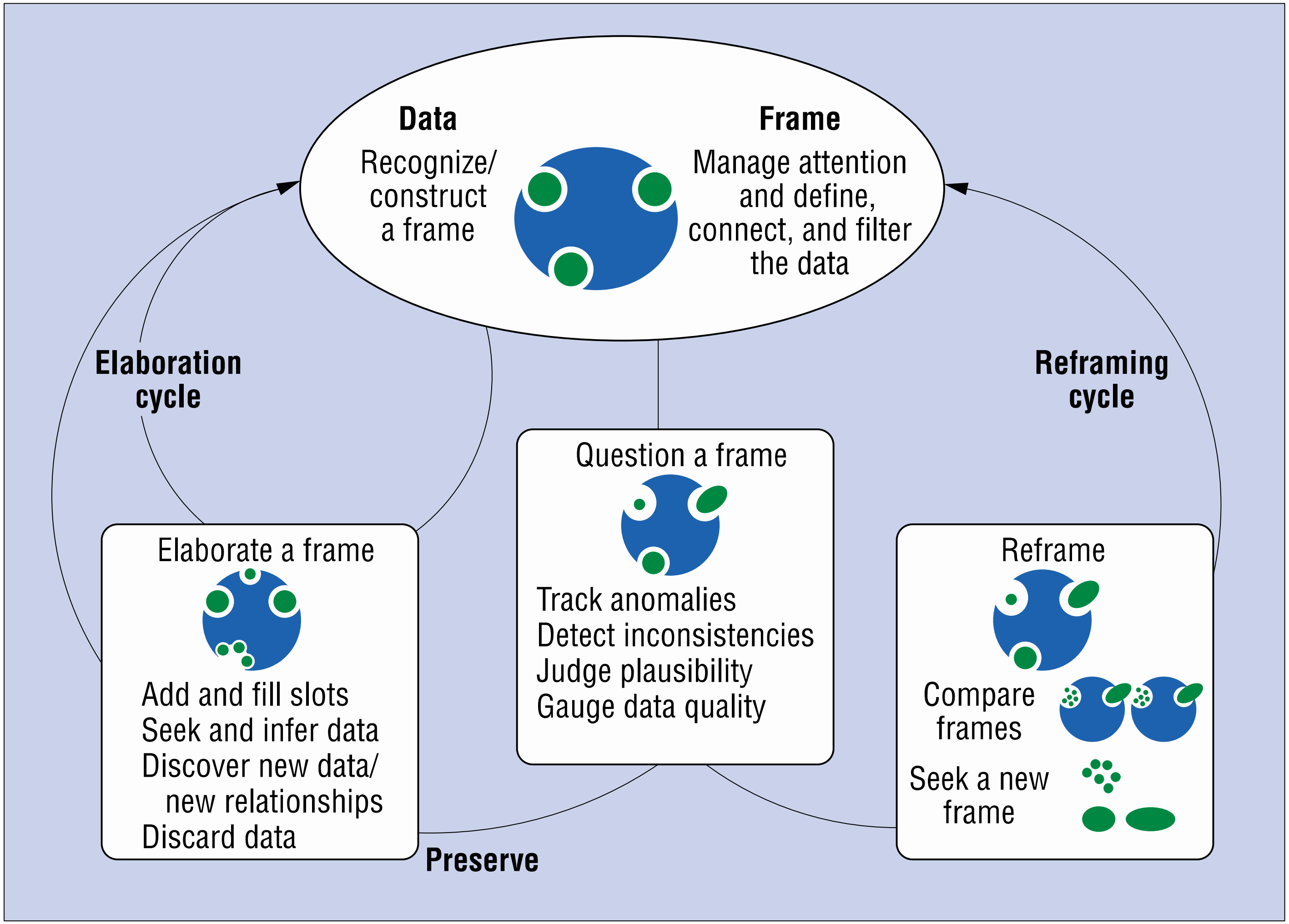
How human achieves Understanding



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

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PIFs

- Complexity
- HSI

- Workload
- Training

- 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

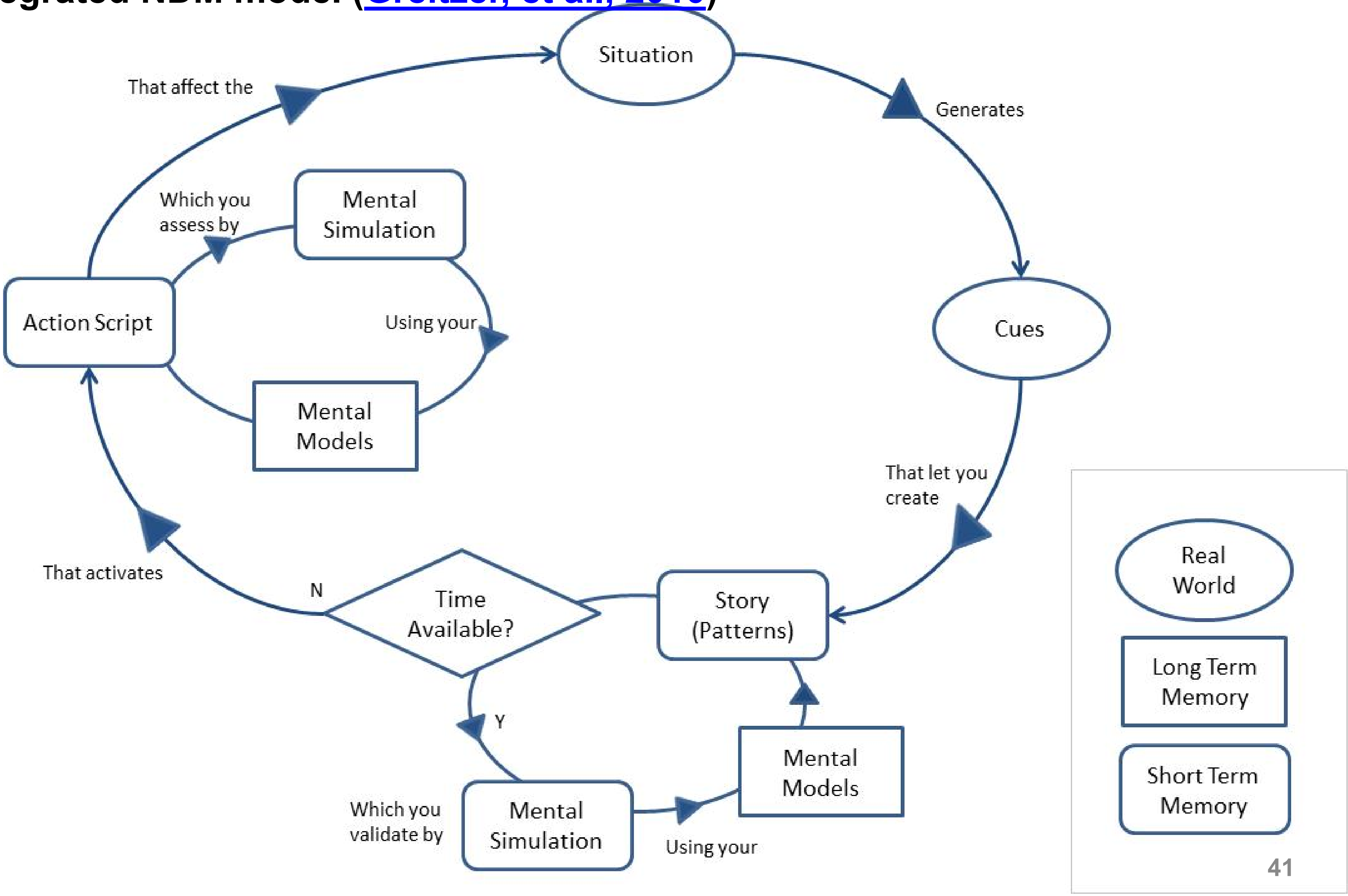
Choose alternative strategies

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*

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Proximate Cause - *Incorrect Internal Pattern Matching*

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PIFs

- Task complexity

- Workload
- complexity

- 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

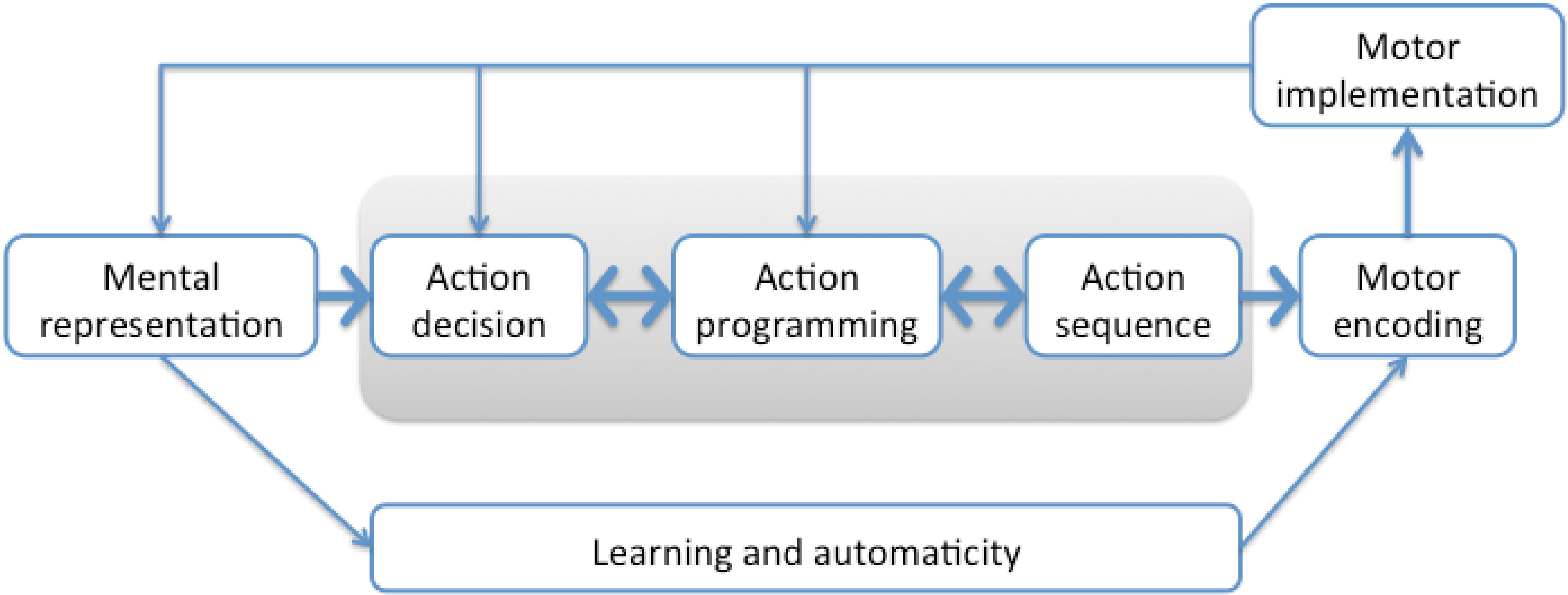
Execute a simple action

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

Proximate Cause - *Failed to take required action (did not attempt action)*

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- Action initiated too late

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PIFs

- Workload
- Procedures

- Workload
- Complexity
- HSI
- Training
- Procedure

Outline

I. Goals, limitations, and process of developing the cognitive basis

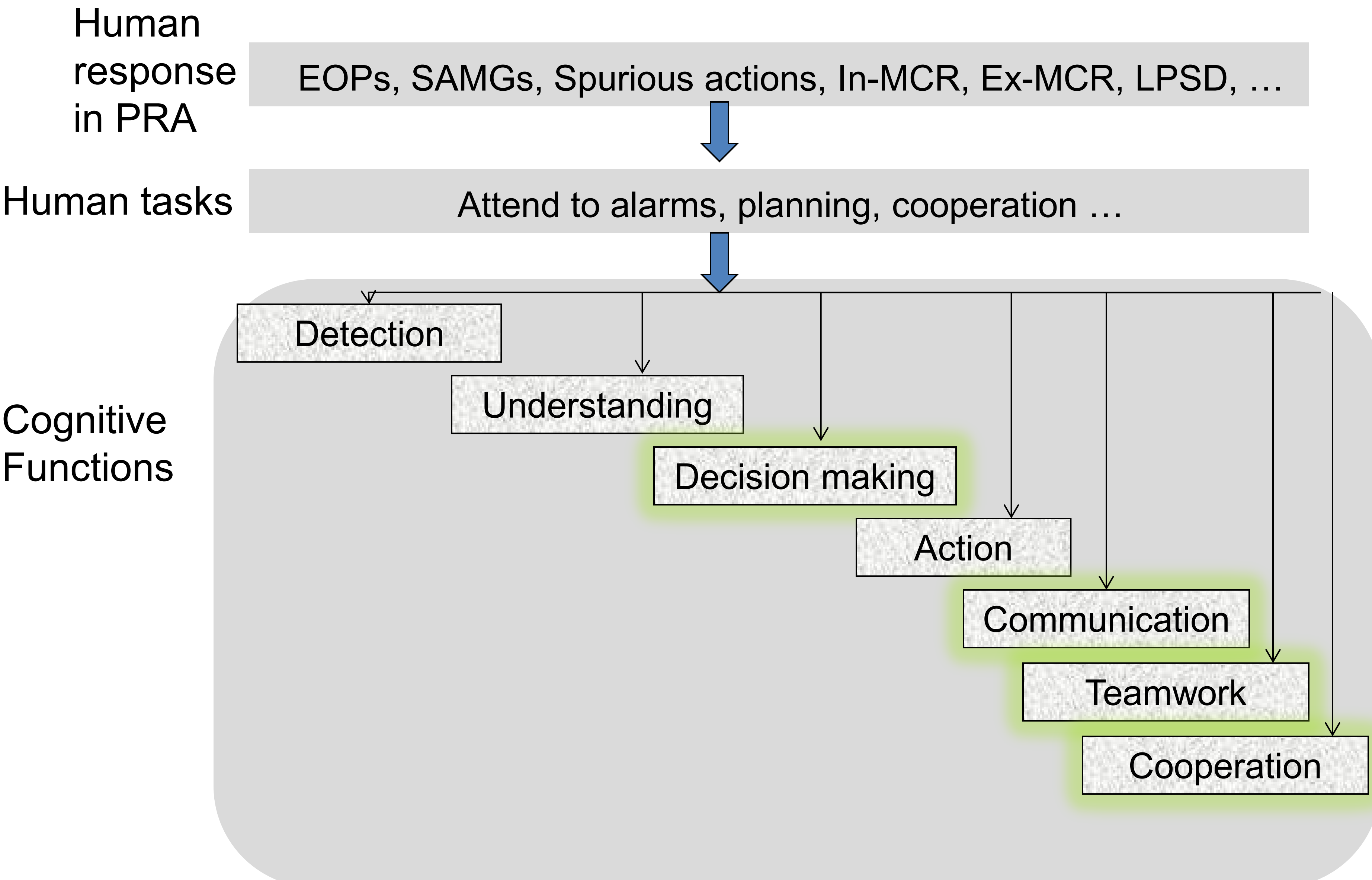
II. The cognitive basis – five cognitive functions

III. Additional study of literature and operational experience

Additional study of literature and operational experience

- Cognitive functions and their objectives for events in all kinds of NPP hazards
- Literature review of cognitive mechanisms and error causes for the new functions / scopes
- Inventory of PIF characteristics
- Extension of the cognitive basis – Function/objectives, mechanisms, error causes, and PIF characteristics

Cognitive functions in NPP hazards



Extend the scope of cognitive functions to human responses in all NPP hazards

Scope of *Decision-making* in human response to all NPP hazards

- Program sequences of action execution
- Choose alternative strategies
- Modify procedural plans
- Develop response plans
- Distributed / dynamic decision-making
- Dynamic decision-making
- Determine criteria

Develop an inventory of PIF characteristics

Three types of PIFs modeled so far -

Cognitive workload and task complexity –

demanding cognitive resources, challenging cognitive mechanisms, and leading to errors.

HSI/environment and procedures –

Aggravating the cognitive demands

Training, work process, and organizational factors –

Militating the demands and providing barriers to error causes, recovering errors

PIF Characteristics

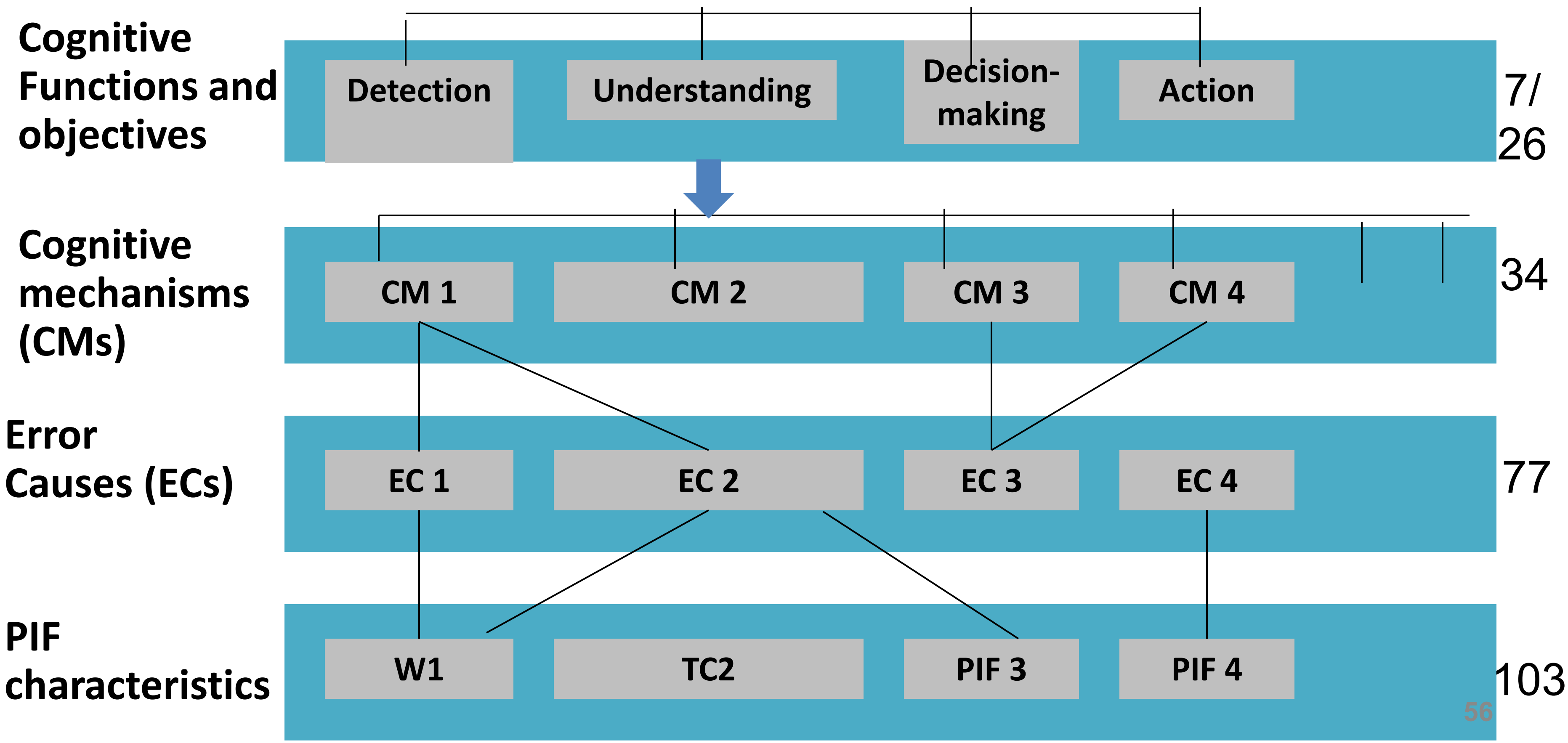
For each cognitive function, we identified the PIF characteristics that challenge the cognitive mechanisms and trigger the error causes.

Example PIF characteristics for *Understanding*

Context factor	Example challenging context character	Cognitive mechanism
Workload	Multitasking, Interruption	Integration
Task demands	Unfamiliar scenario	Mental model
HSI	System behavior is not apparent or masked	Information selection
Procedure	Criteria are ambiguous	Integration
Training	Under-trained system failure modes	Mental model

Summary of the cognitive basis for human error analysis

Each cognitive function is associated with cognitive mechanisms, error causes(or failure mechanisms), and error-prone task and barrier (or PIFs) characteristics.




PULL
MIDVALE
SCHOOL FOR
THE GIFTED

Part III - A Generic HRA Methodology for NPP Applications

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Products

Product	Intended applications
Cognitive basis for human error analysis	• HRA • Human performance • Human factors engineering
Generic methodology for NPP applications	• **HRA for all kinds of human events in NPP (Level-3 PRA, LPSD, external events, etc.)**
An IDHEAS method for internal, procedural events	• Internal, at-power event PRA (PRA models, SDP, ASP, etc.)

Research Goal and Requirements

Goal:

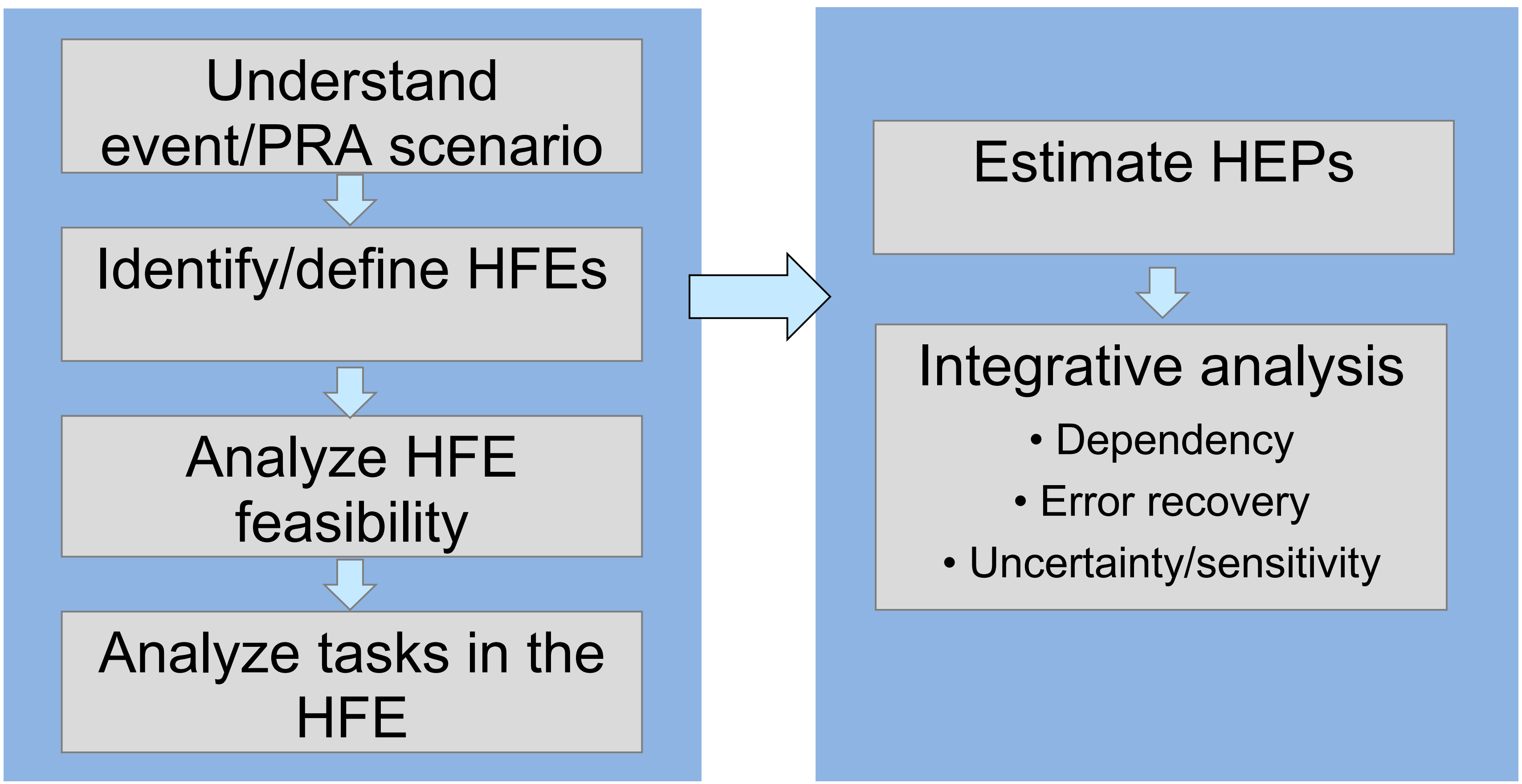
Develop a generic HRA methodology applicable to all HRA applications in NPPs

Requirements:

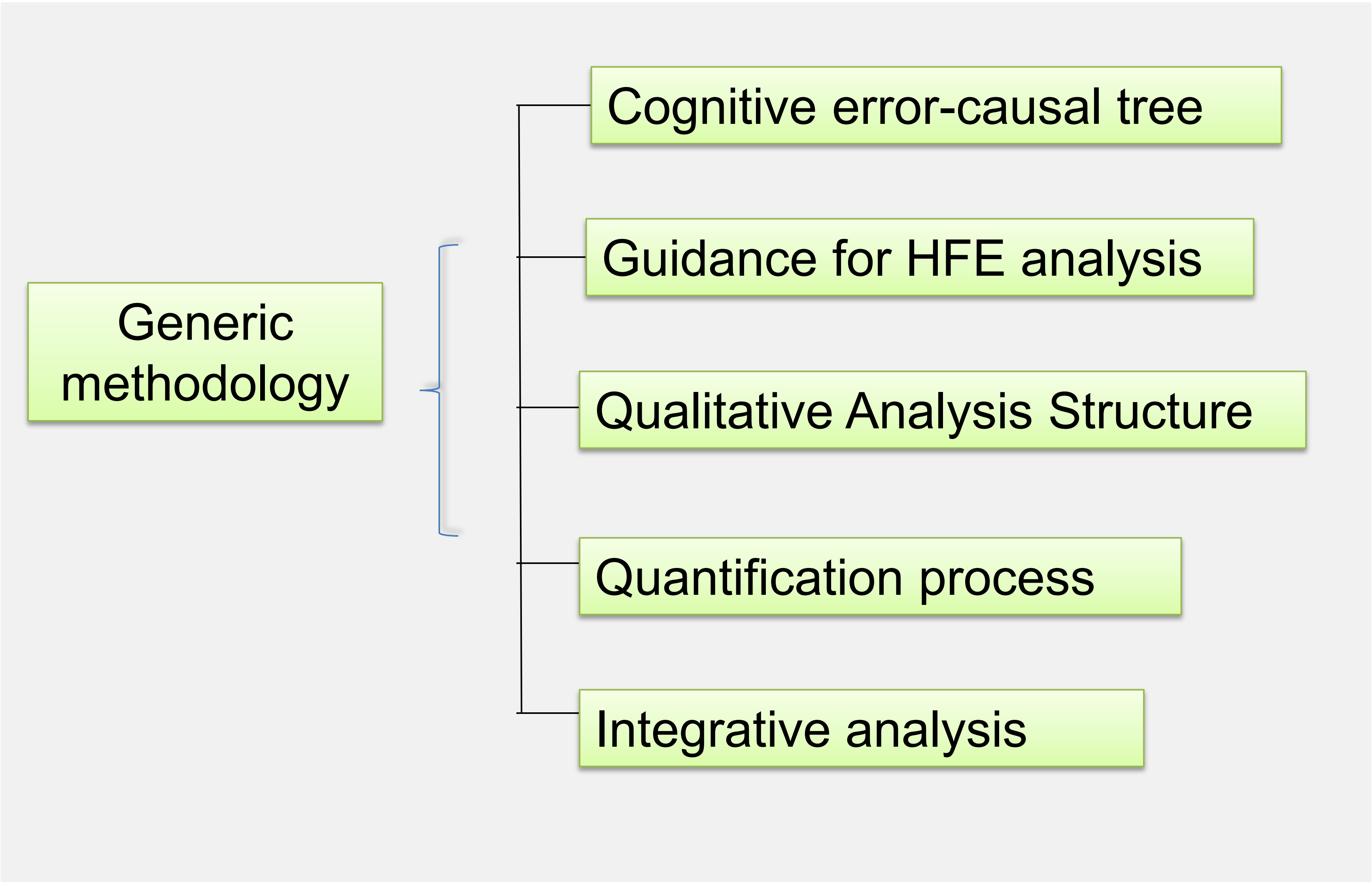
- Generic for all HRA applications with state-of-the-art technical basis.
- Conform to the ASME PRA/HRA standard and HRA Good Practices
- Retain and integrate the strengths of existing HRA methods
- Enhance capabilities to address the key weaknesses in current state-of-practice

HRA process

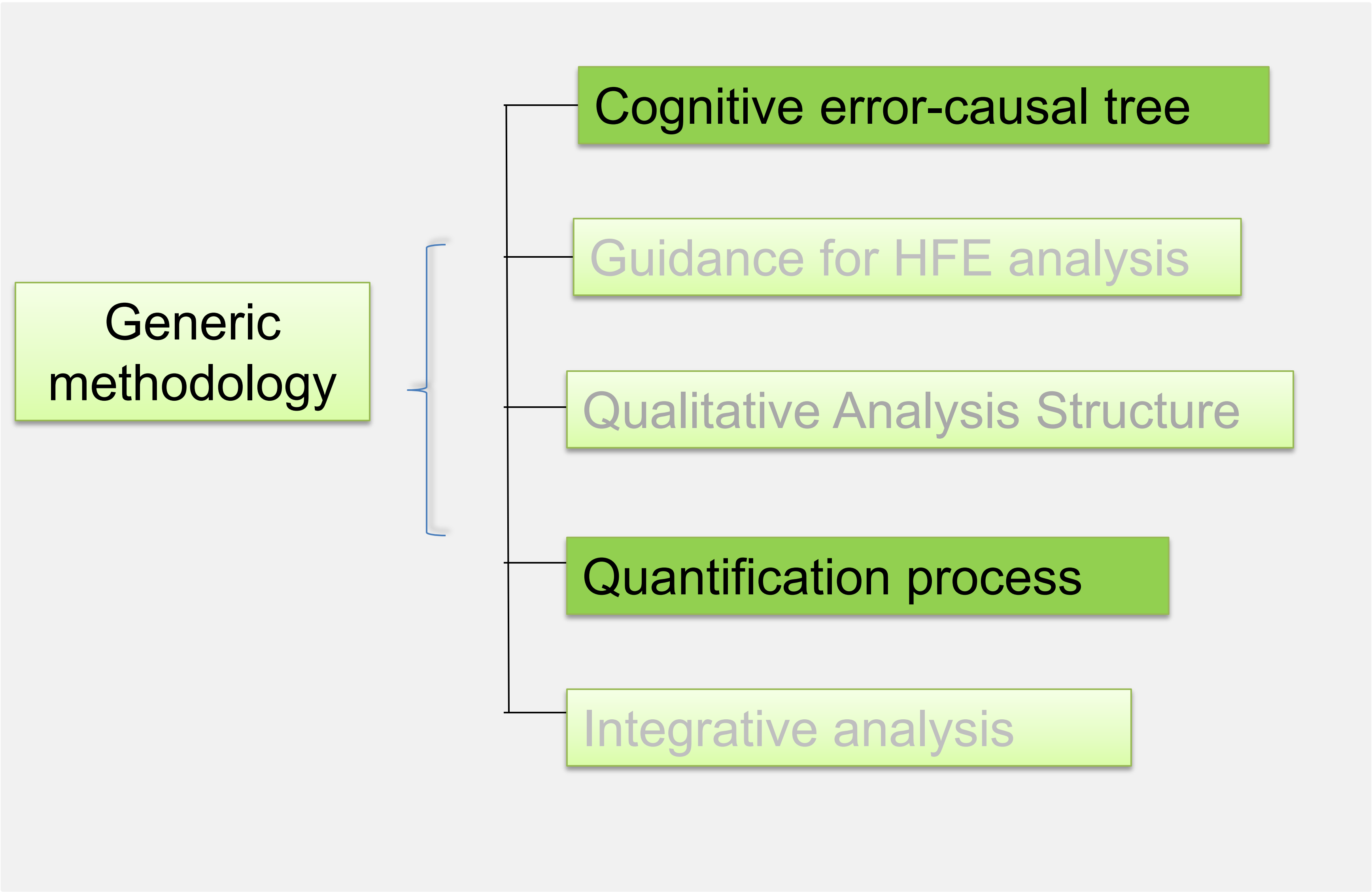
HRA process is defined in the PRA standards and recommended in HRA Good Practices.



The Generic Methodology



The Generic Methodology

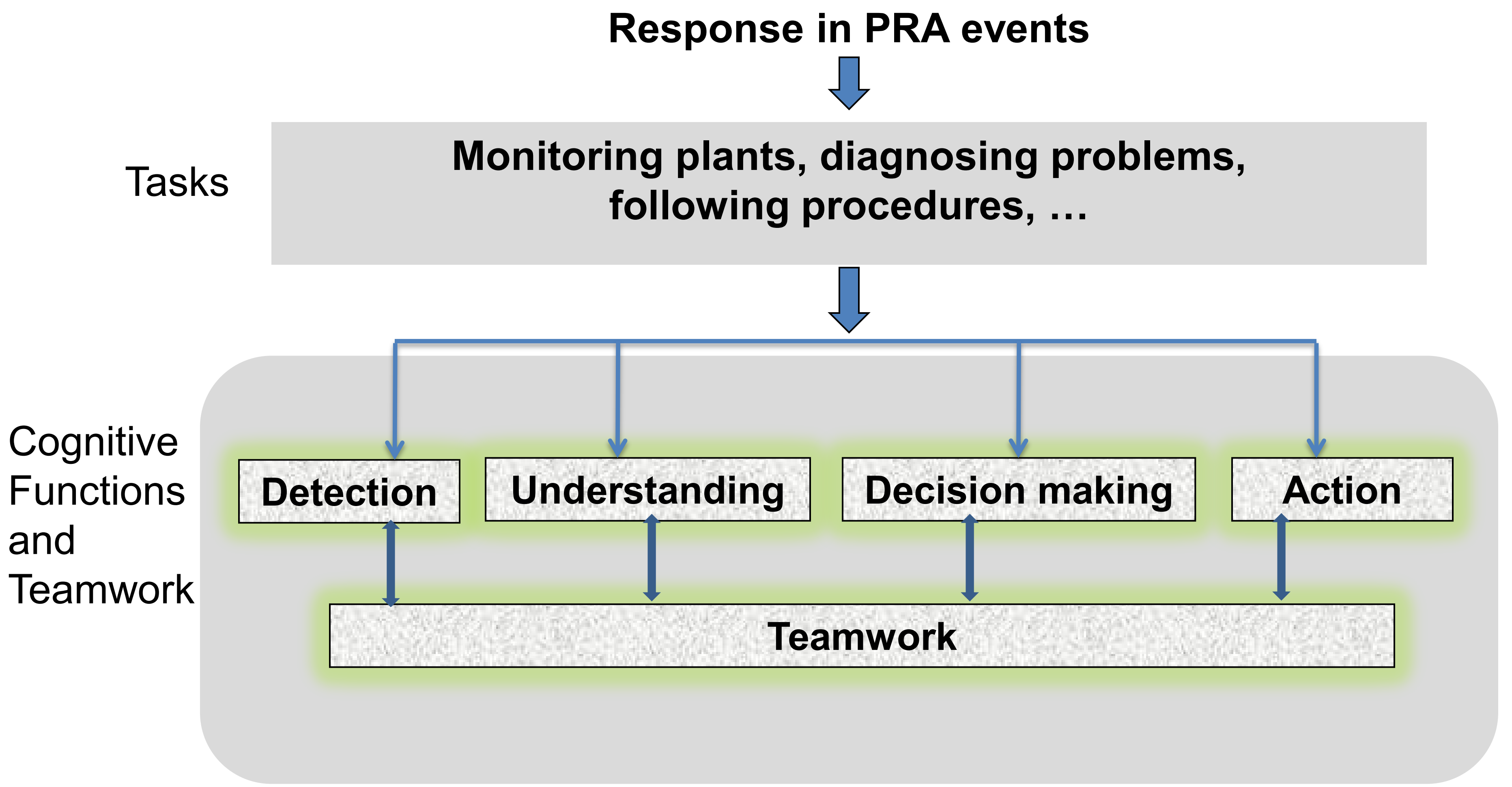


Cognitive Error-Causal Tree

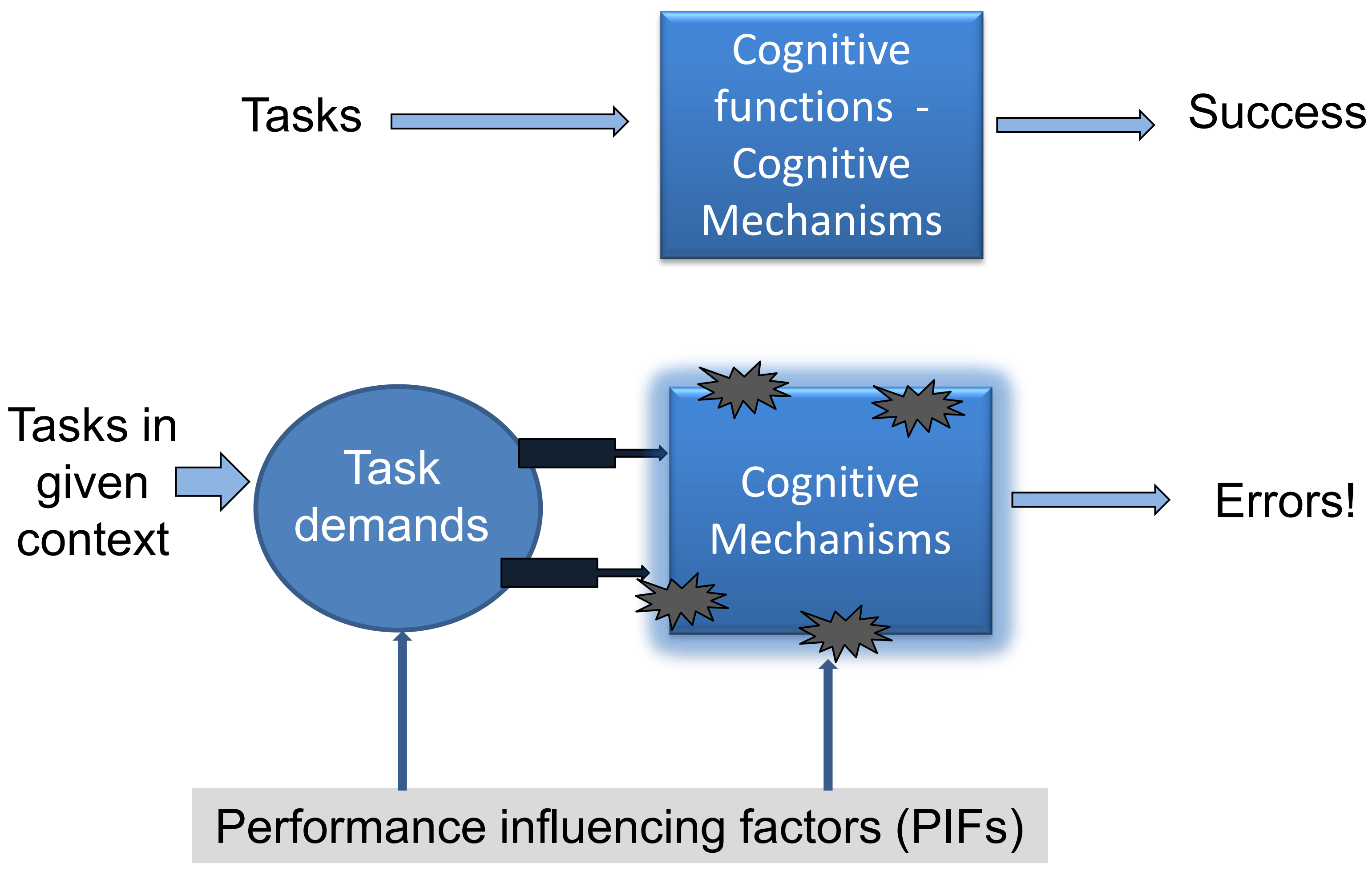
Synthesized from the lit review report, research in decision-making, NPP task analysis and event reports, and HRA practices

- Guidance for HFE analysis
- **Cognitive error-causal tree**
  - Cognitive functions, objectives, and processes
  - Cognitive mechanisms and error causes
  - Context characteristics that challenge the cognitive mechanisms
- Qualitative Analysis Structure
- Quantification process
- Integrative analysis

Human Tasks are Achieved through Cognitive Functions



Why does an Experienced Operator Make Errors?



Error-causal tree for Human Error Analysis

The Error-causal tree includes the following:

I. Cognitive Functions, objectives, and processes
   - How do humans perform a cognitive task?

II. Cognitive Mechanisms
   - What makes humans reliably achieve a cognitive function?

III. Error Causes
   - How does a cognitive mechanism fail?

IV. Challenging Context Characteristics
   - What contextual characteristics lead to errors?

Objectives of Cognitive Functions

Objectives of a cognitive function are the types of generic tasks within the scope of the function in NPP operation.

Objectives were identified by classifying human activities required by NPP system functions into generic cognitive tasks.

Objectives for *Decision-making*

- Select options
- Modify existing strategies
- Make GO/NO-GO choice
- Plan action scripts

Cognitive Process for *Decision-making*:
How is the cognitive function is achieved?

Assumptions for the cognitive process to achieve the objectives of *Decision-making*:

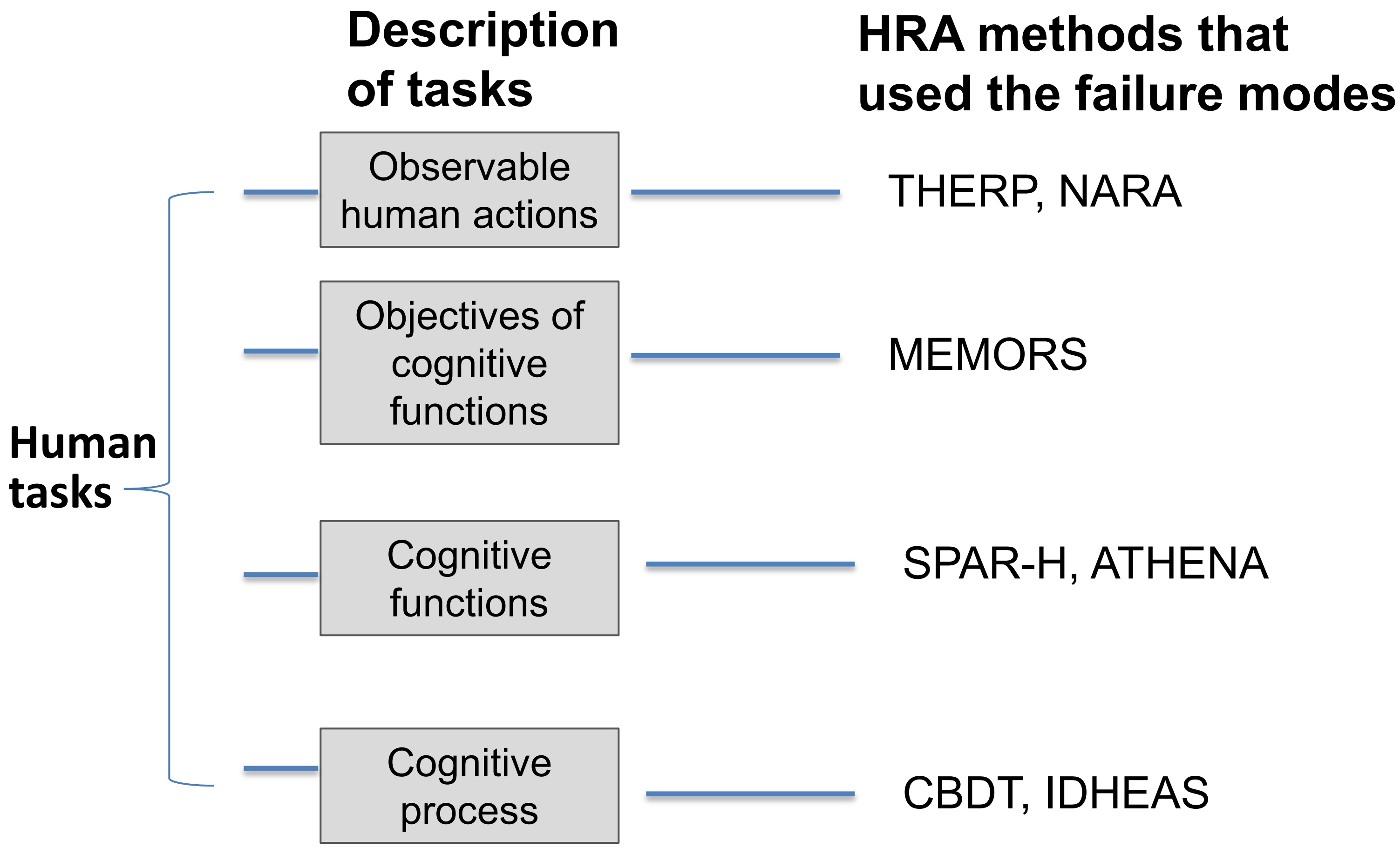
- Information needed is detected
- Situation is assessed
- Decision goals and criteria exist

Cognitive process to achieve the objectives:

- DM1 – Manage the goals
- DM2 - Establish a decision-model to meet the decision goals and criteria
- DM3 –Evaluate pros and cons
- DM4 – Make decision (strategies, choices)
- DM5 - Plan action scripts
- DM6 - Simulate / evaluate the decision / plan
- DM7 – Communicate and Implement the decision

Failure Modes vs. task descriptions

Human tasks can be described or broken down from different perspectives;
A set of failure modes can be derived from each description.



Cognitive Mechanisms:
What Makes Humans Achieve a Function Reliably?

Examples of cognitive mechanisms for *Decision-making:*

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 with *DM*

Attention and working memory - Focus on information pertinent to DM and bind relevant information.

Error Causes:
How does a Cognitive Mechanism Fail?

Examples of error causes for the *Decision-making* function:

Cognitive mechanism: Goal management

- Incorrect goals selected- Errors may arise if operators select the wrong goal to work toward. A variant of this failure mechanism is if the operator selects an implausible goal that cannot be achieved.
- Goal conflict- A conflict may arise in the operator’s mind between the goals of safety and the continued viability of the plant.
- Incorrect prioritization of goals- Goals may be ordered incorrectly in the operators’ mind or given the wrong priority, such that less important goals are addressed first.
- Incorrect judgment of goal success- The threshold used by the operator to judge goal success may be incorrectly set too low and be incorrectly determined as met when it was not.

Context Characteristics

What Contextual Characteristics Lead to Errors?

Context characteristics are classified into three categories

Task demands:

Demanding cognitive resources → Challenges cognitive mechanisms → Leads to errors.

Modifiers (PIFs) that decrease performance:

- Aggravating the cognitive demands of the tasks (e.g. poorly designed HSI);
- Aggravating the capacity limits / vulnerabilities of cognitive mechanisms (e.g., fatigue, stress);
- Not effectively providing barriers (e.g., training, work process, organizational factors) to error causes.

Recovery factors:

- Recovering from errors through good work process, system design, or teamwork

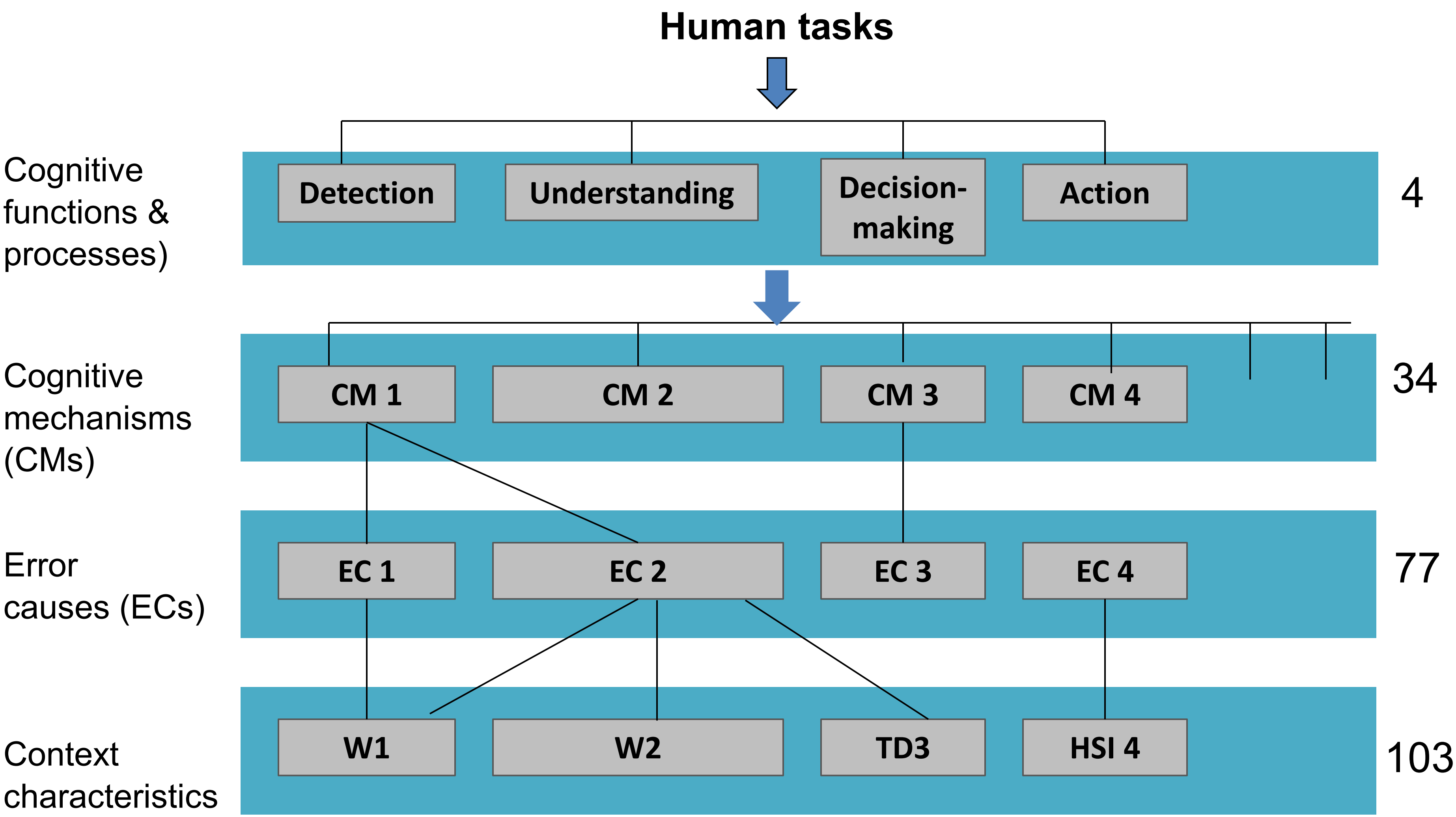
Context Characteristics:
What Characteristics Lead to Error Causes

Example context characteristics for *Understanding*

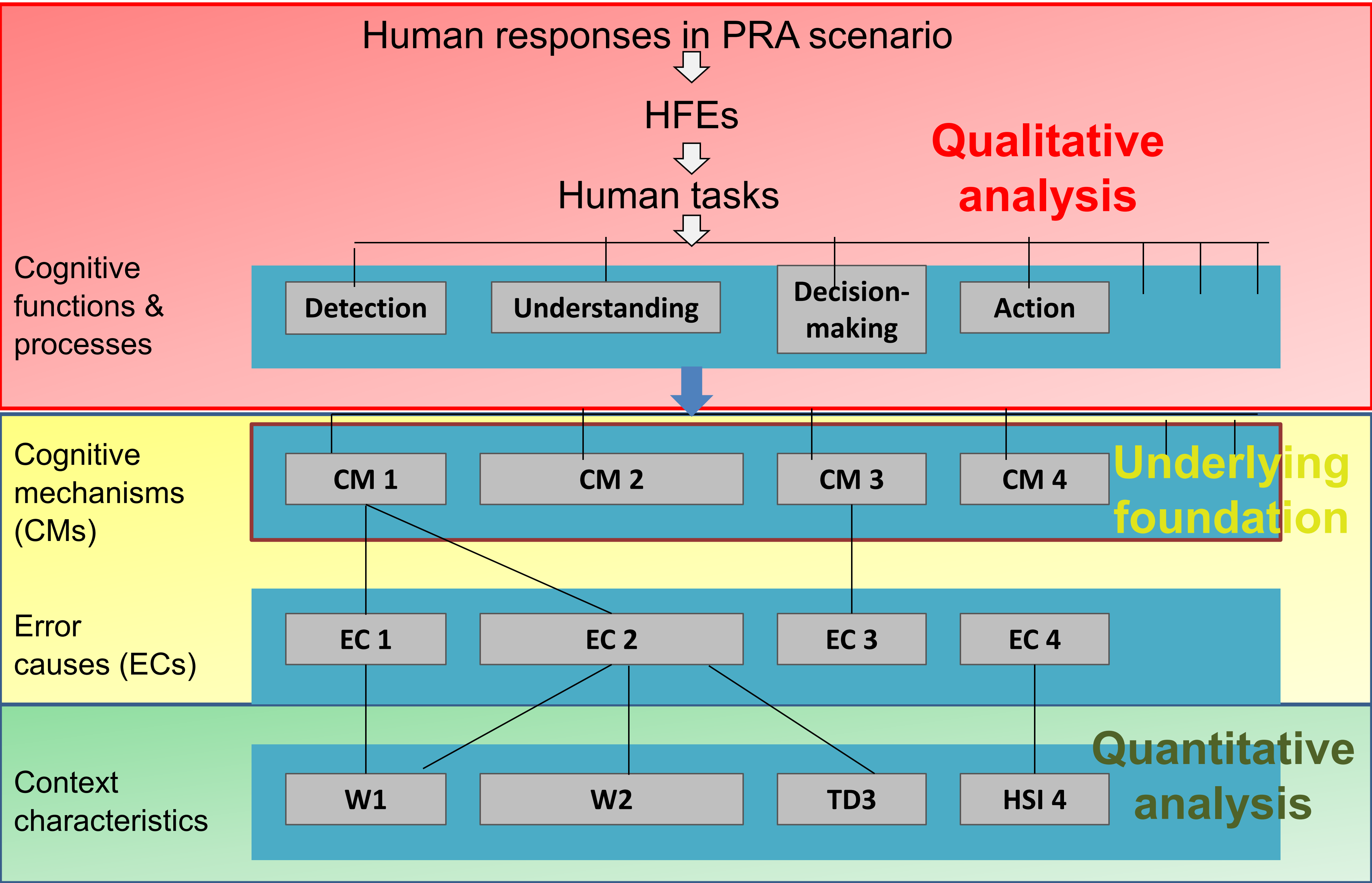
Context factor	Example challenging context character	Cognitive mechanism
Task demands	Multitasking, Unfamiliar scenario	Attention, Mental simulation
Task demands	Multiple competing goals	Goal management
HSI	System state/mode transitions may not be commanded	Pattern recognition
Procedure	Criteria are ambiguous	Mental simulation

Summary of the Cognitive Error-Causal Tree

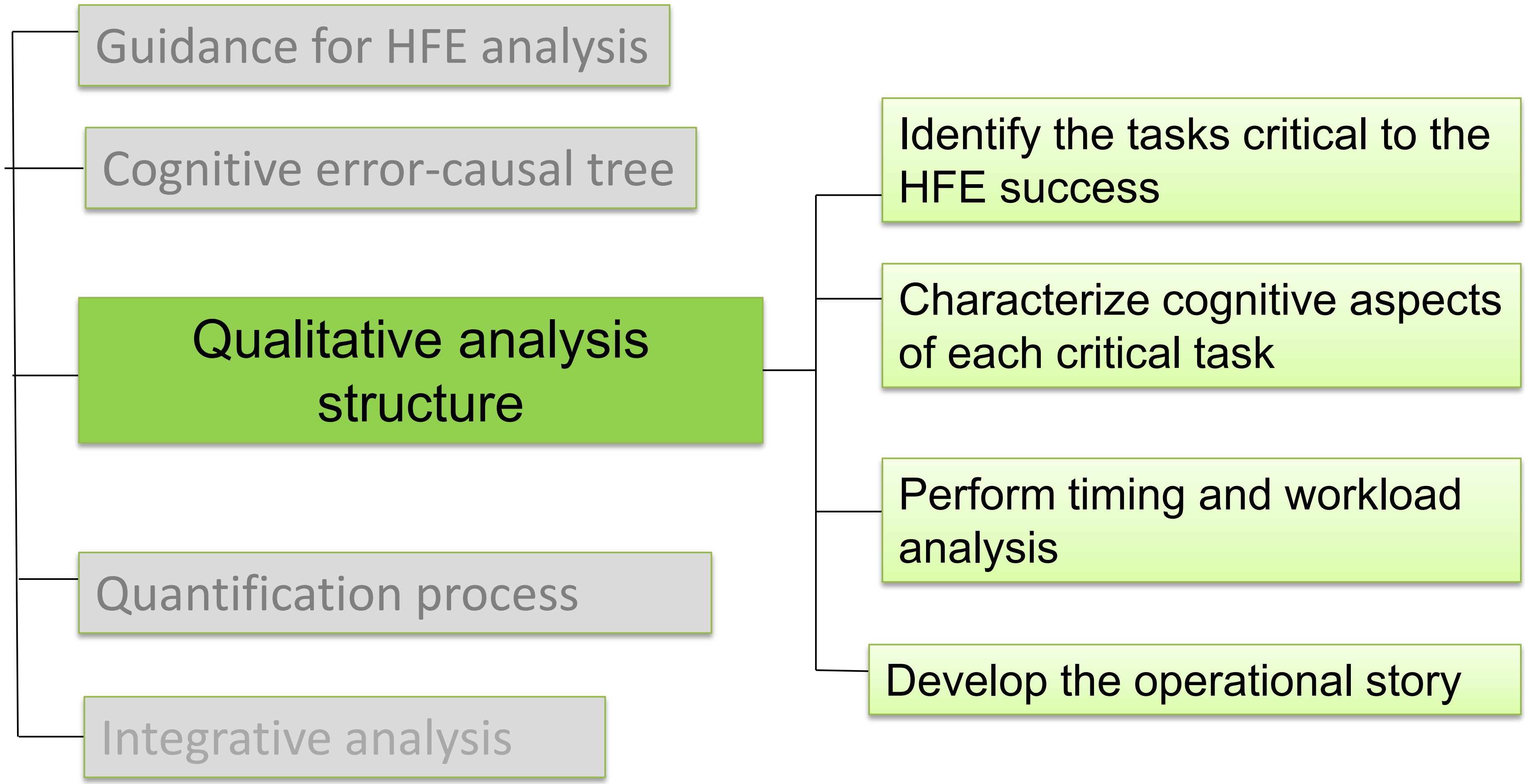
Each cognitive function and its processes are associated with cognitive mechanisms, error causes, and context characteristics.



From Cognitive Error-Causal Tree to an HRA Generic Methodology



Qualitative Analysis Structure



Overview of the Qualitative Analysis Structure

HFE

Stage 1 – Task identification and representation

Task 1 — Task 2 — Task 3 — Task 4

Stage 2 – Task definition and cognitive analysis

- Definition (operators,, cues, tools, strategies)
- Objectives
- Cognitive functions
- Task context

Stage 3 – Analysis of interaction between tasks

- Prior and parallel tasks to the critical task
- Expected timing and durations of the tasks and cues
- Assessment of the Workload factors for every critical task

Quantification Process

- Guidance for HFE analysis
- Cognitive error-causal tree
- Qualitative Analysis Structure
- **Quantification process**
  - Quantification model
  - HEP worksheet
  - Cognitive-process based failure mode analysis (IDHEAS)
- Integrative analysis

Quantification Model: Breakdown of a HFE

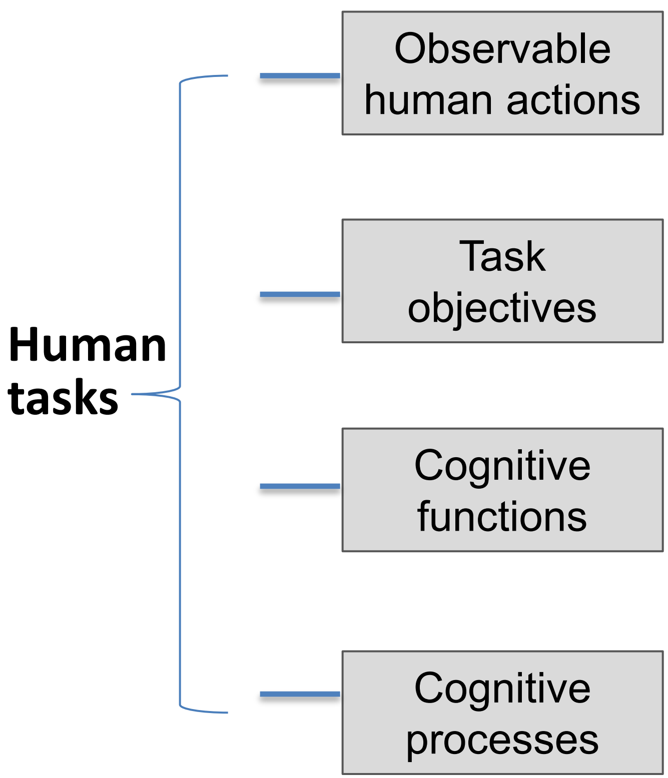
- In the qualitative analysis, an HFE is broken down into a set of critical tasks;
- Each critical task is performed through one or several cognitive functions;
- Each cognitive function can have one or several failure modes;
- HEPs are first estimated for each individual failure mode, then combined to generate the HEP for the event.

Assumption for combining individual HEPs:
HEP of an event = sum of HEPs of critical tasks
HEP of a critical task = sum of HEPs of failure modes

Quantification Model: Selection of Failure Modes

Failure modes can be selected from one of these types of task descriptions: observable human actions, cognitive functions, task objectives, or steps of cognitive processes.

Description of tasks

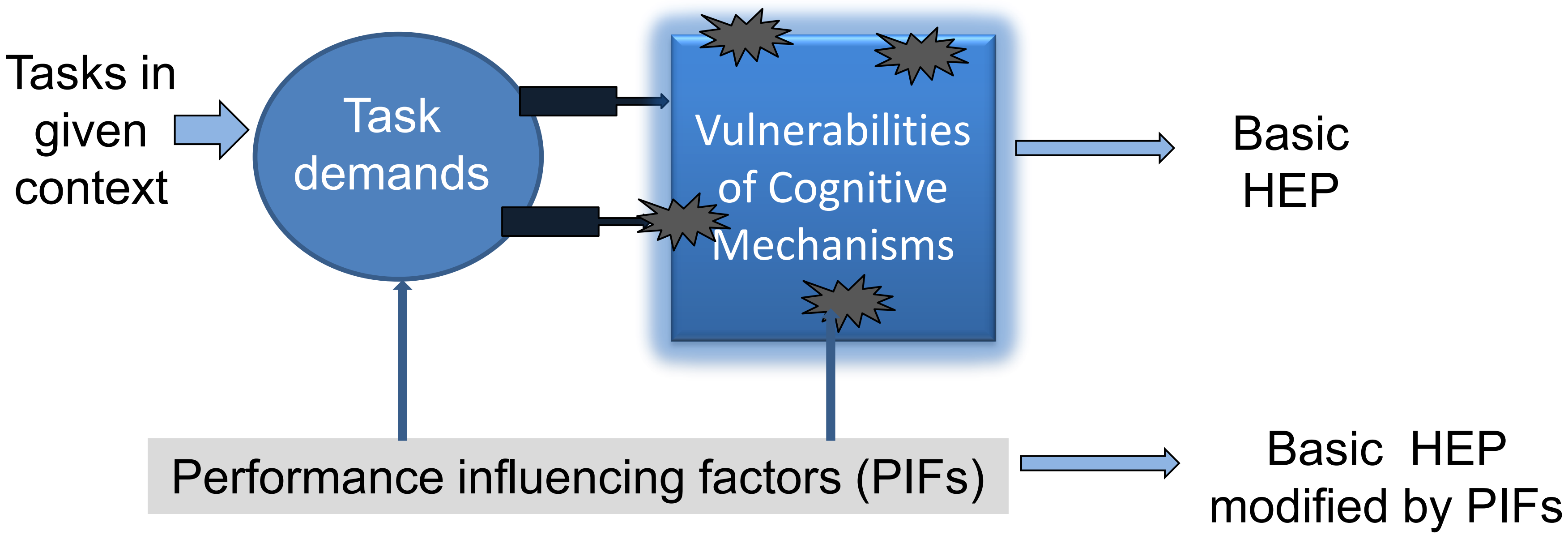


Quantification Model 3:
Selection of Context Characteristics for the Given Failure Modes

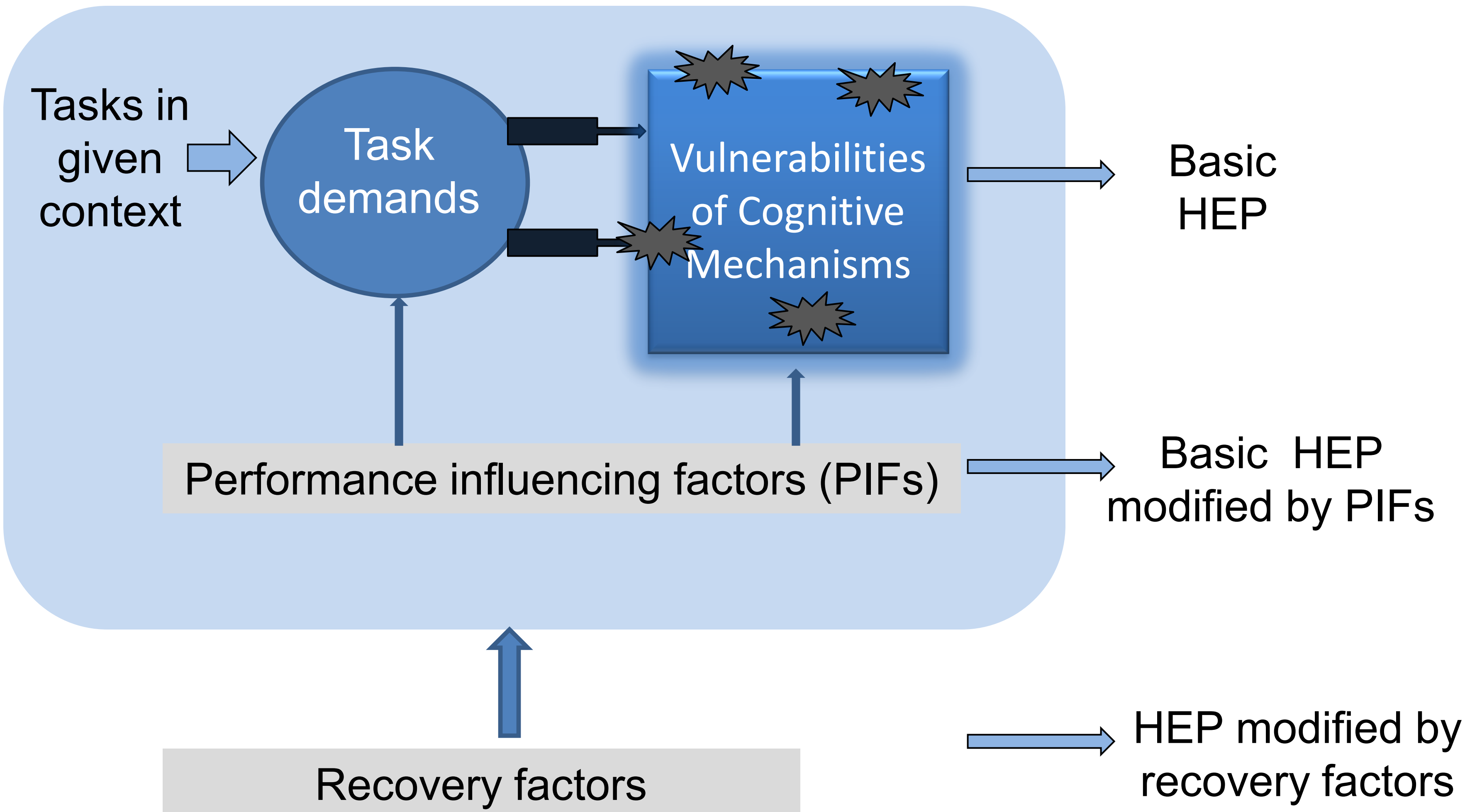
- The master list of context characteristics contains factors contributing to the likelihood of failures of cognitive functions;
- The master list organizes context characteristics according to cognitive functions;
- If failure modes are based on cognitive processes; the context characteristics pertinent to the failure modes can be inferred from the master list.

	Workload	Task complexity	HSI	Procedures	…
Detection					
Understanding					
Decision-making					
Action execution					

Quantification Model: HEP estimation



Quantification Model: HEP estimation



From a Theoretical Model to Practical Implementation

The quantification model, in principle, is applicable to all NPP applications.

Challenges in its practical implementation of estimating HEPs:

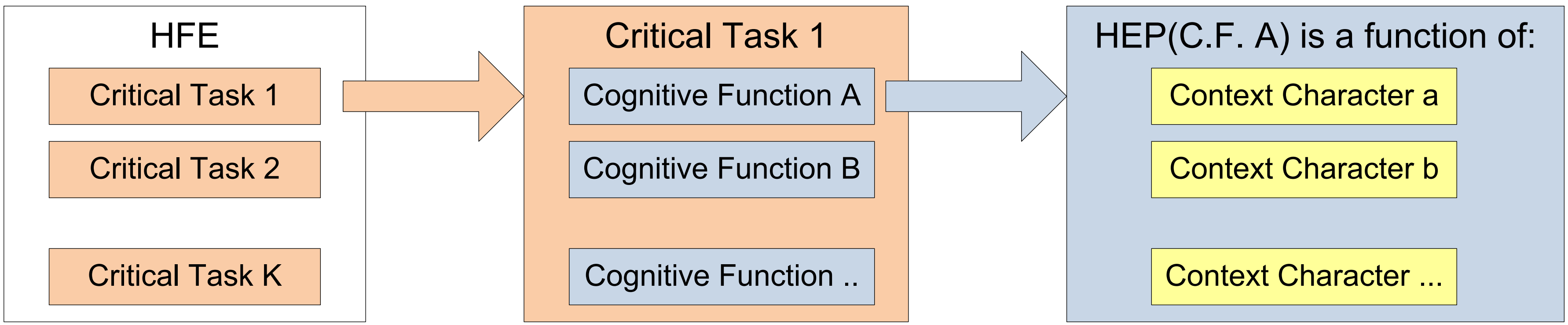
1) Too many context characteristics;
2) The characteristics do not weigh equally in their contribution to HEP;
3) The characteristics do not interact linearly

To practically implement the quantification model

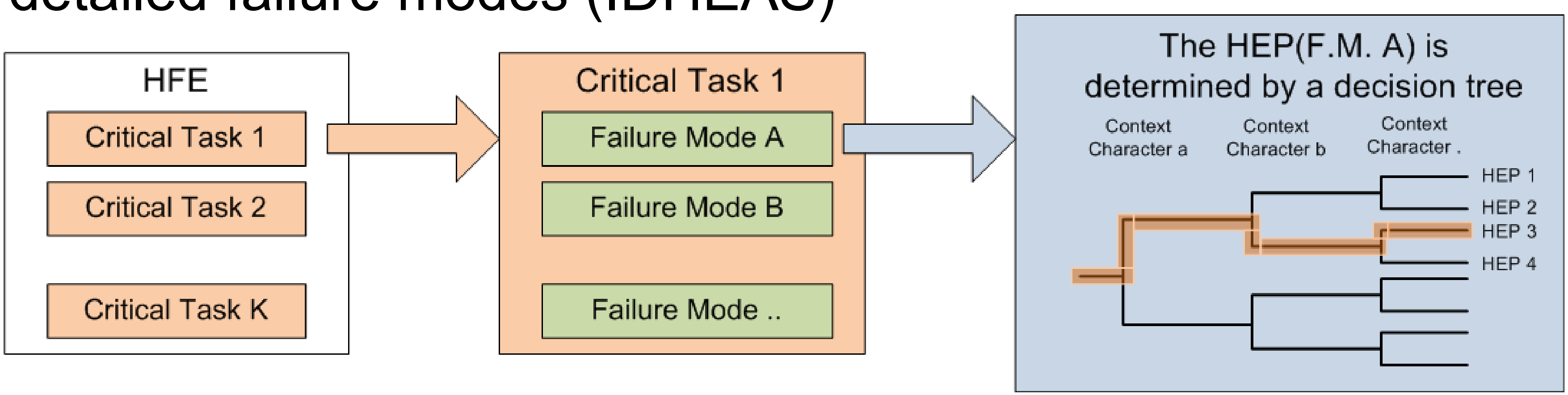
1) Consider only those context characteristics pertinent to the specific application
2) Use expert judgment to assign weight to individual or combination of context characteristics
3) Make heuristics of the interaction of individual characteristics to our best knowledge

Two Implementations of the Quantification Model

HEP worksheet – estimating HEPs of cognitive functions



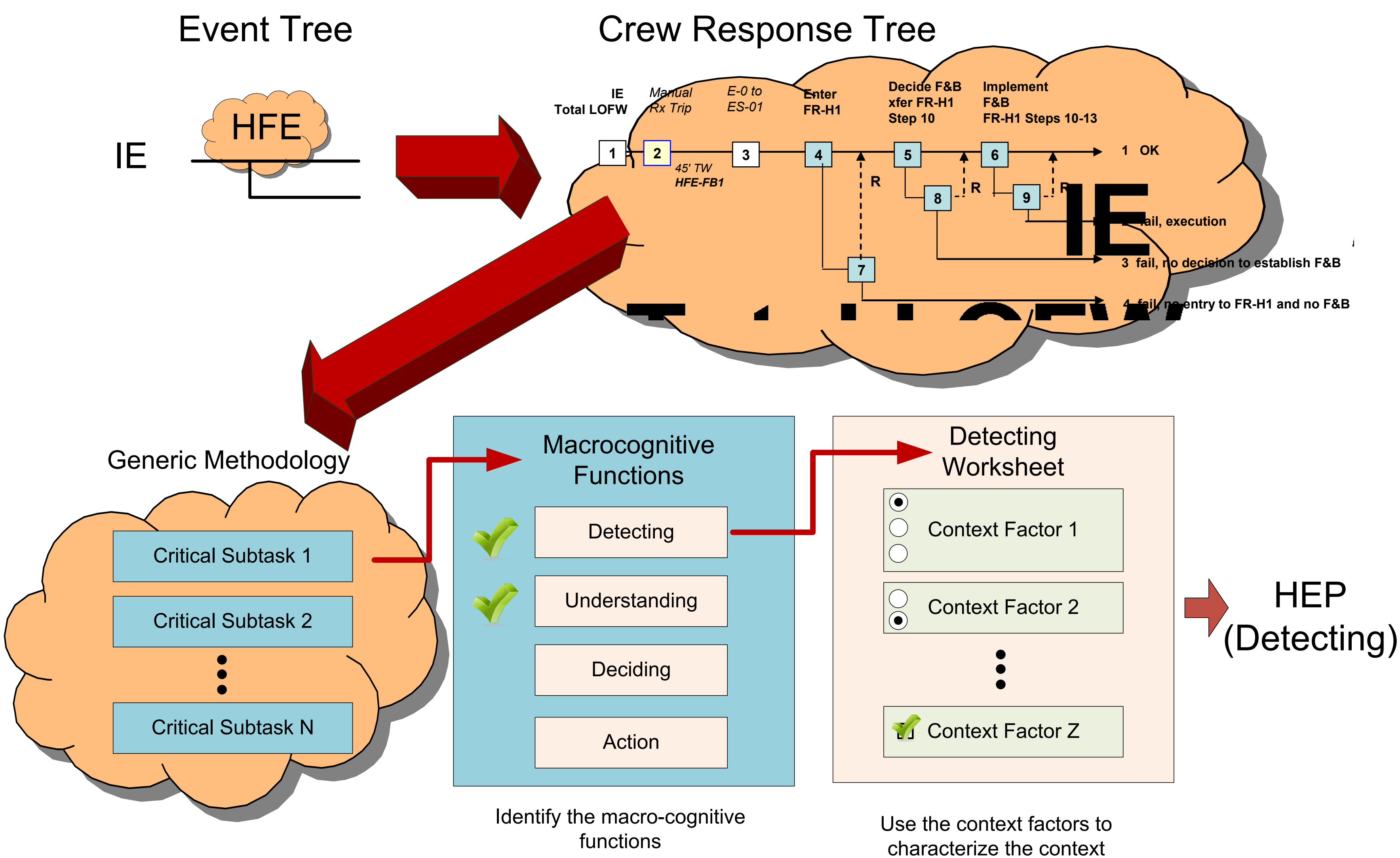
Cognitive process based analysis – Estimate HEPs of detailed failure modes (IDHEAS)



Summary

- The generic methodology is intended to be applicable to all NPP applications.
- The methodology can be tailored to simple, practical implementations for specific applications.
- The HEP worksheet is a mock-up implementation tailored for Level-2 HRA; it will be piloted in 2014.

Overview of the HEP Quantification Flow



Overview of the HEP Quantification Elements

- For the HRA Methods with the specific parameters to calculate HEP identified

Elements	Functions/Explanation
Basic HEP Unit	Parsing an HFE defined in PRA into a number of HEP units based on the analysis units specified by the methods.
Basic HEP	(Initial HEP) Specifying an HEP for each basic HEP unit.
PSFs/PIFs	(Intermediate HEP) Account for the other-than-normal conditions' effects.
Error Recovery	(Intermediate HEP) Crediting the error of the principal responders is recovered by the team members in time.
Task Dependence	(Intermediate HEP) Account for the effects of the failure of a preceding HFE on the current HFE.
Minimum (joint) HEP	(Final HEP) The threshold to limit the minimum HEP values in single or joint to address epistemic uncertainty.

The Generic Methodology's Approach

Elements	Generic Methodology's Corresponding Elements
Basic HEP Unit	HFEs and critical subtasks identification.
Basic HEP	Context factors (Grouped based on macrocognitive functions).
PSFs/PIFs	
Error Recovery	
Task Dependence	Context factors (Grouped based on macrocognitive functions)
Minimum (joint) HEP	Use the conventional practice.

Context Factors

- Represent error causes from the operational perspective
  - E.g., information (alarm) is not salient vs. noticing an alarm from the alarm board showing a few alarms
- Each factor has discrete states, e.g., for alarm salience, three discrete states for the alarm board status
  - Showing a single alarm or a few alarms with clear problem pattern
  - Showing a few alarms without clear pattern
  - Showing overwhelming number of alarms
- Benefits of using the context factors
  - **Repeatability**: Each context factor's status can be objectively identified
  - **Data support**: Consistent with the SACADA methodology
  - **Comprehensive**: Covers all error causes of the cognitive mechanisms identified in the IDHEAS methodology.
  - **Systematic**: The error causal tree provides links for systematic search of error mechanisms (modes) and error forcing context based on the context factors.

A Context Factor Example – Decision Type

- the Deciding Macrocognitive Function

- **Standard:** Implementing the HFE specified plant function is an obvious choice.
- **Competing goals <u>with</u> concrete GO vs. NO-GO criteria:** The main concern of this type of decision is violating the safety rules and practices. The rules (procedures) provide clear direction but because of high economic consequences or other reasons (e.g., convenience) the procedures are not followed. An example is the loss of heat sink event that occurred at the Davis Besse nuclear plant in 1984. There were two competing goals: perform F&B and restore AFW to provide RCS cooling in the events. Based on the condition, a F&B should have been performed. But there was an alternative to restore AFW back to service, performing F&B and restoring AFW were competing goals.
- **Competing goals <u>without</u> concrete GO vs. NO-GO criteria:** This is a typical decision in SAGs to decide Go or No-Go of implementing a SAG's function (e.g., inject into SGs) where high-level instructions may or may not be available, examples are:
  - Injecting into dry hot SGs could either prevent SG tube failures or cause tube failure.
  - Venting containment can protect containment but it could release radioactivity to environment if no radioactivity filtering mechanism in place.
  - Preforming containment spray or firefighting with use of the same water source for cooling the RCS.

Mapping IDHEAS Causal Factors with the Context Factors (examples)

IDHEAS Causal Factors	Context Factors and States
(Detecting) Information changes over time and requires sustained attention over a period of time (determining a trend).	**Display type** (7 options): Chart recorder. **Catch attention** (3 classes) represent the easiness of having operators' direct attention to the information.
(Understanding) System behavior may be unexpected and unexplained	**Familiarity** (3 options): Standard, anomaly, and novel
(Deciding) Conflict goals	**Decision type** (3 options): - Standard - Competing goals with concrete GO vs. NO-GO criteria - Competing goals without concrete GO vs. NO-GO criteria
(Action) Interruptions (Memory bottleneck) makes it easy to forget to do unresolved tasks and prioritize tasks appropriately.	**Delayed memory action** (2 options): Yes and No.

Principles of Grouping Context Factors to Estimate HEPs

- Each macrocognitive function has a set of context factors
- The context factors of each macrocognitive function are grouped into the following four functional groups for HEP estimates:
  - Basic HEP group
    - The context factors whose statuses typically remain unchanged even though the same task is performed at different scenarios or plans, e.g., Identifying the broken SG(s) is instructed by procedures.
    - Establish the initial HEP
  - HEP multiplier group
    - The context factors whose statuses change in different scenarios or plants, e.g., misleading or missing indications.
    - Increase HEP
  - Error recovery group
    - The context factors crediting error recovery by team members and system design, e.g., supervisor presence
    - Decrease HEP
  - Cognitive dependence group
    - The context factors address the tasks dependences' effects.

Calculating HEP

- Independent HEP = Basic HEP × Multiplier × Error Recovery
  - Multiplier
    - Represent the integrated effects of all factors in the HEP Multiplier group.
    - Each factor's status has a fixed HEP multiplier value (≥ 1).
    - The combined effects may have magnified or damped effects – effects may not be linear.
  - Error recovery
    - Represent the integrated effects of all identified recovery mechanisms
    - Each mechanism has a fixed HEP multiplier value (< 1)
    - The total error recovery multiplier is multiplication of the applicable recovery mechanisms.
- Dependent HEP = f(Independent HEP, Dependence Effect)
  - Dependence effect: represents repeated failures caused by the same underlying cognitive failure mechanisms.

Detecting - Context Factors and States - Basic HEP Factors

Catch Attention (the information saliency):

- **Likely:** Salient information comes to the staff or explicitly directed to check the information, e.g.,
  - Notice an alarm or an alarms pattern stands out from the background or the visual and audio effects of the alarm makes it easy to detect.
  - Notice a plant status from an off-site emergency phone call
  - Direct by procedure or other explicit means to check the information
- **Less Likely**
- **Unlikely**

Display type:

- Alarm or legend light
- Analog meter
- Digital readout
- Chart recorder
- Graphs
- Printing recorder with large number of parameters
- Values from indicator lamps that are used as quantitative displays

Information Familiarity:

- **Familiar**
- **Not Familiar**

Communication types and scope:

- **Normal**
- **Extended**
- **Offsite**
- **Offsite extended**

Detecting - Context Factors and States - HEP Multiplier Factors (1/2)

Amount of information: ○ 1 ○ 2 – 5 ○ 6 – 10 ○ > 10

Information appearance:

- ❑ No mimic
- ❑ Similar Displays
- ❑ Information filter
- ❑ Masked information
- ❑ Poor label quality
- ❑ Delay Information

Information content and display:

- ❑ Primary parameter not available
- ❑ Unreliable indication
- ❑ Faulted indication
  - ○ Lighted or annunciated indication (on/off)
  - ○ Value indication (e.g., pressure gauge) - outside of operation range
  - ○ Value indication (e.g., pressure gauge) - jammed

Detecting - Context Factors and States - HEP Multiplier Factors (2/2)

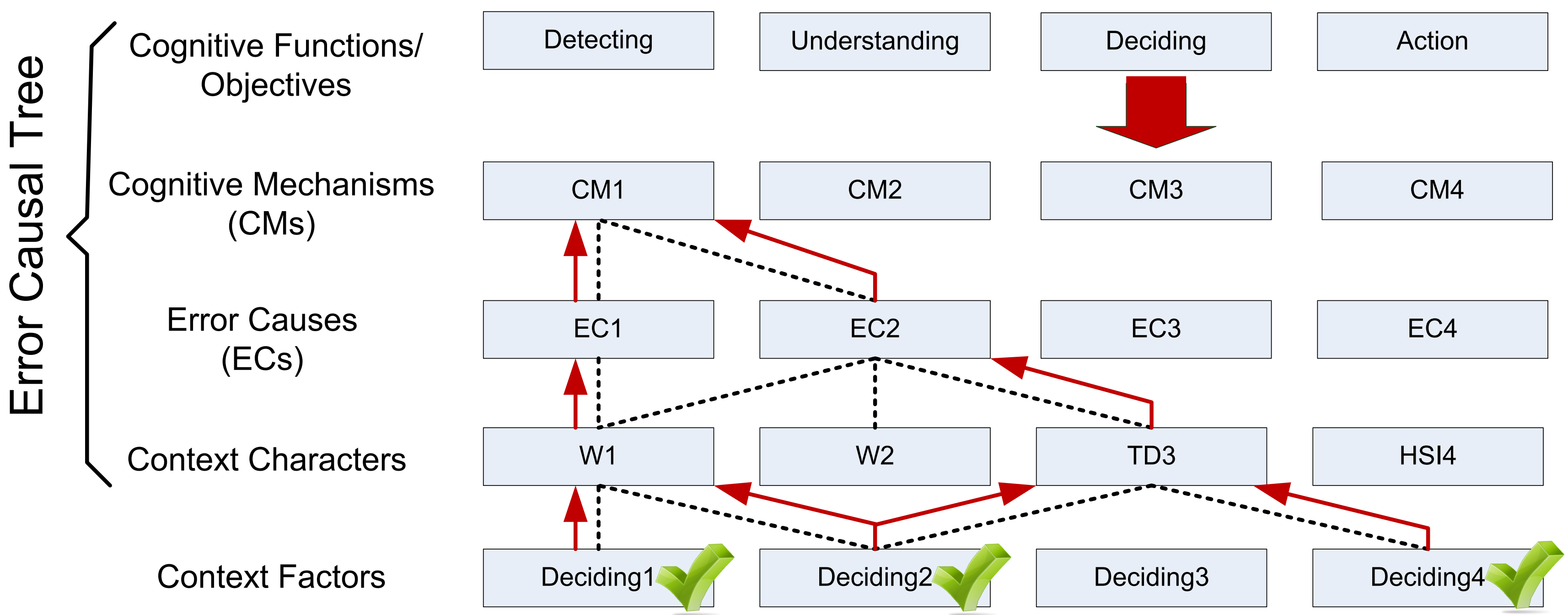
Scenario and environment factors

- ❑ **Fast pace scenario**
- ❑ **Parallel Tasks & distraction**
- ❑ **High psychological stress**
- ❑ **Work environment**
  - ○ **Nominal**
  - ○ **Uncomfortable**
  - ○ **Harsh**
  - ○ **Heroic**
- ❑ **Physical/mental fatigue**
  - ❑ **Physical fatigue**
  - ❑ **Mental fatigue**

Detecting - Context Factors and States - Error Recovery Factors

- **Peer checker presence**: Peer check is available.
- **Supervision Presence**: Supervisor or independent checker is present.
- **Redundant Information (Same person, different cue):** Redundant information that is salient and is conveniently available to makeup the missing detected information. There is sufficient time to detect the redundant information.
- **Fresh mind (Different person, same cue):** The cue exists for a long period time. If the principal responders missed detecting the cue, there are redundant opportunities to detect the cue by the other people not among the principal responders. The people could arrive due to reasons such as shift turnover or additional helpers expected to arrive sometime after the cue occurrence.

It is more than just HEPs



A Different Kind of Decision

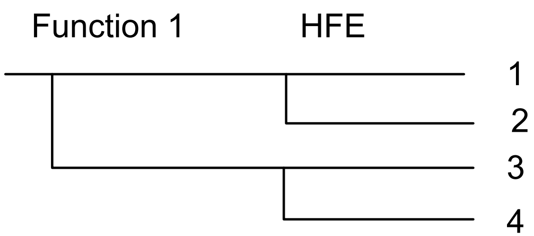
- The "Competing goals <u>without</u> concrete GO vs. NO-GO criteria" type of decision in SAGs differs from the EOP decisions.
- The SAGs identify the potential pros and cons of implementing the mitigation strategy and leave the decision to the decision-makers.
  - The decision-maker also needs to consider the effects of implementing the strategy on the mitigation strategies in place.
  - No action is an option in SAGs.
- Differences
  - No explicit reference for correct vs. incorrect decision.
  - Branch probability is the response probability rather than error probability.

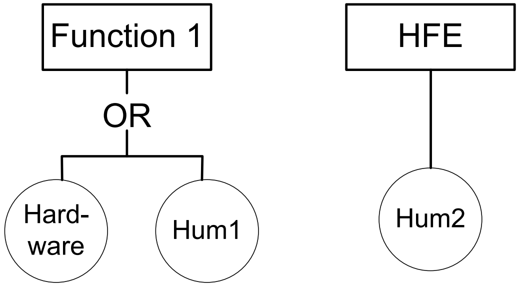
Pros and Cons in Injection in SGs (SAG-1)

- Pros – if no injection into SG(s):
  - The SG(s) will NOT be a heat sink for the RCS.
  - SG tube integrity may be threatened.
  - The SG(s) cannot be used to depressurize the RCS.
  - Scrubbing of fission products from any SG tube leakage will NOT occur.
- Cons – if injection into SG(s):
  - IF feeding a hot, dry SG THEN it could cause thermal shock in the SGs.
  - IF feeding a ruptured or leaking SG THEN fission product could release from leaking SG tubes.
  - IF depressurizing a SG with low water level THEN SG tubes creep rupture may occur.

Various Types of “Dependence”

- **Common PSF**: the same PSFs affect multiple HFEs.
- **Direct dependence (THERP)**: HFE1 failure made HFE2 more complex to perform and/or less time available.
- **Indirect dependence (THERP):** HFE1 failure changed crew configuration in HFE2.
- **Resource sharing:** HFE1 and HFE2 share the same resources (staff, equipment, etc.)
- **Trust Redundancy/authority:** e.g., the checker omitted responsibility because of trust in the doer.
- **ET/Cutset**: ET and cutset provide different levels of details.





- **Fixation**: Cognitive and behavior inertia caused systematic errors.

Observations of the Conventional Dependence Models

- Use a number of factors to classify dependence into five levels.
  - Not specific about what types of dependence are modeled. Insufficient in discussing the dependence mechanisms.
  - The factors are sufficient condition but not necessary condition for dependence to occur.
- When the analysts doubt the dependent HEP values, there is lack of basis to justify or modify the HEPs.

Dependence in The Generic Methodology

(Draft)

Dependence Type	Context Factors/Comments
Common PSFs	Context factors of independent HEP
Direct dependence	CRT would specify the context
Indirect dependence	Not modeled
Resource sharing	Context factors of independent HEP (e.g., less than adequate resource available)
Trust redundancy	Implicitly covered in the recovery context factors
ET/Cutset	HRA analysis at the cutset level
Fixation	To be covered in the dependence context factors

Most dependences above are modeled in the independent HEP. Only fixation is within the scope of dependence of the generic methodology.

Cognitive Function Based Dependence
(Draft)

- Fixation could occur within the same macrocognitive functions between two HFEs.
- Two groups of dependence factors
  - Necessary group: These factors are necessary for dependence to occur.
  - Sufficient group: These affects affect the likelihood (or level) of dependence.

Some Dependence Considerations

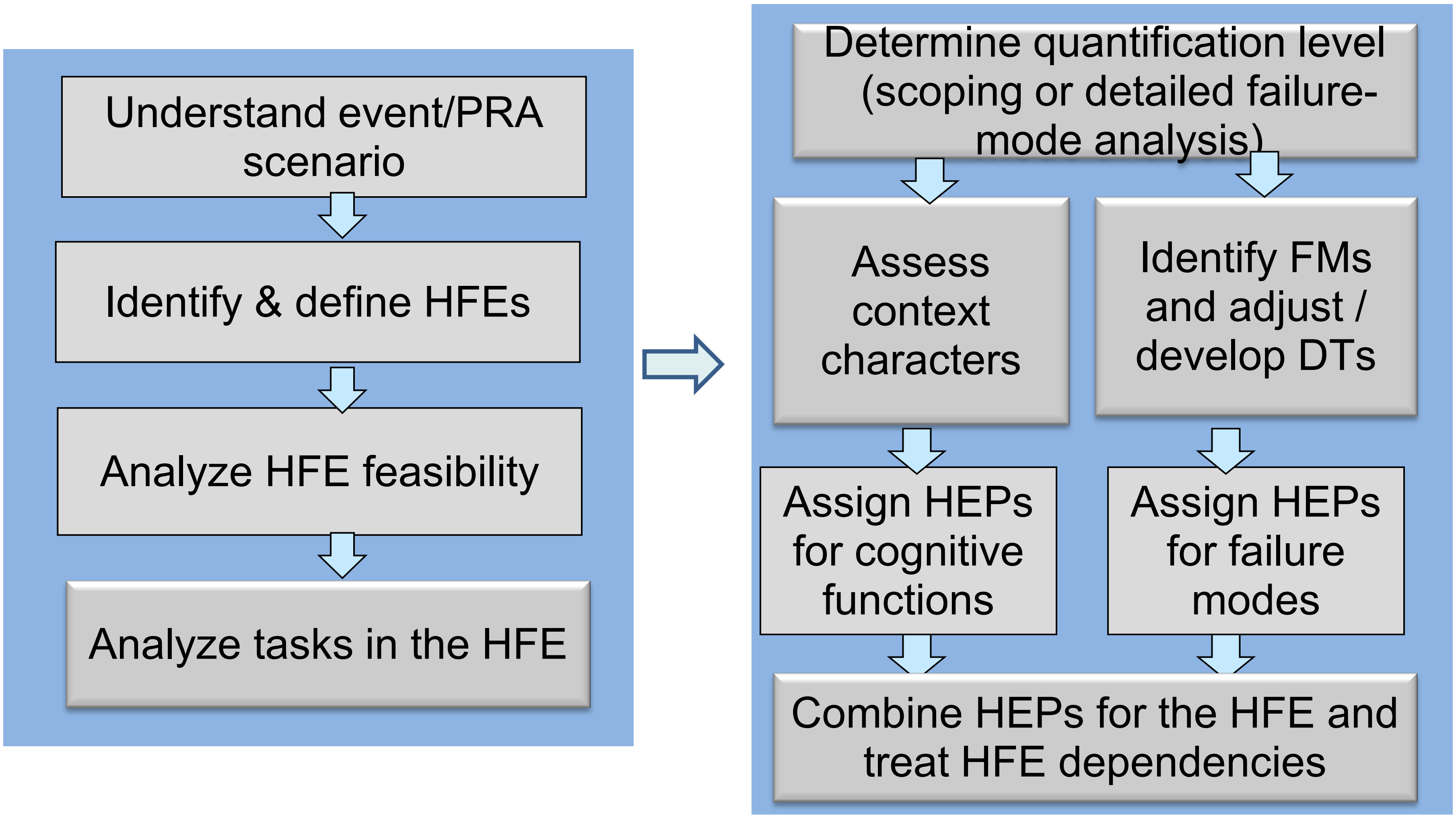
- Detecting:
  - The mentality of the parameter was checked earlier; therefore, no need to re-check.
- Understanding:
  - An incorrect plant status perceived in the HFE1 will cause an incorrect understanding of plant status needed for HFE2.
- Deciding: decision on the same attributes, e.g.,
  - Barriers (fuel, RCS/RPV, containment, and release scale)
  - Component (e.g., RCPs) vs. plant safety
  - Urgent-but-less-important vs. important-but-less-urgent
  - Influence of outside stakeholders
- Action:
  - Same activities and the system does not provide salient feedback
  - Fatigue in performing the same activities

Minimum (Joint) HEP

- Threshold to address model incompleteness and data observation
  - The primary purpose in adopting a minimum or limiting value is to recognize that there may be causes of human failure that have not been thought about, or that are not accounted for in the particular HRA method that is used. In this way, the limiting value is one way to treat completeness uncertainty of the "unknown unknown" kind (Gareth Parry, 2010, EPRI report).
  - Incident and accident experience, as well as human error data collection efforts and general expert opinion, appears to recognise the value of 10^{-4} for a single human error, and 10^{-5} for a set of human errors by different people, as 'credibility thresholds' in HRA" (Barry Kirwan, 2007)
- A separate issue from dependence
- Adopt current practice:
  - 10^{-5}: generally acceptable minimum value
  - 10^{-6}: acceptable only with strong justification

Backup slides

Summary of the IDHEAS process



Guidance for HFE analysis

–adapted from HRA Good Practices, PRA standards, Fire HRA, and others

- Guidance for HFE analysis
  - Scenario understanding
  - HFE identification & definition
  - HFE feasibility analysis
- Cognitive error-causal tree
- Qualitative Analysis Structure
- Quantification process
- Integrative analysis

HFE identification

- NUREG-1792 (HRA Good Practices) and PRA Standards provides guidance for general process and considerations of HFE identification.

- NUREG 1921 (Fire HRA) provides detailed guidance for identifying the following three types of post-initiator actions:

- Internal event operator actions
- Operator actions outside of internal events
- Undesired operator responses to spurious alarms, indications, and digital I&C failures

HFE definition

- From HRA Good Practices, PRA standards, and Fire HRA

An HFE should be defined to represent the impact of the human failures at the function, system, train, or component level as appropriate. The definition should include the following:

- Accident sequences, initiating event, and subsequent system and operator action successes and failures preceding the HFE
- Accident sequence-specific procedural guidance
- The cues and other indications for detection and evaluation
- Accident sequence-specific timing of cues and the available time for successful completion
- The available time for action
- The high-level tasks required to achieve the goal of the HFE
- The undesired failure consequences and the likely situations for the failures to occur

HFE feasibility analysis

Feasibility analysis is to assess whether an HFE is feasible.

NUREG-1852 provides guidance for conducting a thorough feasibility assessment of manual actions. It identified the following feasibility criteria:

- Sufficient time to complete the tasks
- Sufficient manpower
- Cues available
- Adequate procedures and training
- Accessible location
- Availability of equipment required for critical tasks
- Operable relevant components

IDHEAS guidance on estimating performance time

Time estimation model in NUREG-1852:

Time Margin = (Available Time- (Cognition Time)
- (Execution Time)

IDHEAS guidance:

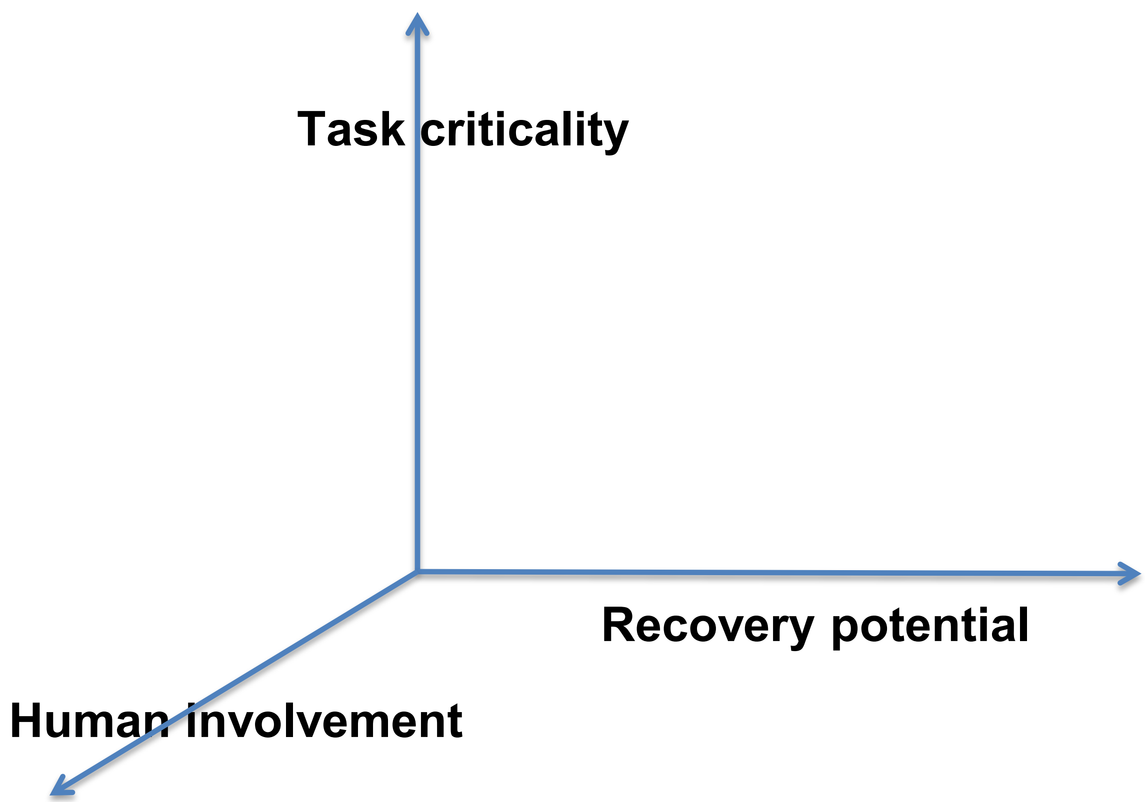
Estimating the cognition and execution time is based on the following three sets of factors:

- Contributing factors to estimate time needed
- Modification factors to estimate time range
- Bias factors to calibrate the estimation

Qualitative analysis structure – Part 1: Identify the tasks critical to the HFE success

Objective –

Identify and represent safety-critical tasks for quantification; failing each critical task leads to failure of the HFE.



Qualitative analysis structure - Part 2: Characterize cognitive aspects of the critical tasks

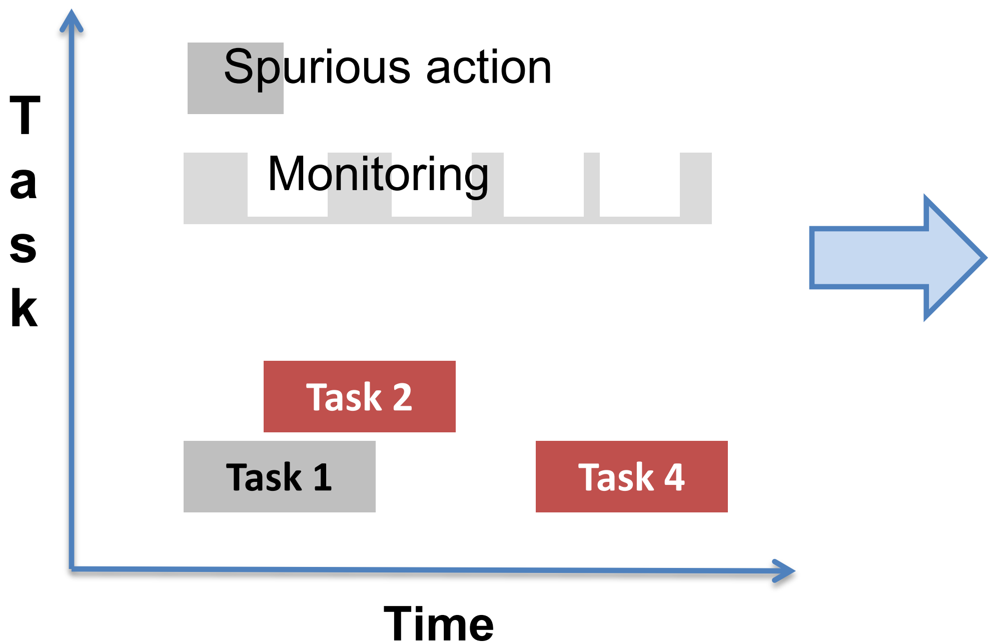
Objective - Identify cognitive characteristics of every critical task.

Cognitive features	Description
Task goal	The expected outcome of the task (e.g., reach hot shutdown within 3 hours) including the constraints of operation (e.g., cool down RCS but not exceeding 100 ºF/hr)
Cognitive functions and objectives	Activities to achieve the goal and the desired outcome of the activities
Plant cues and supporting information	The information (i.e., cue) to initiate the task. A cue could be an alarm, an indication, a procedure instruction or others (e.g. onsite report). The supporting information is in addition to the cue and is needed to perform the task.
Procedures and operational guidance	Guidance used to perform the tasks.
Personnel	Personnel who performs the task or specific task objectives.

Qualitative analysis structure - Part 3: Perform timing and workload analysis

Objective – Assess workload

Timing



Workload characters

- W1 - Multitasking interference
- W2 - Interruption / distraction
- W3 - Complex, sustained cognitive demand
- W4 - Timing

Integrative analysis
– Adapted from NUREG-1921

- Guidance for HFE analysis
- Cognitive error-causal tree
- Qualitative Analysis Structure
- Quantification process
- Integrative analysis
  - Dependency analysis
  - Sensitivity/uncertainty analysis
  - Recovery analysis

EPRI Perspective on IDHEAS

- Barriers to industry testing or piloting the method
  - Method not complete
    - Quantification of existing trees
    - Prolonged control actions
  - Perception that there is not consensus within NRC on acceptance of IDHEAS
  - Utilities "busy" with existing workload

- Application of insights to EPRI HRA Methodology
  - CBDT branch point choices
  - Additional DTs?
  - Qualitative analysis
  - Dependency analysis

- EPRI path forward - **TBD**
  - Participation in testing and user's guide
  - Generic guidance v. current EPRI projects in LPSD, FLEX, External Events, Level 2, etc.
  - Dependency, including minimum joint HEP

- Recommendations for NRC path forward for quantification of remaining trees:
  - Representative use cases should be incorporated into the testing to ensure the output is reasonable (aggregation).
  - Link to SACADA so in future can improve quantification values

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Demonstration of Applying the HRA Generic Methodology

Y. James Chang

Human Factors and Reliability Branch
Division of Risk Analysis, RES

Presented to ACRS subcommittee
January 15, 2014

Purpose of this Presentation

- Present an HEP calculation example to obtain ACRS' comments on the generic methodology
  - Use the severe accident guideline 3 (SAG-3) "inject into RCS" of a Westinghouse plant as an example to quantify the HEP
  - More emphasis on the process than the numbers
  - Numbers will be refined by expert elicitation and V&V process

Presentation Outline

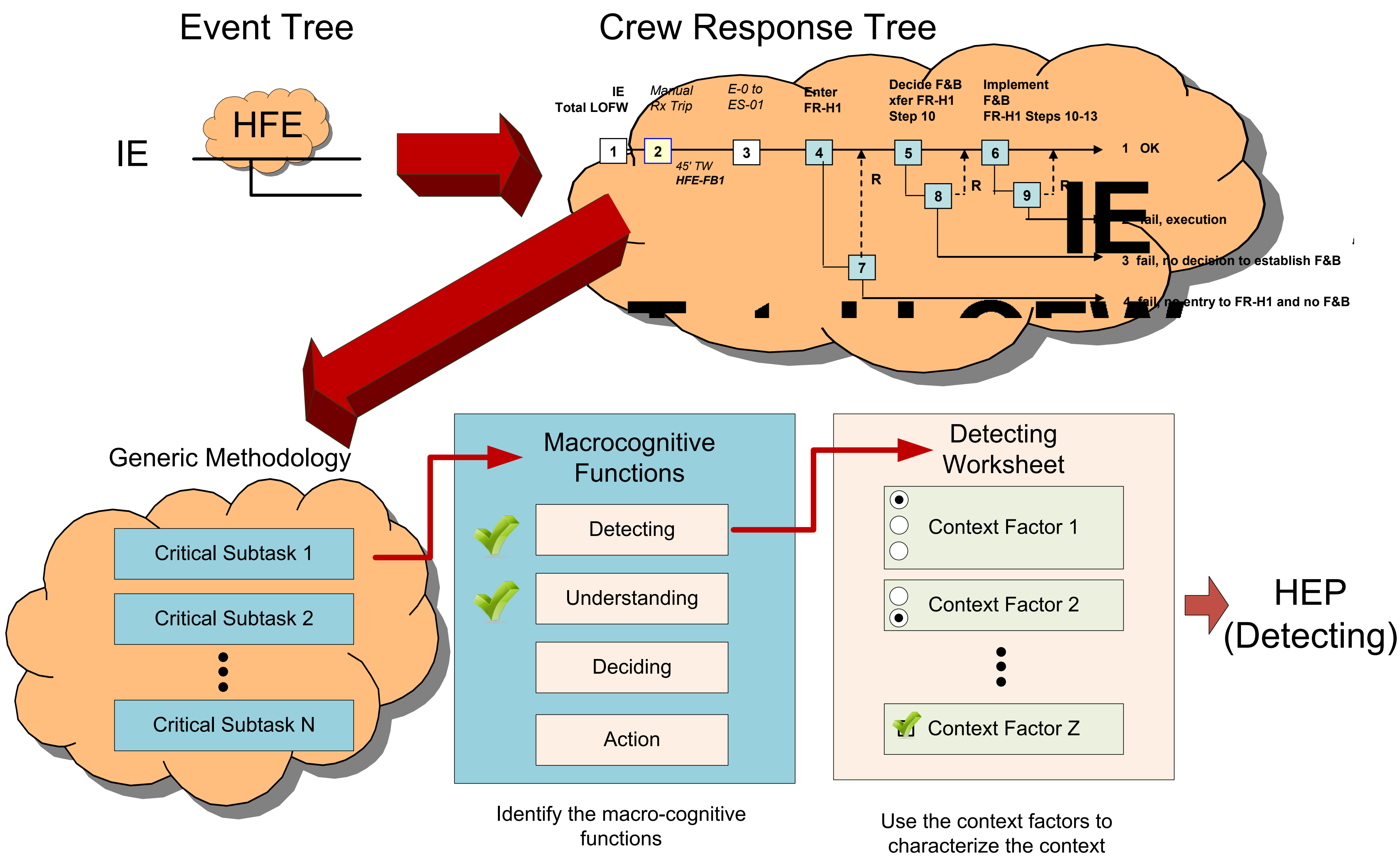
- Overview of the SAMGs
- Introduction of SAG-3 “Injection into RCS”
- Use HEP worksheets to calculate HEPs

HEP Calculation Elements

Elements	Generic Methodology's Corresponding Elements
Basic HEP Unit	HFEs and critical subtasks identification.
Basic HEP	Context factors (Grouped based on macrocognitive functions).
PSFs/PIFs	
Error Recovery	
Task Dependence	Context factors (Grouped based on macrocognitive functions)
Minimum (joint) HEP	Use the conventional practice.

Not discussed in this presentation

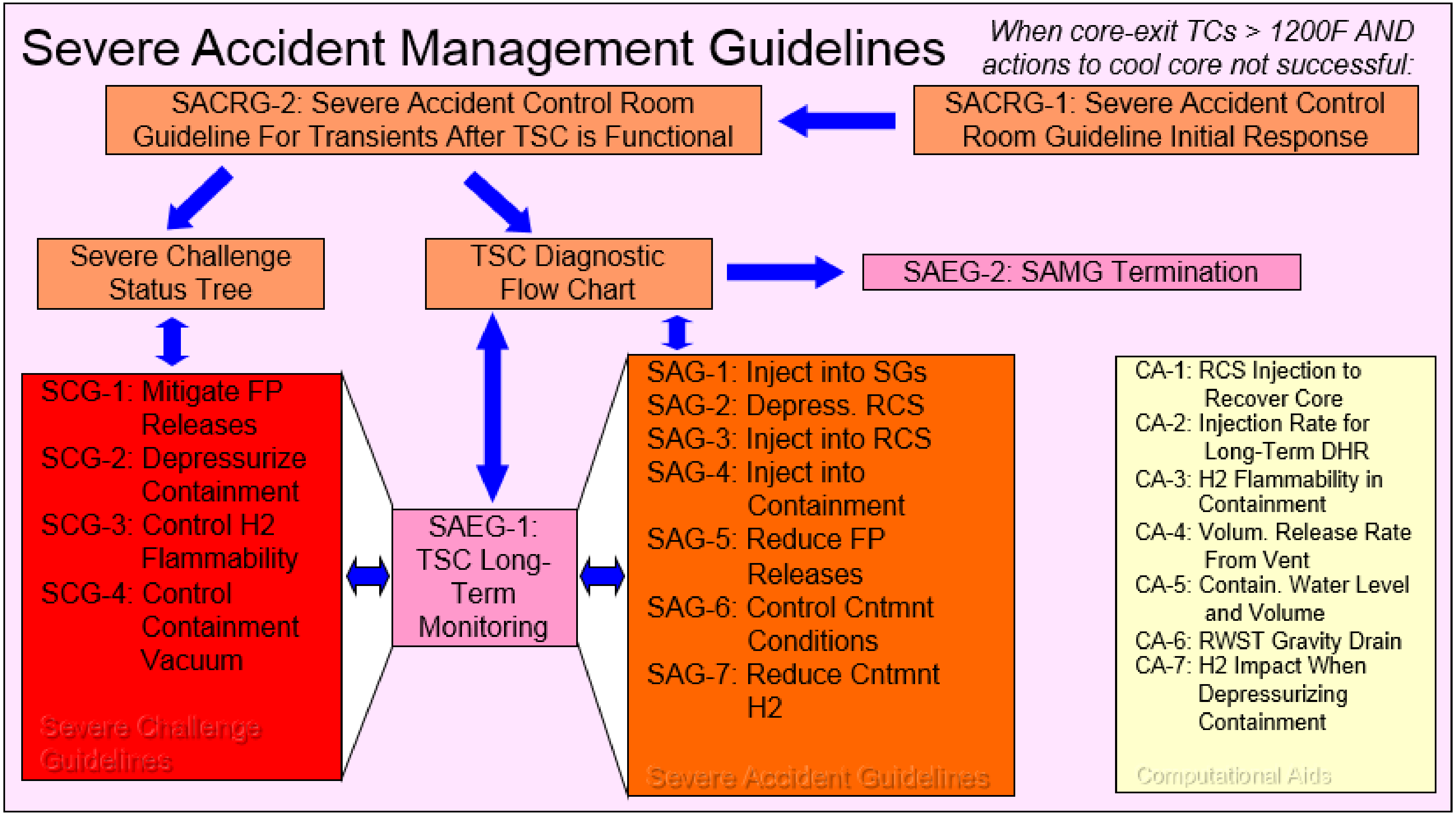
HEP Quantification Flow



Overview of Westinghouse SAMGs

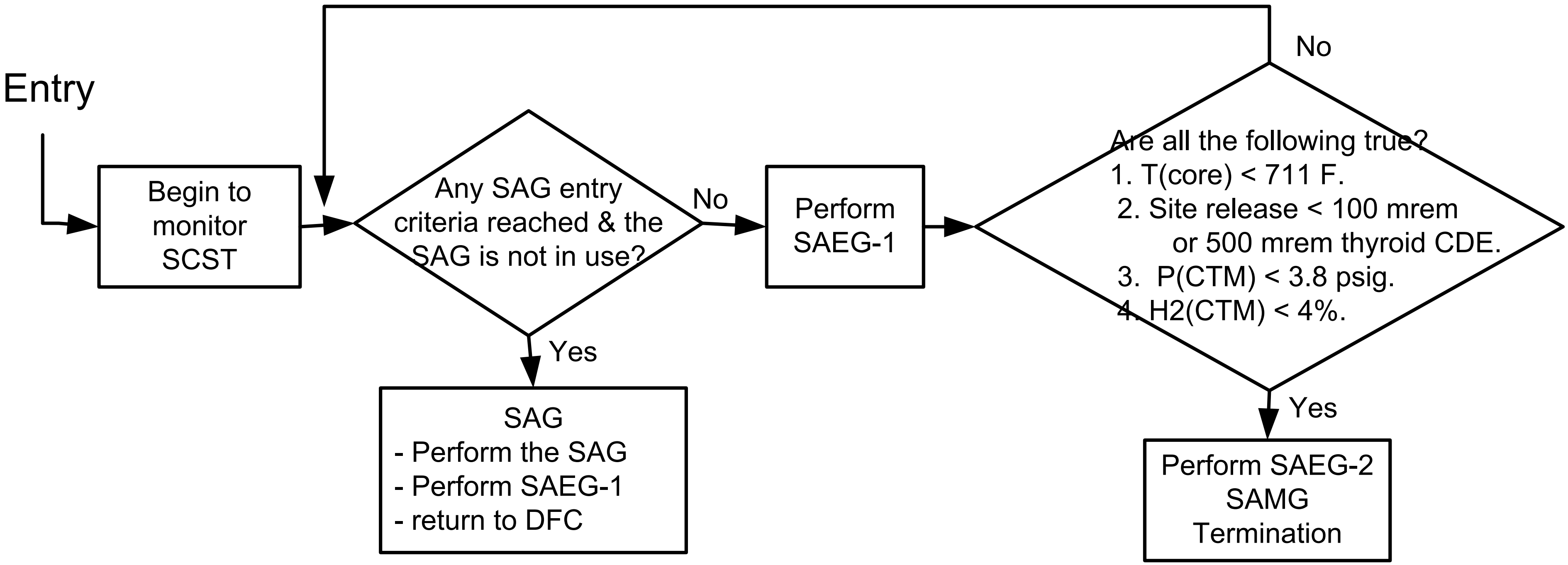
- Entry condition: Core exit temperature > 1200° F & increasing
- Contain the following guidelines:
  - 2 Severe Accident Control Room Guidelines:
    - Initial Response (SACRG-1)
    - After the TSC is Functional (SACRG-2)
  - 2 diagnosis guidelines:
    - Diagnosis Flow Chart (DFC)
    - Severe Challenge Status Tree (SCST)
  - 11(12) mitigation guideline including:
    - 7(8) Severe Accident Guidelines (SAGs)
    - 4 Severe Challenging Guideline (SCGs)
  - 2 Severe Accident Exit Guidelines
    - Long Term Monitoring (SAEG-1)
    - SAMG Termination (SAEG-2)
  - 7 computational aids (CA-1 to CA-7)

Relations Between SAMGs

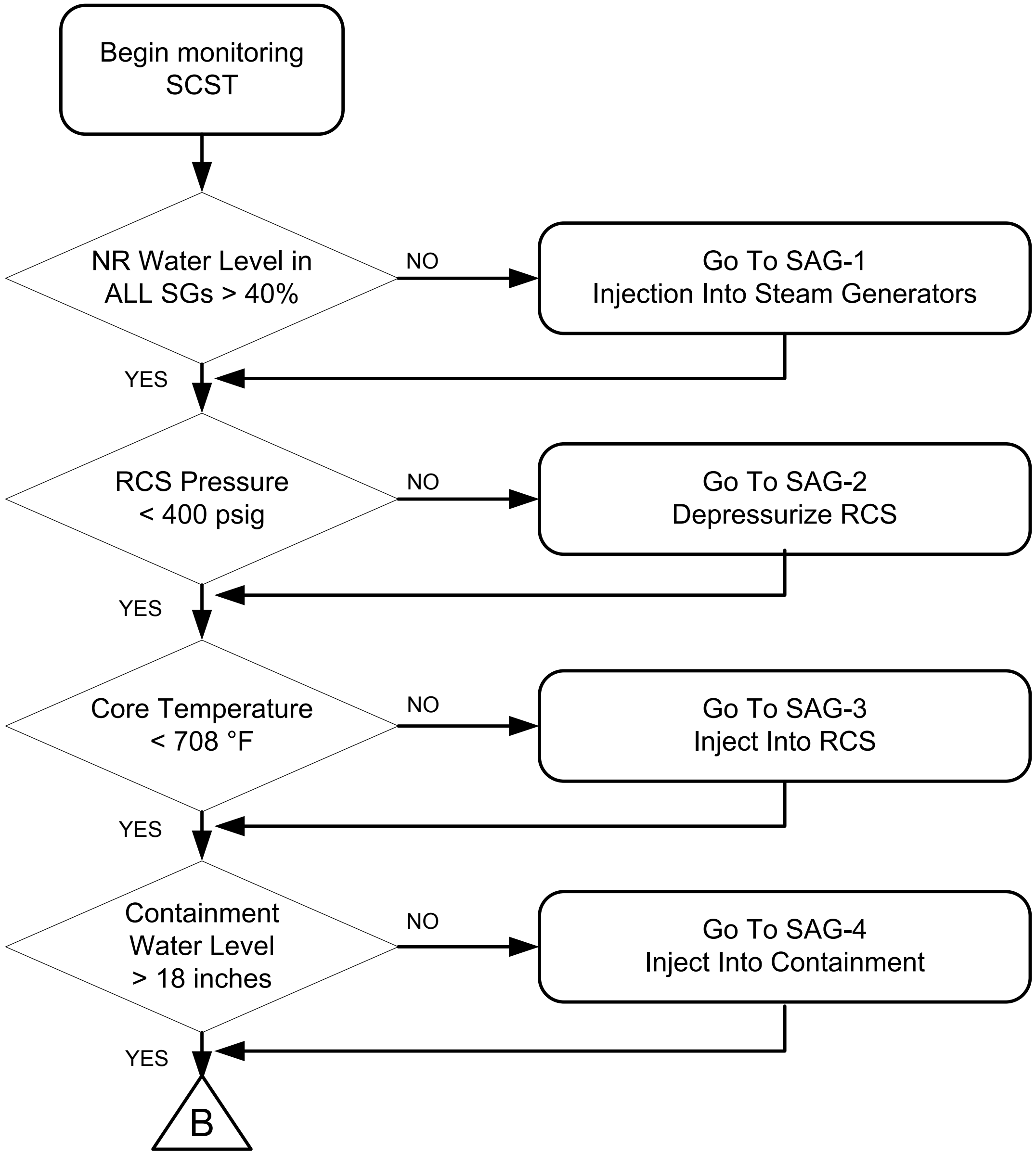


(by Donald Helton)

Overview of the DFC



Prioritized SAGs in DFC



SAG-3 Inject Into RCS

ENTRY Core temperature > 708° F and increasing

STEP 1 Identify the available RCS injection path

STEP 2 Refer to CA-1, RCS injection to recover the core to determine the potential for reflooding the core

STEP 3 Identify and evaluate any negative impacts

STEP 4 Determine if RCS injection should be initiated

STEP 5 Identify the preferred RCS injection path

STEP 6 Identify RCS injection limitations

STEP 7 Direct control room to implement strategy

STEP 8 Verify strategy implementation by monitoring appropriate parameters while continuing with this guideline (computer points may be used if available)

STEP 9 Determine if additional mitigating actions are necessary

STEP 10 Determine if another RCS injection path is needed to refill the core

STEP 11 Identify long term concerns due to injecting into the RCS

STEP 12 Return to the diagnostic flow chart or guideline and step in effect

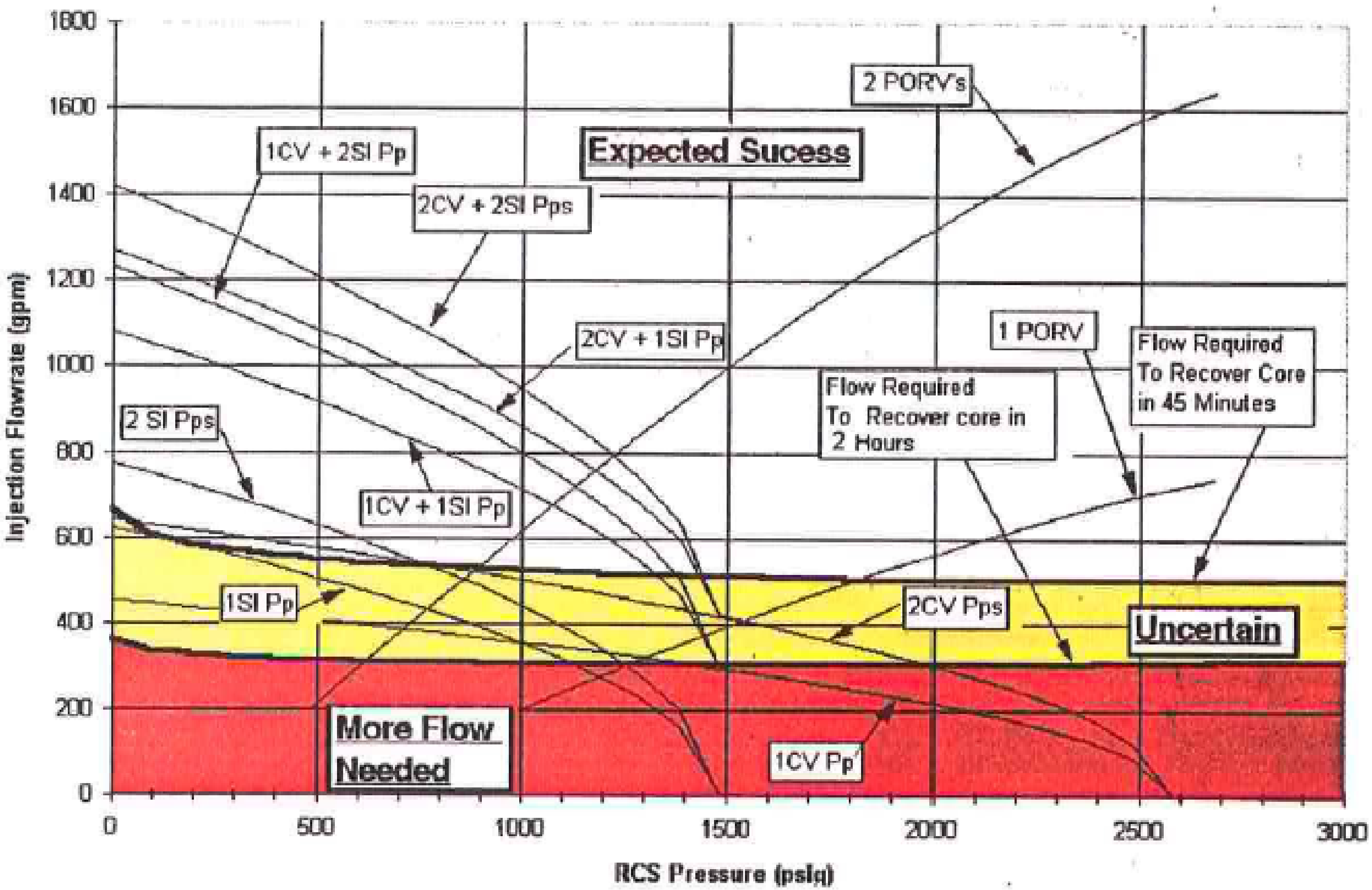
STEP 1 Identify the available RCS injection path (Main)

CHARGING PUMPS	SI PUMPS	RH PUMPS	MAKEUP SYSTEM
Selected Pump(s): ___ A ___ B	Selected Pump(s): ___ A ___ B	Selected Pump(s): ___ A ___ B	Selected System: ___ M/U ___ VCT
Suction Source(s): ___ RWST ___ VCT ___ BAT ___ PWST RH Pump Disch: ___ RH Pump A Via Train A ___ RH Pump A Via Train B ___ RH Pump B Via Train B ___ RH Pump B Via Train A	Suction Source(s): ___ RWST ___ VCT ___ BAT ___ PWST RH Pump Disch: ___ RH Pump A Via Train A ___ RH Pump A Via Train B ___ RH Pump B Via Train B ___ RH Pump B Via Train A ___ Cnmt Smp Via RH Train A ___ Cnmt Smp Via RH Train B	Suction Source(s): ___ RWST ___ Cnmt Recirc Sump Charging Source(s): ___ VCT ___ BAT ___ PWST	Supply Source(s): ___ VCT ___ BAT ___ PWST
Discharge Path(s):	Discharge Path(s):	Discharge Path(s):	Discharge Path(s) Via Charging Pump

STEP 1 Identify the available RCS injection path (Supplement)

CHARGING PUMP STATUS	SUCTION SOURCE	INJECTION PATH
CHARGING PUMP A • Bus 141 (241) energized: YES / NO • Pump functional: YES / NO IF any NO response, THEN pump NOT available.	RWST • Level greater than 0% • Valve alignment(s) - OPEN • _CV112D or E OR • _SI8806 and • _SI8923A and • _SI8807A or B, and • _SI8924	HI HEAD SI HEADER • _SI8801A or B - OPEN
• Lube oil cooling supplied from YES / NO If NO lube oil cooling is available, pump operation may continue for 90 MIN. Monitor pump temperatures, if possible.	VCT (Flow Limit per Table A-5) • Level greater than 10% • BA and/or PW Pump(s) available • Instrument air available • DC Bus _13 energized • Valve alignment(s) - OPEN • _CV112B and C • _CV110A and/or 111A • _CV110B or 111B	NORMAL CHARGING • Instrument air available • DC Bus _13 or _14 energized • _CV121 - THROTTLED OPEN • _CV8106 - OPEN • _CV8105 - OPEN • _CV182 - OPEN

STEP 2 Refer to CA-1, RCS injection to recover the core to determine the potential for reflooding the core



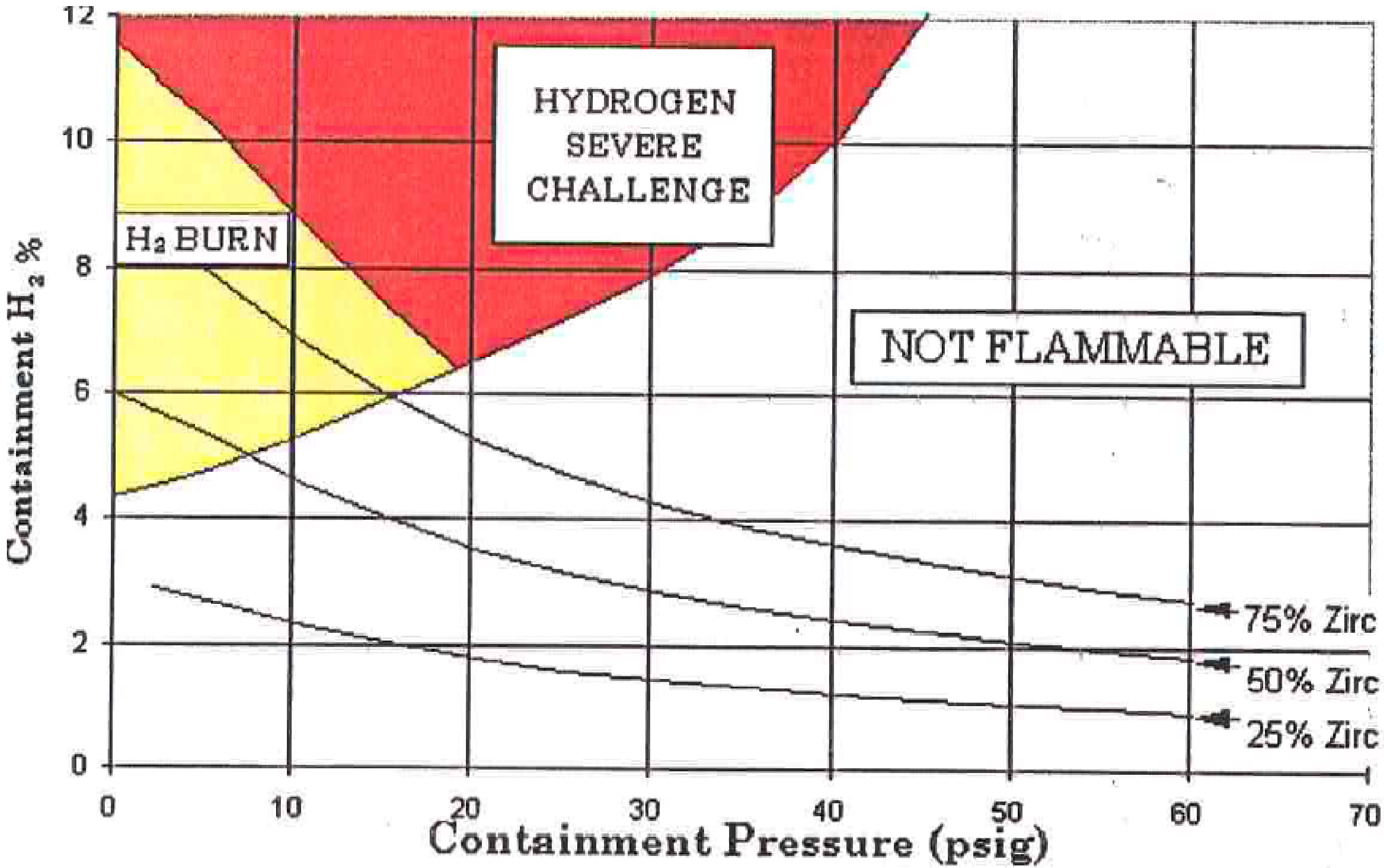
STEP 3 Identify and evaluate any negative impacts

- Identify five potential negative impacts
  - Containment Severe Challenge from a Hydrogen Burn
  - Creep Rupture of SG Tubes
  - Containment Flooding
  - Auxiliary Building Habitability
  - RCP Seal Degradation
- Provide
  - The conditions in which the negative impacts may occur
  - Mitigative actions to prevent negative impacts

Attachment for Determining Containment Severe Challenge From A Hydrogen Burn

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
a.	Obtain containment pressure:_______ PSIG	
b.	Check measured containment hydrogen concentration - AVAILABLE	Perform the following: 1)Use 75% ZIRC REACTION line on CA-3, HYDROGEN FLAMMABILITY IN CONTAINMENT. 2)GO TO Step 1.e.
c.	Obtain containment hydrogen measurement: _______%	
d.	Estimate containment hydrogen concentration after RCS injection: ________________% + (25% Zirc) = ______% (Step 1.c from CA-3)	
e.	Determine if containment challenge from hydrogen burn exists using CA-3, HYDROGEN FLAMMABILITY IN CONTAINMENT	
f.	Check containment challenge from hydrogen burn - NOT FLAMMABLE	RETURN TO SAG-3, Step 3.c while continuing with Step 1.g of this Appendix
g.	Monitor containment hydrogen to determine margin to a hydrogen severe challenge	
h.	Record results of expected negative impact evaluation for containment challenge from a hydrogen burn on Table B-1	

CA-3: Determine Hydrogen Burn



STEP 4 Determine if RCS injection should be initiated

Step	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4a	Evaluate the positive impacts of injecting into the RCS: •Core melt may be mitigated •Potential for reactor vessel failure may be reduced •Fission products released from the core debris will be scrubbed •Revaporization of fission products deposited on the reactor pressure vessel or RCS piping may be stopped	
4b	Compare the positive impacts of injecting into the RCS with the negative impacts of injecting into the RCS	
4c	Determine action - DECISION IS MADE TO INJECT INTO RCS	RETURN TO the Diagnostic Flow Chart or guideline and step in effect.

Plant Differences in Step 4

- **When the decision is NOT to inject into RCS**
  - **The reference plant instructs to go back to DFC and step in effect**
  - **Another plant provides the following instruction**
    - 1. Identify reasons why negative impacts are not acceptable.
    - 2. Prioritize actions to restore equipment necessary for mitigating negative consequences.
    - 3. Return to the Diagnostic Flow Chart guideline and step in effect.

STEP 5 Identify the preferred RCS injection path

Step	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
5a	Identify the flow path to inject the most water into the core	
5b	Determine if injection, recirculation, or RCP bumping should be performed: 1)Injection may be preferred if Auxiliary Building habitability is a concern 2)Recirculation may be preferred if containment flooding is a concern 3)RCP bumping may delay vessel failure; but, will NOT provide sufficient water inventory to accomplish other goals	
5c	Identify the preferred system and lineup from Step 1.b (Appendix A, Step 4): 1)Pump or makeup system 2)Suction source 3)Discharge path	

STEP 6 Identify RCS injection limitations

PARAMETERS	CONCERNs
Flow rate	• Hydrogen generation concerns. • Creep rupture concerns. • Containment flooding concerns. • RWST water volume (no limit until RWST level decreases below 0%, then limit the RWST refill rate). • RCS pressurization above pump shutoff head.
Duration of Injection	• Pump support conditions. • Suction supplies of water.

SUCTION SOURCE	LIMITATIONS
RWST	• May be used until level is less than 0%.
VCT	• May be used as long as level is maintained greater than 10%. • Injection flowrate is limited to a maximum of 200 GPM. • Makeup system and BA and/or PW pumps must be available. • If PW is the only source of makeup, boron dilution will occur.

STEP 7 Direct control room to implement strategy

- In the Westinghouse SMAGs, the TSC **directs** the control room to implement the mitigation strategies
- In the GE and CE SAMGs, the TSC **recommends** to the control room the mitigation strategies.

STEP 8 Verify strategy implementation by monitoring appropriate parameters while continuing with this guideline

- Identify the statuses to be monitored
  - Charging Pump Status
  - SI Pump Status
  - RH Pump Status
  - RCS Pressure
  - Core Temperature
  - Reactor Vessel Water Level
  - Containment Hydrogen
  - Containment Water Level
  - Containment Pressure

PARAMETER	METHOD OF MEASUREMENT
SI Pump Status	• SI Pump A Discharge Pressure: _PI-919 • SI Pump A Flow: _FI-918 • SI Pump B Discharge Pressure: _PI-923 • SI Pump B Flow: _FI-922

STEP 9 Determine if additional mitigating actions are necessary

NEGATIVE IMPACT	DETECTION METHOD	MITIGATING ACTIONS
Containment Severe Challenge From A Hydrogen Burn	Current hydrogen measurement nearing Severe Challenge Status Tree setpoint.	• Stop CS pumps and RCFCs to allow the containment to steam inert. • Isolate all potential ignition sources to prevent a hydrogen burn. • Maximize injection flow. • Open all available PZR PORVs to steam inert the containment.
Creep Rupture of SG Tubes	Large increase in fission products detected by secondary side monitors: •_PR27J, SJAE/Gland Steam Exhaust Gas Rad Monitor •_RT-AR022 and _RT-AR023, MS Line Rad Monitors •_RT-AR024, MS Line Penetration Rad Monitors	• Isolate ruptured SG. • Open all available PZR PORVs. • Maximize injection flow to cover the core as fast as possible. • Maximize SG feed flow to ruptured SG.

STEP 10 Determine if another RCS injection path is needed to refill the core

Step	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
10a	Evaluate if the existing injection flow is expected to refill the core: 1)Refer to CA-1, RCS INJECTION TO RECOVER THE CORE 2)Monitor plant response: •Check RCS pressure – <u>STABLE OR DECREASING</u> •Check core exit TCs – <u>STABLE OR DECREASING</u> •Check RCS temperature – <u>STABLE OR DECREASING</u> •Check RVLIS – <u>INCREASING</u> •Check source range - <u>DECREASING</u>	
10b	Check existing injection flow - <u>ADEQUATE</u>	IF another injection path is available, THEN RETURN TO Step 2.

STEP 11 Identify long term concerns due to injecting into the RCS

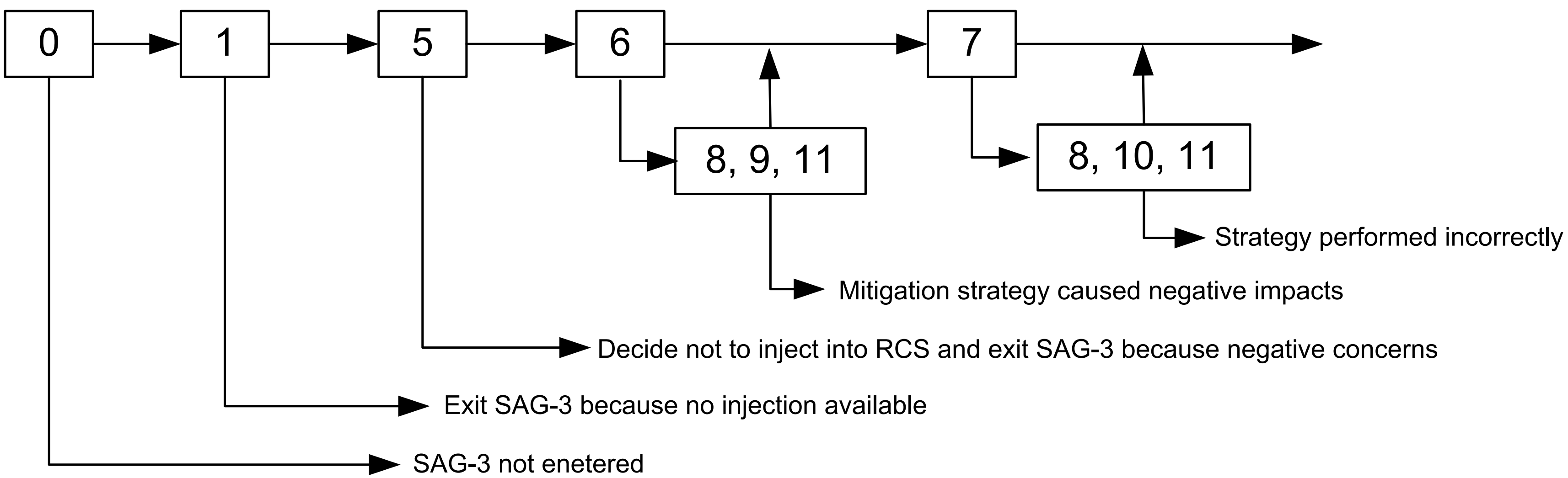
Step	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
11a	Refer to Appendix C for the long term concerns	
11b	Identify any additional parameters to be monitored to address long term concerns	
11c	Identify any additional long term concerns	
11d	GO TO SAEG-1, TSC LONG TERM MONITORING, while continuing with the next step	

Parameter to Monitor	Concerns	Recovery Actions
RCS Pressure - LESS THAN SHUTOFF HEAD OF SOURCE **•SI pumps - 1500 PSIG** **•RH pumps - 210 PSIG** **•BAT pumps - 100 PSIG** **•PWST pumps - 100 PSIG** **•VCT - 50 PSIG**	Inadequate injection flow	• Increase injection flow. • Open PZR PORV(s) and reactor head vent valves. • Use another injection source.
Core Temperature OR RCS Temperature – INCREASING	Core heat removal	Start / Bump RCPs after RCS is refilled.

Consequence of Not Performing Step Correctly

#	Title	Consequence if not performed as expected
0	DFC entry to SAG-3	SAG-3 not entered
1	Identify the available RCS injection paths	Return to DFC; restore injection path
2	Refer to CA-1, RCS injection to recover the core to determine the potential for reflooding the core	Chose an inadequate injection path
3	Identify and evaluate any negative impacts	Omit the negative concerns or false identification of negative concerns resulting in not injecting into RCS
4	Determine if RCS injection should be initiated	Decided not inject into RCS
5	Identify the preferred RCS injection path	Chose a less than optimal injection option
6	Identify RCS injection limitations	Cause negative impacts
7	Direct control room to implement strategy	Actions are not carried out as expected
8	Verify strategy implementation by monitoring appropriate parameters while continuing with this guideline (computer points may be used if available)	No recovery if the negative impacts occur
9	Determine if additional mitigating actions are necessary	No recovery if the negative impacts occur
10	Determine if another RCS injection path is needed to refill the core	No recovery if the RCS injection is insufficient
11	Identify long term concerns due to injecting into the RCS	No recovery if the negative impacts occur or the RCS injection is insufficient
12	Return to the diagnostic flow chart or guideline and step in effect	Not applicable

Crew Response Tree



Macrocognitive Functions

#	Title	Macrocognitive functions
0	DFC entry to SAG-3	Detecting
1	Identify the available RCS injection paths	Detecting
2	Refer to CA-1, RCS injection to recover the core to determine the potential for reflooding the core	Detecting
3	Identify and evaluate any negative impacts	Detecting
4	Determine if RCS injection should be initiated	Understanding and deciding
5	Identify the preferred RCS injection path	Understanding
6	Identify RCS injection limitations	Detecting
7	Direct control room to implement strategy	Action
8	Verify strategy implementation by monitoring appropriate parameters while continuing with this guideline (computer points may be used if available)	Detecting
9	Determine if additional mitigating actions are necessary	Detecting
10	Determine if another RCS injection path is needed to refill the core	Detecting
11	Identify long term concerns due to injecting into the RCS	Detecting
12	Return to the diagnostic flow chart or guideline and step in effect	Not applicable

Detecting – Worksheet (1/4)
- DFC Enter Into SAG-3

Catch Attention (the information saliency):

- **Likely:** Salient information comes to the staff or explicitly directed to check the information, e.g.,
  - Notice an alarm or an alarms pattern stands out from the background or the visual and audio effects of the alarm makes it easy to detect.
  - Notice a plant status from an off-site emergency phone call
  - Direct by procedure or other explicit means to check the information
- **Less Likely**
- **Unlikely**

Display type:

- Alarm or legend light
- Analog meter
- Digital readout
- Chart recorder
- Graphs
- Printing recorder with large number of parameters
- Values from indicator lamps that are used as quantitative displays

Information Familiarity:

- **Familiar**
- **Not Familiar**

Communication types and scope:

- **Normal**
- **Extended**
- **Offsite**
- **Offsite extended**

Detecting – Worksheet (2/4)
- DFC Enter Into SAG-3

Amount of information:

☑ 1 ○ 2 – 5 ○ 6 – 10 ○ > 10

Information appearance:

- ❑ No mimic
- ❑ Similar Displays
- ❑ Information filter
- ❑ Masked information
- ❑ Poor label quality
- ❑ Delay Information

Information content and display:

- ❑ Primary parameter not available
- ❑ Unreliable indication
- ❑ Faulted indication
  - Lighted or annunciated indication (on/off)
  - Value indication (e.g., pressure gauge) - outside of operation range
  - Value indication (e.g., pressure gauge) - jammed

Detecting – Worksheet (3/4)
- DFC Enter Into SAG-3

Scenario and environment factors

- ❑ Fast pace scenario
- ❑ Parallel Tasks & distraction
- ❑ High psychological stress
- ❑ Work environment
  - Uncomfortable
  - Harsh
  - Heroic
- ❑ Physical/mental fatigue
  - ❑ Physical fatigue
  - ❑ Physical fatigue

Detecting – Worksheet (4/4)
- DFC Enter Into SAG-3

- ☑ **Peer checker presence**: Peer check is available.
- ❑ **Supervision Presence**: Supervisor or independent checker is present.
- ❑ **Redundant Information (Same person, different cue):** Redundant information that is salient and is conveniently available to makeup the missing detected information. There is sufficient time to detect the redundant information.
- ☑ **Fresh mind (Different person, same cue):** The cue exists for a long period time. If the principal responders missed detecting the cue, there are redundant opportunities to detect the cue by the other people not among the principal responders. The people could arrive due to reasons such as shift turnover or additional helpers expected to arrive sometime after the cue occurrence.

HEP & Contributors (Draft)

- Values are only for demonstration purposes.
- Final Independent HEP: 4.4E-3
  - Basic HEP:
    - Failed to detect: 1E-4
    - Failed to communicate: 3.3E-3
    - Read incorrectly: 1E-3
  - HEP multiplier
    - Parallel Tasks & distraction x 2
    - High psychological stress x 5
  - Error recovery
    - Peer checker presence x ½
    - Fresh mind x 1/5
- A software application is expected to be developed for the HEP calculation and analysis documentation.

Technical Items

- Unlike EOPs, which are updated based on simulator exercises, the SAMGs may have higher guideline-scenario mismatch situations.
- Less known about the decision makers' training on implementing SAMGs.

BACKUP SLIDES

Understanding Worksheet (1/4)

- Determine if RCS injection should be initiated

Understanding types:

- ○ Hardwired
- ✓ Procedure directed
- ○ Procedure guided
- ○ Knowledge driven

Familiarity:

- ○ Standard situation
- ✓ Anomaly situation
- ○ Novel situation

Communication types and scope:

- ○ Normal
- ✓ Extended
- ○ Offsite
- ○ Offsite extended

Understanding Worksheet (2/4)

- Determine if RCS injection should be initiated

Information adequacy:

- ✓ Adequate
- ○ Largely adequate
- ○ Less adequate
- ○ Inadequate

Information consistency:

- ✓ Consistent
- ○ Less consistent
- ○ Inconsistent
- ○ Not applicable

Parameter approximation:

- ✓ Read from indicator
- ○ Approximate estimate from pre-plotted diagrams

Understanding Worksheet (3/4)

- Determine if RCS injection should be initiated

Scenario and environment factors

- [ ] Fast pace scenario
- [x] Parallel Tasks & distraction
- [x] High psychological stress
- [ ] Work environment
  - Uncomfortable
  - Harsh
  - Heroic
- [ ] Physical/mental fatigue
  - [ ] Physical fatigue
  - [ ] Physical fatigue

Miscellaneous

- [x] Information with mixed levels of importance
- [x] Require close coordination

Understanding Worksheet (4/4)

- Determine if RCS injection should be initiated

- ☐ **Supervision Presence**: Supervisor or independent checker is present.
- ☑ **Redundant Information (Same person, different cue):** Redundant but delayed information that is salient and is conveniently available to indicate a wrong diagnosis is taken.
- ☑ **Fresh mind (Different person, same cue):** The time available for averting a wrong diagnosis is relatively long and the principal responders made a wrong diagnosis, there are redundant opportunity by the other people arrived later to identify a correct diagnosis. The people could arrive due to reasons such as shift turnover or additional helpers expected to arrive sometime after the cue occurrence.

Deciding Worksheet (1/5)
- Determine if RCS injection should be initiated

Decision types:

- Standard
- Competing goals <u>with</u> concrete GO v.s. NO-GO criteria
- Competing goals <u>without</u> concrete GO vs NO-GO criteria

Familiarity:

- Standard situation
- Anomaly situation
- Novel situation

Communication types and scope:

- Normal
- Extended
- Offsite
- Offsite extended

Deciding Worksheet (2/5)

- Determine if RCS injection should be initiated

Decision authority and level:

- ○ Operation staff
- ✓ Plant management
- ○ Stakeholders

Decision criteria:

- ○ Clear criteria
- ✓ Guided decision
- ○ On the scene
- ○ Conflict

Information quality:

- ❑ Insufficient information
- ❑ Uncertain information
- ❑ Lack of system feedback
- ❑ Change in response plan

Deciding Worksheet (3/5)
- Determine if RCS injection should be initiated

Scenario and environment factors

- ❑ Fast pace scenario
- ✔ Parallel Tasks & distraction
- ✔ High psychological stress
- ❑ Work environment
    - Uncomfortable
    - Harsh
    - Heroic
- ❑ Physical/mental fatigue
    - ❑ Physical fatigue
    - ❑ Physical fatigue

Miscellaneous

- ✔ Information with mixed levels of importance
- ✔ Require close coordination
- ❑ Information Ergonomics

Deciding Worksheet (4/5)

- Determine if RCS injection should be initiated

Concerns – if Not Inject

- [x] Release
- [ ] Containment integrity
- [x] RCS integrity
- [ ] Core cooling
- [ ] Criticality
- [x] Scrubbing
- [ ] Equipment damage
- [ ] Habitation
- [ ] N/A

Concerns – if Inject

- [ ] Release
- [x] Containment integrity
- [x] RCS integrity
- [ ] Core cooling
- [ ] Criticality
- [ ] Scrubbing
- [x] Equipment damage
- [x] Habitation
- [ ] N/A

Deciding Worksheet (5/5)

- Determine if RCS injection should be initiated

- ❑ Vivid plant responses contradict with expectations or vivid negative plant responses to the action plan.

Action Worksheet (1/4)
- Direct control room to implement strategy

Action types:
- **Single:** such as push a button and turn a switch
- **Random:** Perform a number of discrete actions
- ✓ **Order:** Perform a series of discrete actions
- **Control-and-monitor**

Duration:
- **< 10 minutes**
- **< 60 minutes**
- ✓ **> 60 minutes**

Familiarity:
- **Standard situation**
- ✓ **Anomaly situation**
- **Novel situation**

Communication types and scope:
- **Normal**
- ✓ **Extended**
- **Offsite**
- **Offsite extended**

Action Worksheet (2/4)
- Direct control room to implement strategy

Feedback information:

- ❑ Unintuitive plant response
- ❑ Inadequate plant feedback

Information/control display:

- ❑ No mimic
- ❑ Similar Controls/Displays
- ❑ Information filter
- ❑ Inconsistent label
- ❑ Unreliable indication

Information quality:

- ❑ Insufficient information
- ❑ Uncertain information
- ❑ Lack of system feedback
- ❑ Change in response plan

Action Worksheet (3/4)

- Direct control room to implement strategy

Scenario and environment factors

- ❑ Fast pace scenario
- ❑ Parallel Tasks & distraction
- ✔ High psychological stress
- ✔ Work environment
  - ○ Uncomfortable
  - ✔ Harsh
  - ○ Heroic
- ❑ Physical/mental fatigue
  - ❑ Physical fatigue
  - ❑ Physical fatigue

Miscellaneous

- ❑ Delay for memorized action
- ❑ Ergonomically difficult
- ❑ Degraded controls
- ❑ Less than adequate personnel and equipment available

Action Worksheet (4/4)

- Direct control room to implement strategy

Action recoverability

- ○ Immediately recoverable
- ○ Delayed recovery
- ○ Unrecoverable

Error recovery mechanism

- ❑ Questioning Action Plan
  - ○ Questioning
  - ○ No questioning
- ❑ Peer checker presence
- ❑ Supervision Presence
- ❑ Fresh mind (Different person, same cue)
- ❑ System feedback

The IDHEAS Method for internal at-power events

Presented by Jing Xing
RES/DRA/HFRB

Products

Product	Intended applications
Cognitive basis for human error analysis	• HRA • Human performance • Human factors engineering
Generic HRA methodology for NPP applications	• HRA for all kinds of human events in NPP (Level-3 PRA, LPSD, external events, etc.)
An IDHEAS method for internal, procedural events	• Internal, procedural event PRA (PRA models, SDP, ASP, etc.)

Contributors

NRC/EPRI Draft Report

An Integrated Decision-Tree Human Event Analysis System (IDHEAS) Method for NPP internal at-power operation

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Outline

I. Overview of IDHEAS

II. Summary of the external review

III. Expert elicitation of HEPs

Outline

I. Overview of IDHEAS

II. Summary of the external review

III. Expert elicitation of HEPs

Elements of the Method

- Identification and definition of HFEs
- Feasibility assessment
- Task analysis and development of crew response tree (CRT)
  - Identification of critical tasks and opportunities for failure
- Crew failure modes (CFM) to describe failures of a critical task
- Decision trees (DT) to assess contextual impact on the HEP of a CFM
- Quantification – Combining HEPs of CFMs to generate the HEP for the event
- Integrative analysis (Dependency & Uncertainty)

IDHEAS process

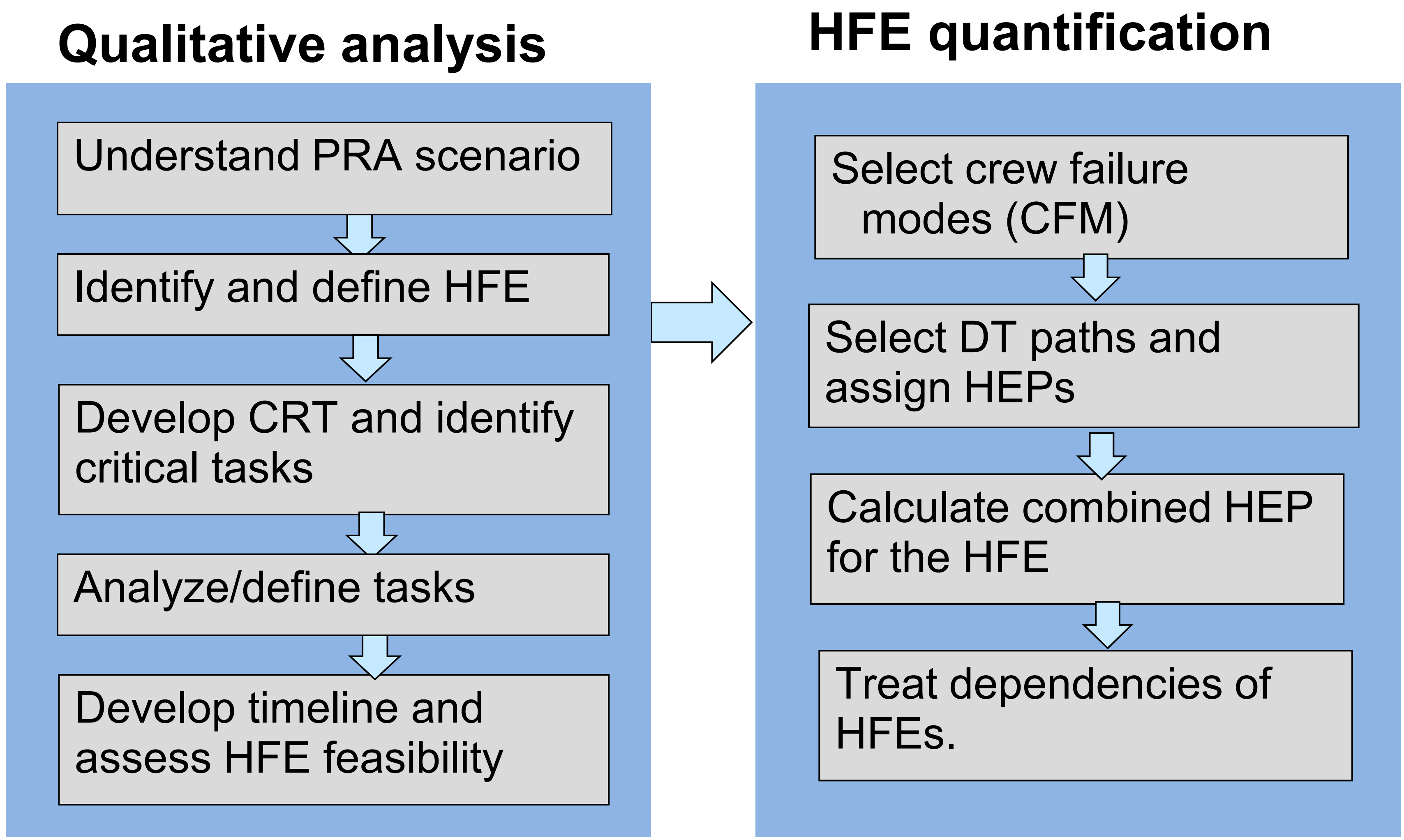


Illustration of the IDHEAS process

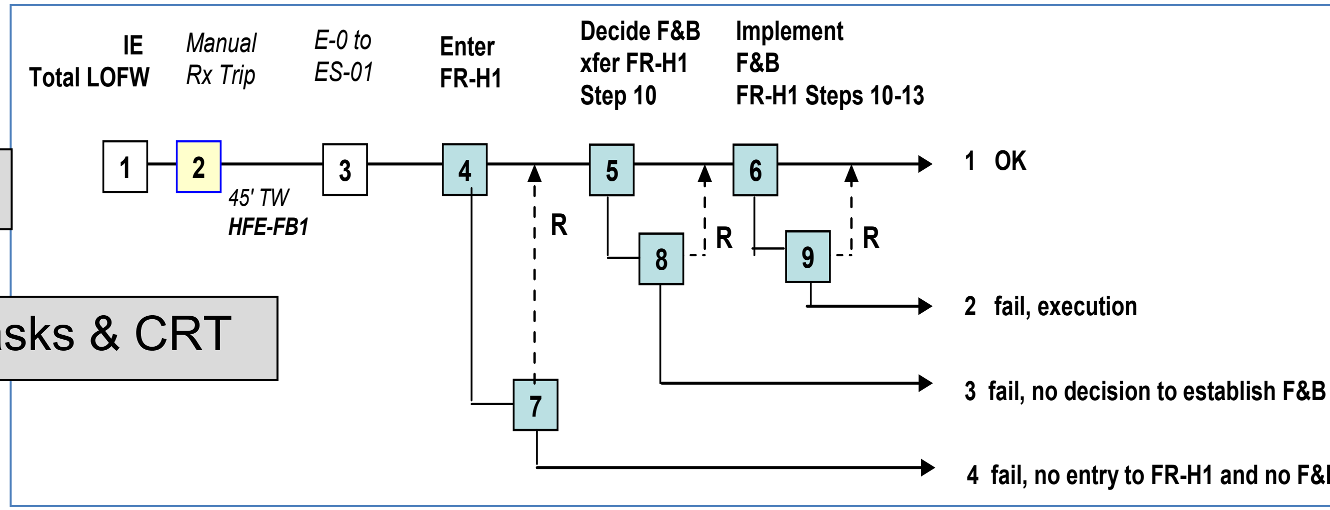
Qualitative analysis

PRA scenario

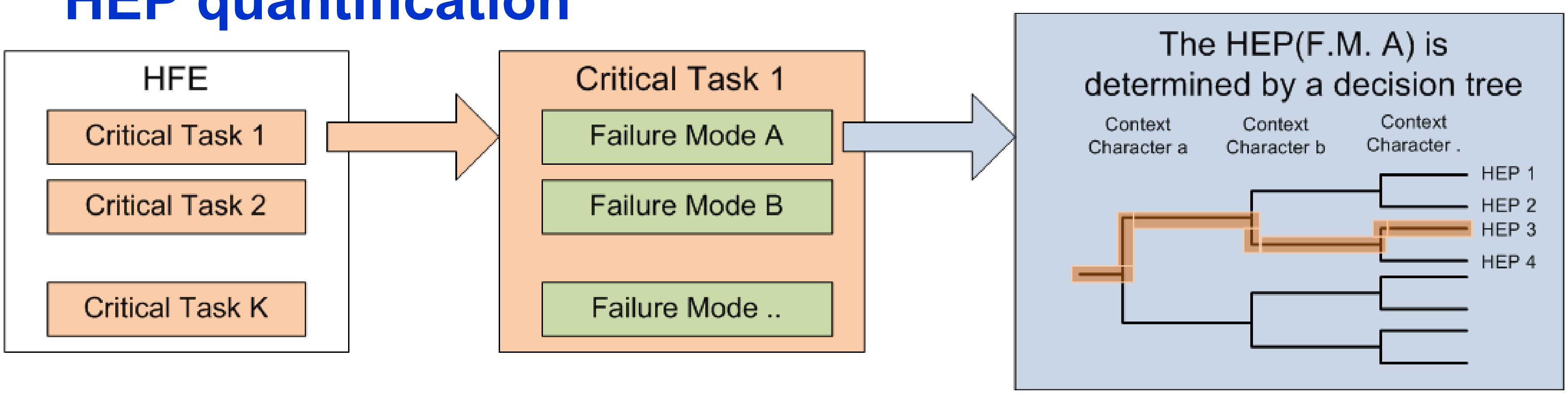
Identify and define HFE

HFE Feasible?

Tasks & CRT



HEP quantification

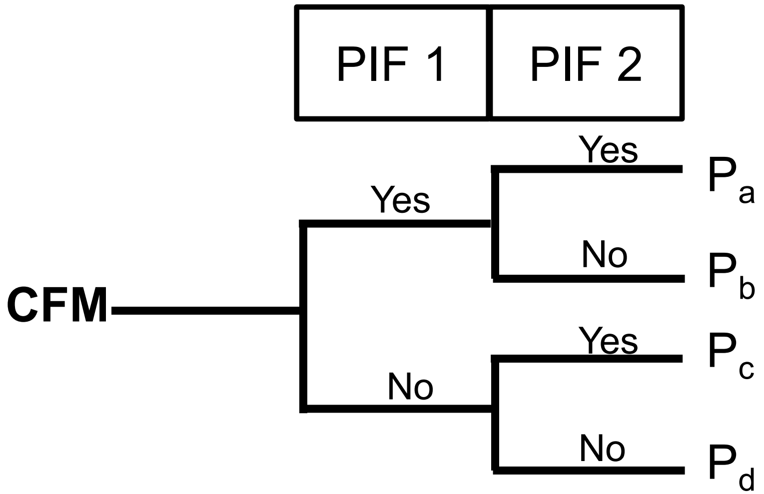


CFMs and Phase of Response

	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 simple 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

- Decision points relate to existence of those PIF categories
- Decision tree paths represent different crew failure scenario
- A probability is assigned to each end point of a path



- The quantification of the HEP takes the following form for a PRA scenario S:

$$HEP(HFE|S) = \sum_{CRT\ sequence} \sum_{CFM} Prob(CFM\ |CRT\ sequence, S)$$

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External review of the draft IDHEAS report

Four reviewers completed the review and provided written comments

- 2 domestic and 2 international reviewers
- All have 10+ years experience in HRA
- 3 reviewers have extensive experience in practicing HRA

Scope of the review

The reviewers were instructed to focus their review on three aspects and provide comments on the specific elements of the method:

General Methodological Aspects

1) Do the concepts and processes specific to this approach improve or extend HRA theory or demonstrate new aspects in the understanding of human errors that lead to improved HRA modeling and treatment?
2) Does the approach include clearly defined strategies that will enable users to better model human performance for HRA purposes and improve HRA practice?

Professional/Research Aspects

3) Does the approach offer new knowledge that is differentiated and distinctive in the domain of HRA?

4) Does the approach make an advance in terms of reducing HRA subjectivity and variability?

5) Is the approach consistent with the known HRA good practices?

Scope of the review

Method Specific Aspects

6) The understanding of the cognitive mechanisms and performance influencing factors (PIFs) from the literature review

7) The overall method process: the identification of human failure events (HFEs), development of crew response trees (CRTs), and the use of CFMs and DTs to obtain HEPs.

8) The use of a CRT as a tool for supporting the cognitive task analysis and representing the scenario dynamics

9) Treatment of timing issues in assessing feasibility

10) The structure of the model of human performance

a) The concept of CFMs tied to crew's cognitive activities

b) The use of the DTs

c) The use of sets of questions to guide the analyst to taking the correct path through a DT branch

d) The use of expert elicitation in the development of the method to come up with the HEPs for the quantification process

Comments from reviewers

Question	Comment
1) improved HRA modeling and treatment	• *The method does not demonstrate new aspects in the understanding of human error.* • *It provided steps forward in HRA theory and application*
2) model human performance for HRA purposes	*the method would produce good models for human performance and improve HRA practice.*
3) Offer new knowledge	*The method provides a better description of how to apply existing HRA techniques*
4) reducing HRA subjectivity and variability	• *IDHEAS provides a more systematic and robust method for HRA which should help to reduce subjectivity and variability* • *testing is needed to determine if this is the case*
5) consistent with the known HRA good practices	Yes

Comments from reviewers

Question	Comment
6) Use of the psychological literature review and the distillation of that into the CFM/DT/PIF format	• *the most important contribution of your effort and the right approach* • *aspects of teamwork, crew characteristics, and crew dynamics had not been addressed by the method*
7) The overall method process	• *overall method appears to be valid, logical, well structured and robust.* • *it will be a labor intensive method*
8) The use of a CRT as a tool for supporting the cognitive task analysis	• *CRT method as a way of graphically displaying the critical tasks and recovery options* • *more guidance was needed for documenting the information related to the CRT*
9) Treatment of timing issues and feasibility analysis	• *the treatment of timing issues was fine* • *the guidance for feasibility assessment was confusing*

Comments from reviewers

Elements of the structure of the model of human performance	**Comment**
a) The concept of CFMs tied to crew's cognitive activities	• *a good feature, makes the whole analysis more closely linked to operational issues* • *Uncertainty in that we had the complete set needed for modeling*
b) The use of the DTs and in particular the explanation of how the underlying cognitive mechanisms lead to the choice of PIFs	• *this works and the explanation will support analysts* • *a useful technique for systematic and robust exploration of PIFs linked to the CFMs* • *use of the set of DTs "may preclude a more detailed task analysis and learning*
c) The use of sets of questions to guide the analyst to taking the correct path through a DT branch	• *All reviewers seemed happy with the use of DT question sets as useful guidance for the analyst* • *the evaluation of the decision tree nodes was not based enough on objective criteria. The questions relied too much on subjective or anecdotal descriptions*
d) The use of expert elicitation for the HEPs of DT paths	• *updating these HEPs by interpreting data from simulators in an update process.*

Revisions to address the comments

Comments addressed:

1) Reconstructed the format of the report for conciseness and clarification
2) Made revisions and added information / explanation for the comments; added examples of developing CRT, documenting task analysis, and estimating HEPs.
3) Added the documentation of exercising the full process of the method.
4) No change made to the main structure of the method
5) Made revisions to address specific comments on CFM definitions, DTs, and PIF definitions and PIF evaluation questions.

Comments not addressed:

1) No change made to the approaches and main structure of the method
2) Comments regarding to the practical use of the method will be addressed in the IDHEAS User' Manual.

Outline

I. Overview of IDHEAS

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III. Expert elicitation of HEPs

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 judgments.

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

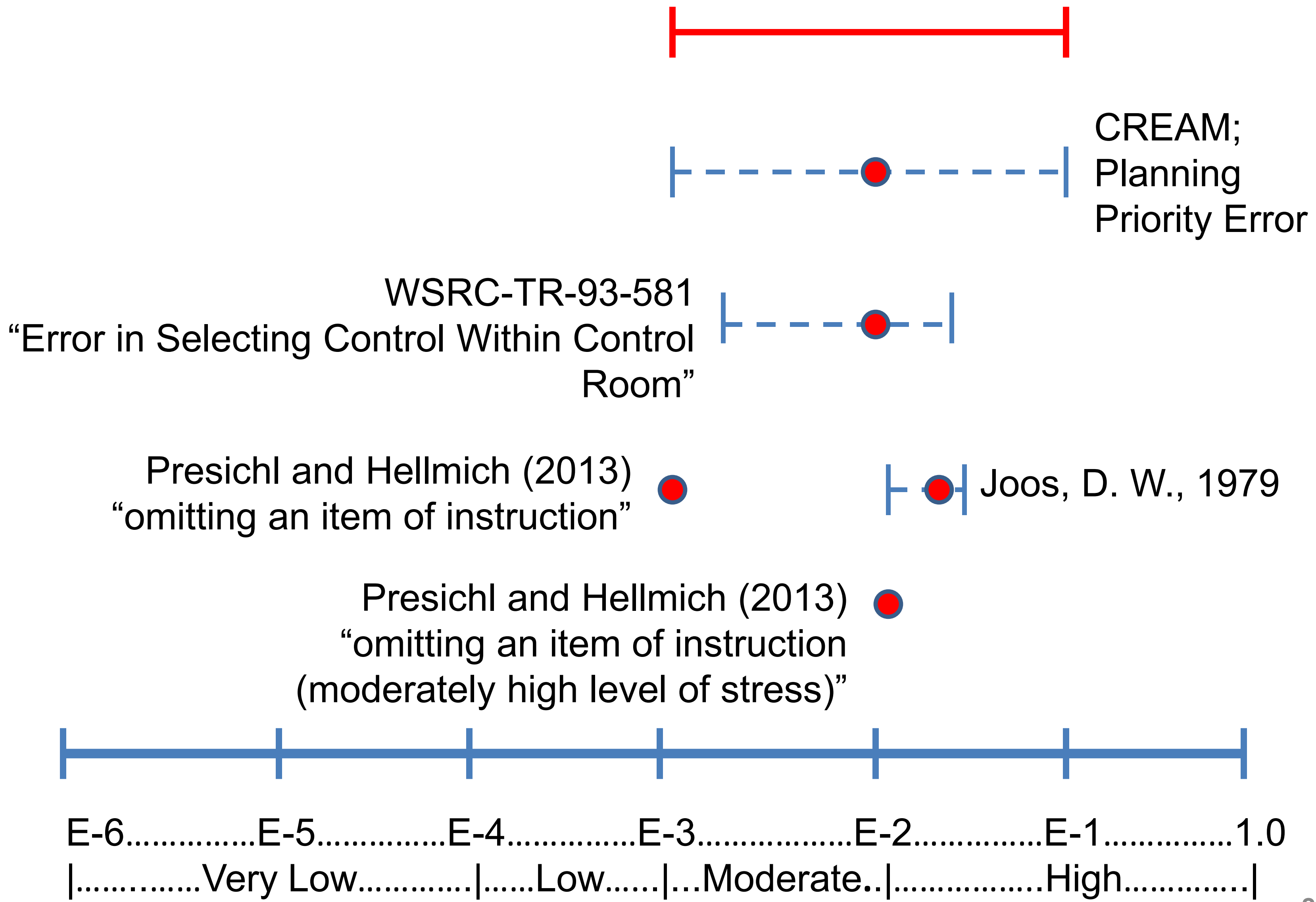
Workshop #2

- PE estimate HEPs for selected branches
- RE question PE's estimation
- TI integrates HEPs

Example: Data from the literature

Task Description	CFM Identification	Data Source, Type & Numerical Info.	PIFs & Notes
Task goal: I (PSA/Alarm response) *Information source*: Visual indicators (legend lights or printouts) announced by compelling auditory signals *Activities to achieve the goal*: Attend to one or more annunciator displays and read the messaged information	CFM combination: • Key alarm not attended to • Critical data misperceived	• Chapter 7.115 in EDC Vol. 2 “Error Probability in Responding to Annunciator Displays” (P. 1395)	• PIF: Workload ○ Interruption
		• Experimental data • Developed for NPP situations	
		• HEP of incorrectly responding to one annunciated legend light is **0.0001** (EF =10). An interruption less than one minute increases the HEP by a factor of 10. An interruption longer than one minute increases the HEP to **0.95**. • HEP caused by false alarms is **0.001** (EF=10).	• An incorrect response is failure to respond at all or failure to read the message correctly.

Example: Empirical data for CFM *Misread or Skip Step in Procedure*



Workshop #1 procedure

1. Resource experts select a CFM to work on
2. Data expert presents the CFM and the decision-tree
3. ~15mins for resource experts and evaluators to work on worksheet #1
4. Resource experts take turns to present the initial judgment; evaluators and other resource experts ask questions and discuss.
5. (Optional) Data experts present the summary datasheet for the CFM upon resource experts or evaluators' request.
6. TI lead wrap-up the issues for the CFM and move to the next CFM.

Example: worksheet (partial) for Workshop #1

CFM Expert Worksheet: Key Alarm Not Attended To

Task 1: Rank every DT scenario/path
Instructions:
1.1 Write the DT scenario number above the HEP estimate line (given below the table) in the position you think best represents it's HEP or write the HEP level/rank in the last column of the table
* VL – very low; L – low; M – moderate; H – High (as defined in the HEP estimate line below)

DT scenario	PIFs for the DT path					Rank (VL, L, M, H)*
1	High distraction	&	Poor HSI	&	Low perceived urgency	
2	High distraction	&	Poor HSI	&	High perceived urgency	
3	High distraction	&	Good HSI	&	Low perceived urgency	
4	High distraction	&	Good HSI	&	High perceived urgency	
5	Minimal distraction	&	Poor HSI	&	Low perceived urgency	
6	Minimal distraction	&	Poor HSI	&	High perceived urgency	
7	Minimal distraction	&	Good HSI			

HEP Estimate:
E-6……………E-5……………E-4……………E-3……………………E-2……………E-1……………1.0
|……..……Very Low ………..|……Low…….|….Moderate….|……………High……………..|

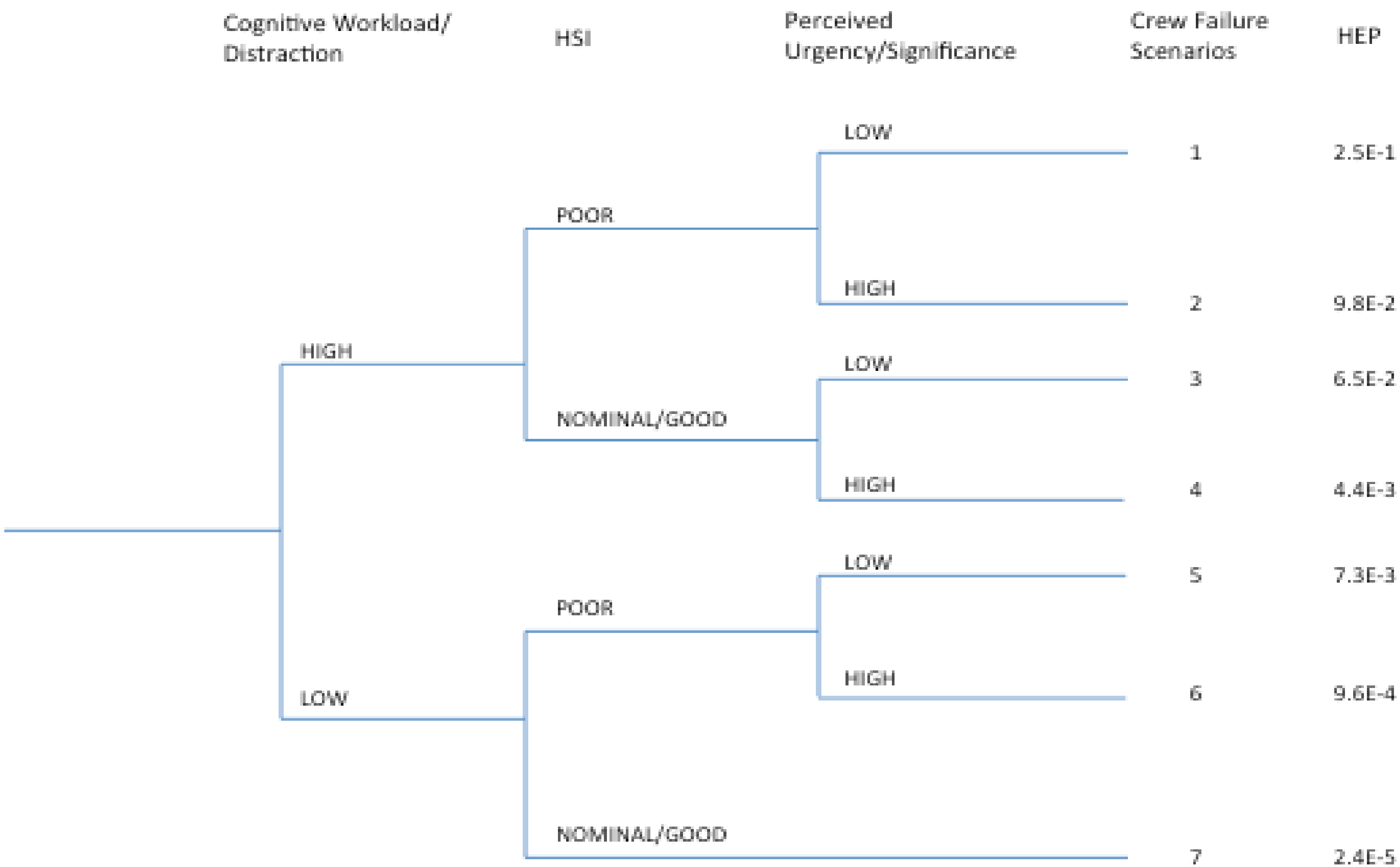
Worksheet for workshop #2

Workshop #2 is for proponents to estimate HEP distribution of the DT paths

Name:								
CFM								
Arguments								
Assessment								
DT paths	Evaluator's Distribution: percentiles							Calculation
	1st	10th	25th	50th	75th	99th		Mean
1								
2								
Justification for making modifications:								
Consensus								

Example of the HEPs for a decision-tree

Key Alarm Not Attended To



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.

Conclusions
SRM mission "One method" – "Are we there yet"

	Goal and requirements	Assessment
Goal	Develop a new HRA methodology to reduce variability and apply to all HRA applications.	Yes – Variability to be tested
Require-ments	• Conform to the PRA/HRA standards and HRA Good Practices	Yes
	• Retain and integrate the strengths of existing methods	Yes
	• Have enhanced capabilities to address the key weaknesses in current state-of-practice.	Yes - To be tested
	• Have a state-of-the-art technical basis	Yes
	• Create methodology generic enough for all HRA applications in NPPs	Yes

Initial Testing of the IDHEAS Method

Presented by Jing Xing
RES/DRA/HFRB

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Products

Product	Intended applications
Cognitive basis for human error analysis	• HRA • Human performance • Human factors engineering
Generic HRA methodology for NPP applications	• HRA for all kinds of human events in NPP (Level-3 PRA, LPSD, external events, etc.)
An IDHEAS method for internal, procedural events	• Internal, procedural event PRA (PRA models, SDP, ASP, etc.)

IDHEAS Status and planning

Product	Status	FY14 plan
Cognitive basis for human error analysis	• Completed	• Publish final report
Generic IDHEAS methodology for NPP applications	• Draft report • Initial piloting in explored in Level-3 PRA	• Expert elicitation of HEPs • Test in Level-3 PRA
IDHEAS method for internal, at-power events	• Externally reviewed • Initially tested	• Test the method

Outline

I. Summary of the initial testing

II. Demonstration of working with IDHEAS – LOFW event

III. Insights on inter-analyst variability

Outline

I. Summary of the initial testing

II. Demonstration of working with IDHEAS – LOFW event

III. Insights on inter-analyst variability

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 number of areas need to be improved

Insights from testing – Individual elements of the method

Timeline and Feasibility analysis

- Not clear how to get information to answer feasibility questions before a task analysis is conducted

  - Not clear what is an acceptable initial assessment

  - More convenient to delay feasibility assessment after a task analysis is complete

- Time analysis was one of the most challenging parts of task analysis

  - Need specific guidance and/or data for timing estimates (e.g., time for travel and manual actions)

  - Need guidance on how to modify timing information obtained from plant personnel

Insights from testing – Individual elements of the method

CRT and task analysis

- Procedure-based CRT does not capture some non-procedural tasks

- Insufficient guidance on task decomposition and identification of critical tasks / subtasks.

- Need guidance on treating procedure transfers – They are not actions executed on the plant but they are critical to success.

- Guidance on cognitive task analysis and workload analysis in the generic methodology should be included in IDHEAS.

Insights from testing –
Individual elements of the method

Crew Failure Mode

- Need guidance on determining the presence / absence of CFMs.

  - Many CFMs seemed to be possible for a critical task to fail but the likelihood was not high – Some analysts kept them some did not.

- CFMs do not capture some complicating factors

  - e.g. the crew cannot exit FRH1 to deal with SGTR

- The boundaries of some CFMs need to be clearly defined.

  - e.g. CFM "Fail to Initiate Execution" vs. CFM "Misread or Skip Critical Step(s) in Procedure". Is skipping a procedural step an instance of failure to initiate execution?

Insights from testing –
Individual elements of the method

PIFs / Branching evaluation questions

- Some PIFs / branch points need to be objectively defined
- Workload is vaguely defined and causes confusion
- Some performance drivers identified in qualitative analysis are not modeled in CFM/PIFs therefore have no influence on quantification

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Demonstration of working -
Step 1: HFE identification and definition

HFE definition

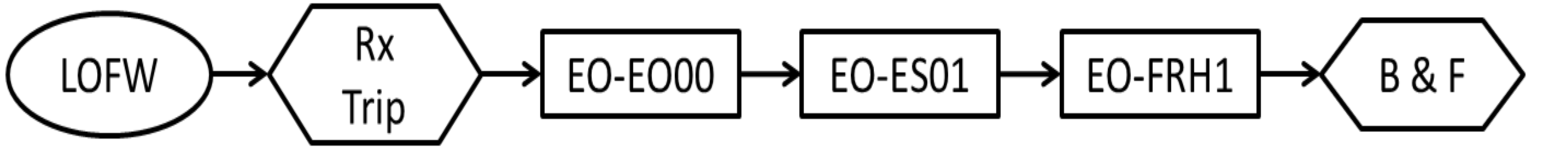
Item	Description
HFE identifier	HFE 1A
HFE definition	The probability of failing to establish feed and bleed within 45 minutes of the reactor trip, given that the crews initiate a manual reactor trip before an automatic reactor trip.
PRA scenario	Total Loss of Feedwater (TLOFW) followed by a manual reactor trip.
Plant state or physical condition by which response must be completed	Initiate B&F to avoid core damage.
Time window	45 minutes
Manipulations required for successful crew response	• Actuate Safety Injection • Open both of the PRZ PORVS

Demonstration of working -
Step 2: Feasibility assessment and time estimation
Step 2.1: Characterization of the expected success path

<u>Operational Story</u>

- Reactor trip
  When the LOFW occurs, the operators will be alarmed by the feedwater pump trip annunciators, and the SG levels will be dropping fast. Reinforced by their training, the operators are likely to manually trip the reactor in about 30 seconds.
- Enter EO00
- Enter ES01
- Verify AFW flow
- Transfer to FRH01
- Initiate B&F
- Implement B&F

<u>Scenario roadmap</u>



Demonstration of working -
Step 2: Feasibility assessment and time estimation
Step 2.1: Characterization of the expected success path

Timeline

Time	Event or action	Cues & Comments
0:00	Main feedwater pump 11 trips	• Feedwater pump trip alarms • Decreasing SG level • Low SG level alarms
0:10	Main feedwater pumps 12 & 13 trip Aux feedwater pumps 11, 13, 14 trip	
0:30	Manual reactor trip	• Action based on training: reactor trip after loss of all MFWPs. • Trip assumed to be at 0:40 (??)
	Enter EO00 and execute Steps 1 - 4	• Assume there is no delay in entering EO00 after reactor trip. • One minute for each step per ASEP Table 8-1 5 (b). • Operators indicated that the four steps would take 2 minutes. ASEP Table 8-1 5 (e) gives 4mins.
3:30	SG level below 50%	T/H calculation

Timeline (cont)

4:30	**Transfer to ES01 from Step 4 of EO00**	**SI not activated and not required**
	Step 3: Verify AFW flow to SG	• Non-decreasing AFW tank level • Decreasing SG level • Check recirc valve status • Cross connect AFW
	Monitor critical safety functions	STA detects red path on CSF trees
7:30 (T_{delay})	Transfer to FRH1 from Step 3 of ES01	Takes three minutes to complete Steps 1 and 3 of ES01 (per ASEP Table 8-1 5 (b)).
9:30	Transition to Step 10 to initiate B&F	• SG levels below 50% WR • Takes two minutes to complete Steps 1 and 2 of FRH1 (per ASEP Table 8-1 5 (b)).
14:30	B&F completed	• Takes five minutes to complete B&F actions (Texe = 5 minutes). • Operators are well trained on B&F.

Demonstration of working -
Step 2.2: Feasibility assessment

Feasibility analysis

HFE 1A is feasible based on the following assessment.

Assess the time to complete the tasks

Based on the operational story and timeline developed above, the time required to complete B&F is around 15 minutes, which is shorter than the 45 minute window. Note that to demonstrate feasibility, the estimated 15 minutes is based on the shortest procedural path.

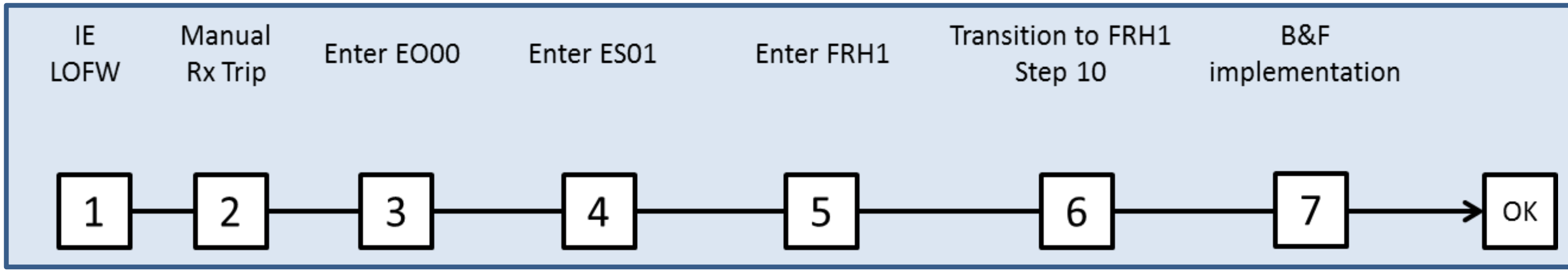
Assess cues

The cues are sufficient (see Table 2). Although the AFW flow indication is misleading, operators are trained to rely on other cues to diagnose the diverted AFW (see discussion about the operational story).

…

Demonstration of working -
Step 2.3:Development of CRT

CRT of HFE 1A



Description of Node 7

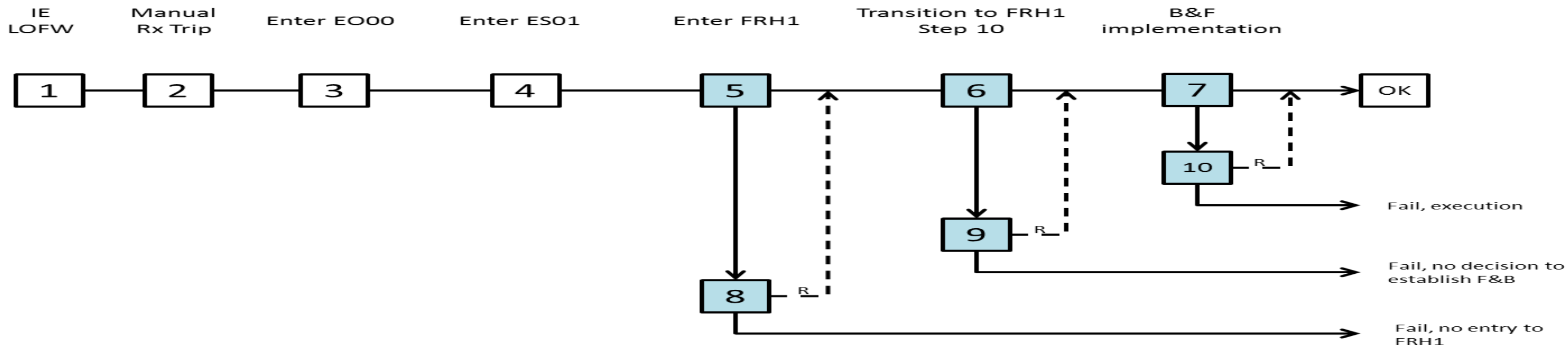
Node No.	7
Node label	B&F implementation
Crew response modeled by node	Implementation of B&F per procedure guidance in Steps 10 through 13 of FRH1.
Success outcome	Established RCS feed and bleed paths.
Plant evolution and key cues for node	Pump and valve indications
Procedural guidance	Steps 10 through 13 of FRH1
Training	The operators are well trained on B&F.
Manipulations (Execution tasks)	• Step 10, actuate SI • Step 12, establish RCS bleed path
Operational narrative	The operators are well trained to implement B&F per guidance in Steps 10 through 13 of FRH1. According to operator interviews, it takes five minutes to complete B&F actions.
Comment	

Demonstration of working -
Step 2.4: identification of critical tasks

Critical Sub-Tasks for Node 7 (B&F Implementation)

No.	Critical Sub-Task	Task Characterization	
1	Actuate SI	Nature & requirement	Execution
		Plant information/cue	N/A
		Responsible crew member	TBD
		Procedure	FRH1 Step 10
2	Verify RSC feed path	Nature & requirement	Cognitive subtask – parameter monitoring and comparison against procedure criteria.
		Plant information/cue	• HHSI pump status • HHSI suction, discharge, and cold leg injection valves status
		Responsible crew member	TBD
		Procedure	FRH1 Step 11
3	Establish RCS bleed path	Nature & requirement	• Cognitive subtask – parameter monitoring and comparison against procedure criteria. • Execution
4	Verify RCS bleed path	Nature & requirement	Cognitive subtask – parameter monitoring and comparison against procedure criteria.
		Plant information/cue	• Pressurizer PROV status • Pressurizer PROV isolation valve status
		Responsible crew member	TBD
		Procedure	FRH1 Step 13

Demonstration of working -
Step 2.5: Identification of potential recovery opportunities



Recovery Opportunity for Node 7 (B&F Implementation)

Node No.	10
Node label	Recovery of Node 7
Failure of Node 6	Failure in executing tasks specified in Steps 10 through 13 of FRH1.
Recovery potential	• Steps 11 and 13 of FRH1 instruct the operators to verify if B&F is properly initiated.
Cues	• HHSI pump status • HHSI suction, discharge, and cold leg injection valves status • Pressurizer PORV isolation valve power status • Pressurizer PORV isolation valves status • Pressurizer PROV status • Pressurizer PROV isolation valve status
Procedural guidance	• Steps 11 and 13 of FRH1

Demonstration of working -
Step 3: Crew failure mode evaluation

CFM Applicable to Node 7

Crew Failure Mode	Applicability	Comments
AR: Key Alarm not Attended to	No	No alarm.
SA-1: Data Misleading or not Available	No	Pump and valve status available and not misleading.
SA-2: Wrong Data Source Attended to	No.	No apparent complicating factors. Crew is well trained for B&F.
SA-3: Critical Data Incorrectly Processed/Misperceived	No	Pump and valve status is not likely to be misperceived
SA-4: Critical Data Dismissed/Discounted	No	The crew is instructed by the procedure to check plant parameters.
SA-5: Premature Termination of Critical Data Collection	No	The crew is not monitoring plant parameters.
RP-1: Misinterpret Procedures	No	Procedure steps are clear and the crew is well trained.
RP-2: Choose Inappropriate Strategy	No	No other strategy in the procedure.
E-1: Delay Implementation	Yes	Try to restore FW to avoid release of primary fluid into the containment.
E-2: Critical Data not Checked with Appropriate Frequency	No	The crew is not monitoring plant parameters.
E-3: Fail to Initiate Execution	No	The crew is instructed to initiate B&F and is well trained for B&F.
E-4: Fail to Execute Simple Response Correctly	Yes	Failure to execute Steps 10 through 13 in FRH1.
E-5: Fail to Execute Complex Response Correctly	No	Steps 10 through 13 of FRH1 are simple tasks. The crew is well trained for these tasks.
AP-1: Misread or Skip Critical Step(s) in Procedure	No	Step 11 or 13 provides an immediate recovery for skipping Step 10 or 12.
C-1: Miscommunication	No	All actions are in the control room. Workload is not very high. No

Demonstration of working -
Step 3: Identification of potential recovery opportunities

Evaluation of DT paths for Node 7

Crew Failure Mode	PIF Evaluation	Comments
Delay Implementation		Try to restore FW to avoid release of primary fluid into the containment.
Reluctance and Viable Alternative	Exists	Release of primary fluid into the containment is undesirable.
Assessment of Time Margin	Correct	The crew is well trained for B&F. Once they find out that there is no way to restore FW or B&F can no longer be delayed, they would not hesitate to start B&F.
Additional Cues	Yes	CSFTs
DT path # 4; HEP = 6.5E-03		
Fail to Execute Simple Response Correctly		Failure in executing Steps 10 through 13 of FRH1
HSI	Nominal/Good	The crew is well trained for B&F. No other challenges.
Workload	Low	Procedure steps are clear without complex logic.
Recovery Potential	Yes	Steps 11 and 13 provide an immediate recovery opportunity.
DT # 8; HEP = 1.6E-06		

Demonstration of working -

Step 4: HEP calculation

HEP for HFE 1A

Node	CFM	DT path #	HEP
5	Data misleading or not available	5	
	Misread or Skip Critical Step(s) in Procedure	14	
6	Misread or Skip Critical Step(s) in Procedure	14	
7	Delay Implementation	4	6.5E-03
	Fail to Execute Simple Response Correctly	8	1.6E-06
Total			

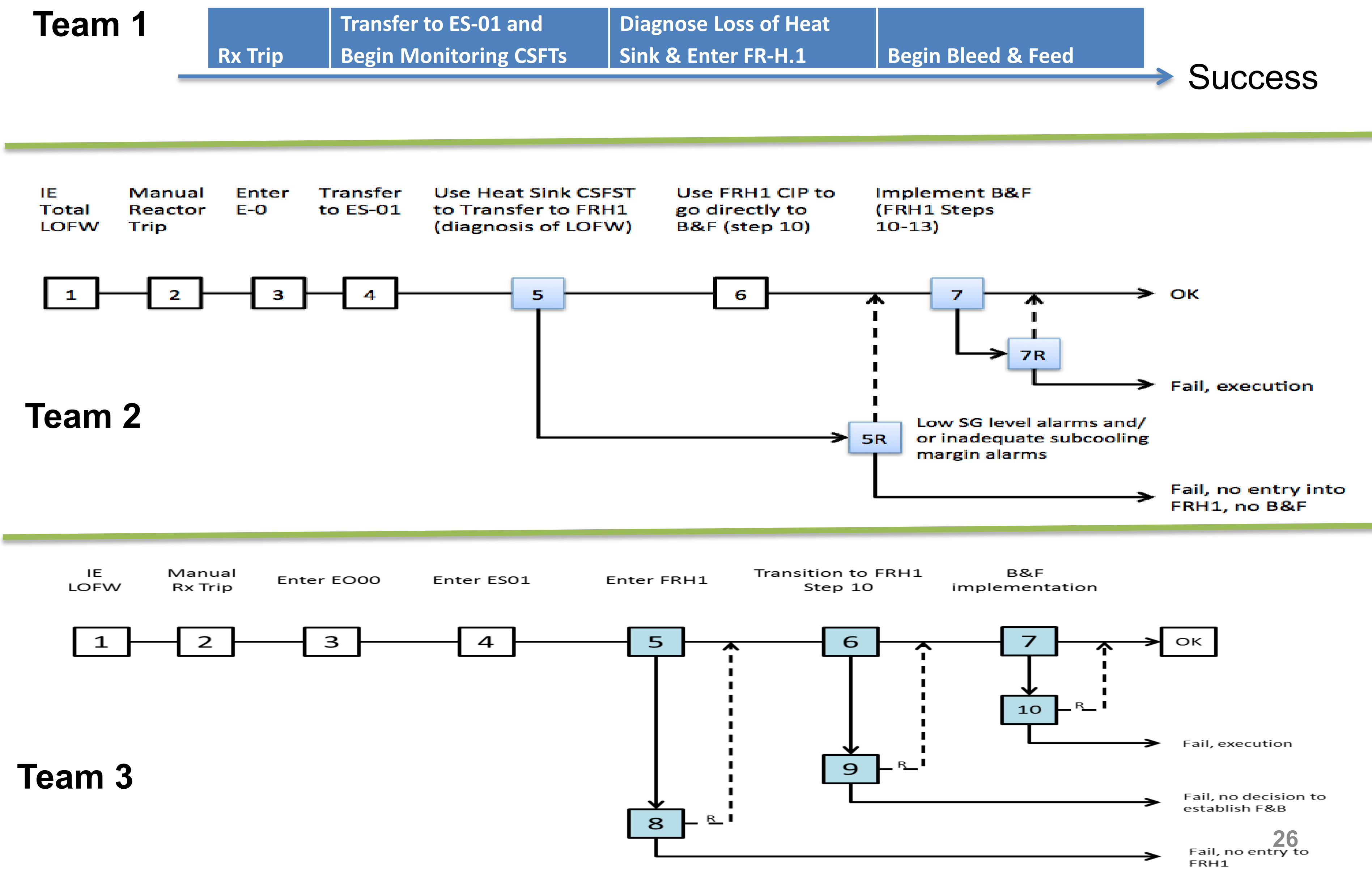
Outline

I. Summary of the initial testing

II. Demonstration of working with IDHEAS – LOFW event

III. Insights on inter-analyst variability

CRT of LOFW scenario HFE 1A (B & F)



Critical tasks for HFE 1A

	Team 1	Team 2	Team 3
Task 1	Transfer to ES-01 and start monitoring CSFTs.		
Task 2	Enter FR-H.1 via CSFT	Recognize LOFW & Enter FR-H.1 via CSFT	Enter FR-H.1 via CSFT
Task 3	Decide to Start B&F and Execute B&F	Initiate B&F (and implement B&F)	Initiate B&F
Task 4			Implement B&F

Critical tasks among the teams are similar, different in whether a task is critical or level or detail at which a task is broken down.

CFMs and DT paths identified for HFE 1A

Team 1

Task	CFM	DT path #	HEP
1	Data Misperceived	15	negligible
2	Data Misleading	5	1E-2
2	Misread or Skip a Step	14	negligible
3	Data Misperceived	15	negligible
3	Delay Implementation	4	5E-3
3	Fail to Execute (Simple)	8	negligible
Total			1.5E-2

Team 3

Task	CFM	DT path #	HEP
2	Data misleading or not available	5	
	Misread or Skip Critical Step(s) in Procedure	14	
3	Misread or Skip Critical Step(s) in Procedure	14	
4	Delay Implementation	4	6.5E-03
	Fail to Execute Simple Response Correctly	8	1.6E-06
Total			

CFMs identified by team 2

Task 2: Transfer to FRH1

- Delayed implementation
- Misinterpreted procedure
- Skip steps of procedures
- Miscommunication

Task 3-4: Initial B&F

- Fail to initiate excitation
- Fail to execute response correctly
- Skip steps of procedures
- Miscommunication

Note: The analyst used an early version of the report before the external review and expert elicitation; the later version made lots of changes in defining CFMs and their boundaries, as well as the PIFs and the PIF evaluation questions.

Preliminary observation on inter-analyst variability

- The three teams did not demonstrate major differences in the results; they all capture the significant critical tasks, CFMs, and DT paths.

- Teams varied in determining the significance of the critical tasks and level of breaking down the tasks; However, that had little impact in identifying the significant CFMs.

- Teams varied in determining the insignificant (unlikely) CFMs; those CFMs had weak effects to the total HEP of the event.

- Teams demonstrated great consistency in determining DT paths.

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 number of areas need to be improved

Planning the formal testing in 2014

How well the method meets its Goal?

<u>Method Goal</u> - Develop a new method to reduce variability

How well the method advances the state-of-practice?

<u>Method Requirements -</u> Have enhanced capabilities to address the key weaknesses in current state-of-practice

- Generic weaknesses – e.g.,
  - Guidance for qualitative analysis,
  - Transition from qualitative analysis to quantification,
  - Selection of PIFs and justification for the effects of PIFs,
  - Transparency
  - Traceability
- Method-specific weaknesses – e.g., SPAR-H:
  - Identification of tasks,
  - Great variation in PIF multipliers,
  - Justification for PIFs

RES HRA Program

Sean E. Peters

January 15, 2014

HRA in 2014

- Foundation
  - Cognitive Basis developed , peer reviewed, and used for HRA method development (also used for NRC's human factors work)
- Data
  - SACADA database developed - Collecting data
  - Human Performance Test Facility – Collecting data
- Methods
  - IDHEAS being finalized and tested
- One Method
  - Eliminates method-to-method variability
- Use of the methods
  - Scientific basis, data, empirical basis and improved guidance
  - Improves consistent application of HRA
- Applications
  - Generic method for all application areas; specific application models can be tailored from the generic method

Schedule

- Cognitive Basis Report
  – Publish in 2014
- Generic Method
  – Expert Elicitation of HEPs - 2014
  – Test Quantification Model – 2013/14
  – Publish - 2015
- IDHEAS (Method for internal procedural events)
  – Complete HEPs and Decision Trees – 2013/14
  – Test Method – 2013/14
  – Publish - 2015

Future of IDHEAS Method

- Computerized
- Tailored for particular need
- HEPs linked to Data
- Upgradeable to incorporate lessons learned from modeling