

# **Official Transcript of Proceedings**

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                              Reliability and PRA Subcommittee

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 + + + + +

7 RELIABILITY AND PRA SUBCOMMITTEE

8 + + + + +

9 WEDNESDAY

10 APRIL 24, 2013

11 + + + + +

12 ROCKVILLE, MARYLAND

13 + + + + +

14 The Subcommittee met at the Nuclear  
15 Regulatory Commission, Two White Flint North, Room T2B1,  
16 11545 Rockville Pike, at 1:00 p.m., John W. Stetkar,  
17 Chairman, presiding.

18 SUBCOMMITTEE MEMBERS:

19 JOHN W. STETKAR, Chairman

20 J. SAM ARMIJO, Member

21 DENNIS C. BLEY, Member

22 HAROLD B. RAY, Member

23 MICHAEL T. RYAN, Member

24 STEPHEN P. SCHULTZ, Member

25 WILLIAM J. SHACK, Member

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1  
2 NRC STAFF PRESENT:

3 JOHN LAI, Designated Federal Official

4 YUNG HSIEN JAMES CHANG, RES/DRA/HFRB

5 DON HELTON, RES/DRA/PRAB

6 SEAN PETERS, RES/DRA/HFRB

7 JING XING, RES/DRA/HFRB

8 ANTONIOS ZOULIS, NRR/DRA/APOB  
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## P R O C E E D I N G S

1:00 p.m.

CHAIR STETKAR: Okay. 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, Dennis Bley, Harold Ray, Sam Armijo, Mike Ryan will be joining us, Bill Shack and Joy Rempe.

John Lai of the ACRS staff, is the designated federal official for this meeting. The Subcommittee will hear the latest developments on the HRA methods and their application in response to Commission's SRM-MC062-010.

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

We have received no written comments or requests for time to 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,

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1 analyze relevant issues and facts and formulate proposed  
2 positions and actions as appropriate for deliberation  
3 by the full Committee.

4 Rules for participation in today's meeting  
5 have been announced as part of the notice of this meeting  
6 previously published in the Federal Register.

7 A transcript of the meeting is being kept  
8 and will be made available as stated in the Federal  
9 Register Notice.

10 Therefore, we request that participants in  
11 this meeting use the microphones located throughout the  
12 meeting room when addressing the subcommittee.

13 The participants should first identify  
14 themselves and speak with sufficient clarity and volume  
15 so that they may be readily heard.

16 We will now proceed with the meeting. And,  
17 Sean, do you want to say something?

18 MR. PETERS: Yes, I'd like to thank the  
19 Subcommittee for taking the time to work with us on this  
20 topic.

21 What you're going to hear today is what was  
22 requested back in December, which was the understanding  
23 a little bit more about the psychological foundations  
24 for the IDHEAS method and more about the applications  
25 to all events and we definitely look forward to hearing

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1 your comments.

2 To let you know, Jing has taken this project  
3 and done a tremendous amount of work to get this to this  
4 first stage. Trying to get the various stakeholders  
5 to come to some type of cohesiveness and agreement has  
6 been an incredible challenge on this project and Jing  
7 has really mastered that up to this point.

8 But just to let you know, it's definitely  
9 a work in progress and we are having continuing meetings  
10 to try to enhance this product. So, we are definitely  
11 looking for input from the ACRS Subcommittee here and  
12 would be happy to incorporate fresh ideas or new ideas  
13 for incorporation into our IDHEAS project.

14 And with that, I'll pass it to Jing.

15 MEMBER BLEY: Before we start -

16 CHAIR STETKAR: Dr. Bley.

17 MEMBER BLEY: - may I make a statement?

18 CHAIR STETKAR: You may.

19 MEMBER BLEY: My conflict in this area has  
20 actually grown and my company is involved with the staff  
21 in developing various aspects of this work.

22 So, I should not participate in  
23 deliberations with the Committee on this topic.

24 CHAIR STETKAR: Thank you.

25 Anyone else?

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(No response.)

CHAIR STETKAR: Okay. And, Jing, I don't know who all is out there on the bridge line. I understand there are several people out there.

They can hear us. If you need help from them, just let us know. We'll open it up and get them to participate.

MS. XING: Okay. I think earlier I told our team the bridge line is made one way. So, they probably on bridge line now, but they expect - thank you. I appreciate that.

Okay. So, thanks, ladies and gentlemen, and I really appreciate your being here to review this work. And especially I notice you are just up from the previous meeting without any lunch break.

And as Sean said, the first topic for this afternoon - can everyone hear me? The first topic for this afternoon is to go over our literature reviews that we have pretty much done in 2011 and which we never gave the Committee a briefing of the whole story. So, today you will first hear the story.

And the second part for this afternoon, I will have the matters that we are still in developing expanding our early work into the Level 2 domain.

So, here just you saw this slide back in

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1 December, the IDHEAS - the products from IDHEAS.

2 So, what we have now is the cognitive basis  
3 for human error analysis. It was developed for to  
4 provide a technical basis for human reliability analysis  
5 and actually also for human factors engineering. And  
6 the report is right now in peer review and we intend  
7 to have it published in FY14.

8 So, taking ACRS' suggestion from last  
9 meeting, we started the peer review in February. So,  
10 the drop-dead time is the end of May of this -

11 MEMBER SHACK: Now, how broad is the peer  
12 review?

13 MS. XING: In terms of the broadness, it's  
14 globally. So, we have about seven members committed,  
15 seven people committed to provide some review. And this  
16 include university professors and the people who work  
17 in the government agency - other government agency, and  
18 the industry expert like people who have - who are  
19 well-known in the government or in cognitive engineering  
20 like Christopher Wickens - well, he didn't commit. I  
21 don't know if he's there. And also staff from other  
22 countries. From German and British and Halden in  
23 Norway.

24 So, because this review is purely voluntary  
25 and this report is over 300 page, so we told them they

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1 could rate the review at different levels. To the very  
2 high level of coverage and the soundness of the approach,  
3 and to the deeper level. If they like to provide us  
4 in-line comments, that will be highly appreciated.

5 MEMBER SCHULTZ: Jing, have you determined  
6 how you're going to incorporate the comments of the peer  
7 review into the document, or are you going to modify  
8 the document based on peer review comments, or are you  
9 going to incorporate peer review as an appendix?

10 MS. XING: It's hard to say that now. What  
11 I had in mind is we're probably going to do both. Since  
12 we are out of our staffing support, there's a contract  
13 there, so we probably cannot address every comment.

14 And also because this report is quite  
15 comprehensive in terms it covers every major area of  
16 human performance, some of our expert reviewer only work  
17 in one particular area. So, they probably have lots  
18 of detailed comments in that area and may not necessarily  
19 address it.

20 So, I'm thinking by the end we collect all  
21 the comments. If they're really major comments, we need  
22 to address them.

23 And for the detailed comments are really  
24 - or for some comment like you would need to, for the  
25 work or add lots of details when they just classify the

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1 comments and put them in appendix and develop then for  
2 the future document.

3 MEMBER SCHULTZ: Thank you.

4 MR. PETERS: This is one of our concerns with  
5 the peer review is that out in the real world there are  
6 a lot of people that have very detailed knowledge on  
7 one particular area.

8 And Ms. Xing said this is supposed to be  
9 a comprehensive across all the human performance  
10 domains. So, we are a little bit worried about getting  
11 too focused in particular areas of the peer reviewers  
12 and not focusing off of the other areas.

13 So, I think Jing is going to try to take  
14 those comments and try to maintain at least a relative  
15 balance across the report. And we could feasibly keep  
16 some more of the detailed comments like you had indicated  
17 in an appendix or something like that in the back of  
18 the report. It's feasible for that.

19 MEMBER REMPE: Jing, I need to interrupt  
20 something too that I missed earlier because I was doing  
21 some file transfers, but I do have an organizational  
22 conflict of interest although I'm not personally  
23 involved with this work.

24 And so, I know I've declared it in prior  
25 meetings, but probably ought to have it on the record.

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1 Sorry.

2 CHAIR STETKAR: Thank you.

3 Jing, you mentioned several peer review  
4 participants and you've discussed, you know, detailed  
5 comments in very specific areas.

6 Have you assembled the whole peer review  
7 team? Are you trying to develop any sort of consensus  
8 high-level peer review comments?

9 I mean, in many cases a peer review benefits  
10 from people with different perspectives and experience  
11 kind of trading off things among themselves in a team  
12 rather than sitting isolated in a little closet writing  
13 their own comments and sending them to someone.

14 So, have you organized peer review team  
15 meetings, or is this simply individual experts providing  
16 you comments on a report?

17 MS. XING: It's the individual expert.

18 CHAIR STETKAR: Okay. So, that's not really  
19 a peer review process as we understand it for many other  
20 functions.

21 MR. PETERS: Yes, we are somewhat fiscally  
22 constrained at the moment. Research took a very major  
23 hit to their funding. So, the actual ability to  
24 formulate a team and fund people to come out to the  
25 meetings, we have to really rely on a strictly volunteer

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1 basis for this.

2 CHAIR STETKAR: Volunteer and individual.

3 MR. PETERS: Exactly.

4 MS. XING: In fact, if we can have that  
5 funding, I would review our - the report of the IDHEAS  
6 level internal procedure event report that's coming out  
7 pretty soon to review.

8 MEMBER BLEY: Jing, maybe I could offer a  
9 point of clarification doing this as an independent peer  
10 review, but also this project has had a number of  
11 meetings along the way with experts from a broad variety  
12 of organizations, not just the authors of the report  
13 involved in discussions and feedback.

14 So, there's been in that way, a bit of an  
15 in-process peer review.

16 CHAIR STETKAR: But as a developmental type.

17 MEMBER BLEY: Yes, I mean, they've had  
18 meetings, had people in, talked about what they're  
19 doing.

20 CHAIR STETKAR: Yes, thank you.

21 MS. XING: The early version of the report  
22 has been in a peer review that, peer review means you  
23 are outside our development team by a number of NRC staff  
24 and INL senior staff. So, those we have a more goes  
25 through the workshops. We have had standing progress

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1 of that.

2 Okay. So, this work was conducted by a big  
3 team and Erasmia Lois was the project manager. April  
4 Whaley, which was - compared all the different pieces  
5 works into this to produce this single report.

6 And I was the architect for this project.

7 And the rest of our team members pretty much work in  
8 - we have weekly meeting, and they work in a parallel  
9 fashion.

10 So, each member work in one individual  
11 cognitive function, but we use the weekly meeting to  
12 make sure we're coordinating each other.

13 So, for this I will briefly talk the goals  
14 and the process of the development of this cognitive  
15 basis and some limitations we have in this report.

16 And then we can either quickly go through  
17 the five cognitive functions or look at - select what  
18 functions to look at details.

19 And also, I would like to have some time  
20 at the end to talk about some additional study of the  
21 literature review and the operational experience review  
22 in our effort of expanding the method for Level 2 domain.

23 And those materials are not in the report that you may  
24 have produced so far.

25 So, what's in the middle in this gray box

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1 is a very high-level cognitive basis for human  
2 performance. And this is essentially the cognitive  
3 basis they use, you know, pretty much all the HRA method  
4 either explicitly or implicitly.

5 And why each are there is we don't - there  
6 hasn't been enough effort to look into these.  
7 Therefore, we know that some performance influencing  
8 factors like fatigue, we know if you are high fatigue,  
9 that you have a high chance to make a failure.

10 But a lot of methods did not explicitly have  
11 the explanation how a performance shaping factor, a  
12 factor a party to the task makes a failure.

13 So, because of this implicit, it introduce  
14 a lot of subjectivity, variability in the HRA practice.

15 So, our effort here is try to make this  
16 cognitive basis more explicit by look inside this gray  
17 box and see what are the mechanisms to make this function  
18 work. And how do it fail? And how is it different  
19 performance influencing factors that would affect the  
20 chance of fail. So, that's our goal with this project.

21 So, we must - explicitly we try to identify  
22 cognitive mechanisms underlying the operational  
23 failures in internal procedure events.

24 The literature review is limited for those  
25 operation, the task is in the more procedure event

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1 situation.

2 Also, identify the factors that influence  
3 human performance where possible and identify how those  
4 factors actually affect the chance of failures.

5 And develop a structured cognitive  
6 framework to compile this information and use it as a  
7 psychological foundation for the IDHEAS method that we  
8 are developing.

9 So, faced with the goal we set in -

10 CHAIR STETKAR: Before you go to the next  
11 timeline here, can we go back to the previous slide?

12 What elements of the review and kind of the  
13 framework that's laid out in the report are limited  
14 because of that first bullet? In particular, the  
15 qualification that says internal, procedural events.

16 Because as I read the report, it doesn't seem to be  
17 limited that way.

18 The IDHEAS methodology gets very  
19 procedure-centric and says we're only going to do this  
20 for internal events, but I wasn't quite sure how this  
21 basis document is limited that way.

22 Could you explain a little bit where you  
23 think it is?

24 MS. XING: Yes, that clear in the later  
25 slides, but I give you quick -

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1 CHAIR STETKAR: Okay. Okay, fine.

2 MS. XING: I can give you a quick -

3 CHAIR STETKAR: No, no, no. That's fine.  
4 We'll wait until we get there. Thanks.

5 MS. XING: Okay. Okay. This very messy  
6 slide. I don't like messy slides. It kind of give you  
7 the project timeline and the milestone what happened  
8 here.

9 So, we start this activity in October 2010.  
10 And we are - we are in - we're close to P4 in the process  
11 for external peer review.

12 I'd like to briefly talk what happens  
13 difference between the first period and the second  
14 period.

15 In the first period, we - our team decided  
16 to do this literature review. We didn't have a very  
17 clear idea how this should be done.

18 So, it's easy to come up those five basic  
19 cognitive functions, because it's almost universal in  
20 all the major cognitive literature.

21 And let's say for the - we started with the  
22 function, the detection. What does exactly "detection"  
23 mean?

24 It means you say something, you perceive  
25 something and is that about your readiness sense of how

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1 to work or about how your brain to interpret what you  
2 see.

3 We didn't have a very clean structure how  
4 to do that. So, we basically went to search everything  
5 we think related to detection function and it took our  
6 team a tremendous amount of time to collect a huge amount  
7 of information.

8 And just to give you an example, once I  
9 search the keyword the forward retina in the public  
10 medical database, that was back about seven years ago,  
11 it came up like 30,000 articles.

12 So, and our team, they try to organize and  
13 put those selections in most relevant information. And  
14 when we talk relevant, we use the procedure event as  
15 a framework.

16 So, and at the end of that period, we  
17 presented the work to ACRS and also some of our own staff  
18 and people feel you have a lot of use for information  
19 here, but it's not - they don't know how to use it because  
20 it wasn't well structured if you still have the memory  
21 for the April 2011 meeting.

22 So, after that meeting, ACRS meeting, we  
23 - the team decided we need to come up -

24 CHAIR STETKAR: Let me interrupt you here.

25 Just for the record, you have not presented

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1 this to the ACRS. You presented it to our subcommittee.

2 MS. XING: Subcommittee.

3 CHAIR STETKAR: So, be very, very careful  
4 when you put things on the record or in writing. The  
5 ACRS has not yet reviewed any of this material. We have  
6 not written a letter report on this.

7 So, any feedback you received as today, will  
8 be individual members in the Subcommittee setting.

9 MS. XING: Okay, okay.

10 CHAIR STETKAR: Thank you.

11 MS. XING: Thank you.

12 So, at that point we decided to come up with  
13 a framework how to do this related to their method and  
14 participating our product. And also, that's when we  
15 decide the scope of there.

16 At that time, our team's goal was to develop  
17 the IDHEAS method for internal procedure events only.

18 So, we set up the goal of the scope of literature review  
19 for that.

20 And, therefore, for every function we  
21 didn't do like a thorough task analysis, but we kind  
22 of - our team got a sense, okay, what are the detection  
23 function in the control room for the procedure event?

24 And we determine some like you going to  
25 respond to alarm. And you check the indicators and you

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1 monitor the status. So, we're trying to get a sense  
2 of those.

3 Then we focused - then we developed a set  
4 of keyword where you're going to search in the  
5 literature.

6 Those keyword in the paper in the report  
7 and those keyword are particular for this procedure  
8 event scope.

9 For example, when we try to decide the  
10 decision-making, the scope for the decision-making  
11 function, there was a large amount of literature  
12 distributed in decision-making, which means the  
13 decision was made by people at different locations with  
14 different responsibilities and receiving information  
15 from different situations, different set of  
16 information, that kind of situation. Then we decided  
17 to lay that out of our real scope.

18 So, what we have here in this report is not  
19 say only apply to internal matter, apply to external,  
20 no. It's applied to general human performance, but some  
21 aspect of human performance were not covered in this  
22 review.

23 CHAIR STETKAR: You know, I guess I missed  
24 that reading the report. It's been a while since I read  
25 it, a couple of months, but I didn't get the sense of

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1 that qualification in the report.

2 MS. XING: Yes, and another -

3 CHAIR STETKAR: I do from the IDHEAS  
4 methodology report. But my concern here is, is the  
5 fundamental psychological basis report being influenced  
6 too heavily by narrow focus in the application?

7 MS. XING: It's not -

8 CHAIR STETKAR: I mean, I'm starting to get  
9 that sense -

10 MS. XING: Yes.

11 CHAIR STETKAR: - and it bothers me a bit.

12 MS. XING: It's not to influence, but it just  
13 is the scope. You have a big pie. You do not cover  
14 the entire pie. You need a piece or two of that piece  
15 of pie.

16 MR. PETERS: John, which report are you  
17 referring to? Are you referring to the -

18 CHAIR STETKAR: I'm referring to 2114.  
19 NUREG-2114.

20 As I read through that report - and as I  
21 said, I think I would have flagged it if I found too  
22 many references to only procedures and only internal  
23 events.

24 MS. XING: And -

25 CHAIR STETKAR: I didn't get that sense

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1 reading that report. I got the sense that it was more  
2 comprehensive and that the report on the methodology  
3 application of these principles, basically, suddenly  
4 gets focused into everything works in terms of  
5 procedures and internal events and in the main control  
6 room.

7 MR. PETERS: You're referring to the  
8 methodology report, referring to the Phase 2 report,  
9 the joint report with EPRI for control room -

10 CHAIR STETKAR: Right - well, that's the -  
11 yes, I'm referring to the thing that I think will be  
12 discussed in this.

13 MR. PETERS: Okay. I was just trying to  
14 refer, because what we are talking about today will be  
15 the Phase 3 report which will be the generic  
16 applicability method.

17 So, perhaps we will -

18 CHAIR STETKAR: Okay. Maybe I have a  
19 disconnect here, but -

20 MS. XING: Yes, another part I'm with you  
21 is the sense we recovered, is very comprehensive. Let  
22 me talk a little bit about the source of the information  
23 we're having.

24 So, first we talk when we talk the scope,  
25 let's talk about the coverage of the area. And then

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1 we talk about the depths of the information coverage.

2 The source of information we look for, you  
3 can separate into several layers. On the very bottom  
4 there we look at cognitive neuroscience literature which  
5 really talk about the inside of the brain, how you  
6 actually make a decision, which part of - that part is  
7 universal.

8 CHAIR STETKAR: Yes.

9 MS. XING: So, regardless where you are, you  
10 are inside or outside the control room, you know, inside  
11 part of your brain, those hardware, wire. Those are  
12 universal.

13 And then on top of that we look at the  
14 psychologic experiment, the cognitive and psychologic  
15 experiment.

16 From that experiment, we have some  
17 limitations. There are, for example, let's just use  
18 decision-making as an example.

19 There are some psychological experiments  
20 if they involve people at - two different person receive  
21 different set of information and how they make decision  
22 with this kind of uncertainty.

23 And that kind of literature is not included  
24 just because our team with the limited time we have we  
25 focus on those more like the control room

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1 decision-making you already have a procedure that will  
2 pretty much give you a basic starting for your decision.

3 CHAIR STETKAR: That's the point that  
4 bothers me. You have a procedure which is a book and  
5 it's a reference. It's only one piece of reference  
6 material that you have.

7 Reference material that you also have is  
8 your own knowledge and training, your environment, what  
9 people are screaming at you or saying to you in a very  
10 controlled manner. So, it is not a procedure-driven  
11 context.

12 As much as other people might want to make  
13 you think that it is, it is not. And that, I didn't  
14 get that procedure-driven context as I read through  
15 NUREG-2114.

16 It seemed to make a lot of sense that says  
17 procedures are part of the whole stew that affects a  
18 group or an individual's decision process, but I now  
19 hear you telling me that I have procedures.

20 So, therefore, the way I think is guided  
21 by those procedures.

22 MS. XING: That's -

23 CHAIR STETKAR: And that's not the message  
24 that I'm getting from 2114. I am getting the message  
25 from the EPRI-driven methodology, and I have real

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1 problems with that. And we've discussed that in the  
2 past.

3 MR. PETERS: Yes.

4 CHAIR STETKAR: But my fear is that too much  
5 of that procedure-centric view of the world is creeping  
6 into this part of the process.

7 MEMBER SCHULTZ: I agree, John. I thought  
8 here we were working to develop a general model, general  
9 picture incorporating the other elements of the  
10 environment as they affect all of the pieces of the  
11 model.

12 MS. XING: Yes, I should say there's no way  
13 that procedure event kind of plan is not influence this  
14 work, because this was part of the entire IDHEAS project.

15 At the time we conduct the literature  
16 review, the project team had a clear goal. We were going  
17 to develop a method for procedure event only.

18 So, that's why in 2012 last year when we  
19 tried to extend the method to the broad scope, we have  
20 to do a lot of additional literature review focused on  
21 those - the areas that was left out, yes.

22 MR. PETERS: So, I guess what I'm hearing  
23 is Jing says we took that original scope and expanded  
24 it. And, John, what you're telling us is that you didn't  
25 catch that original scope.

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1           It's not only that original scope in what  
2   you read. You read in the - in that NUREG, you read  
3   that it is more applicable than just procedural-driven.

4           CHAIR STETKAR: That's what I read. And,  
5   in fact, there are many examples that show how procedures  
6   can sometimes aid and can sometimes detract from  
7   effective decision-making.

8           MEMBER SHACK: Now, there was a certain  
9   emphasis on dealing - you're dealing with trained  
10  people.

11          CHAIR STETKAR: You're dealing with trained  
12  people.

13          MEMBER SHACK: Knowledgeable people.

14          CHAIR STETKAR: That's right. That's  
15  right.

16          MEMBER SHACK: And in teams.

17          CHAIR STETKAR: Yes, in teams.

18          MEMBER SHACK: So, that's not a general -

19          CHAIR STETKAR: You're not putting me out  
20  in the middle of the desert and saying, make a decision  
21  today.

22          So, it is focused on team dynamics,  
23  knowledgeable, trained people that do have procedures  
24  to a greater or lesser extent available as one of their  
25  aids. But, as I said, the discussion in the NUREG,

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1 anyway, seems to strike a balance among all of the  
2 influencing elements.

3 I don't want to call it influencing factors,  
4 because that means something different.

5 MR. PETERS: So, Jing, you mentioned earlier  
6 that there were pieces that were - pieces of the  
7 psychological literature that were left out of this  
8 report.

9 Could you elaborate on what types of things  
10 are not included?

11 CHAIR STETKAR: Well, she mentioned one  
12 thing about distributed decision-making. That if  
13 you're down the hall and somebody calls you and says  
14 it's raining outside, and I'm sitting in here and  
15 somebody calls me and says it's precipitating outside,  
16 we might make a different decision about what we're going  
17 to do about that, because we might be receiving slightly  
18 different information as opposed to us all sitting in  
19 the same room together.

20 And there are probably a few other things,  
21 but -

22 MS. XING: Yes, so it's like you go to - for  
23 the high level, it's more influenced by procedure. But  
24 if you look at the bottom levels, the neuroscience part,  
25 that part isn't really universal part.

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1 And, also, limitation in the second bullet,  
2 the factors, how the factors affect different - affect  
3 human performance. We didn't get much of that down in  
4 the report.

5 And so, it was towards the later stage of  
6 the literature review the team members feel like it's  
7 just too much. They don't know how to go to that part  
8 of literature and don't know how to put it together.

9 So, we didn't do a systematic work, but we  
10 collected lots of example how the individual factor  
11 would work, that you will see in the appendix.

12 So, we wouldn't say that's a very - we can't  
13 judge how complete that part is, but we put as much as  
14 we could find in some parts there.

15 And also, the third bullet is the structure  
16 of the cognitive framework and we already had some issues  
17 when our team used that.

18 So, in the report we talk a lot about  
19 mechanism, mechanism. The mechanism if you look at the  
20 Appendix A and B, you will see appendix - the word  
21 "cognitive mechanism" sometimes means some good thing.

22 You need to have to make people perform more reliably.

23 And sometimes mechanism means a bad thing,  
24 make you fail. So, that's whenever we try to fix it.

25 And I also receive some very initial

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1 feedback from the peer reviews in the information  
2 meeting I went in March. And interestingly, all the  
3 three international - three or four international  
4 reviewers there, they all told me the same thing. They  
5 feel very confused about the last function, the teamwork  
6 and communication.

7 CHAIR STETKAR: That, of everything in the  
8 report, is probably least well-developed.

9 MS. XING: Yes, they feel like -

10 CHAIR STETKAR: And I think the report  
11 acknowledges that.

12 MS. XING: Yes, they feel very confused how  
13 that one was handled. So, there's still some - there's  
14 some limitation. Some, we can't address them.

15 So, just a look at this is the strategy we decided  
16 to work in. So, first off, this was already - we start  
17 this in the very first place when we decide to have the  
18 literature review.

19 There are human response in the PRA event.

20 And within the response there are human-centered tasks,  
21 what are the tasks the human does.

22 And the intent of each of this task is  
23 supported by a set of high-level cognitive functions.

24 So, our literature will focus on each of these five  
25 functions.

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1           And for every function, we try to list it  
2           in the following. First, as we just talked, the scope  
3           of the cognitive function in the nuclear power plant  
4           control room tasks. When we say control room tasks,  
5           our mental models or procedure-driven tasks.

6           So, we try to identify what objectives the  
7           functions try to achieve there and that gave us the  
8           scope for the rest.

9           Then we look at the cognitive mechanisms  
10          which ask how the human - how humans perform the function  
11          and what make the humans reliably achieve the function  
12          objectives.

13          With that information, we first located the  
14          error causes or sometimes we refer as the failure  
15          mechanisms. And we group this failure mechanisms into  
16          what we call the proximate causes, which we saw in Item  
17          3 is almost like connected part of Item 2. So, you know  
18          this how you make it work, and these are the things to  
19          make it not work.

20          And the last part we look has affects of  
21          PIF, like what are PIF, performance shaping factor, or  
22          the aspects of performance shaping factor lead to those  
23          error causes.

24          So, the report for every chapter is for one  
25          function. And each chapter is a structure based on these

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1 four layers. What you say the first layer, the tasks  
2 is more based on our experience, these people have  
3 control room operation experience.

4 The second level is largely based on the  
5 - it's largely based on neuroscience and cognitive  
6 psychology literature. That part is more - it's less  
7 influenced by internal/external procedure.

8 And when you come to the third part, the  
9 error causes, we are more focused on what happened  
10 inside.

11 Probably you can find 100 different error  
12 causes and we manage to report results relevant to the  
13 procedure-driven performance. And the effect of PIF  
14 then would pretty much focus on the control room  
15 performance.

16 So, then at the end we structure the  
17 important - we put all the information into a structure  
18 like this. You're probably already familiar.

19 On the top is the cognitive function and  
20 we group - on the third column are all these different  
21 failure mechanisms.

22 We group these failure mechanisms into  
23 proximate causes. And also for the failure mechanisms,  
24 we look into the information, what performance shaping  
25 factor would influence this mechanism.

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1           One thing I like to point out is when we  
2 actually used this to develop the IDHEAS method, we find  
3 that the proximate causes really doesn't help us, which  
4 initially we thought it would help us by grouping these  
5 causes together. Then we find, okay, when you group  
6 together, you lose the detailed connections.

7           So, we actually really used the failure  
8 mechanisms. Never really - never really use the  
9 proximate cause. It's just the easy way for you to think  
10 about it. Instead of think about a hundred failure  
11 mechanisms, these mechanisms fell into three categories.

12       That's all we used for this.

13           MEMBER ARMIJO: Could you give just some  
14 examples of a performance influencing factor, then a  
15 mechanism and then a proximate cause just -

16       MS. XING: Okay.

17           MEMBER ARMIJO: - to put it into something

18       -

19           MS. XING: Let me quickly see if I have one  
20 here.

21           CHAIR STETKAR: You're going to walk through  
22 that in a few slides.

23           MEMBER ARMIJO: You know, just a quick little  
24 example.

25       MS. XING: Okay.

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1 MEMBER ARMIJO: I don't want -

2 MS. XING: Let's talk real quick example for  
3 detection. One proximate cause here is cues or  
4 information not perceived. That's a proximate cause.  
5 You didn't perceive the cue or information.

6 And the failure mechanisms, these are some  
7 examples of the failure mechanism. It can be because  
8 the cue salience is low. Like you've got - one alarm  
9 is critical, important. You got several alarms -  
10 several hundred alarms all there with the equal salience.

11 Or you are - you've been working for a long  
12 hour or nothing happened and vigilance is getting low.

13 So, even something happen where they didn't say anything  
14 like one quart for the airport as the security people.

15 If you don't say very often, you often don't say that  
16 that's a vigilance. That's another way to make you not  
17 state the important information.

18 Or your working memory capacity is  
19 overloaded. You have a good -

20 MEMBER ARMIJO: I see that the PIF is a  
21 proximate cause, but what are the mechanisms?

22 MS. XING: Okay, the mechanisms is not here.

23 The mechanisms - this is a mechanism. The mechanisms,  
24 let's say, talk about the salience mechanism.

25 We are - I'm looking at this entire room.

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1 My focus is on the members I'm talking to.

2 What my vision says to do is first to do  
3 is find the important information relevant and filter  
4 out those relevant information. That is a mechanism.

5 If in the vision -- like if you all wear  
6 the clothes like those chairs, there will be less chance  
7 I can identify you. So, that's a mechanism.

8 MEMBER ARMIJO: So, mechanisms are related  
9 to your physical capabilities, eyesight, hearing, other  
10 things that input data into your brain?

11 MS. XING: Yes, mechanism is more related  
12 once you pass your - the sensation part, how your brain  
13 process this information.

14 MEMBER ARMIJO: Okay.

15 MEMBER BLEY: This is for detection, Sam.

16 MEMBER ARMIJO: Yes, this would just have  
17 to be a detection thing, but -

18 MEMBER BLEY: This is -

19 CHAIR STETKAR: But in detection, you got  
20 more to think about.

21 MEMBER ARMIJO: This is the one where data  
22 is coming in, in some way and you're processing it.

23 MS. XING: Yes, you are processing it.

24 MEMBER ARMIJO: Okay.

25 CHAIR STETKAR: The understanding

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1 decision-making one is a little bit more obscure.

2 MEMBER ARMIJO: Yes.

3 CHAIR STETKAR: But it gets the idea through  
4 a little bit better.

5 MEMBER ARMIJO: Okay, thank you. That  
6 helps. Get that into the mic.

7 MS. XING: Okay. So, in the infrastructure  
8 -- that's another weak - limitation in the current  
9 report. We didn't explicitly call up these mechanisms.  
10 So, we primarily focus on the failure mechanisms.

11 Okay. So, that's just to give you an  
12 overview of the process and the considerations there.

13 Now, I have a choice for you. So, here are the five  
14 cognitive functions.

15 We can spend the next 20 or 30 minutes either  
16 talk one function in a greater detail, or quickly go  
17 through all the functions.

18 What is your choice?

19 CHAIR STETKAR: I think, Jing, we, at least  
20 the Subcommittee members, obviously a bunch of changing  
21 faces, some of who now need to be silent, have been  
22 exposed to sort of the big picture.

23 So, it might make more sense and it might  
24 be a little bit easier for some of the members present  
25 who haven't had that background to select one and walk

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1 through it.

2 MS. XING: Yes.

3 CHAIR STETKAR: I think that might be a  
4 little it easier. So -

5 MS. XING: Okay. So -

6 CHAIR STETKAR: - if you can do it that way.

7 MS. XING: - the decision-making process,  
8 which one you pick?

9 MEMBER ARMIJO: Decision-making. This is  
10 not meant to imply there's a sequential, because  
11 communication, coordination are starting right after  
12 you've detected something, normally, I would think.

13 (Laughter.)

14 CHAIR STETKAR: That's one of the  
15 discussions.

16 MEMBER ARMIJO: That's part of it?

17 MS. XING: Yes, that's one of the -

18 CHAIR STETKAR: That's why her figure on -  
19 if you go back to Six, Slide 6, why it's in sort of the  
20 middle there.

21 MEMBER ARMIJO: Okay.

22 MS. XING: Yes.

23 CHAIR STETKAR: The others are more or less  
24 sequential.

25 MEMBER ARMIJO: Yes, right. Got it.

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1 MEMBER SHACK: More or less.

2 CHAIR STETKAR: And iterative.

3 MEMBER SCHULTZ: Well, as we described or  
4 you describe/discuss decision-making, can you discuss  
5 the connections between and among the elements here?

6 MS. XING: Okay. So, how about let's do  
7 this? We can start with detection and -

8 CHAIR STETKAR: No, let's not start with  
9 detection, because that's the easy one that we've walked  
10 through too many times.

11 MEMBER ARMIJO: Decision-making.

12 CHAIR STETKAR: Let's start with  
13 decision-making and -

14 MS. XING: Okay, let's just go through  
15 decision-making.

16 CHAIR STETKAR: - depart from it as  
17 necessary.

18 MEMBER ARMIJO: What's wrong with  
19 understanding?

20 CHAIR STETKAR: Decision-making is good.

21 MEMBER RAY: Decision-making. I answered  
22 first.

23 (Laughter.)

24 (Discussion off the record.)

25 CHAIR STETKAR: We'll get back to

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1 understanding. Some of the threads will -

2 MEMBER RAY: I've made lots of decisions  
3 where I didn't understand what I was doing.

4 MEMBER SHACK: Well, that's never stopped  
5 us before, right?

6 (Laughter.)

7 MEMBER RAY: Well, but that's part of the  
8 thing. You need to understand before you make a  
9 decision. That's what I think.

10 MS. XING: I will quickly walk you the first  
11 slides of every element. Then jump to decision part  
12 of the paper. So, just so we get a sense of how they're  
13 related.

14 So, for detection, it's the process of  
15 perceiving information in the work environment allowing  
16 humans to perceive a large amount of information, but  
17 focus - selectively focus on the important pieces of  
18 information.

19 And the scope in the control room procedure  
20 event basis detect - like detect the salient signals,  
21 alarms and identifying the perceived pertinent  
22 information, monitor parameters. They are the major  
23 functions.

24 So, once you get this information, you will  
25 go to understanding stage. Which understanding is

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1 evaluation of the current condition to assess the plant  
2 status or to diagnose the problems and abnormalities.

3 So, you receive those information in the  
4 detection stage and you come to assess and verify the  
5 information. The information might be misleading.

6 And you receive many pieces of information.  
7 You want develop a coherent representation.

8 And you need to maintain situational  
9 awareness, what happened in the immediate past, what  
10 is going on now and what might go on next.

11 And another part for understanding is you  
12 want the diagnosis of abnormalities. So, that's what  
13 the understanding part.

14 Together detection and understanding many  
15 cognitive model to call this a state as diagnosis -  
16 diagnosis including detection and understanding.

17 Okay. Now, we have a good understanding  
18 and we can go to detection.

19 CHAIR STETKAR: Just for - that's a good -  
20 23 is a good one for folks who haven't thought about  
21 this much, because there's some subtleties in here -  
22 you've characterized it as understanding. In the  
23 report, it's called understanding and sense-making.

24 And the sense-making part of it is important  
25 to some of this and it's important to the way people

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1 respond to things.

2 So, if you could just go through these five  
3 little attributes here, I think it might also help.

4 MS. XING: Okay. So, let's say, you  
5 probably still can make an understanding of some simple  
6 things, some simple things. But for complex task, these  
7 are the things to make you work in a more reliable way.

8 The first element is data content. The  
9 data you receive has to come as a meaningful - have to  
10 be meaningful, make sense to you.

11 And if they are misleading or conflicting,  
12 it's likely you not have a greater understanding of  
13 what's really happening.

14 So, that - and the next element is mental  
15 model. So, where you have understanding is you have  
16 this information - external information come to your  
17 brain.

18 And one famous quote about visual  
19 understanding, this is by a professor from MIT many years  
20 ago, you see a cat, because you know a cat. If you don't  
21 know a cat, you don't see a cat. You see a bunch of  
22 lines and something.

23 So, you have this mental model of what's  
24 happening. You put this information you receive into  
25 that mental model and generate your understanding of

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1 the situation.

2 So, a good mental model is critical for  
3 understanding. It's developed through training and  
4 experience.

5 So, the next stage is you have good data,  
6 you have good mental model and you need to integrate  
7 them together.

8 And you can - you may have many different  
9 versions of a cat. So, you see a white cat, a black  
10 cat, a kitten, all this you have. Now, you generalize  
11 them all.

12 When you see a new cat, you kind of compare  
13 to the cat in your mind or you might compare the cat  
14 to an image of a tiger for someone who grew up in the  
15 jungle.

16 So, you have to select the right - you have  
17 to choose which mental model you should use here and  
18 confirm your understanding. Maybe you reject your  
19 mental model looking for other mental model that fits  
20 the data better. So, this is the integration stage.

21 And to support the integration, you need  
22 attention and working memory. So, attention control  
23 will ensure that all parts of the cognitive process and  
24 understanding are achieved.

25 You tried to understand this, you were

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1 distracted by something else, your attention was paid  
2 to other things. When you come back, you might have  
3 lose your mental picture/image.

4 And working memory is critical. Because  
5 understanding here is you kind of try to bind all these  
6 different pieces of information, external and the  
7 internal, binding them together, hold them together,  
8 and that is done. The mechanism for that is working  
9 memory.

10 So, but unfortunately, working memory is  
11 very capacity limited. So, you can only hold at maximum  
12 - if you want to relate some information together, you  
13 can only - the magic number for that is about four.  
14 You can relate four different things together.

15 If I read you a sentence that have ten  
16 different concepts -

17 CHAIR STETKAR: As you get older, it gets  
18 down to about 0.7.

19 (Laughter.)

20 (Discussion off the record.)

21 MS. XING: Just before that magic number  
22 four, there's another magic number. If you don't try  
23 to relate them, I need to hold them like my to-do list.  
24 Use this information like later on. The magic number  
25 for that is about nine or ten, something.

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1           So, just for those two number, I myself have  
2           a good collection of a full box of papers. And you can  
3           easily find 5,000 article experiment trying to think  
4           of what's the number. There have been a long history  
5           fighting people trying to fight on these two numbers.

6           Finally they realize, oh, you are talking  
7           different thing. So, that's about working memory.  
8           It's a critical element.

9           CHAIR STETKAR: The key is the four isn't  
10          400.

11          MS. XING: And also the belief process. The  
12          belief process is different from your mental model.  
13          Mental model is your understanding, your early - you  
14          get it from early years.

15          And the belief is more like your individual,  
16          which I believe this is what happened. And that can  
17          greatly influence your final understanding.

18          So, like we saw that in TMI, you data relate  
19          this is wrong. So, you wouldn't go looking for  
20          information in that direction.

21          So, these are the things that make you do  
22          a good job with your understanding less likely making  
23          error.

24          CHAIR STETKAR: Or can cause you to make  
25          errors, because you have a mental model with the way

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1 the world works and you discount validate it because  
2 it doesn't fit your mental model. And people do that  
3 all the time.

4 So, this understanding is a lot more than  
5 just -

6 MEMBER ARMIJO: Oh, yes.

7 CHAIR STETKAR: - saying, you know, this  
8 is a cup.

9 MS. XING: To me, I see just a white and black  
10 thing there.

11 CHAIR STETKAR: And now that Harold has left,  
12 you can describe decision-making.

13 (Laughter.)

14 (Discussion off the record.)

15 MEMBER ARMIJO: Given you have  
16 understanding.

17 MS. XING: So, decision-making by definition  
18 is the judgment of what should be done and the decision  
19 to do it.

20 So, decision-making within the control room  
21 is characterized as involving experts and it being  
22 largely driven by procedure in the internal, procedural  
23 event. So, this is an element that is highly infamous  
24 by procedure event.

25 So, therefore, when we decided the scope

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1 - so, this is at the time we think - or our team believed  
2 the - initially we got - we talked to some people on  
3 our team who think, oh, there's really no decision-making  
4 in control room, because you do everything by procedure.

5 Still, the procedure tell you to do - by  
6 procedure you up your diagnosis, you - procedure lead  
7 you to do the feed and bleed. You still need to - the  
8 operator or the shift supervisor still need to program  
9 the sequence of this, your plant.

10 You do a feed and bleed. When you do that?

11 And how you do this and you want this where something  
12 need to be done precisely at some time, or after, okay,  
13 you do something that needs to be done precisely at some  
14 time these are all the same. So, you still need to make  
15 the decision.

16 And in the first high-level station  
17 decision-making, a lot of time the procedures, or you  
18 finish the trip procedure.

19 Now, you come to step and you need to decide  
20 there may be one to help you do the diagnosis. Maybe  
21 not one single procedure there for you. You need to  
22 make a decision -- choose the alternatives between these  
23 procedures.

24 Or even you are in a procedure, sometimes  
25 the procedure presents you different alternatives. You

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1 need to make a decision of that.

2 And that there are also situations that the  
3 scenario does not quite match the procedure. You need  
4 to probably not come up with an entire new procedure,  
5 but you need to make some deviation, modify the plan,  
6 the response plan.

7 So, those are the decision-making we look  
8 into. So, those blank boxes, I will fill them in for  
9 now and talk about the method expansion.

10 Okay. Here I guess because most people are  
11 not interested in the neuroscience part, so I skip the  
12 neuroscience model for decision-making, only present  
13 a high-level decision-making model.

14 The most influential decision-making model  
15 in the area is done by Gary Klein who has done lots -  
16 did lots of decision study for military and aviation.

17 So, his model is a naturalistic  
18 decision-making model. By naturalistic decision-making  
19 it means you - the early decision-making study had  
20 normative decision-making model like you have several  
21 choices.

22 You find some way to compute which choice  
23 give you the best gain. And then you choose the one  
24 that like give you - supposedly you want to achieve some  
25 point at the shortest time and that's your function.

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1 And your decision would be based on that function, which  
2 choice gave you the shortest time.

3 And he finds that doesn't really work in  
4 the naturalistic setting. And look at those military  
5 commanders, the fighters. If they're going to do such  
6 a calculation, they just make a decision.

7 So, he thinks the decision-making in a  
8 naturalistic setting is based on your - some kind of  
9 like pattern match. Through your experience, you  
10 already develop a lot of basic pattern like Situation  
11 A will be Decision A. Situation B would be Decision  
12 B.

13 If you come to a situation kind of between  
14 A and B, you probably quickly come up in a decision  
15 combination like that. So, and you do this - you do  
16 this pattern match-up first.

17 So, you start with the situation on the top,  
18 and then you use the situation generate as a cues  
19 important element and use those cues. That will lead  
20 you to create a story, a pattern. Okay, this is a  
21 pattern.

22 Suppose you have time. And if you have time  
23 - if you don't have time, okay, this is a pattern. So,  
24 my decision should be go, fight, fly the missile.

25 Suppose you have more time than a second

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1 and you want to, okay, wait a second, this is a pattern  
2 I want to upload in the mental model I start before,  
3 bunch of mental model for situations similar to this  
4 and make - use your mental model to make a mental  
5 simulation simulating if I take this action, what's going  
6 to come out of it.

7 And you do this in a cycle for a while.  
8 And finally you take your decision. Then you use your  
9 - you choose your decision. Then you use your decision  
10 to - that decision will activate the actions, scripts  
11 which are the new settings more like procedures steps.

12 And you put that into your action scripts  
13 and still you don't immediately put into action. You  
14 still go to a cycle of mental simulation. Probably you  
15 make a decision. Your problem already change. The  
16 status already updated. So, you take more information  
17 making more mental simulation and then you put into  
18 action.

19 Or if you still - you don't feel comfortable  
20 with your mental simulation, you have a fear, I'm not  
21 sure what this - if this action is really going to lead  
22 to my goal, you will try to locate your situation, try  
23 to get more data.

24 So, you go through this detection,  
25 understanding, mental simulation again and here is the

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1 point that you have to put your action towards.

2 So, this is the process of how you make a  
3 decision in the naturalistic setting. And in this  
4 process you will use your - like your mental model comes  
5 from your long-term memory.

6 And your mental simulation and the pattern  
7 match, those rely on your working memory. So, this is  
8 - what we will call this is a basic mechanism of how  
9 you make decision.

10 So, here is a list of the elements that make  
11 the function reliable. Because in the naturalistic  
12 setting, your decision always come from a goal. You  
13 just don't make a decision randomly. You make a decision  
14 to achieve certain goal.

15 So, goal management is important. It's a  
16 base decision. You need to have a clear goal. And these  
17 goals need to be prioritized.

18 Sometimes, I guess a lot of times, those  
19 goals are conflicting. So, you need to have strategies  
20 how to make which goals the most important. You need  
21 to enforce them.

22 And then you have this pattern recognition  
23 stage or pattern match. The situation to make a decision  
24 is matched to some decision you have made before.

25 So, and basically you gain this through your

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1 training and experience, which I would say in the  
2 internal procedure situation this is also largely driven  
3 procedure helps you do a lot of things.

4 And mental simulation is assess the pattern  
5 and outcome of the decision. Presumably the procedures  
6 already feed a lot of mental simulation for you. And  
7 still it's the situation slightly deviated from your  
8 mental model. You need to do more mental simulation  
9 to say, okay, if that's the - that's going to work.

10 And in the decision-making process, there  
11 are many different kind of biases and good wishes. Like  
12 an example, I typically make a decision based on my wish  
13 instead of the real situation.

14 And as in the profession, you cannot let  
15 that happen. So, you have to assess your bias of your  
16 decision.

17 For example, one type of bias is -- my  
18 pattern recognition is only based on what happened very  
19 recently, but not think of the broad history.

20 So, they can interfere your decision-making  
21 and you have to assess or be aware of your bias and  
22 suppress your bias to make a clear decision-making.

23 And of course as we saw there, attention  
24 and working memory are important in holding the  
25 information and binding the relevant information

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1 together.

2 So, at this mechanism level I can't, I mean,  
3 all these mechanisms applicable for your procedural or  
4 non-procedural event, but something like in the  
5 procedure make - in the decision-making, for example  
6 the team decision-making. And there, there will be some  
7 mechanism about how you achieve a team decision-making,  
8 a team decision. How you achieve a consensus. Those  
9 information are not included - and the mechanism are  
10 not included in this list.

11 So, any question on this?

12 MEMBER RAY: Well, I know that John said  
13 we're too focused on procedures or somehow we didn't  
14 want to be bound up by procedures, but somewhere in all  
15 of this the simple task of following a procedure must  
16 - the decision is I will take the next step in the  
17 procedure, I guess.

18 CHAIR STETKAR: Sure.

19 MEMBER RAY: So, that would fit in with all  
20 of this as one way to make a decision, which is I'll  
21 continue with the procedure that I am following.

22 MEMBER ARMIJO: Or you decide to stop because  
23 you get another piece of information.

24 MEMBER RAY: Yes, that's right. I just  
25 wanted to translate it into how at least I normally think

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1 of things that go on in the control room as being governed  
2 by procedures.

3 They're not inconsistent with this  
4 decision-making model you are describing, right?  
5 You're not having to -

6 MS. XING: No.

7 CHAIR STETKAR: They're not inconsistent,  
8 Harold, but let me read something. I don't want to read  
9 too much here, but it says, in a very familiar setting  
10 in which the cues match almost perfectly the procedural  
11 guidance, the operator may follow the procedures for  
12 full diagnosis needed. In a familiar setting that  
13 deviates just slightly from either procedural guidance  
14 or from previously encountered situations, the operator  
15 will have to adapt some and plan a response based on  
16 an analogous experience. In a novel setting, the  
17 operator will have to construct a new response plan using  
18 his or her knowledge of the plant and system and previous  
19 experience. Each of these options, but particularly  
20 the last two, may be seen through the lens of the  
21 integrated - whatever you call it - normal  
22 decision-making model.

23 MS. XING: Yes.

24 CHAIR STETKAR: The operator or crew will  
25 use cues presented in the situation to construct a story

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1 of what is happening and how the scenario is unfolding.

2 This mental image will be used in developing a response  
3 plan and alternative actions. The response plan may  
4 be largely prompted by procedures or entirely conceived  
5 by the operators. The operator may evaluate the  
6 response plan or action scripts from mental simulation  
7 to evaluated suitability and put it into action. One  
8 of the defining features of decision-making in a nuclear  
9 power plant is the dynamic nature of the event. Maintain  
10 the appropriate situational awareness updating the  
11 mental model of the situation and planning response  
12 accordingly are important steps.

13 And it goes on. So, you're right.  
14 Procedures do play - and this is - this is a description,  
15 and I think it's a really good description. It's from  
16 the NUREG. It says, procedures play a role, but they're  
17 not the only thing.

18 If you believe that the world is acting  
19 specifically exactly the way the procedure says it ought  
20 to work, then you'll probably follow the procedure and  
21 you might be right or you might be wrong.

22 If you're ignoring the procedures, you're  
23 going to make your own decisions and you might be right  
24 or you might be wrong.

25 MEMBER RAY: Yes.

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1 CHAIR STETKAR: So, this framework although  
2 Jing has mentioned procedures, procedures, procedures,  
3 is general. And some, you know, she takes the next step  
4 in here and all of everything else you're going to hear  
5 is general. It isn't just procedures.

6 MS. XING: Yes, the same procedures in this  
7 sense does not work for no procedure. This works for  
8 the situation. It's just the length in the known  
9 procedure situation there are probably couple more  
10 mechanisms than what we listed here.

11 So, it's not about applicability. It's  
12 about the completeness.

13 CHAIR STETKAR: Okay.

14 MS. XING: So, I didn't make this - sorry  
15 I didn't make this clear up front.

16 CHAIR STETKAR: That should be something I  
17 think, you know, as you go through the process - I don't  
18 know what feedback you have received from your peer  
19 review crew.

20 Some of that notion in the report should  
21 be made a little bit more explicit that why in the sense  
22 of completeness do some of these attributes - are some  
23 of them limited because you have focused on that type  
24 of an environment.

25 MS. XING: Yes, thanks.

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1           MEMBER RAY: Well, yes. I did notice that  
2 this talked just about the control room, for example,  
3 in one of the earlier slides. That's all we're talking  
4 about, isn't it? Control room.

5           CHAIR STETKAR: The slides do, but the report  
6 doesn't. See, that's the difference between sitting  
7 in this meeting room with this presentation.

8           I hate to do that, but this is a tailored  
9 presentation that, in fact, is, I believe, more narrow  
10 than the document that's being presented.

11           I just do. I mean, that's my own opinion  
12 because - that's right. So, I think you have, you know,  
13 to be a little bit careful in that sense.

14           MEMBER RAY: Well, I am trying to be and  
15 that's why I asked the question I did. But like I say,  
16 I took it that we were starting with something that was  
17 bounded by the walls of the control room, because that's  
18 what it said.

19           MS. XING: Sorry. I think that's my fault  
20 did make it confusing in the first place. As we said,  
21 we have the applicability and the completeness.

22           So, as far as applicability, what we talk  
23 in this report is applicable to internal or external  
24 event procedure.

25           In terms of the completeness, there is some

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1 part above the external event not included in the report.

2 CHAIR STETKAR: Remember, though, and I have  
3 to keep bringing you back, the term "internal event"  
4 and "external event" is an artificial construct of people  
5 who draw little boxes that have "and" and "or" gates.

6 People who work in the real world don't make  
7 those distinctions. They don't know, oh, my God, I have  
8 a PRA internal event going on because that pump tripped  
9 - oh, no, wait a minute. It's an external event because  
10 the pump tripped because the wind blew down my power  
11 - no, wait a minute. Maybe that's a loss of - they don't  
12 think that way. They don't know.

13 And most of what's in this document applies  
14 to the way people think. It doesn't apply to internal  
15 events or external events or control room or procedures  
16 or some scope of some artificial PRA construct, and that  
17 ought to be the power of this report.

18 How someone wants to interpret this report  
19 and use it for some narrow focus is their business, but  
20 this ought to be the starting point.

21 MEMBER SCHULTZ: In fact, it should not.  
22 It should not distinguish between internal and external.

23 MS. XING: And, in fact, 99 percent of the  
24 literature reviewed are not in the nuclear domain.

25 CHAIR STETKAR: Sure. And that's - because

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1 I don't think that a, you know, just because I have a  
2 degree in nuclear engineering and used to be in a nuclear  
3 power plant, I don't think I'd fundamentally think  
4 different than an airline pilot or somebody who runs  
5 a chemical plant or any other trained professional.

6 MEMBER SCHULTZ: I'm afraid if you had taken  
7 those thousands of references and said, I just want those  
8 that apply to nuclear plants, you would have gotten a  
9 very small number.

10 CHAIR STETKAR: Well, I'm not sure. There  
11 are a lot of people who have gotten degrees and go to  
12 a lot of conferences.

13 (Discussion off the record.)

14 MS. XING: A lot of literature, you know,  
15 for neuroscience literature is not anything about  
16 nuclear power plant.

17 This cognitive literature, people like to  
18 take the abstract out of an airplane setting because  
19 that's easy to understand. They don't like take an  
20 abstract out of a nuclear power plant setting, because  
21 it's too complicated. It's hard to control an  
22 experiment in that study.

23 So, I appreciate this comment and will make  
24 sure in the final report -

25 CHAIR STETKAR: I think in terms of, you

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1 know, if you say, for example, there are five line items  
2 on this slide, if there was a more holistic treatment  
3 of the decision-making function, it might have seven  
4 or eight.

5 MS. XING: Yes.

6 CHAIR STETKAR: I think that you don't  
7 necessarily need to identify those, obviously, but at  
8 least kind of highlight the fact of where this framework  
9 might be somewhat incomplete because of the way you've  
10 needed to bound the problem.

11 MEMBER RAY: Well, let me ask - try one more  
12 time here.

13 Is goal management in this context then if  
14 we're looking at this slide and the five items on there,  
15 it says, decisions to be made have clear goals and can  
16 be prioritized.

17 Okay. Can they also be reflected in a  
18 procedure?

19 MS. XING: I, you know, my understanding,  
20 the procedures already prioritize the goals for you.

21 MEMBER RAY: Exactly.

22 MS. XING: I'm not sure about that, but  
23 that's just my general understanding.

24 MEMBER RAY: That's right. And so, I'm just  
25 saying it's permissible, I would guess, that goal

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1 management could involve a procedure, for example, use  
2 of a procedure.

3 MS. XING: Yes, but still like this is what  
4 I've learned. When you - in the training class they  
5 instruct when you try to do a feed and bleed, even all  
6 the information pointing you to the direction of feed  
7 and bleed, you will still think about the use - you still  
8 try to preserve the plant as much as you can.

9 So, even - so, that's the point even you  
10 - the procedure probably already prioritize the goal  
11 for you to do the feed and bleed, but you may have  
12 additional goals and other consideration.

13 MEMBER RAY: Well, it's an interesting  
14 proposition. Not all people operating a nuclear power  
15 plant have gone to MIT and have a nuclear degree.

16 CHAIR STETKAR: Thank God.

17 MEMBER RAY: And many of them simply are  
18 trained to follow procedures.

19 CHAIR STETKAR: Well, but even there,  
20 Harold, if you look at the procedures - and feed and  
21 bleed is an excellent example. The procedures basically  
22 first cue you to find out whether you have adequate  
23 secondary heat removal.

24 And they then instruct you to try like heck  
25 to get adequate secondary heat removal back while you're

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1 monitoring critical safety functions.

2 And finally when it gets to a point of no  
3 return in the procedure which is written very crisply  
4 in black and white, it says initiate feed and bleed.

5 In the real world if you know that any minute  
6 now, just any second now you're going to get that  
7 feedwater pump running or get that valve open or whatever  
8 it is, you might hesitate. You just might hesitate,  
9 because you have a conflicting goal now restoring  
10 something that you're familiar with, or dumping a bunch  
11 of water in the containment.

12 So, even though the procedure if you read  
13 it according to training and everything else points you  
14 toward feed and bleed because that's the safe thing to  
15 do, there is indeed a conflict there. And somebody needs  
16 to make a decision that says, Ralph, open the valve now.

17 So, it's an excellent example of that  
18 conflict between perhaps - the ultimate clear goal in  
19 this sense is maintain core heat removal, but how you  
20 accomplish that may not necessarily be so clear.

21 MS. XING: Okay. Thank you.

22 So, we can look at the proximate causes and  
23 error causes. It's kind of funny because we identify  
24 the error causes first and group them into proximate  
25 causes, but they ought to be presented in the way like

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1 we identify proximate cause first.

2 So, these are the three proximate causes  
3 we group here. One is that you have incorrect goals  
4 or priority setting. Think of the feed/bleed example  
5 we just talked where you have a goal conflict there.

6 And another proximate cause is the  
7 incorrect internal pattern match. Match the situation  
8 to what you have.

9 So, in that example, error cause for this  
10 would be you did not update the mental model to reflect  
11 the changing state of the system. So, you could use  
12 the wrong model.

13 And also the proximate cause is incorrect mental  
14 simulation or evaluation of options. For example, if  
15 the system response is inaccurate or not updated quick  
16 enough and you may not get to make the correct simulation  
17 of what's going to happen for your proposed action.

18 So, and this very mechanism really  
19 manifests in the operators incorrectly predicting how  
20 the system would response to the proposed action.

21 I think for this section we have totally  
22 about between 15 to 20 error causes. So, I only put  
23 some example here for each.

24 And PIF, performance shaping factors, as  
25 I said earlier, this is the relatively weak part of our

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1 - in our report. It has a lot of limitation.

2 The majority of our literature review, the  
3 information we put here are from the lab studies. In  
4 those lab study, most the lab study don't study  
5 performance shaping factors.

6 They will never study - they don't study  
7 workload, but they will say, okay, what's the difference  
8 between you monitor three airplane versus monitor 20  
9 airplane.

10 So, that's - so, we have to - our team have  
11 to make a lot of our own inferences, which we got some  
12 - we got a situation like this and some of our team member  
13 may say, okay, this is a workload factor from three  
14 airplane to 20 airplane. We got more workload. You  
15 make more detection error, but because you have a high  
16 workload.

17 And another person would interpret, oh, you  
18 got a task complexity issue there. Because 20  
19 airplanes, there got to be more relation between these  
20 airplanes.

21 So, therefore, the performance shaping  
22 factors that we put there is really stay at a very high  
23 level. We think this is relevant, but it may not be  
24 the only factor work for this.

25 And in the extreme case you can say probably

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1 all the performance shaping factor would work for every  
2 situation. Training always matters. Complexity  
3 always matters. Workload always matters.

4 That's why later we have some expansion.

5 But for now for what we report in the literature we  
6 give since we couldn't really process this and give a  
7 clear distinction. So, we just put some examples in  
8 the appendix instead of saying this performance shaping  
9 factor is exclusively work for this failure mechanism.

10 CHAIR STETKAR: I know you said at the start  
11 that you're in the process of receiving feedback from  
12 your peer reviewers.

13 Where are you in that process? Have you  
14 received reports from all of your reviewers, or are they  
15 coming in, or are they being prepared?

16 MS. XING: No, we actually haven't received  
17 any formal review back.

18 CHAIR STETKAR: Okay, okay, okay.

19 MS. XING: Those -

20 CHAIR STETKAR: Then I won't ask the question  
21 I was going to ask. I just wanted to know where you  
22 are.

23 MS. XING: Those feedbacks only I met those  
24 reviewers in a meeting. So, we had some verbal exchange  
25 of information.

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1 CHAIR STETKAR: Thanks.

2 MS. XING: So, when you look at those PIFs,  
3 the very first example is very tricky when you say, well,  
4 a conflict in the goal. Is it task complexity or work  
5 process? It's really hard to say. So, it's very much  
6 a subjective judgment what you put there.

7 And the next one like not updating your  
8 mental model, it could be because of high workload or  
9 it could be because the situation is so complex.

10 So, that's we see the performance shaping  
11 factors information we put there is only give you a  
12 high-level direction, not explicitly tell you how to  
13 work them. And we will see more of this in the extension  
14 work.

15 Okay. So, that's about the  
16 decision-making. And if you like, we can jump to see  
17 the expansion which I will talk more about the  
18 performance shaping factors.

19 CHAIR STETKAR: Just -

20 MS. XING: Another function?

21 CHAIR STETKAR: No, I'm not going to let you  
22 off that easily, but you don't have any slides for it.

23 Do you have any slides for the - what I tend  
24 to call crew dynamics or you call it team coordination?

25 MS. XING: No, I didn't prepare slide for

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1 that.

2 CHAIR STETKAR: You didn't, yes, okay.  
3 Never mind. Go on.

4 MS. XING: For the reason I mentioned  
5 earlier.

6 CHAIR STETKAR: That's a difficult area.  
7 It's the area I think that you mentioned earlier from  
8 preliminary feedback that the report is - I don't  
9 necessarily say weakest. It's just least definitive  
10 in that area.

11 MS. XING: Yes.

12 CHAIR STETKAR: But it does make some  
13 progress at least to try to organize information. But  
14 if you don't have any slides prepared, then I guess we'll  
15 just skip it.

16 MS. XING: Yes, I couldn't -

17 CHAIR STETKAR: I was going to try to  
18 challenge you in that area.

19 MS. XING: Okay, but I could just briefly  
20 talk -

21 CHAIR STETKAR: All right.

22 MS. XING: - about some progress we have  
23 there.

24 Now, basically when we have as we pointed  
25 out in the report, when we worked on that function,

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1 it is a separate function or it should be part of other  
2 functions.

3 That's interesting. We had a similar  
4 debate here in our expert elicitation workshop regarding  
5 communication. So, should it be a separate failure mode  
6 or it's just a moderate factor moderate the other failure  
7 mode. We haven't solved that problem yet. We'll solve  
8 it next week.

9 CHAIR STETKAR: One of the reasons that I  
10 bring it up is that in the NUREG report it is, as I said,  
11 kind of the least definitively developed. However, when  
12 you go to the application, the methodology, IDHEAS, it  
13 suddenly becomes divided into very, very distinct,  
14 little pieces.

15 MS. XING: Actually three.

16 CHAIR STETKAR: Right. And I was curious  
17 about how that very distinct, very crisp three-piece  
18 approach to the world evolved from what's in the broader  
19 document.

20 So, I don't know if you want to talk about  
21 that now or whether you want to talk about it in the  
22 next -

23 MS. XING: I can talk about it now to give  
24 you the transition to that. So, when we decide - in  
25 the early stage when we decided this function and we

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1 said, okay, that's really the person who is responsible  
2 for this part. There's really not so much about  
3 communication teamwork because it's a three-way fix.

4 There's really not no real teamwork there,  
5 because you really a supervisor with instruction to the  
6 other operators and the other operator performance  
7 excuse the action and report back.

8 CHAIR STETKAR: Jing, is that the way the  
9 real world works?

10 MS. XING: That's what - I don't want to put  
11 this on record. I don't think that's the real way.

12 CHAIR STETKAR: I don't think it's the way  
13 the real world works either, and I think we had many  
14 -

15 MS. XING: That's what we -

16 CHAIR STETKAR: - examples from the real  
17 world that says the real world does not work that way  
18 not only in the nuclear power industry, but in many other  
19 industries.

20 MS. XING: I think the real world work  
21 differently. And, like, we cross this - like in the  
22 Halden study we see, let's say we have the European  
23 countries and us, United States, and the Japan plant  
24 with this observation.

25 In European, they work really like a team.

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1 It's not a supervisor issues instruction to others.  
2 They all - whenever they put a malfunction there, they  
3 see something abnormal, they immediately group together  
4 to the center of the room and have a talk. Then go do  
5 something.

6 CHAIR STETKAR: Okay.

7 MS. XING: And in the America team, it's more  
8 - it's not that much a group, but it's - they have some  
9 conversation. Talk about more than just procedures.

10 And the Japan even has participator study  
11 with some other source of information I heard. Some  
12 plan basic at the Japan plant. They never talk. So,  
13 each person stays in his own set, do what he's supposed  
14 to do. They don't get together and talk.

15 "Never" is a word that they use. I guess  
16 it's a little bit exaggerated. I'm sure they talk.

17 CHAIR STETKAR: Yes, but, I mean, you've  
18 highlighted sort of three different ways that people  
19 may work together or not work together.

20 MS. XING: Yes. So, when we did that, okay,  
21 let's just stay to the American way or the America, what  
22 does the procedure said? And you have this three-way  
23 communication. It's always supervisor read out the  
24 procedure and you read back.

25 CHAIR STETKAR: How did we lose all component

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1 cooling water at HB Robinson during the fire event?

2 MS. XING: Sorry?

3 CHAIR STETKAR: How did we lose all component  
4 cooling water at HB Robinson during the fire if people  
5 followed the procedures and read back in a very  
6 structured manner?

7 It's an American plant under a real event

8 -

9 MS. XING: I guess -

10 CHAIR STETKAR: - that missed very  
11 important functions going on in the plant. So, how did  
12 we do that if that's the American model?

13 So, I'll challenge you that -

14 MS. XING: There's a failure of  
15 communication.

16 CHAIR STETKAR: Okay.

17 MS. XING: That's in the failure mode we  
18 captured.

19 CHAIR STETKAR: Okay.

20 MS. XING: So, you have this basic  
21 communication, but there always chance like you fail  
22 communication. You didn't start the communication.  
23 You need to communicate that message. You did not start  
24 it and then you come to the factors that can come to  
25 play.

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1           That's not a high priority or I just forgot  
2           or a lot of times this factor is a major player in a  
3           situation like that. And I think distraction is in the  
4           situation in Robinson case. You got distracted.

5           Some recent experiment in Human Automation  
6           Lab that MIT found when you try to follow this restricted  
7           procedure if you have an unexpected add-on task  
8           somewhere, you do it very shortly.

9           Then you are very likely make a mistake for  
10          the rest of the procedure even the procedure is still  
11          there.

12          So, all this can cause a failure often a  
13          three-way communication wall. That's why I say we look  
14          at the potential failure mode, failure mechanism for  
15          communication. And really we didn't do much about the  
16          teamwork and coordination. So, that was early stage.

17          And later on we complete this work in 2012  
18          when we try to expand the work into the Level 3 PRA,  
19          other situations, and we reviewed like the Fukushima  
20          report and other things reported and then look at the  
21          SAMGs.

22          Really you find there's more communication  
23          function rather than there's a three-way. The  
24          communication is there. It's more like it's a task like  
25          you need to communicate this risk happening.

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1 Or when there is high-level decision-maker,  
2 the plant people, do some good work to inject water,  
3 you probably should communicate more than just do it.

4 You should communicate why you need to do  
5 it, and what if you don't do it. So, there's more  
6 communication issues we should model than just this  
7 three-way communication.

8 So, that's why in the initial setting we  
9 try to put this as three separate functions.  
10 Communication, teamwork, and in the report what we  
11 initially called as supervision, later we - just last  
12 week we decided it's really not supervision. James  
13 challenge me, what do you mean by supervision?

14 Okay. You really talking about network  
15 coordination. In a severe accident, you have this many  
16 different function whether this coordination can go  
17 through. If the coordination fail, you would fail  
18 sometimes.

19 So, those really act as individual task  
20 which are critical for the success of your goal. That's  
21 why we put them as three separate functions.

22 But since that is still in development,  
23 we're going to have a series of workshops look at those  
24 each individual function. We may either merge them.  
25 They may stay as a separate function or we merge them.

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1 That's still in development.

2 CHAIR STETKAR: I guess my only feedback and  
3 it's obviously a work in progress in this particular  
4 area, would be that in the same sense of the other  
5 macrocognitive functions that you - in the context of  
6 NUREG 2114, don't get too trapped into a particular  
7 construct in this teamwork communication, whatever you  
8 want to call it, element, you know, similar to the passage  
9 that I read earlier that although procedures may be  
10 important, there are other things happening in terms  
11 of things that influence decision-making. And the  
12 report at least makes you aware of those other features.

13 So, in the same sense of this communication  
14 teamwork process, I hope you'll keep that high level  
15 perspective.

16 MS. XING: Thanks.

17 MEMBER REMPE: This is a questioning  
18 attitude to encourage and that would -

19 CHAIR STETKAR: That's part of this  
20 communications, yes. I mean, that's, you know, you can  
21 call it - I hate the word "safety culture," but -

22 MEMBER REMPE: I do too. That's why I said  
23 questioning attitude to -

24 CHAIR STETKAR: But that's part - and that's  
25 been identified. I mean, you know, the airline industry

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1 has worked on that for a long time where the person in  
2 the right seat, you know, didn't question the person  
3 in the left seat. And people have died because of that.

4 MEMBER REMPE: Some symptoms is not what  
5 you'd expect when you're looking at other -

6 CHAIR STETKAR: So, that's part of it.

7 MEMBER RAY: Well, I think - and, again, I  
8 keep reflecting on as much as we might want things to  
9 be different, if this - if the kind of teamwork that  
10 you're describing or - I think it comes with the problem  
11 of beyond design basis events and that sort of thing.

12 But if we're going to actually have people  
13 do what you're talking about people doing on the flight  
14 deck, it's going to have an impact on the people who  
15 can be qualified to participate in that kind of a process.

16 You don't let just the senior aircraft  
17 mechanic become the guy who flies the airplane. And I'm  
18 afraid that in many organizations, at least ones I'm  
19 familiar with, that is what happens.

20 CHAIR STETKAR: Well, that's the -

21 MEMBER RAY: And so, if you say to people,  
22 well, here are the procedures and if it looks like a  
23 good thing to do, follow them. But if things don't look  
24 like they're lining up with the procedures, then get  
25 together and decide what to do.

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1 I'm just not sure about all of that.

2 CHAIR STETKAR: Well, I think Jing mentioned  
3 that I think as you go further out into the evolution  
4 of a real event, the notion of that team and the  
5 communications becomes a lot more, let's say, difficult  
6 to define.

7 MEMBER RAY: I don't dispute it. I'm just  
8 saying -

9 CHAIR STETKAR: That's -

10 MEMBER RAY: - there are implications of  
11 -

12 CHAIR STETKAR: Oh, yes.

13 MEMBER RAY: - what we're talking about  
14 here that I think -

15 CHAIR STETKAR: But, I mean, even within the  
16 confines of just draw the block walls and close all the  
17 doors and hit the plant with some sort of challenge,  
18 then I'll keep using the HB Robinson fire until I find  
19 a, you know, until the next thing happens.

20 Even within the construct of that where  
21 people were operating within their own little world,  
22 there were obvious problems in terms of either a lack  
23 of communication or perhaps too much focus on specific  
24 issues.

25 The team didn't melt the core, but the team

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1 didn't accomplish all of the functions that one would  
2 expect them to function, to accomplish. At least not  
3 in the time that you normally expect them to do that.

4 MR. CHANG: This is James Chang. I am  
5 researcher at the SACADA project.

6 Within this project that we have developed  
7 in connection with the training staff, we talk about  
8 how we characterize the supervision complication.

9 And there's two things for the purpose of  
10 this project that the eventual goal is having the method  
11 for predictive analysis.

12 So, what this I think that's come here when  
13 we define a PIF at this level, that's only trying to  
14 study which always having the predictive purpose in mind.

15 CHAIR STETKAR: Okay, great. Thank you.

16 MS. XING: Okay. So, we'll use the last ten  
17 minutes to talk about some additional work that's not  
18 included in the report and which one part we already  
19 talk is expansion of the scope like in the  
20 decision-making or the expansion of basic communication,  
21 teamwork, cooperation.

22 So, with this additional extension and the  
23 - also they did additional work for that extension.

24 And an important part is the third bullet.  
25 As we said earlier, those PIF, performance shaping

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1 factor, at the high level does not really help us in  
2 developing the estimates of HEP. So, we developed one  
3 which I called an inventory of PIF characteristics.

4 And finally we can reconstruct cognitive  
5 basis in this level, and make a mechanism to make it  
6 work reliably. Error cause is the other one. Failure  
7 was to make a clear distinction.

8 So, this is early model. So, here you see  
9 the expansion for the decision-making part. Now, I fill  
10 out those columns in the right side.

11 So, beyond the procedure situation you  
12 could come to a situation where you need to develop  
13 response plans from SAMG event.

14 And you will need to make distributed and  
15 dynamic decision-making. And you need to come to a point  
16 to determine criteria is based on single person or based  
17 on team consensus. So, these are just a couple example  
18 by reading those.

19 (Discussion off the record.)

20 MS. XING: So, these are some expansion of  
21 the scope.

22 CHAIR STETKAR: Now, let me ask you a  
23 difficult question. We've heard that, I mean, we have  
24 the Level 3 PRA project charging ahead with lightning  
25 speed. And we've heard that this methodology, if you

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1 will, will be used in that project.

2 Is that correct, or not?

3 MR. PETERS: Jing won't want to step into  
4 that one.

5 CHAIR STETKAR: That's why -

6 (Laughter.)

7 MR. PETERS: I'll just say it's yet to be  
8 determined.

9 CHAIR STETKAR: Okay.

10 MR. PETERS: My intent is to try to use as  
11 much information as we can from this project to inform  
12 that.

13 One of the people that are on both of these  
14 projects now is James Chang. So, he's on the Level 3  
15 development, and he's also on the development for the  
16 IDHEAS.

17 So, what I don't want to do is have two  
18 separate projects that go two different directions.  
19 So, we're trying to keep it as integrated as possible.

20 CHAIR STETKAR: Right.

21 MR. PETERS: There are some differences and  
22 there may be some technical difference of opinion amongst  
23 individual team members that may come to light in this  
24 process, but we'll try to keep it as in mind as we can.

25 CHAIR STETKAR: Thanks. One of the reasons

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1 I ask, Sean, is what Jing has highlighted on the  
2 right-hand slide of this slide and some of the issues  
3 that Harold brought up about response plans, distributed  
4 decision-making, less, perhaps, procedurally-based  
5 decisions tend to become much, much more important when  
6 you get out into the severe accident and Level 3 parts  
7 of the risk assessment process.

8 So that, you know, depending on the  
9 decisions and how wholly integrated you're going to  
10 become in that Level 3 PRA project, some of the things  
11 on the right-hand side of this slide might be more  
12 important.

13 MR. PETERS: I tend to agree. And any  
14 feedback we can get from ACRS or the ACRS subcommittees  
15 that kind of push to that direction to make these  
16 considerations is always helpful when trying to convince  
17 other parties.

18 There's a different dynamic - I know you  
19 might not want to step into that, but there's a different  
20 dynamic in that there are a lot of time and pressure  
21 - schedule pressures on the Level 3 team. And as I  
22 understand, some of the considerations they have to  
23 include are trying to expand existing methodologies into  
24 those domains versus what they would consider a new  
25 methodology here in IDHEAS.

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1           My own impression of IDHEAS and how I think  
2           the model works for IDHEAS is I don't see it as a new  
3           model. Taking a lot of the pieces that ACRS or at least  
4           in the Subcommittee had incorporated or told us to  
5           incorporate in some of the letters that said take some  
6           of the existing work that we've done in fire and put  
7           that into a qualitative analysis portion, I don't see  
8           that as us developing something new, but capturing a  
9           lot of development that the staff has already done.

10           So, any feedback or anything that the ACRS  
11           could provide to help provide some high-level guidance  
12           in the project may be helpful.

13           CHAIR STETKAR: We should talk - and to keep  
14           us on track here a little bit on the agenda, at the end  
15           of the meeting here we should talk a little bit about  
16           that.

17           Because if you do want formal feedback from  
18           the ACRS, we need to - the plan for that, you know, full  
19           committee meeting and a letter and whether you want that  
20           letter.

21           You may want to think about it a little bit  
22           this afternoon, but focus strictly on this NUREG or focus  
23           on the NUREG with, you know, whatever is developed in  
24           the application of the methodology and the timing of  
25           that.

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1 So, keep that in the back of your mind and

2 -

3 MR. PETERS: I would love to. And  
4 thankfully Don Helton just stepped into the room for  
5 the second part of the briefing. And so, I may be  
6 stepping on his toes or his team's toes with whatever  
7 I say. So, it would be good to have in that discussion.

8 CHAIR STETKAR: Yes. Good, good, thanks.

9 MS. XING: Okay. So, and the other part to  
10 expansion is we develop an inventory of PIF  
11 characteristics, which is the basic concept. You can't  
12 just say complexity, workload, HSI, which - what aspect  
13 of this factor would affect failure of mechanism.

14 This is in term of the amount of work, it  
15 have the equal amount as we develop the original report.

16 For develop this list, we rely on not just the  
17 literature, but also a lot of the event report and the  
18 whole stack of NTSB report there and also the other  
19 existing HRA method. So, try to make as comprehensive  
20 as we could get.

21 So, basically these are the performance  
22 shaping factors we modeled and put them in the three  
23 categories, cognitive, workload and task complexity.  
24 So, these are direct challenge your cognitive  
25 mechanisms.

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1 And then the HSI environment and procedures  
2 is basically to aggravate your cognitive demanding.  
3 And then you have training, work process, organizational  
4 factors. This - presumably they should make your work  
5 demanding easier as of like some very complicated tasks.  
6 With the training, you can do it almost automatically.

7 They presumably provide barriers to error  
8 cause. There is always a cause, no matter where your  
9 training goes and that's where we focus on this.

10 So, for each of the cognitive function and  
11 we go through each of these PIF and identify the PIF  
12 characteristics that challenge the cognitive mechanism  
13 and trigger those error causes.

14 So, I put some example here - or, sorry,  
15 I put "understanding" here. So, let's look at the first  
16 column of those PIF called the context factors. And  
17 for workload here, I show two example. One is  
18 multitasking. One is interruption - another is  
19 interruption. We have to have five workload factors  
20 there.

21 And Phase 2 were challenges of cognitive  
22 mechanism which the integration process when you try  
23 to integrate the external information with your mental  
24 model.

25 If you have multitasking, you have

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1 interruption, you likely make a mistake. So, another  
2 example, the next one is easier.

3 Task demand is an unfamiliar scenario. If  
4 you got an unfamiliar scenario, you are very much - you  
5 are very likely don't have a perfect mental model there.

6 So, this will make the connection more  
7 explicit. The extent of just talking HSI workload will  
8 give this explicit link of the characteristic link to  
9 the cognitive mechanisms.

10 And so, this is in the - this list is in  
11 the appendix of the volume the Generic Methodology.  
12 And we actually used this in - this list in developing  
13 the decision trees for the internal event.

14 CHAIR STETKAR: Now, for my benefit because  
15 I keep getting confused about which hat you're wearing  
16 when you say it's in the appendix of the generic  
17 methodology, it's in the appendix of the EPRI research  
18 report on IDHEAS. It's not in the appendix of NUREG  
19 2114, right?

20 I'm staring at the appendix of NUREG-2114.

21 MS. XING: I am actually sorry I cannot make

22 -

23 CHAIR STETKAR: I understand that, but I'm  
24 going to try to keep you separate, because there are  
25 two distinct -

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1 MS. XING: You know, now I think I remember.  
2 I'm not quite sure it's 100 percent correct. I think  
3 we have it in both.

4 CHAIR STETKAR: Well, in 2114 there are some  
5 nice - as you expand your - I really like the colors,  
6 the kind of green, blue, pink. I don't know what the  
7 actual shades are, but there are actual drawings that  
8 eventually get you to individual PIFs at least in the  
9 context of the NUREG that affect, for example,  
10 understanding and it's a much larger list than what you  
11 have here.

12 MS. XING: I will challenge that. You know,  
13 it's a must larger list. But if you like - if you list  
14 many stats for individual examples, those individual  
15 examples will group into some characteristic topic here.

16 CHAIR STETKAR: Okay, I'll give you that.

17 MS. XING: Because I checked that list.

18 CHAIR STETKAR: I'll give you that one.

19 MS. XING: Okay, yes, but there could be I  
20 missed one or two points, but a list - I went through  
21 that appendix see if we miss any, no.

22 And some of them I did not use. As we said,  
23 those - a lot of PIF we put there is based on our own  
24 inference.

25 When I feel I'm not competent about this

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1 inference and I did not see an example from the  
2 experience, a personal experience reveal or literature,  
3 I did not include them.

4 And I also exclude a lot of them which are  
5 not so relevant to the control room. For example,  
6 particularly in the HSI part we had a lot examples in  
7 the literature review report. And the majority of those  
8 example from lab setting, which do not applicable to  
9 a nuclear power plant setting. So, I take those out.

10 And so, the list presented isn't selective.

11 Like, initially I got the HSI factor from all kinds  
12 of sources. Several pages. And finally narrow it down  
13 to like 10 to 20 items.

14 So, what we are going to do next after next  
15 week, we will have this larger development group together  
16 and go through those list and say, put those in the more  
17 operational setting.

18 CHAIR STETKAR: Okay. I'm not - I'll belabor  
19 it one last time. If there's anything that you can do  
20 to not change NUREG-2114 and make it focused only on  
21 quality of the display and quality of the procedures,  
22 please don't do that. Because everything I hear you  
23 saying is quality of the procedures and quality of the  
24 displays.

25 And that's fine for a particular

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1 application within a narrow construct, but that's not  
2 the purpose of NUREG-2114.

3 MS. XING: So, that -

4 CHAIR STETKAR: So, if you can keep that  
5 split and -

6 MS. XING: Yes, we -

7 CHAIR STETKAR: - don't let that, you know,  
8 I'm not sure when you talk about you're getting the group  
9 together and making decisions.

10 MS. XING: We do lots of changes. That's  
11 why I decide to have this as a separate not changing  
12 that, because that's the foundation part.

13 CHAIR STETKAR: Right.

14 MS. XING: And this is real world  
15 implementation.

16 CHAIR STETKAR: That's the whole point.  
17 Okay, good. Good.

18 MR. PETERS: It should be in a separate  
19 report.

20 CHAIR STETKAR: Yes, yes.

21 MS. XING: And also like another example in  
22 this list, I did not include as many HSI factors that  
23 are specifically for digital interface. And, however,  
24 we would probably really need to include that, because  
25 in new reactors you do have computerized procedure come

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1 up.

2 There's a whole big list of HSI factors  
3 specific for computerized procedure, but that's another  
4 issue.

5 So, and then finally we organize  
6 information in Phase 4 levels. On the top level is the  
7 cognitive functions and the objectives.

8 And the next level are the cognitive  
9 mechanisms. And below that is the error causes and the  
10 PIF characteristics.

11 The number on the right is just to give you  
12 a reference of how many item we put there. And this  
13 number right now is a dynamic - keep changing every week  
14 or add something new, eliminate something. So, but just  
15 to give you kind of a sense what we have there.

16 CHAIR STETKAR: Are there any other  
17 questions on this part of the presentation? If not -

18 MEMBER ARMIJO: I like the cartoon.

19 CHAIR STETKAR: - thank you. And it just  
20 looks too much like me. I used to have a crewcut.

21 (Laughter.)

22 CHAIR STETKAR: Let's take a 15-minute  
23 break and come back at 3:15.

24 (Whereupon, the proceedings went off the  
25 record at 2:59 p.m. for a brief recess and went back

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1 on the record at 3:14 p.m.)

2 CHAIR STETKAR: Okay. We're back in  
3 session. Let's hear about the methodology.

4 MS. XING: Okay. So, thanks. Before start  
5 talking the general methodology and just, I think,  
6 reminds the history for this part. And from the  
7 beginning of the IDHEAS project back a couple years ago,  
8 the team had been focused on the small circle you see  
9 there - well, actually it should be a cube. I don't  
10 know how to draw the cube for internal at-power Level  
11 1 procedure.

12 And we have this large circle of the HRA  
13 applications. Particularly we have Level 2, Level 3  
14 HRA Projects going on.

15 And so, this is we try - this work represents  
16 an effort of expansion from the small circle to the big  
17 circle. The expansion is not just extension from what  
18 we develop for the IDHEAS method for procedure event.

19 We took input from many others, particularly for HRA.

20 And also for the process of developing this  
21 expansion, just call it Level 2 HRA, initially is James  
22 and I, we work together. Laid out this theoretical  
23 framework of how we think it should be done, what it  
24 should have included in each part.

25 And once we laid out this framework to make

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1 it a real method that implementable, we are extend the  
2 team by including HRA and PRA expert in our agency.  
3 Some people say is an expert from our research like Susan  
4 Cooper and Song-Hua Shen.

5 MR. CHANG: Yes, we have Don Helton, Song-Hua  
6 Shen and Chris Hunter. Chris Hunter was doing the  
7 analysis. Don Helton was knowledgeable in the Level  
8 2 activity.

9 And we also had people from NRR, Jeff  
10 Mitman, knowledgeable in the low-power shutdown and is  
11 currently also doing another project involving the  
12 Fukushima activity.

13 Region 1 we have Rudy Bernhard, the SI.  
14 Several meeting, in the SI meeting, he express a strong  
15 interest in helping and has a very senior experience  
16 there at SI.

17 We also have NRO, Jim Kellum. He has 20,  
18 30 years trainer - plant operation training experience.

19 And then also help the plant down in Maryland develop  
20 the SAMG procedure guidance. So, all these are NRC  
21 internal staff.

22 MS. XING: So, what I -

23 MR. CHANG: I'm sorry. One more person.

24 John Kauffman, he is our senior people  
25 knowing the admins in the operating experience so that

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1 we can always go to him for operating experience.

2 MS. XING: So, what I'm going to talk today  
3 is primarily this framework we laid out and this team  
4 will start working next week. Next Tuesday will meet.

5 And so, for this meeting I would more view  
6 this part of the meeting as a discussion instead of  
7 briefing something that already there as a product.  
8 So, appreciate comments from you and suggestions.

9 So, we're talking this middle part as a  
10 product, generic methodology for NPP applications which  
11 include all hazards and scopes, the big circle.

12 So, I will talk for briefly the goal and  
13 approach and talk to part of this framework, task  
14 analysis and proposed method for HEP quantification and  
15 briefly the path forward.

16 So, the goal, we talked this a lot in the  
17 last several previous meetings, is to develop an  
18 integrated methodology applicable to all HRA domains  
19 in this big circle.

20 And this method should be generic enough  
21 for all the applications and with a good technical basis.

22 And also to make a smooth transition once it - try our  
23 best to conform with current HRA standard and a good  
24 practice. Retain and integrate the strengths of the  
25 existing method. And enhance the capability to address

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1 some key weakness in the current method.

2 So, this is how the framework laid out.  
3 It's no different from - it's pretty much a copy from  
4 a PRA standard or HRA good practice.

5 You start by understanding the scenario,  
6 identify HFE, human failure events, and analyze the  
7 feasibility. Then you going to analyze the tasks which  
8 we typically call the qualitative analysis, analyzing  
9 the performance shaping factor, estimate the human error  
10 probability, HEP, and do dependency analysis and  
11 uncertainty analysis, which I didn't put up there.

12 So, this is a basic framework. We're going  
13 to keep all the same. And this is a very messy slide.

14 So, you can now just look at on the left side, which  
15 tells the input, the strength in the existing method  
16 that we take.

17 So, specifically the first of three parts,  
18 understanding scenario, identify HFE and analyze  
19 feasibility, we pretty much - it's not copy-paste, but  
20 it's a very high level adaptation from fire HRA and the  
21 fire feasibility and reliability analysis report. And  
22 also in each of these element we take something from  
23 the existing report.

24 So, on the right side are the areas we make  
25 enhancement. So, some - and for today I will primarily

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1 talk what's in this yellow box, the task analysis and  
2 the inventory of performance shaping factors which we  
3 already talked a moment ago. And I would like to focus  
4 our discussion on this quantification method that we  
5 are proposing.

6 So, the technical approach is we start from  
7 this cognitive basis that we talked earlier. And to  
8 use this for HRA, what we need is on the top part, you  
9 know. We got this and we would like to develop procedure  
10 or guidance to translate operator response in the PRA  
11 scenario into this first level for cognitive basis.

12 So, in other words, we try to represent  
13 EPRI's response in the PRA scenario in term of the HFEs.

14 Then it goes down to operator task. And then for the  
15 operator tasks, what are the cognitive functions  
16 involved. So, this part we typically - this like  
17 traditionally we call qualitative analysis.

18 And on the bottom part we have that  
19 inventory of PIF or context characteristics who try to  
20 use that in a structured way to come up in an HEP  
21 quantification.

22 So, the things we need to do, which I already  
23 said, we need to come up in the procedural guidance to  
24 represent PRA scenario human-centered tasks and  
25 associated cognitive characteristics.

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1           And we develop that PIF characteristic  
2 list, but we want to make it really in the nuclear power  
3 plant setting and come up with a method to put all this  
4 information together to estimate the probability. So,  
5 these are the tasks that we needed to do.

6           So, for the first part I talk about the task  
7 analysis structure. This is largely to what we already  
8 did in the Level 1 - not Level 1, the internal procedure  
9 IDHEAS that we presented to you last December. So, I'll  
10 just quickly go through.

11           I'm sure you know what a CRT is by now.  
12 So, develop CRT and identify critical tasks. Then  
13 characterize the cognitive aspects of this task. And  
14 perform cognitive workload analysis. And addition to  
15 that is to try to refine the PRA operational story from  
16 the cognitive perspective.

17           I want to talk about CRT again. Basically,  
18 CRT is the way to graphically represent the tasks and  
19 use that to identify the safety-critical tasks based  
20 on the task criticality, recovery potential and the human  
21 involvement.

22           Once the critical tasks are identified, we  
23 look at this cognitive features. The task goal, the  
24 functions and objectives involved. And the plant cues  
25 and the other supporting information, procedures, time

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1 available and personnel.

2 With this information - this is not a  
3 complete list. We also have other items there, but that  
4 information can allow we perform a timing and a workload  
5 analysis.

6 See, we could lay out those tasks with their  
7 relevant time. With that, we can in the workload - in  
8 the workload the characteristics so the timeline would  
9 allow us to say which tasks.

10 In this example, you are doing tasks.  
11 There is overlap in Task 1, Task 2 in terms of timing.

12 So, you are doing multitasking there when you come to  
13 Task 2.

14 And also maybe there could be interruption  
15 and distractions if there is spurious action there.  
16 So, and also this will allow us to analyze the time  
17 demanding and available time. So, these are just the  
18 general concept how we do collecting this information.

19 And because we are gradually break down the  
20 scenario into HFE then to critical task, then these  
21 cognitive functions. So, at the end before we going  
22 to quantify the HEP, we wanted to make or have a coherent  
23 understanding and make sure we do not lose the context  
24 if we keep doing this breakdown.

25 So, when we do the PRA scenario

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1 understanding, we put together an operational story in  
2 the system. Now, with all the supporting information,  
3 we can refine that story to have a coherent understanding  
4 of the HFE cutset from human-centered perspective.

5 By doing so, it can help us to square off  
6 of those very low probability HFEs. This is based on  
7 the conversation with the PRA folks. A lot of time you  
8 come to in that you - in a scenario, you come to a hundred  
9 HFEs. You have to have a way to select the most important  
10 one. So, these provide some guidance in what situation  
11 you can think, okay.

12 And the context of the PIFs are in good  
13 condition. No dependency between this HFE and this  
14 previous one. So, we probably just assign a minimal  
15 HFE number. Then go to the next - otherwise you do a  
16 more detailed quantification analysis.

17 Of course there's some activity going on  
18 right now to - I think we have some argue, what does  
19 that mean, HFE?

20 MR. ZOULIS: My name is Antonios Zoulis and  
21 I'm from NRR/DRA. This kind of goes as counter to what  
22 we usually do. And when we do a PRA, it's we basically  
23 assign a conservatively value. And then if it doesn't  
24 contribute much to your access sequence, then you leave  
25 it. You don't do any further analysis. This is kind

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1 of a little bit different.

2 Can you explain the - because maybe I - I  
3 don't know. Maybe I'm misunderstanding. Are you  
4 trying to say like of the lowers possible HEP you can  
5 go to, or are you saying you're screening HEP or can  
6 you explain that a little bit?

7 MS. XING: Okay. This is just an  
8 explanatory idea. And I - we talked about the PRA  
9 approach. You do a sensitivity analysis.

10 This is after the sensitivity analysis.  
11 You still have many HFE there. More HFE than you could  
12 handle.

13 Maybe you could use this as a screening tool  
14 to screen off those ones that you can simply assign a  
15 minimal HEP instead of going to a detailed analysis.

16 However, this right now, this part is just  
17 a concept. We don't know if it's really going to work  
18 or not. That's what we are trying to look with next  
19 step.

20 MR. ZOULIS: Okay.

21 CHAIR STETKAR: I tend to agree. You know,  
22 I read through this and, I'm sorry, it's just too easy  
23 to dream up ways of throwing things away.

24 For example, there's - I'll give you a  
25 quote. For instance, the timing of the serial onset

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1 of salient objects is critical for the objects to be  
2 detected because of subsequent object onset can impair  
3 the working memory for intermediate preceding object  
4 - you don't have to understand what that means. It's  
5 in context.

6 The important thing is yet this  
7 characteristic is irrelevant to nuclear power plant  
8 tasks, because the salient objects, in other words,  
9 alarm, remain on until the operators 9intentionally  
10 suppress them.

11 That means that because I'm at a nuclear  
12 power plant, I always understand completely what all  
13 of the alarms are telling me. So, as long as I have  
14 alarms, I can throw out this action.

15 That is contrary to everything that we  
16 understand. If I set that action at 1.0, maybe it  
17 doesn't make any difference, but I would have at least  
18 given me a chance to explore whether it might be  
19 important.

20 So, this whole notion of throwing things  
21 away because they're unimportant because for some reason  
22 I have alarms or procedures or I have - everybody is  
23 trained better than the average or any of those notions  
24 that you hear floating around, is, in fact, contrary  
25 to sort of the general way of letting things rise to

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1 the surface and then determining whether they're  
2 important or not.

3 MS. XING: Okay, yes. This was the  
4 consideration -

5 CHAIR STETKAR: That's been a long - that's  
6 been a long tradition in human reliability analysis is  
7 that you do simplified, conservative, perhaps, large  
8 uncertainty analysis first. And if it's not important  
9 with that type of an analysis, it's not important.

10 I don't need to refine my analysis  
11 techniques. I don't need to get more sophisticated  
12 about evaluating particular factors that might influence  
13 the behavior.

14 MS. XING: So, first of all this wasn't  
15 intended against that practice. This was started after  
16 that practice, if we feel there is still too many HFE  
17 that an analyst can handle, maybe this will work.

18 And, again, this is just a concept. Maybe  
19 we not use these at all. So, that's - I think I already  
20 have the feedback with -

21 CHAIR STETKAR: It's just I was looking at  
22 a risk assessment the other day and people threw out  
23 a lot of things because they said, well, we have so many  
24 human actions in our model that everything is being  
25 driven by human actions.

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1 Well, of course it was, because everything  
2 was manually actuated, you know. That's not an excuse  
3 for throwing out the manual actions.

4 MS. XING: Yes.

5 CHAIR STETKAR: Sometimes life is difficult.

6 MS. XING: Okay. Put a comment on this.

7 So, really I think I would like to focus  
8 on next like talk about quantification part of how we  
9 want to do that.

10 And the overall approach is not new. On  
11 this top row you have the HFE. You start using the -  
12 some method started working on HFE level. And some  
13 method work on task level or some work on even detail  
14 - further detail level. Then you look at this and how  
15 the PIF's a factor, the failure probability of this HFE.

16 What here we have in the middle is some more  
17 detailed information compared to what we have in the  
18 previous method. We have this - come to this method  
19 of identify critical tasks, how to break the critical  
20 task into the functions and objecting.

21 CHAIR STETKAR: Jing, and I've kind of asked  
22 you this before, and I think you gave me an answer, but  
23 in the NUREG-2114 framework there are five basic  
24 macrocognitive functions. The first four and this sort  
25 of teamwork communication issue that we're talking

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1 about.

2 Here, for some reason, the decision was made  
3 to split that single thing out into three distinct  
4 macrocognitive functions.

5 Even though we don't understand what it is,  
6 it now has become very discrete and compartmentalized.  
7 Why?

8 MS. XING: Okay. Again, this is just the  
9 concept. And the reason what actually happened is not  
10 a split.

11 It was on purposely in the literature review  
12 report. We purposely merged those into one function.

13 CHAIR STETKAR: Okay.

14 MS. XING: And because the consideration,  
15 we talk about four procedure events, because really we  
16 don't need to separate this. Really not much teamwork  
17 and cooperation going on.

18 So, that's why that was the decision we made  
19 at that time. We decided let's just keep this one a  
20 single function representing this high level.

21 CHAIR STETKAR: What I'm worried about,  
22 thought, is that the first four are actually really  
23 complex issues.

24 I mean, you could subdivide each one of  
25 those four into further little bits and pieces and cells

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1 on a spreadsheet or whatever you want to do with them.

2 And I'm curious why communication, teamwork  
3 and cooperation need to be assessed individually within  
4 the construct of this methodology given essentially the  
5 same visibility as understanding and sense making, which  
6 is a very complex process.

7 So, it just doesn't seem - I don't  
8 understand why.

9 MS. XING: Okay. First, we initially  
10 considered this are the separate function. You have  
11 your specific objectives in doing communication. And  
12 in the current control room, it seems when we analyze  
13 for the procedure event, all we need for teamwork or  
14 coordination is doing this really communication.  
15 That's all we needed to do.

16 And in the extreme case even you don't have  
17 that three-way communication, you probably still can  
18 get most the task done like the Japanese plant.

19 And here, I went to consider this in the  
20 big scope like in the SAMG domain and severe accident  
21 scenario.

22 You have this explicit goals for each of  
23 these. For communication, it's not just to help you  
24 do a better job. So, you have the agenda, the purpose  
25 of communicating the risk either to general - to your

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1 up-level or to the lower down. If you don't do this  
2 part, you will fail. You will fail your task.

3 Same there is teamwork. Something  
4 specific about teamwork. Like at some point you  
5 probably need - I don't know if that will happen or not,  
6 but people talk that there will be team consensus need  
7 to be achieved for some decision and some other decision  
8 don't need team consensus. It's my single  
9 decision-maker.

10 So, and for cooperation you have this  
11 different center network the centers -- have certain  
12 cooperation whether you deliver the right labor force.

13 You need the cooperation between the different side  
14 of different centers.

15 If this part fail, you will still fail the  
16 task. So, this is a consideration we think as initially  
17 let's treat them separately. I mean, really doesn't  
18 matter. Just like did in the earlier method. We  
19 treated communication as a separate failure mode. Then  
20 in our expert elicitation workshop we had an intensive  
21 discussion. A lot of people feel communication should  
22 not be treated separately.

23 Now, we're talking about maybe we should  
24 have treated it as part of the other functions. So,  
25 it's highly possible at the end Phase 3 function may

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1 be merged to those functions. But at this point since  
2 this is your exploration, we put them as a separate.

3 MEMBER BLEY: Jing, can I ask a question,  
4 because I'm a little confused at this point.

5 You know, when I think of communication,  
6 I think of this verbal communication. But I also think  
7 of the team communicating having briefings to discuss  
8 where are we, what should we be doing next, do we  
9 understand where we are, that sort of thing.

10 Is that - they way you've broken them out  
11 here, is the communication only the verbal three-way  
12 communication?

13 MS. XING: No. Actually the communication  
14 would involve either verbal communication or maybe  
15 there's a situation communication between human and the  
16 system.

17 For example, like at Fukushima event people  
18 talk about the use of rubbers going to the radiation  
19 areas. What's the communication and the coordination  
20 between human and the machine? So, that's another part  
21 - that's also part of communication, we're thinking.

22 CHAIR STETKAR: But, see, that's - I got  
23 really confused there also because as I read the report,  
24 the communications focuses mostly on - well, again, I'll  
25 quote.

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1           Communication is information exchanged  
2 between crew members or between crew and the machine  
3 systems.

4           And it focuses when you get into the  
5 details, it focuses more on the human system interface.

6           If the displays are good, communication is good.  
7 That's the context that eventually devolves into - in  
8 the document.

9           MS. XING: That's not - it's not about the  
10 interface. It's about - more about the content of what  
11 you need to be communicating and the effectiveness of  
12 communication.

13           So, anyway, I think at this part - at this  
14 point I'm not trying to clear up the confusion, but it's  
15 good to know you have a confusion because other people  
16 will have same confusion.

17           That's something we're going to discuss at  
18 our meeting.

19           CHAIR STETKAR: It's confusing to me because  
20 if I take the same approach to, for example, the  
21 understanding sense making, single box there, if I have  
22 an incorrect mental model for whatever reason, I may  
23 fail that task, that macrocognitive function.

24           You know, that's a subcontributing cause.  
25 It's not part of that basic macrocognitive function.

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1       You follow me?

2               A lot of the examples you were giving seemed  
3       to focus more on the analogy of an incorrect mental model,  
4       inadequate training or something like that rather than  
5       the higher level teamwork recognizing that I don't quite  
6       understand what that means anyway.

7               MS. XING: Yes.   So, what we're going to do  
8       next in this large team workshop, we would like for each  
9       of these functions and to come up with example,  
10      operational examples.   What do we talk about detection?  
11      What are the typical detection tasks in the severe  
12      accident case?   What are the communications needed to  
13      do that?

14              And by doing that, we may come up with  
15      something different.   Maybe the boxes either merged or  
16      merge into one or merge into the top four boxes.

17              So, but this is just initially we threw out  
18      this framework and have a team beside it.   So, some  
19      examples I put there in the current report was very  
20      limited by looking at SAMG and looking -

21              CHAIR STETKAR:   What's the distinction  
22      between teamwork and cooperation?

23              MS. XING: Yes.

24              CHAIR STETKAR: I see those as the same  
25      thing.   Am I missing -

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1 MS. XING: Like, in some example in a lot  
2 of literature behind this was driven from a lot of work  
3 data by NASA. When they talk about their research or  
4 the work they done by teamwork, which primarily means  
5 the crew, how this shuttle who worked as a team.

6 And cooperation is between the shuttle and  
7 the centers on the ground. So, what I -

8 CHAIR STETKAR: Between different teams  
9 then.

10 MS. XING: Yes, different teams.

11 CHAIR STETKAR: Okay, I got it.

12 MS. XING: And then what I saw in the  
13 Fukushima report, there's also analogy between the tech  
14 center and the plant people. And what do you call the  
15 Thai prime minister said Japan's president of the cabinet  
16 gave the plant direct -

17 CHAIR STETKAR: Yes. Seems to me like it's  
18 things progressing from individuals from detection all  
19 the way to action and execution that could be just one  
20 person.

21 MS. XING: Right.

22 CHAIR STETKAR: Then the communication and  
23 teamwork is the crew within the control room.

24 MS. XING: Yes.

25 CHAIR STETKAR: And then cooperation and

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1 above is other teams and up to a prime minister, maybe.

2 MS. XING: Yes.

3 CHAIR STETKAR: Okay. I got it.

4 MS. XING: So, we don't know if - probably  
5 eventually we think we don't need a model or there's  
6 no way we can model that. But just as an initial start,  
7 we like to put that - putting it here. So, have our  
8 people with more operational experience to decide. So,  
9 it's good you have confusion. That means that's an area  
10 we need to pay attention, work on.

11 MEMBER SCHULTZ: What's a concern to me is  
12 that in the first presentation on 2114, it seemed - this  
13 is very complicated. And so, it seemed that what you  
14 brought to the table in that presentation was a model  
15 associated with the cognitive functions, which I thought  
16 was very understandable that you had detection,  
17 understanding, decision-making and action execution  
18 moving appropriately together and even with feedback  
19 loops on certain elements.

20 And you had communication, teamwork,  
21 cooperation as a base to that or a field in which that  
22 sat.

23 And then you had connections between the  
24 PIF characteristics and some of those. In other words,  
25 you weren't drawing lines as you show in this diagram

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1 where all the PIF characteristics were influencing the  
2 cognitive functions and objectives.

3 And I think if we're moving to this type  
4 of pictorial, this picture, I think you're losing the  
5 power of what you've presented in the other model.

6 And also, in fact, presenting something  
7 that could be interpreted by those that are developing  
8 a model now in a very different way than what you  
9 described earlier and I think the power is being lost.

10 So, it may just be the picture that you've  
11 drawn here in order to tie things together and it's not  
12 that way, but I thought the approach was building and  
13 that this would be in the implementation, a way in which  
14 to use that power from start to finish.

15 And now, I seem to see it breaking up and  
16 arrows drawn differently and I'm not confused. I just  
17 think, again, that the power of the models may be lost  
18 here.

19 And I think as you said, we're going to get  
20 together and talk about this. It is extremely important  
21 that that be done now and decisions be made so that you  
22 determine whether you're going to retain that or you're  
23 going to go a different direction, because I see a  
24 different direction evolving here.

25 MS. XING: So far the conversation I had with

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1 people including those reviewers for the other report

2 -

3 MEMBER SCHULTZ: The other report.

4 MS. XING: Yes. And there's two different  
5 opinions. Some people think, okay, you have - really  
6 you have separate, different functions in the teamwork.

7 Teamwork is not just to support individual worker, but  
8 they have additional function for teamwork.

9 And the other opinions what you just  
10 described in our early version. So, at this point I  
11 just would like to leave this for the team, which we  
12 would think a better model.

13 CHAIR STETKAR: By the way, that bottom box  
14 has changed from supervision to cooperation which  
15 already changes a mental model from the way it's been  
16 presented here in terms of what that means.

17 Supervision is different from talking to  
18 people in the technical support center and the emergency  
19 operating facility and the prime minister, for example.

20 MEMBER SCHULTZ: Yes.

21 CHAIR STETKAR: It could be I am the dictator  
22 in the control room and you will do things my way. That's  
23 a supervisor - it is not quite cooperation or teamwork  
24 or communication, but, I mean, that's - some of that  
25 - those notions of supervision, that supervision model

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1 are developed in the 2114 study.

2 MEMBER SCHULTZ: That's the one we did first.

3 CHAIR STETKAR: That'S the psychological  
4 framework.

5 MEMBER SCHULTZ: Yes, okay.

6 CHAIR STETKAR: So, it sort of morphs into  
7 different notions. And I agree with Steve that it's  
8 important to understand what that is and not necessarily  
9 make it devolve into some sort of serial process that  
10 means internal events, Level 2, Level 3, emergency  
11 planning, because it's different.

12 MS. XING: Thanks. I do appreciate the  
13 comment. That's what I'm looking for from this meeting  
14 and -

15 CHAIR STETKAR: And you're obviously  
16 struggling with that one anyway. So, go on.

17 MS. XING: So, people have no problem with  
18 the top four functions. When it goes to this level -

19 (Laughter.)

20 CHAIR STETKAR: That's good. If that's  
21 true, then you've made tremendous progress.

22 MS. XING: I don't know if we can make any  
23 - how much progress we can make. At least for the time  
24 I worked at NASA, I know they keep debating if you just  
25 think teamwork is to support the individual worker, you

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1 miss some big part of it. Then the question never really  
2 solved.

3 The part you missed is because you didn't  
4 model them well in the individual activity or is this  
5 truly a separate function.

6 So, I think it come to this setting, the  
7 nuclear power plant setting, and let our domain expert  
8 contribute what will be the best model.

9 So, you saw this before. So, here based  
10 on this information, we are proposing two different ways  
11 for the HEP quantification.

12 The first one is a scoping analysis which  
13 is to determine the HEP - just to estimate an HEP range.

14 And this way is very much when you think about this  
15 method, you can think of like far edge would be an example  
16 for this kind of approach.

17 You identify this and the critical tasks,  
18 although it did not explicitly give you qualitative  
19 guidance for how to identify critical task.

20 When you start from the task and you break  
21 the task into two functions, combination which is  
22 detection, understanding and decision-making and  
23 execution.

24 So, there you have this set of performance  
25 shaping factors and HEP of the cognitive function failure

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1 will determine by the multipliers of HEP factors.

2 So, this is largely - this proposal largely  
3 in this direction. So, except we're going to quantify  
4 either four function, these in the major function, or  
5 five or seven, which we don't know at this moment per  
6 our discussion. Either we want models or the three  
7 bottom as three separate function or we want to treat  
8 them as a moderator to the top four function. We don't  
9 know at this point.

10 And this other one is more you can - the  
11 detailed failure mode analysis you can use our IDHEAS,  
12 early IDHEAS, or CBDT as a mental model.

13 You are not to look at the failure of the  
14 cognitive function, but you break them - in the very  
15 detailed failure, break the tasks into the different  
16 type of failure model. And it quantifies use of decision  
17 tree to quantify those failure modes, HEP, those failure  
18 modes.

19 So, we are exploring these two  
20 possibilities and try to see how they work.

21 CHAIR STETKAR: Before you leave this - yes,  
22 you can go to the next one, because it's relevant. Have  
23 you talked very much with people from the industry about  
24 their experience with doing human reliability analysis  
25 for the NFP 805 fire transition PRAs?

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1           Because I've heard feedback as part of -  
2           help me, Dr. Shack. NUREG-1921 is the right one in this?

3           As part of the methodology there, they  
4           developed a scoping -

5           MS. XING: Okay.

6           CHAIR STETKAR: - process. And I've heard  
7           feedback from people saying, yes, they try to do that  
8           and indeed all it was, was extra work that got them two  
9           high numbers. And everybody is doing the detailed  
10          analysis, because it - they just spent time deriving  
11          numbers that were too high for their purposes anyway.

12          So, and it's sort of this slide.

13          MS. XING: Yes, lots of triangles there.

14          CHAIR STETKAR: And from what I've heard,  
15          now, I, you know, I have not polled everyone in the  
16          business, but there seems to be a move afoot to go away  
17          from this notion of scoping, because it's an added task  
18          that doesn't seem to be buying anybody anything.

19          Have you had any feedback from that  
20          perspective, or is there actually still reasonable  
21          support for that, that part of the task?

22          MS. XING: I heard feedback in both -

23          CHAIR STETKAR: Oh, okay. Okay, fine.

24          MS. XING: People say what you just said,  
25          and that was also my impression in the scoping method

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1 for fire HRA like is shown in this diagram. The HEP  
2 estimation pretty much started from Point 1 to really  
3 high number.

4 CHAIR STETKAR: Yes.

5 MS. XING: And more than a third of those  
6 situations modeled end up HEP 0.1.

7 CHAIR STETKAR: Yes.

8 MS. XING: So, I use the triangle to indicate  
9 those. And so, then the other voice I heard was, okay,  
10 this is as much as you can do. So, we only model the  
11 most severe situation.

12 So, that's - I put the slide there just to

13 -

14 CHAIR STETKAR: Okay, okay.

15 MS. XING: I could feel what people think.

16 CHAIR STETKAR: Okay. As long as you're  
17 still hearing support for that sort of process, that's  
18 fine.

19 MS. XING: Not for support or against it,  
20 but fire HRA is the one at some point was proposed to  
21 be used at Level 2. That's why we do - we take a lot  
22 of look at what's really there, how we could use it.

23 CHAIR STETKAR: Okay.

24 MS. XING: Basically the scoping analysis  
25 and the fire HRA, it did not go to the test level. It's

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1 more like as HEP level classified - I'm sorry. I  
2 frequently confuse HEP and HFE as a failure event. You  
3 classic model is four type of failure event in control  
4 room, ex control room, alternative shutdown and the  
5 spurious actions.

6 For each type of action the HEP is - the  
7 failure probability is determined by these five  
8 performance shaping factors which are the effect of fire,  
9 basically. So, visibility, the smoke. Time in fire  
10 and execution complexity, time available and time  
11 margin.

12 So, among these factors the time margin is  
13 primarily give you these different levels of HEP. Most  
14 of other factors will give you either low or high.

15 So, personally I feel we might be missing  
16 something important in this game. It's a good  
17 high-level approximation. You probably capture the  
18 most important thing. But since, now we have more  
19 information about - we know how to get down to task and  
20 function level, we have more detailed information than  
21 these five high-level PIFs, maybe we can do a better  
22 - do a more detailed, better job, but that's where we  
23 think it's going to.

24 MR. CHANG: It may be the scoping this work  
25 is kind of misleading. If you look at the previous slide

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1 that the two approach, two HEP quantification approach,  
2 we look at that comparing to even the CBDT, it's a rich  
3 tool than the detailed analysis level.

4 The difference is that the upper one is if  
5 I say, okay, what's the detection failure probability?  
6 What's the diagnosis failure probability that come to  
7 that level?

8 And then the bottom ones come to, okay, what  
9 type of failure modes?

10 MS. XING: So, in terms of the right column  
11 when you look at the performance shaping factors, it  
12 comes to a very detailed level and probably detailed  
13 - I would say a lot more detail than CBDT.

14 And it's only like at what level you  
15 quantify HEP at a very detailed failure mode versus as  
16 a function, a cognitive function level.

17 And we feel like cognitive function level  
18 is probably the best compromise we can use. So, because  
19 it can allow us direct link to these failure mechanisms.  
20 We know why it failed.

21 And on the up side, it also can link to the  
22 tasks. We can bring our tasks into these functions.  
23 So, that's - we like this model at - we decide to model  
24 this at the function level.

25 So, this is the concept of we just talked

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1 for every cognitive function. You look at the  
2 individual characteristics in the PIFs in that list we  
3 talked and to see how that affects the different failure  
4 mechanisms for this function.

5 So, this is a concept like in the horizontal  
6 there you have hopefully after you locate all those PIF  
7 characteristics, you come up in some kind of index which  
8 we talk later. In fact, we're still exploring what is  
9 this index.

10 The most simple one for now, you can think  
11 of the mental model, you just add up how many those PIF  
12 characteristic are checked. Five versus 20.

13 CHAIR STETKAR: People used to try to  
14 estimate the failure likelihood of electronic devices  
15 by counting up the number of piece parts. It didn't  
16 work so well.

17 MS. XING: And then you can relate to that  
18 to in some kind of relation like, for example, a relation  
19 like this to the HEP. And still we needed to - next  
20 stage we need to use our group to work out of this, how  
21 we do this index. Simply add up, or more sophisticated  
22 way. And also, how to relate the index to HEP. That  
23 part we expect to use expert elicitation, but first we  
24 need to work out this index thing.

25 So, we talk - we look at what's being used.

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1 We talk fire HRA. The index there is like each  
2 performance shaping - each of these five performance  
3 shaping factors. Cognitive as one factor.

4 And the - their combination will lead you  
5 to different HEP level. The way to combine them is use  
6 the multiplication like the time margin. If it's less  
7 than - greater than - if it's less than 200 percent,  
8 means that you need to perform this task in - you have  
9 30 minutes to perform this task. If you can get it down  
10 to 15 minutes, that's a 200 percent margin.

11 If it's greater than 200 percent margin,  
12 you're fine. If it's less than 200 percent, the failure  
13 probably will be ten times more than what it would be.

14 So, same way - that's the way SPAR-H we use  
15 too. You just multiply these factors. I talk to the  
16 SPAR-H people. There's a problem we have there. It  
17 can easily get you to very high HEP because of this  
18 multiplication.

19 CHAIR STETKAR: But that's one of the reasons  
20 for SPAR-H. It's not supposed - it's not designed or  
21 intended to actually give you a realistic quantification  
22 of human reliability.

23 It's some way that someone out in the region  
24 can quickly evaluate some general relative importance  
25 of something, I believe, anyway.

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1 MS. XING: Yes.

2 CHAIR STETKAR: And, you know, it's okay.

3 You know, we're closer to Los Angeles than we are to,  
4 you know, Delhi here. Within that regime, it's okay  
5 to be pretty doggone course.

6 But one of the reasons I wanted to ask you  
7 about the scoping is, how much of your effort right now  
8 on developing this methodology, and I realize that at  
9 ACRS we're not involved in, you know, budgeting and  
10 schedule and things like that, but if you're developing  
11 this scoping methodology and struggling with am I going  
12 to multiply things, am I going to add them, how am I  
13 going to get, you know, some sort of combination of some  
14 handful of performance influencing factors that can  
15 allow me to scale along five orders of magnitude in human  
16 error probability, you're spending a lot of time doing  
17 that for something that nobody is going to use because  
18 it's really conservative anyway.

19 It's not at all clear that that's a useful  
20 expenditure of time and resources. Maybe you ought to  
21 be focusing more on refining some of the detailed  
22 analysis.

23 And, again, we can't, you know, it's not  
24 - it's not our role for budget and schedule, but -

25 MR. PETERS: One of the factors we have to

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1 consider is our SRM told us that we have to create a  
2 method for the Agency to use, I mean, or we have  
3 interpreted it that way that we have to create a method  
4 for the Agency to use, but the "for the Agency to use"  
5 was specifically in there.

6 And for the applications that we really have  
7 on HRA, almost all the applications are those regional  
8 or ASP analyses or STPs that are done.

9 So, a couple factors that we had to look  
10 into were we wanted to enhance the realism of the results,  
11 you know.

12 Obviously what you're saying is absolutely  
13 true. It should give you this kind of go, no-go, what  
14 are the important factors.

15 CHAIR STETKAR: This might be a slightly  
16 finer tuned, you know, version of that.

17 MR. PETERS: Yes. And the only other use  
18 that we found for our agency is this whole Level 2 portion  
19 of the Level 3 PRA project. It's one of the uses that  
20 we would be particularly using as the Agency, but in  
21 the long run, I mean, this is - it appears to be a project  
22 that's done one time and then you move on.

23 So, the rest of what we need to develop in  
24 this methodology is something that we can use. So, my  
25 concepts at least in the back of my mind at this moment

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1 are that we probably need to improve some of those aspects  
2 with SPAR-H with what we learn in this project.

3 And the quantification scheme being one of  
4 the more important parts of the SPAR-H analysis, I think  
5 we need to put some energy onto making improvements  
6 there.

7 CHAIR STETKAR: Well, part of the SRM also  
8 was to try to bring together a large number of disparate  
9 human reliability analysis methods into - I don't want  
10 to say the be all end all method, but at least a more  
11 cohesive framework.

12 And that's - I think that part of it extends  
13 beyond this internal agency applications for  
14 significance determination or whatever, because -

15 MR. PETERS: The SRM did tell us to work with  
16 ACRS, industry and others to try to get - and what I'm  
17 - my interpretation of how we've implemented this is  
18 some kind of single method that almost everybody uses  
19 or at least is applicable.

20 CHAIR STETKAR: Because there are a lot more,  
21 you know, the NFP 805 applications is one that's ongoing  
22 right now that in many cases does have heavy involvement  
23 of evaluation of human performance.

24 New plants are required to have a PRA. new  
25 plants, you know, to a greater or lesser extent have

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1 made commitments or indicated, anyway, that they want  
2 to have risk informed applications which may be  
3 influenced to a greater or lesser extent by HRA.

4 So, looking forward, you know, down the road  
5 here, this is an opportunity to kind of develop something  
6 that's really useful going forward, you know, beyond  
7 just sort of the SPAR-H pass/fail, is it bigger than  
8 a breadbox sort of notion.

9 MR. PETERS: I think you're hitting right  
10 on that. So, I guess we'll hear your feedback that that  
11 part, that future use for the industry and the world  
12 may be even more important than -

13 CHAIR STETKAR: I think it is much more  
14 important. I think it is much more important, but that's  
15 my personal opinion.

16 And it's just, I mean, if I heard something  
17 that you knew exactly how to do this part of it, the  
18 scoping, that it was just something that was so obvious  
19 that required essentially very little effort on your  
20 part, I wouldn't have even raised the question.

21 But if indeed you're struggling with this  
22 and spending a lot of effort on this particular part  
23 of the issue, you know, because I suspect that once you  
24 - you say a concept is being explored and you have four  
25 things there. And I'm sure that no matter which of those

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1 concepts you explore, you're going to hear 15 different  
2 opinions about should you have a linear sum of, you know,  
3 PIFs one through seven with a multiplier by Number 8,  
4 or it could get really messy, which it probably will.

5 MEMBER SCHULTZ: A times B plus C minus D.

6 CHAIR STETKAR: To the n minus 12.

7 MS. XING: So, one thing we know from this  
8 two method is use this multiplication for HRA and SPAR-H.  
9 And even not everybody agrees.

10 And also for using this - the multiplication  
11 is a big - one of the big sources for the variability,  
12 because just two people choose two PIF and multiply  
13 differently, you end up with two other different HEP.

14 So, here we have information that allow us  
15 do better. Just to think of this as is it complex or  
16 not. That's just too much.

17 We can look at this ten individual  
18 complexity factors and the question is how we going to  
19 combine them together?

20 So, that's we threw up that we like the  
21 approach for that in the next couple months. We first  
22 work on this conception model. Let's just explore this.  
23 Take a couple example.

24 Here's an event. These are the PIF  
25 characteristic involved. And what do you think when

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1 they come together, the likely chance? Are they going  
2 to - we try to explore this a little bit in our workshop.

3 We got some very preliminary information. A lot of  
4 people say I can't really tell.

5 We try to do some - explore all this  
6 possibilities starting from simple estimation which is  
7 probably putting it too low. And some weighted  
8 estimation. You give some factors more weight than some  
9 other ones.

10 Or winner takes all, you know. We would  
11 like have expert to select for each PIF characteristic  
12 set for an individual function. Select the ones that  
13 are the most severe, most influential.

14 For example, market testing. That's one  
15 thing I heard from the expert, you know, when you are  
16 doing several things together there's very likely you  
17 make an error.

18 And we have lots of neuropsychology data  
19 showing actually how much more error you make when you  
20 switching between two tasks. So, we can get this kind  
21 of information to try to work.

22 And also, we - these PIF characteristics  
23 are not independent. Some work - they have interaction  
24 with others. Multitasking and the time available if you  
25 have sufficient time for each individual task, you

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1 probably don't really need do a switch. I'm focused  
2 on this, finish this part, then do another task versus  
3 you have very short time. You try to frequently make  
4 a switch between those two to the level you think you  
5 are doing them identically simultaneously.

6 So, this part we try to use our team to work  
7 harder and the goal is to come up something more explicit  
8 than what we have for HRA and SPAR-H. So, that's our  
9 plan.

10 Next. And also for this summer, we would  
11 like focus on this part work, but in the relatively long  
12 term we also like to look at another possibility, which  
13 is an extension of the failure model analysis with data  
14 in the procedure event HRA IDHEAS method.

15 In that method, we identify the 14 failure  
16 modes which we already realized because of the scope.

17 These 14 failure mode do not represent all the failure  
18 mode outside that scope.

19 So, we probably can keep on - since we  
20 already have the method of doing that, we can keep on  
21 that approach, identify additional failure mode based  
22 on the objectives.

23 And then for each failure mode if this  
24 failure mode is already one of the failure modes that  
25 we develop a decision tree, you can revisit the decision

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1 tree.

2 The decision tree was developed for the -  
3 to supposedly have this long list of PIF characteristic.

4 Our teams are people who have the knowledge on the  
5 operation kind of select four or five the most likely  
6 factor for the decision tree, or some decision tree  
7 factor is a group of individual characteristics.

8 So, then when you - this is where you see  
9 the difference between the different setting. You are  
10 in a procedure event. You select this factor. Some  
11 factor left out, because not important.

12 Then when you come to SAMG, SAM stage,  
13 severe accident management, some factors that you left  
14 out may become the most dominant factor.

15 So, you need to revisit those again almost  
16 like you need to make a lesser modification of the  
17 existing decision tree. And for the ones the failure  
18 mode wasn't included, you need to develop a new decision  
19 tree, but we have some good sense to start on that with  
20 that type of a basis we providing.

21 So, those are the two - I mean these two  
22 are not exclusive to each other. They are actually  
23 complementary to each other in certain - any method that  
24 you will need to look at what's the PIF factors or  
25 characteristic are important for this kind of failure

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1 and how they work together. So, it's just at which level  
2 you quantify them at the failure mode or at a function  
3 level.

4 And the two types of HEPs. So, for the  
5 short term we will use expert judgment like what we just  
6 did in the early this year.

7 And in the long term, we're looking for to  
8 data-driven HEP estimation, at least on the SACADA  
9 project we can expand that to collect more information  
10 beyond just those EOP training. We can have the HEP  
11 more data informed. That's the long-term plan here.

12 CHAIR STETKAR: Can you tell us what you're  
13 doing for the expert elicitation process? Are you -  
14 I know you've done some of that or it's in progress or  
15 I'm not sure where it is, but are you looking at different  
16 combinations of, what? Performance influencing factors  
17 and having the experts say for, you know, one of A and  
18 zero of B and one of C and one of D Expert Number 1 gives  
19 you a range of the HEP, or how is that structured?

20 MS. XING: You talk the one we had.

21 CHAIR STETKAR: I don't know what you've  
22 done. So, I'm asking.

23 MS. XING: Okay. The one we did - where is  
24 - try to find the decision tree. Okay. If you look  
25 at the bottom, the right bottom box, that's an example

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1 of how a decision tree look like.

2 So, you have a failure mode, let's say.

3 CHAIR STETKAR: That's fine.

4 MS. XING: Okay.

5 CHAIR STETKAR: You've helped a lot just by  
6 orienting me toward a particular path -

7 MS. XING: Okay.

8 CHAIR STETKAR: - in a decision tree. So,  
9 you present the experts with that path -

10 MS. XING: Yes, we -

11 CHAIR STETKAR: - and ask them for their  
12 estimate of HEP 3, for example.

13 MS. XING: Yes.

14 CHAIR STETKAR: Okay.

15 MS. XING: And we also ask for more like when  
16 they put HEP there, they put their justification and  
17 what source of information they use, what does it  
18 present.

19 And we also in the expert elicitation, we  
20 ask them to consider this different -- these different  
21 factors. How you think which factor are more  
22 significant than others. Rank the factors.

23 And also, what you think is the interaction  
24 between them if B is dependant on A or whatever the  
25 others.

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1           So, we also collect information which can  
2           give us some starting point for the next stage, think  
3           of how these factors combine.

4           CHAIR STETKAR: One of the things that you  
5           left off your earlier slide was uncertainty as part of  
6           the expert elicitation process.

7           Are each of the experts giving you, for  
8           example, their best estimate, an upper bound and a lower  
9           bound, or an uncertainty distribution or something like  
10          that?

11          MS. XING: Yes, each expert give a  
12          distribution for ten percent and median and 90 percent.

13          CHAIR STETKAR: Okay.

14          MS. XING: And they will integrate all this  
15          distribution together.

16          CHAIR STETKAR: Thank you. I'm glad to hear  
17          that. Good.

18          MS. XING: So, that's what we have in the  
19          other one. But in the other one because we started from  
20          this decision tree, still we have after the first  
21          workshop of expert elicitation, the first workshop is  
22          primarily for the domain expert, the trainers and SRO,  
23          just on the expert to give their understanding, their  
24          rough estimation of this.

25          We even before the meeting we said, okay,

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1 you are going to give us information based on this  
2 decision tree, but still what the information we collect  
3 really valuable which lead to the revision of many  
4 decision trees.

5 One example which we haven't revised is  
6 communication we talked earlier. We feel a lot of expert  
7 who feel this is really not a separate failure mode.  
8 This should be more likely affect every individual other  
9 failure mode. With our counting it, it was saying treat  
10 this as a separate failure mode. We still haven't solved  
11 that yet.

12 So, that's in the - and for the next activity  
13 in this method expansion, we would rely on this NRC team  
14 not to develop the decision trees, but come up with this  
15 relation between PIF characteristic and the failure  
16 probability. That's almost equivalent like developing  
17 the decision tree.

18 CHAIR STETKAR: I didn't quite catch that.

19 Could you -

20 MS. XING: This page. So, that's what we're  
21 working on. So, we're not in the decision tree stage  
22 yet. We're not going to ask them to provide a  
23 probability. We first need to work out the model.

24 CHAIR STETKAR: I guess now I'm confused.

25 I thought - I understand the concept of laying out a

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1 decision tree and I understand that there might be  
2 different opinions about the structure of that decision  
3 tree. And it sounded to me as if you were in the process  
4 of doing that, trying to work - you thought you had a  
5 set of decision trees that would work and got feedback  
6 that required you to go back and rethink some things.

7 And now I'm hearing, well, the next step is you're going  
8 to do what?

9 Abandon those and come to this thing?  
10 Because this is not the decision tree. This is that  
11 other thing.

12 MS. XING: Depend on what you call a decision  
13 tree. Like the scoping analysis in fire HRA, initially  
14 when I read those scoping diagram it was like very  
15 confusing. So, I replot them in the format of a decision  
16 tree.

17 Decision tree is you pick up these couple  
18 factors. These couple factors work together giving you  
19 a number.

20 So, in that sense, you are doing a decision  
21 tree.

22 CHAIR STETKAR: Well, in the sense of whether  
23 you're adding or multiplying things together, I guess,  
24 but - go ahead, Steve.

25 MEMBER SCHULTZ: I thought where you were

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1 going was you had the decision tree and now you're using  
2 this question.

3 You're using this to quantify this approach  
4 to develop quantification of the tree?

5 MS. XING: Yes, we are try to use - we're  
6 looking at those both possibilities and come up with  
7 - one possibility is we are going to identify the failure  
8 mode - additional failure modes that needed and revisit  
9 the decision trees.

10 And another possibility is we look at all  
11 these PIF characteristic list same process as you do  
12 decision tree. Identify which ones are more - are the  
13 most significant ones and combine them somehow.

14 CHAIR STETKAR: That somehow is where I'm  
15 hanging up.

16 MEMBER BLEY: Could I just in for just a  
17 minute, because I was at the elicitation session. And  
18 just to try to add a little clarity, and at the end maybe  
19 a little confusion, I apologize for that, there were  
20 a set of decision trees for the various crew failure  
21 modes that identified.

22 So, they had - for plant status assessment  
23 there were crew failure modes such as key alarm not  
24 attended to, data misleading or not available. A series  
25 of those for response planning, delay implementation,

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1 misinterpret. For execution, fail to execute, fail to  
2 initiate execution, fail to execute a simple case or  
3 a more complex case.

4 For each of those they had developed  
5 decision trees. The decision trees had a limited number  
6 of performance influencing factors or the next level  
7 up things that were thought to be the most important.

8 And as - and they had two workshops. The  
9 first workshop were plant expert folks and procedure  
10 expert folks talking through how this would work and  
11 psychologists and which things might be most important,  
12 did they have it right.

13 Then when they brought in the folks to do  
14 the quantification - well, actually in both workshops  
15 people ran into places where they thought maybe a PIF  
16 that's important wasn't there. So, they had to  
17 rearrange things.

18 And then also questions come up that bigger  
19 model, the one you're hanging up on, how do these fit?

20 Really when I quantify these, it depends on the whole  
21 context in which I'm quantifying them.

22 Well, this pass-through assumed that the  
23 pieces in the decision tree were the only things that  
24 were important. And there's a caveat from all the people  
25 participating in that as you really have to go back when

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1 you're going to use these and look at the context in  
2 which it's used and say is it good enough, did it cover  
3 all the things you needed under this context? So, that  
4 was one of the pieces.

5 And, you know, it was done a little bit in  
6 isolation of that where it's actually going to be used.

7 And that process still isn't tested.

8 Might not be well laid out, but it's also  
9 not tested. So, they haven't gotten to that yet. Not  
10 to try to confuse things further, but -

11 CHAIR STETKAR: I was going to say so far  
12 I'm following you.

13 MEMBER BLEY: - they put together some  
14 rules for how you use the decision trees. And, you know,  
15 you have a two-state tree. Well, things aren't two  
16 state. Things are either completely one way, completely  
17 the other way or somewhere in between. And usually it's  
18 somewhere in between.

19 The rules were applied conservatively such  
20 that if you don't need all the conditions to be good,  
21 you're bad.

22 CHAIR STETKAR: You're bad.

23 MEMBER BLEY: And in some cases, that led  
24 to real concern that you'd really be biasing results  
25 if you use these in that form.

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1           So, sometimes that led to splitting a top  
2 event into some detail so that you could kind of get  
3 a little more clarity in those issues.

4           Now, whether the set that was developed  
5 there is adequate is a separate story, but at least it  
6 gives them something to work with in the next phase.

7           But where I was trying to get to was is we  
8 went through trying to use the trees. The structure  
9 of the concept that got us to the trees came into  
10 question.

11           So, as they start trying to then take these  
12 first-round results on quantification and apply them  
13 to real PRA scenarios where you might have multiple crew  
14 failure modes affecting a particular HFE, there's going  
15 to be more places where that structure probably needs  
16 refinement and they haven't gotten this, you know.

17           My impression is that's not really been  
18 tested. It's been dreamed up and laid out, but not  
19 tested.

20           And when it gets tested, it's going to have  
21 problems. And whether they're easy to solve or not,  
22 I don't have a clue.

23           CHAIR STETKAR: And I'm still not yet as  
24 confused as I thought I was going to be, but I'm still  
25 confused about - from what I'm hearing and tell me where

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1 I'm straying, is that if I stand way back from this and  
2 just think of a systematic way to lay out scenarios,  
3 those decision trees kind of do that, you're saying that  
4 -

5 MEMBER BLEY: Well, they're not scenarios.

6 CHAIR STETKAR: Well, okay.

7 MEMBER BLEY: They are playing the  
8 performance shaping factors against each other.

9 CHAIR STETKAR: Okay, yes. And "scenario"  
10 is the wrong -

11 MEMBER BLEY: Okay.

12 CHAIR STETKAR: Logical combinations of  
13 things.

14 MEMBER BLEY: Okay, yes. We changed the  
15 names.

16 CHAIR STETKAR: Okay.

17 MEMBER BLEY: In the report it talks about  
18 paths through the trees, which is you don't want to -

19 CHAIR STETKAR: And you're right. It's not  
20 a scenario. It's a logical combination of -

21 MEMBER BLEY: If this logical combination  
22 occurs -

23 CHAIR STETKAR: In the context of -

24 MEMBER BLEY: - how likely are you to win?

25 CHAIR STETKAR: Yes.

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1                   MEMBER BLEY: And that was real hard for the  
2 people giving estimates, because they always wanted to  
3 think, well, this isn't very likely, this scenario.

4                   CHAIR STETKAR: Right.

5                   MEMBER BLEY: You have to say it's not a  
6 scenario. If the real world generates this combination  
7 of performance factors, then how likely is it they fail?

8                   And that was a tough concept for the  
9 evaluators to deal with. And I think our results are  
10 a little still corrupted by misinterpretation of that  
11 and wanting to dismiss things - wanting to dismiss  
12 combinations that they thought wouldn't happen in the  
13 real world or very, very unlikely.

14                   And the idea that, you know, you're looking  
15 at it as if that's what there. Now, how likely is it  
16 to succeed or fail? That was hard for them.

17                   CHAIR STETKAR: But where I was hanging up  
18 from where Jing came back to is, how does all of that  
19 relate to whatever is in the forefront of the slides  
20 that are on the screen right now, which is this notion  
21 of - not that one - the notion of somehow a body count  
22 of adding and multiplying things together and seeing  
23 where I'm on a curve from ten to the minus fifth to one.  
24 The scoping notion. Something like that.

25                   MS. XING: Yes, it's not how these two fit

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1 together. It's two different way of -

2 CHAIR STETKAR: Okay, that's what - but my  
3 question is -

4 MS. XING: Yes.

5 CHAIR STETKAR: You said, well, we did a  
6 bunch of this stuff and I just heard it needs sort of  
7 more work and refinement.

8 And then I heard, well, okay, we sort of  
9 did that and we're not finished with that, and now we're  
10 going to go look at this other thing.

11 MS. XING: Here's where they came from  
12 together. They all came from the basis, you know. You  
13 have this - a long list of -

14 CHAIR STETKAR: Go down to the bottom and  
15 make that the - way down to the bottom. Way down along  
16 the -

17 (Discussion off the record.)

18 MS. XING: So, let me talk to this one first.

19 The very bottom part of the PIF characteristics. For  
20 the moment, I've got the data for this. I calculate times  
21 the number how many PIF characteristic is 100 something.

22 Therefore, for each individual function  
23 let's say supposedly on the average each individual  
24 function probably have plenty. In fact, there are many  
25 of them overlapping. So, each individual function

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1 probably have 30 or 40 such PIF characteristics.

2 When you develop a decision tree, you are  
3 actually doing the selection. You select from this 30  
4 or 40 factor, select those three or four most likely,  
5 most influential factor and a different path in the  
6 decision tree represent a different combination of these  
7 factors.

8 So, we were able to do that for the procedure  
9 event, because in that time the task is more fixed.  
10 So, those failure mode, we think it made a good  
11 representation for the control - for operator's task  
12 in the control rooms in the procedure event. So, you  
13 can identify those failure mode.

14 And the performance shaping factor, we know  
15 what are the performance shaping factors in the control  
16 room. Approximately we know. So, we are able to make  
17 that selection. So, you are able to narrow it down from  
18 30 or 40 factor into only three or four. That's how  
19 we develop the decision tree.

20 CHAIR STETKAR: Or from what I was hearing  
21 earlier, or five or six and the relationships might be  
22 different, but go on. I understand that.

23 MS. XING: Yes. So, and because one  
24 consideration we put that. I think there's one or two,  
25 that you don't want to make the tree too big.

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1 CHAIR STETKAR: Why?

2 MS. XING: User don't want to use big tree.

3 CHAIR STETKAR: Users are lazy.

4 MS. XING: And that's -

5 CHAIR STETKAR: The whole point is people  
6 in HRA for 30 years have been trying to make things simple  
7 because people are lazy, and here we are.

8 MS. XING: We have to respect that.

9 CHAIR STETKAR: No, we don't, necessarily.  
10 It's -

11 MEMBER BLEY: And fire PRA are doing all this  
12 detailed circuit analysis. And PRA of a system, you  
13 model all the parts of that system. And you got to know  
14 how the system works to model it. And -

15 CHAIR STETKAR: I've seen fault trees that  
16 go down for every pipe segment and says, does this weld  
17 leak? Does this valve leak? Does this leak?

18 People spend hours and hours of doing that  
19 stuff. And yet, well, because somebody doesn't want  
20 to have a hundred branches in a little logic model we  
21 have to oversimplify the treatment of human response?

22 I don't understand that notion.

23 MS. XING: Yes, that's the - but that is just  
24 a fact. People don't want to - if you make a big decision  
25 tree, they don't want to use it. And I believe it was

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1 our partner EPRI's intention to keep the tree limited  
2 size.

3 MR. PETERS: We'll get that feedback of  
4 people not really wanting to use a method if it may be  
5 more complicated.

6 MS. XING: Yes.

7 MR. PETERS: Which just kind of defeats -

8 CHAIR STETKAR: On the other hand on the fire  
9 stuff, I'll come back to something I said an hour ago,  
10 we heard a lot of that initially on the fire stuff, which  
11 is why they developed the scoping method in that EPRI  
12 report - EPRI research report for fire HRA. And at least  
13 some of the feedback that I've been hearing is people  
14 have been saying, well, yes, it was easy, but, you know,  
15 it was just an extra step we did and was kind of worthless.

16 So, we decided that it was a lot more cost  
17 effective for us to just do the detailed analysis.

18 MS. XING: so, in the fire HRA, the only model  
19 is this five factor. And it's another fault tree,  
20 because too many express pass the record go to 1.0.  
21 HEP 1.0.

22 So, this really to build decision tree, you  
23 have this very high selection process which you are very  
24 likely missing some very important factor that got  
25 selected out, because whoever, you know, we have a great

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1 team to build this decision tree. There are still  
2 important factors or scenarios that were not in our  
3 mental model we're missing.

4 And to come to generic methodology for all  
5 these different hazard, and no procedure and low-power  
6 shutdown lasting for a long period of time, it will be  
7 even more difficulty to make this - select three or four.

8 Or at most, the five most influential factor.

9 That's why I would like to - I propose let's  
10 look at other alternative. I say decision tree. It  
11 means you are limiting to this very small set of factor.

12 Let's not try to create limiting. How  
13 about just select things to go through this big list.

14 Make sure they don't miss important ones. And, again,  
15 somehow we combine this together.

16 In the worst scenario, you make a linear  
17 combination because you already break them down into  
18 detailed level. You're not talking eight PIF. You're  
19 talking all this detailed factor.

20 It should still give you pretty good - give  
21 you a reasonable first-order approximation. It will  
22 probably work better than you select those three or four  
23 most influential factor.

24 CHAIR STETKAR: It's just I hear that and  
25 I come back to the original SRM that says we have - pick

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1 a number - any number of different HRA methods out there  
2 that depending on - two different analysts using the  
3 same methodology will get two different numbers. A  
4 single analyst using two different methods will get two  
5 different numbers.

6 So, one of the goals of this whole process  
7 was to, I thought, develop a little bit more consistency  
8 and kind of coherence, which perhaps I'm not - and  
9 certainly I'm not understanding this scoping analysis.

10 The decision trees regardless of what  
11 problems they may have at the current snapshot in time,  
12 seem to at least provide a way of structuring that thought  
13 process.

14 And maybe this does that also, but I'm not  
15 hearing - I'm not understanding how this does it, because  
16 I'm hearing you say, well, you know, maybe we - we could  
17 consider everything and decide which ones we add and  
18 multiply together or something like that.

19 And I'm just not understanding that scoping  
20 element well enough to see how it actually reduces  
21 variability in this estimation process.

22 MS. XING: We have a reference to compare  
23 with SPAR-H or fire HRA. Okay. There you have, you  
24 know, fire HRA you have these five performance shaping  
25 factors. Each performance shaping factor is going

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1 either up or down the selection.

2 And so, therefore, like in the effect of  
3 fire, you will either select smoke a factor, visibility,  
4 or you will select smoke does not affect visibility.  
5 And in the complexity, you will either say this is complex  
6 or this is not complex.

7 So, then when you really come to judge a  
8 complex - let's say, yes, you perform this control  
9 action, is this complex or not? It's a lot of  
10 subjectivity to judge that.

11 And now that this PIF characteristic list  
12 we put ten factors for what all these ten factors  
13 contribute to complexity if the task isn't performed  
14 needs a coordination between multiple people that's  
15 complex. And if it involved many steps, if it rely on  
16 the central feedback, that's more like a control action.

17 So, you're not just look at your procedure.

18 So, you put these factors there. And now suppose I  
19 have this ten factors. I check by box, yes, it needs  
20 three people collaborating. Yes, it has 20 steps. Yes,  
21 it lasts C can be 20 steps. It is really long.

22 So, I check these factors. That give me  
23 a good set of information to decide whether complexity  
24 - whether it's complex or not rather than just - I'm  
25 sure for people using SPAR-H, I'm sure, for using fire

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1 HRA, they can think of these factors in their mind, come  
2 to a solution.

3 We just put this more explicitly. I think  
4 that this will help reduce the variability. Now, the  
5 question is if I check this risk factor, will this  
6 consider complex or simple?

7 That is the part as I - we don't know yet.

8 That I hope with our larger team will get a better  
9 understanding.

10 For example, I try that in our workshop  
11 expert. We have five factors for workload which are  
12 multitasking, unfamiliar scenario, interruption,  
13 disruption and time demanding - what's the other one?

14 I forgot.

15 Anyway, I try to get them give me some sense  
16 do you think one factor - how many factors would really  
17 make this really bad?

18 And the information I got, different people  
19 give me different opinion, but is a pretty consistent  
20 opinion. Any of this can make if it's high, can make  
21 it bad enough, you're out.

22 So, that's the kind of information we wish  
23 to look for.

24 CHAIR STETKAR: Okay, thanks. We're going  
25 to try to get through the status in the plant and path

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1 forward.

2 MS. XING: Okay. We can talk about the  
3 status along the way. So, I don't know if I can tell  
4 you more than what already -

5 CHAIR STETKAR: No, I think that there -

6 MS. XING: So, we put this basic framework  
7 there, the basic knowledge for that. And the next step  
8 starting next week we have this team work together on  
9 the number of issues on what are the basic functions?  
10 What are the examples for those basic functions and  
11 these PIF factors?

12 And we would like to try out - probably  
13 "scooping" is not the right word because of a mental  
14 model of the fire HRA or SPAR-H but we like just the  
15 two. Work off either two.

16 If the team think, oh, we can't develop a  
17 decision tree, but we better do a checklist, say, or  
18 we think, oh, yes, we can't select the most influential  
19 factor, develop a decision tree.

20 CHAIR STETKAR: So, just so I - because I'm  
21 really being dense here, over the next three months that  
22 line item that says scoping analysis method, that could  
23 be further refinements of the decision trees, or is that  
24 abandoning the decision tree work that has been conducted  
25 to date and trying Plan B?

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1 MS. XING: I'll probably have better answer  
2 to this question after next week.

3 Like for myself, my own concern is it will  
4 be really difficulty for you to develop a limited size  
5 decision tree for all these different situations.

6 CHAIR STETKAR: Okay.

7 MS. XING: So, you probably end up or  
8 actually we try to in the report we put out, let's see  
9 how many more failure mode. We end up to number 40  
10 something, which is too many probably. People already  
11 complain 14 failure mode is too many. If we come for  
12 47, it's too many.

13 And also are we able to select the most  
14 influential factor? We feel confident that we didn't  
15 miss any big fish. If not, then we better.

16 Under the scoping methods that we talked,  
17 you can visualize it's a very huge decision tree. Has  
18 all the 30 factors taken into consideration instead of  
19 limited tree.

20 So, that's the way we want - basically, you  
21 want to develop a huge decision tree. Consider all the  
22 factors or you won't develop a very precise, specific  
23 decision tree.

24 CHAIR STETKAR: Okay. And in the second  
25 half of this year when you say test the methodology and

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1 selected elements of Level 2 PRA, that is the Level 2  
2 part of the Level 3 PRA for the Vogtle plant that's in  
3 progress, or is this a - something conceptual?

4 MS. XING: No, at this point our management  
5 team haven't made a decision yet. So, this is just if  
6 we develop this, have something worked out. We best  
7 give a try.

8 CHAIR STETKAR: Oh, absolutely. I was going  
9 to -

10 MS. XING: Maybe you shouldn't have used the  
11 word "test." Let's say try out.

12 CHAIR STETKAR: I would say pilot the  
13 methodology. It's just a question of, you know, whose  
14 real world, real PRA model are you going to do it with.

15 MR. PETERS: Obviously we'll be doing it with  
16 the one we have. If it's part of the project or something  
17 outside of the project as a separate parallel piloting,  
18 that's yet to be decided.

19 CHAIR STETKAR: But, I mean, the plan is to  
20 actually use that model either in series or in parallel,  
21 if you will.

22 MR. PETERS: Yes.

23 CHAIR STETKAR: Yes, okay.

24 MR. CHANG: I want to say that the next three  
25 months when we're developing this scoping method we'll

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1 take it as far as Level 2. And then also we'll print  
2 Level 2 model, look at it, there is a sequence and see  
3 that how these things - what things we consider not  
4 incorporated into here.

5 CHAIR STETKAR: Okay. Okay, good.

6 MS. XING: And also what I don't put it here,  
7 Halden next year is starting a new experiment going to  
8 the severe accident - I think it's going to severe  
9 accident analysis part. And we like to try out this,  
10 before they start collecting data and after compare with  
11 their expert data.

12 So, all this I think is the proper word is  
13 probably pilot instead of test.

14 CHAIR STETKAR: I think it's really  
15 important that - I'm still confused, but that's okay.

16 I've been confused for the last 45 minutes, and will  
17 remain so. And I'm okay with that.

18 I think it's really important that you get  
19 to a point where you have some confidence in a way of  
20 translating the concepts of performance influencing  
21 factors and whatever you want to call those things,  
22 errors, into a quantification method. And then use it  
23 in a real, you know, study.

24 Because until you get the challenges of  
25 trying to use it in a real study, you're not going to

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1 really understand where the pitfalls are anyway.

2 So, I think it, to me, it seems appropriate  
3 to spend some time, but not too much more time, working  
4 out the bugs on trying to get some way of getting from  
5 a concept to some numbers and then see how it works.

6 MS. XING: So, I - for this meeting I do not  
7 - I cannot clarify your confusion in that part.

8 CHAIR STETKAR: No, that's fine.

9 MS. XING: I like to hear your confusion.  
10 That's the error we like. By looking what's exist in  
11 the two major approach if you use the SPAR-H or fire  
12 HRA kind of approach, multiply, you have some issues  
13 there. Or if you use CBDT kind of approach, decision  
14 tree, you are limited with a set of factors.

15 Maybe there's some kind of combination or  
16 something in between we can work off. So, right now  
17 -

18 CHAIR STETKAR: I was actually hoping at this  
19 meeting we were going to hear a little bit more  
20 specificity on where that's going, but not quite yet,  
21 I guess.

22 MEMBER REMPE: If you're going to go to  
23 severe accidents, are you even also going to try and  
24 understand the interactions between the technical  
25 support center and the operators, too?

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1           Because that would be very difficult, I  
2 think, to model at this time.

3           MS. XING: Yes, we actually have a discussion  
4 at HPT meeting when they were planning new experiments  
5 in 2017 frame, looking in the direction of the issues  
6 between tech center and the control room.

7           And the members provide enough input, I  
8 mean, not solution, just the kind of issues they  
9 visualized.

10          So, for example, one issue is this kind of  
11 awkward, I use is different is age of information. Like  
12 tech center information versus the control room at a  
13 different time. And you don't have the most recent.  
14 And you have - you receive - you probably have a different  
15 set of information.

16          You think tech center makes it - to their  
17 mental model makes the best decision. Maybe that  
18 analysis started in the control room when there's a  
19 severe accident. You can't do it.

20          So, right now I don't see a solution, but  
21 it was good at the HPT to try to collect all this issues.

22          CHAIR STETKAR: There's two thing I'd like  
23 to do. John, could you open up the bridge line? Because  
24 - for a couple of reasons.

25          While we're doing that, do any of the

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1 members have any more questions for Jing and James?

2 MEMBER SHACK: Yes. I mean, how do I even  
3 know when I pick one of these, you know, suppose I pick  
4 whatever combination I pick. I'll get a number.

5 How do I make some judgement as to which  
6 number makes more sense than the other number?

7 MS. XING: You mean the other number from  
8 other method?

9 MEMBER SHACK: Yes. You know, you said you  
10 wanted to do a linear combination. You wanted to  
11 multiply them. I don't know. Take, you know,  
12 exponentials. I'll get a whole bunch of numbers.

13 How do I make a judgement as to which of  
14 these I would prefer to use? I mean, presumably  
15 numerically I can use any of them. I'll get some number  
16 between zero and one.

17 (Discussion off the record.)

18 MEMBER SHACK: I've got those two ends pinned  
19 down.

20 MS. XING: Yes. One practice I use before  
21 in a different project before I work for NRC, you were  
22 - you pick up a stack, I mean, that's when I worked for  
23 the FAA. Fortunately have a lot of event to choose.

24 So, you have - basically you have this --  
25 you have this expert come, okay. Base controller tell

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1 you these are the events most likely trouble wise. These  
2 are less trouble wise.

3 So, you have this ranking and then we try  
4 this different combination rule. Use a different  
5 combination rule apply to this event and say which rank.

6 Like, I use a linear combination. Find  
7 like one chart this event controller rank like this.  
8 If I use linear combination, I come up pretty blasting.  
9 This doesn't work.

10 And if I use multiplication, they rank like  
11 this.

12 CHAIR STETKAR: I mean, suppose you had your  
13 decision tree model which you seem to believe is that,  
14 I mean, would that give you something that you could  
15 at least compare against?

16 MR. CHANG: In the agency, there is method  
17 is expert judgment. It's a structure that is based on  
18 the performance shaping factor and then the expert give  
19 it weight.

20 And then it takes two weeks variable and  
21 then has an equation based on the weights together, the  
22 number. That could be one way that we'll try when we  
23 tried using that method to come up with some thoughts.

24 This is still a somewhat possible approach  
25 come to the specific way, yes.

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1 CHAIR STETKAR: Anything else for the folks  
2 up front?

3 (No response.)

4 CHAIR STETKAR: Okay. What I'd like to do  
5 is there probably have been any number of people sitting  
6 out there on the bridge line screaming at their phones  
7 wanting to be heard.

8 So, first of all, somebody out there just  
9 make some oral statement like "hello" to make sure that  
10 we have the bridge line open, because we don't know  
11 whether it's actually open or not.

12 PARTICIPANT: Hello.

13 CHAIR STETKAR: Thank you. Now, is there  
14 anyone out there who would like to weigh in on anything  
15 that they've heard, make a statement, ask questions?

16 (No response.)

17 CHAIR STETKAR: We've worn them down. Okay.  
18 Yes, that's surprising. Thank you anyway.

19 Do we have any members of the public?

20 (Discussion off the record.)

21 CHAIR STETKAR: So, I've satisfied that  
22 requirement. Thanks out there on the bridge line anyway  
23 for your stamina, whoever is left out there. Thank you.  
24 It's been an interesting, interesting discussion.

25 What I'd like to do, we always do this in

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1 the subcommittee meetings, is go around the table and  
2 see if any of the members have any final comments or  
3 statements they'd like to make.

4 Joy.

5 MEMBER REMPE: No comment. Thanks for the  
6 presentation.

7 CHAIR STETKAR: Bill.

8 MEMBER SHACK: No.

9 CHAIR STETKAR: Sam.

10 MEMBER ARMIJO: I' fine.

11 CHAIR STETKAR: Harold.

12 MEMBER RAY: Well, I was here to try and learn  
13 as you would expect. And I think it's been official  
14 I think this is an important area.

15 I had a hard time, though, sort of like I  
16 guess implied by Bill's question, envisioning how this  
17 actually materializes into the kind of things that we're  
18 used to dealing with.

19 But anyway, that was my aim and I appreciate  
20 the opportunity to be educated.

21 MEMBER SHACK: I wish I had been here in  
22 January to hear the simpler version of this.

23 CHAIR STETKAR: It wasn't simpler.

24 (Laughter.)

25 MEMBER RAY: Anyway, that's all I'd say,

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1 John.

2 CHAIR STETKAR: I would ask Dr. Bley, but  
3 he'll probably just nod his head.

4 MEMBER BLEY: Yes.

5 CHAIR STETKAR: Steve.

6 MEMBER SCHULTZ: I guess my comment at this  
7 point would be for Sean and those two overriding  
8 elements. And that is - the first one is as you're having  
9 these meetings and discussions, I would hope that the  
10 SRM, the goals and objectives that have been set out  
11 in the staff requirement memo would be somehow captured  
12 and put on a wall or handed out at each of these meetings  
13 so that the overall arching - the overarching purpose  
14 of all this work is.

15 Because every time we see things, there's  
16 always this difficulty in trying to keep it contained.

17 And the other element is as we talked earlier for as  
18 we go forward, we're talking about, well, Level 3 PRA,  
19 severe accidents and these types of applications, the  
20 question of how this is going to be done again needs  
21 to be constrained in some fashion or it will bloom again.

22 So, I would hope that the - I would hope  
23 that the process would be developed such that purpose  
24 of focusing and developing a particular approach be a  
25 major purpose of the project.

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1 And that if it's not - if this element is  
2 not going to be used, for example, for the Level 3, then  
3 there has to be a placeholder there with the intention  
4 being that at some point it's going to come together.

5 Ideally it would be used for it. But if  
6 it can't happen now because one element is moving forward  
7 faster than the other, at least create the intention  
8 that it's going to come together somewhere down the road.

9 So, we didn't see the overarching program  
10 plan that would make the SRM happen, but it has to be  
11 there somewhere.

12 And thank you for the discussion. It was  
13 wearing, but I think in the midst of all of it I learned  
14 a lot. Thank you.

15 MS. XING: Thank you.

16 MEMBER SHACK: Of course, I mean, it's easy  
17 to issue the SRM.

18 MEMBER SCHULTZ: Yes, it is.

19 CHAIR STETKAR: That's right.

20 MEMBER SHACK: Down here where the rubber  
21 meets the road -

22 MEMBER SCHULTZ: Exactly where we saw the  
23 difficulties. Many of them.

24 CHAIR STETKAR: I actually think there has  
25 been a lot more progress. It's been painful. I quite

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1 honestly, I really like the psychological framework.  
2 I think that brought together an awful lot of really  
3 good stuff.

4 The challenge is reducing that into  
5 something that an analyst can use in practice. So, I  
6 think that the whole project, you know, has developed  
7 a lot of useful things except now, like you said, we're  
8 getting to where the rubber meets the road and how do  
9 you translate that information into something that is  
10 six significant figures to the minus three.

11 That's all I can do with no uncertainty.

12 (Laughter.)

13 MEMBER RAY: John, let me just say one - I  
14 don't think that just being able to make that kind of  
15 a judgement, like you said, ten to the minus six, ten  
16 to the minus - I'm more interested in does it ever tell  
17 us anything about what we should do differently.

18 Training and qualifications and level of  
19 detail and the procedures that are being used, that kind  
20 of stuff, that's, to me, more rewarding than knowing  
21 what part of some remote probability this piece of the  
22 puzzle represents.

23 It's do we do anything differently than we  
24 did before, or are we just going to feel enlightened  
25 by the end result and that's it?

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1 I think it's got to be directed toward  
2 something that you do differently. Either you automate  
3 instead of relying on the operators, or you train them  
4 a lot better, or you do procedures differently or you  
5 have more staffing, something.

6 Workload was a big piece of one of those  
7 slide puzzles. It was bigger than procedures or  
8 training. Either one.

9 Well, okay. That would be a payoff if we  
10 decided we needed to reduce the workload, but, you know,  
11 it's that sort of thing that I'm more interested in.

12 MEMBER SCHULTZ: That's where I think the  
13 benefit may well come and I think it is coming from your  
14 comment, Dennis, and your discussion that the benefit  
15 may come from the kind of discussing the guts of the  
16 process with the team versus the overall methodology  
17 and having it work well in the computer and all of that.

18 That the discussion of performance  
19 influencing factors and how they fit together, what's  
20 important, what's not important, those discussions could  
21 prove to be the benefit of what can be captured in terms  
22 of identifying the improvement opportunities.

23 MS. XING: And in that sense I have more  
24 confidence than, you know, even at this point we haven't  
25 figured out that confusion part, how these factors work

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1 together, but we are confident each individual  
2 characteristic can make sense.

3 And for Harold's question just to think  
4 previously after you've done a PRA, HRA, you can say,  
5 okay, this happened because HSI is bad. So, you need  
6 to improve HSI.

7 That doesn't give you much information.  
8 Just like you walk to a doctor. Doctor tell you, hey,  
9 you are sick.

10 (Laughter.)

11 MS. XING: And this characteristic list and  
12 the basis will give you more information on that. You  
13 say, okay, this thing is not salient enough and the fire  
14 situation. Therefore, you need to consider  
15 improvement.

16 For that part, I think we already achieve  
17 the improvement up to the existing method. So, the  
18 objective for the SRM is to reduce this variability  
19 because the method hasn't tested yet.

20 Even theoretically I think it should  
21 improve, but we have test better to see it really is.

22 CHAIR STETKAR: And I echo Harold's concern  
23 is that the real strength of this process is to identify  
24 the contributors to the errors. And that's one of the  
25 reasons why I am a bit skeptical about the quick and

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1 dirty way to get to a number, because you need to get  
2 to a number, because we've tried that in the past and  
3 it gets numbers.

4 MEMBER BLEY: To Harold's question earlier  
5 I point you all to a transcript of this August committee  
6 10, 12 years ago when we brought results from the ATHENA  
7 method here.

8 And ATHENA is one of the methods. It was  
9 developed to look for cases that would put operators  
10 in a spot so error was very likely. You know, we're  
11 not talking ten to the minus six. We're talking 0.1,  
12 0.5 or worse. And that ended up being unusual conditions  
13 that put you here.

14 One of the complaints was that, gee, this  
15 method isn't very useful for calculating the  
16 probabilities of these events, because every one of these  
17 you find, they fix.

18 (Laughter.)

19 MEMBER BLEY: I'll leave it at that.

20 MEMBER ARMIJO: Success.

21 CHAIR STETKAR: Anything else from the  
22 members? If not, one last thing and we don't have to  
23 make any decisions here.

24 A couple of hours ago we mentioned if the  
25 staff would like a letter from the Committee, because

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1 I'll reiterate for the record that anything that you've  
2 heard today are simply the ramblings of individuals on  
3 the Subcommittee.

4 If the staff would like a letter from the  
5 Committee, we need to understand, you know, what the  
6 topic is, when you might want it.

7 And of course, you know, there is quite a  
8 level of interest among at least the Subcommittee members  
9 on this general topic. So, we also need to think about  
10 scheduling, I think, another subcommittee meeting if  
11 you're going to hit that July target.

12 I certainly would like some of the cobwebs  
13 in my head straightened out sometime in the summer to  
14 early autumn time frame when you've struggled with all  
15 of that so I can understand a little bit better. So,  
16 keep in touch with John for that.

17 With that, thanks again. I appreciate it.

18 Sean, anything?

19 MR. PETERS: No, I just - I'd like to thank  
20 everybody for taking the time and providing very useful  
21 insight to us.

22 As you can tell, we're really working hard  
23 to try to come up with that perfect mix of what's usable  
24 and not usable. There's a huge interplay between those  
25 two pieces.

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1 And I really appreciate your input and we'll  
2 try to take it back and come up with our best shot at  
3 it.

4 (Laughter.)

5 MR. PETERS: We'll bring it back to the  
6 Committee. And in the long run, you know, in the long  
7 run we definitely will want, you know, once we've started  
8 testing it and then finalize the documentation, we would  
9 love to give ACRS a letter at that point.

10 If you want it on Level 3 usage, I'll try  
11 and get back to you guys.

12 CHAIR STETKAR: Because, I mean, we're going  
13 to eventually have to write a letter, because the SRM  
14 really was written to us. So, we can't remain silent  
15 forever.

16 With that, we are adjourned. Thank you  
17 all.

18 MS. XING: Thanks.

19 (Whereupon, at 5:14 o'clock p.m. the  
20 meeting was adjourned.)  
21  
22  
23  
24  
25

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A large, stylized graphic of an atomic symbol, consisting of a central sphere and three elliptical orbits, is positioned on the left side of the slide, extending from the top to the bottom.

# Building a Psychological Foundation for Human Reliability Analysis

Presented by Jing Xing  
RES/DRA/HFRB

# IDHEAS products

## Product

## Intended applications

## Status

Cognitive basis  
for human error  
analysis

- Technical basis for HRA and Human factors engineering

- In Peer review
- Publish in FY14

IDHEAS Generic  
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

- Peer review on 5/15/2013
- Testing in FY13-14

# Contributors

NUREG-2114

INL/EXT-11-23898

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# Outline

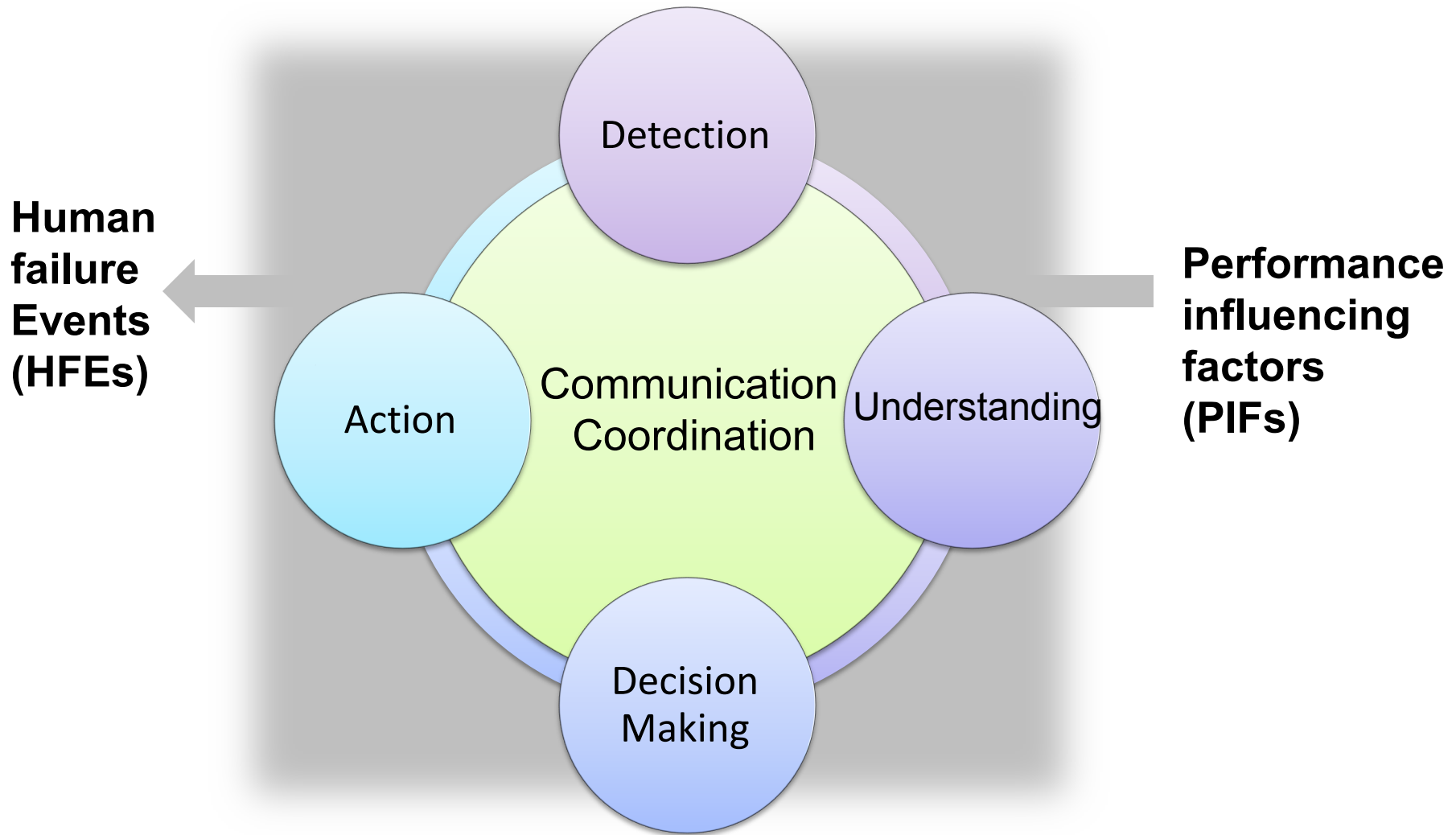
- I. Goals, limitations, and process of developing the cognitive basis
- II. The cognitive basis – five cognitive functions
- III. Additional study of literature and operational experience

# Outline

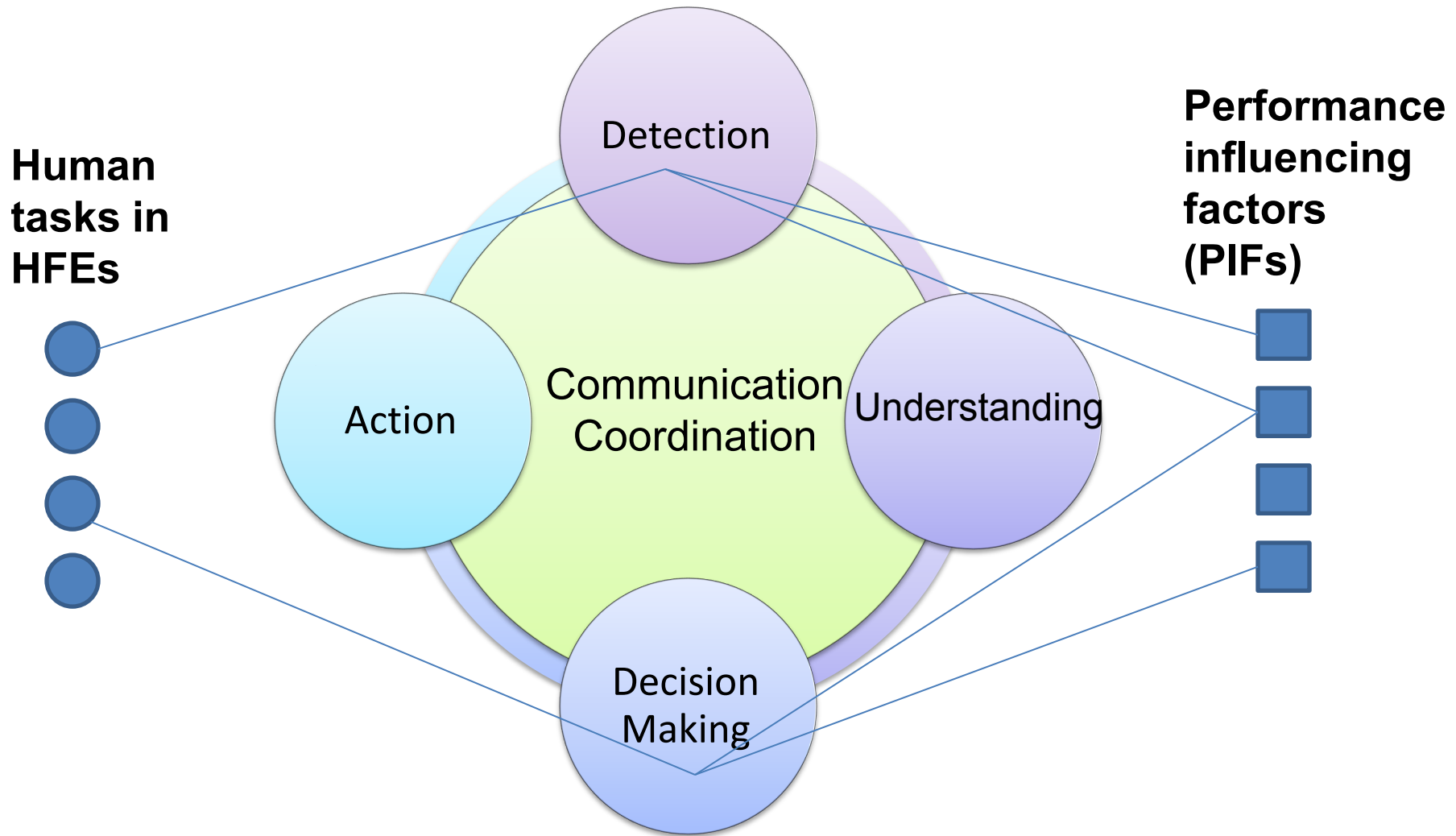
- I. Goals, limitations, and process of developing the cognitive basis
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# Cognitive basis used in HRA methods



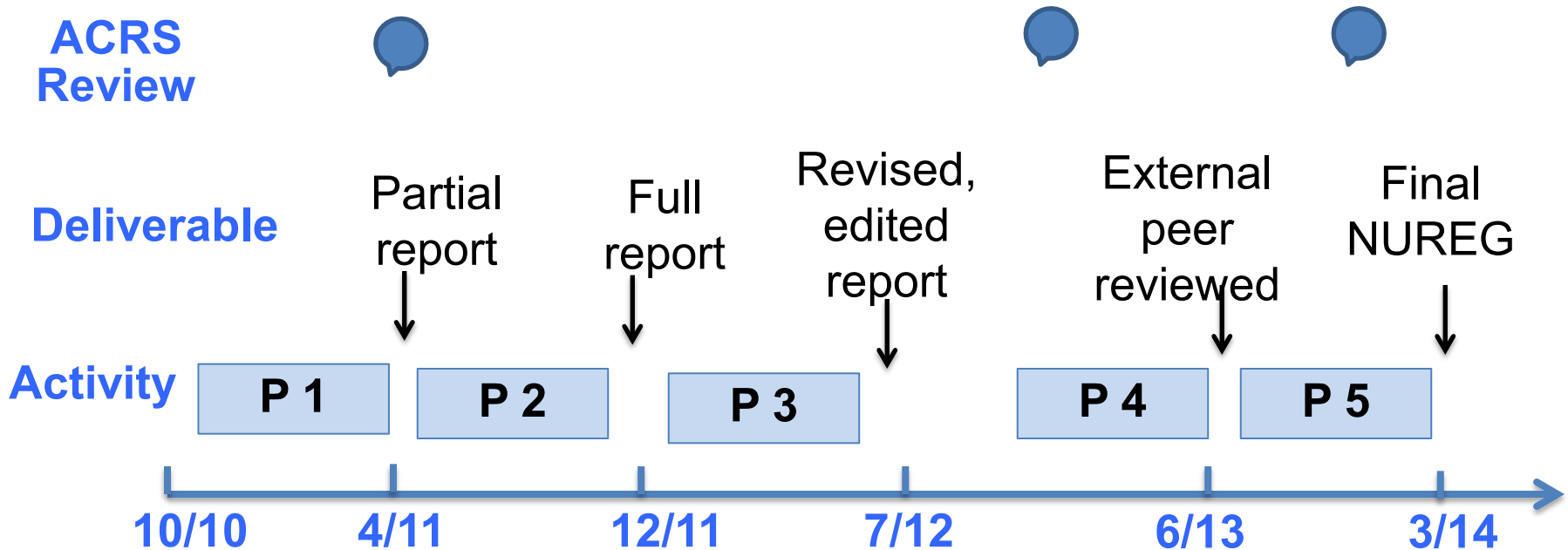
# Enhance the cognitive basis for HRA



# Goals of the literature review

- Identify cognitive mechanisms underlying NPP operator failures in internal, procedural events
- Identify factors that influence human performance and, where possible, identify how those factors affect the chance of failures
- Develop a structured cognitive framework that can serve as a psychological foundation for IDHEAS

# Project timeline, Milestones, and coordination



P1: Initial literature review for the *Detection* function – Lack of structure

P2: Developed a framework for all the functions, determined the scope for every function, and completed the structured review for all the functions

P3: Revised the report incorporating NRC and INL peer review comments

P4: External peer review

P5: Incorporate ACRS and peer review comments

# Cognitive functions underlying human performance

Cognitive tasks are achieved through the following functions:

*Detection, Understanding, Decision-making, Action execution, and Communication/coordination.*

Response in PRA events

Tasks

Monitoring plants, diagnosing problems, following procedures, ...

Cognitive Functions

Detection

Understanding

Decision making

Action

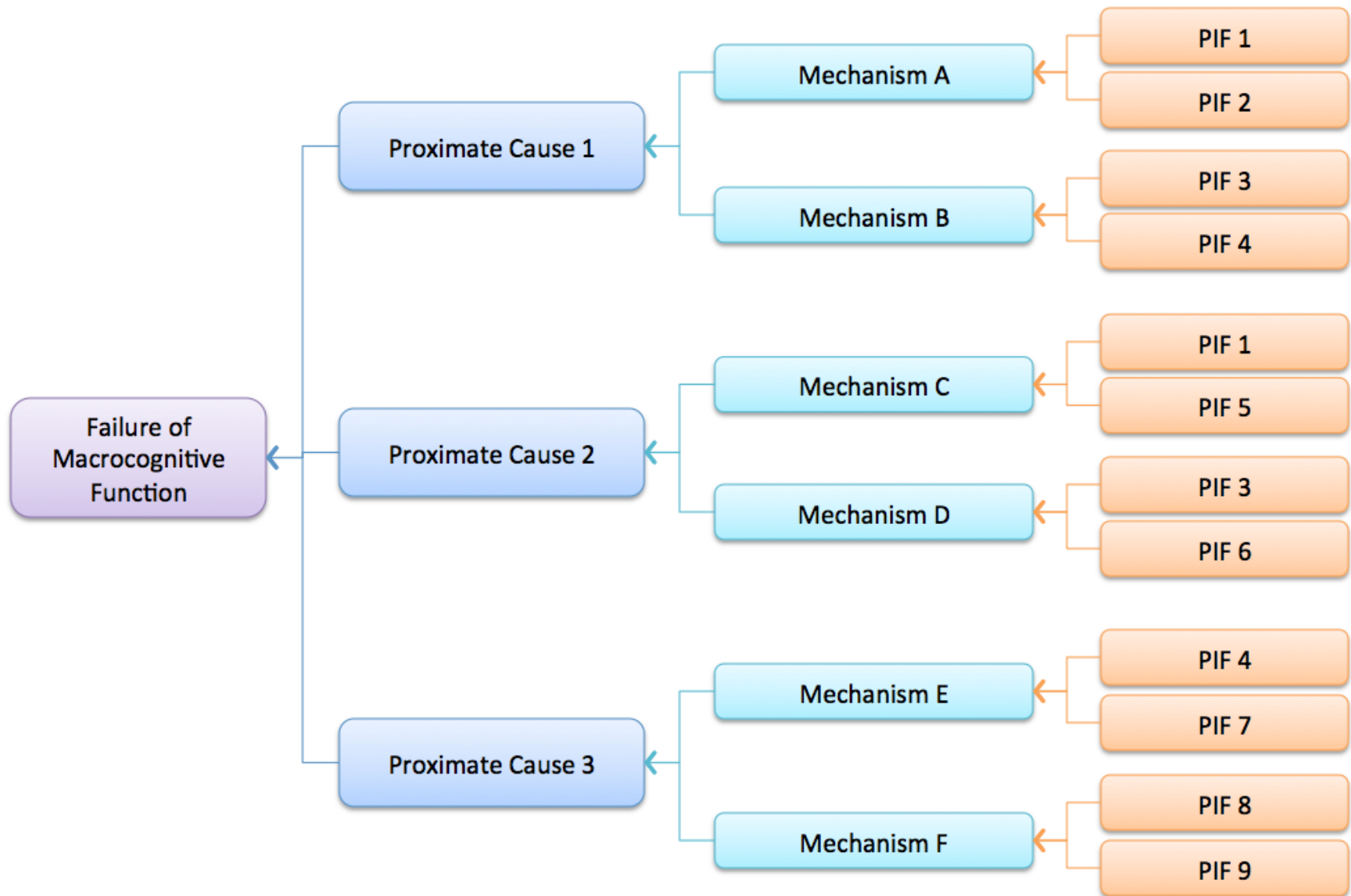
Communication/  
Coordination

# 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 objectives?
- III. Error Causes (i.e., failure mechanisms) and Proximate Causes (PCs)
  - How a cognitive mechanism fails?
- IV. Effect of PIFs
  - What PIFs leads to error causes?

# Outcome - Structure of the cognitive basis



# Outline

I. Goals, limitations, and process of developing the cognitive basis

## II. The cognitive basis –

- Detection
- Understanding
- Decision-making
- Action execution
- Communication/coordination

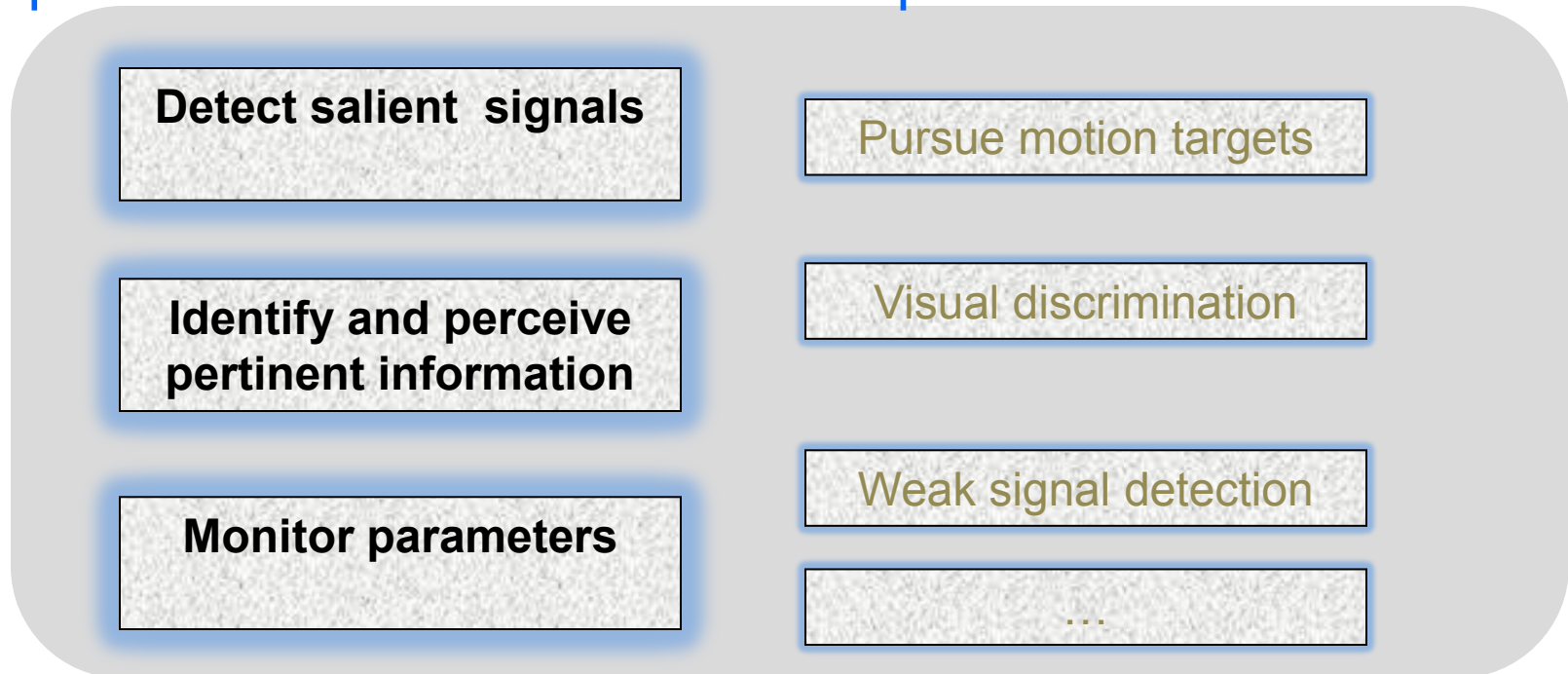
III. Additional study of literature and operational experience



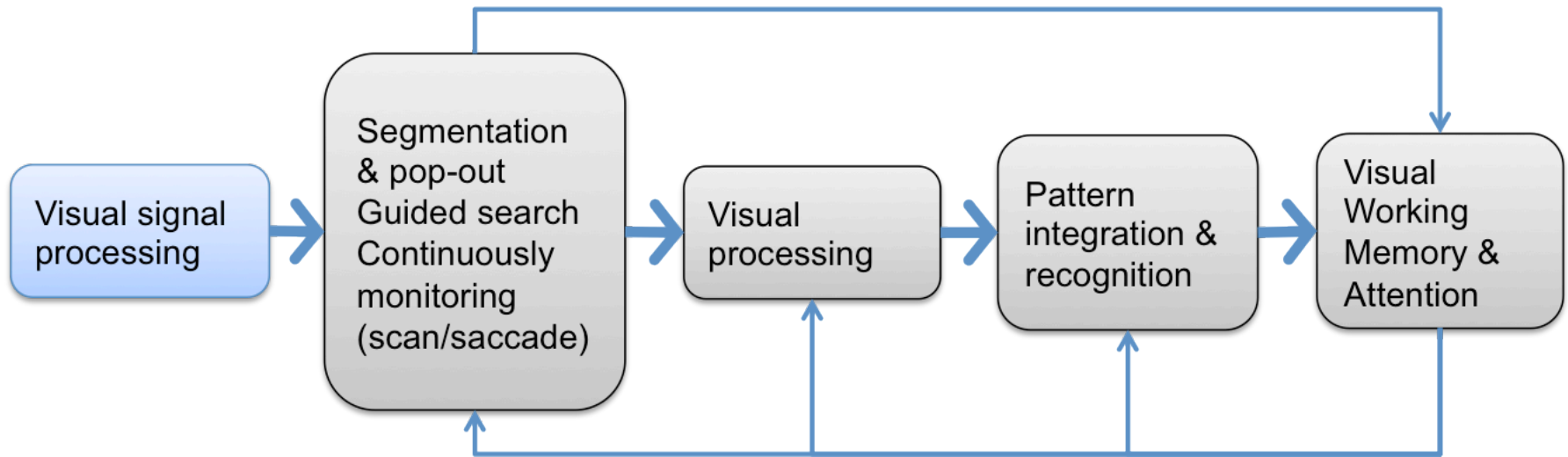
# ***Detection* - Scope in NPP internal procedural events**

*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**



# ***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**

- Cue salience is low and not detected
- Unable to maintain vigilance
- Mismatch between expected and actual cues
- Working memory capacity overload

## **PIFs**

Human-system interface (HSI)  
Fatigue, fitness-for-duty  
Training, procedures  
Workload, task complexity

## **Proximate Cause - Cues/information not attended to**

- Too many salient cues
- Overreliance on primary indicator

Task complexity, HSI  
Training and experience

## **Proximate Cause - Cues/information misperceived**

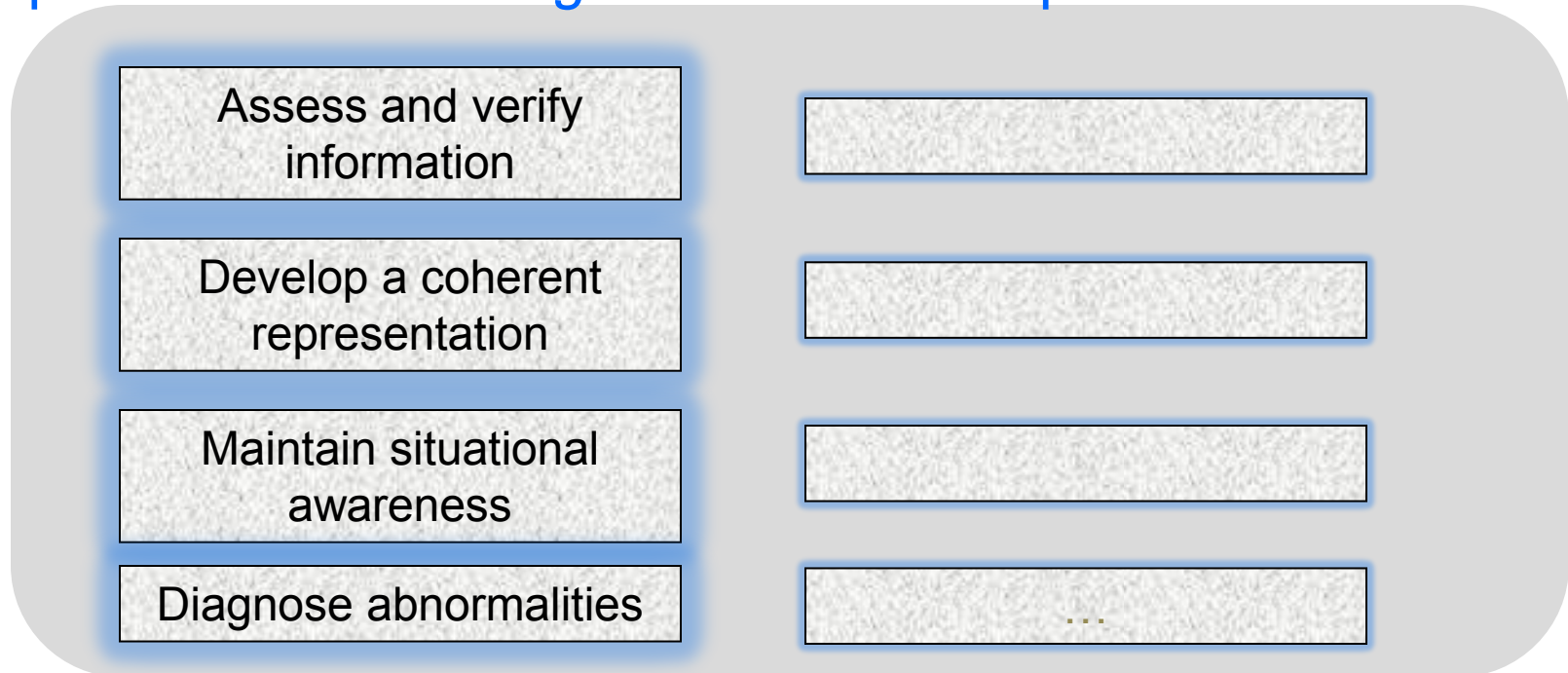
- Cues are too complex or similar
- Prior experience biases expectation
- Memory processing error

HSI, task complexity  
Training and experience  
Fatigue, workload, time

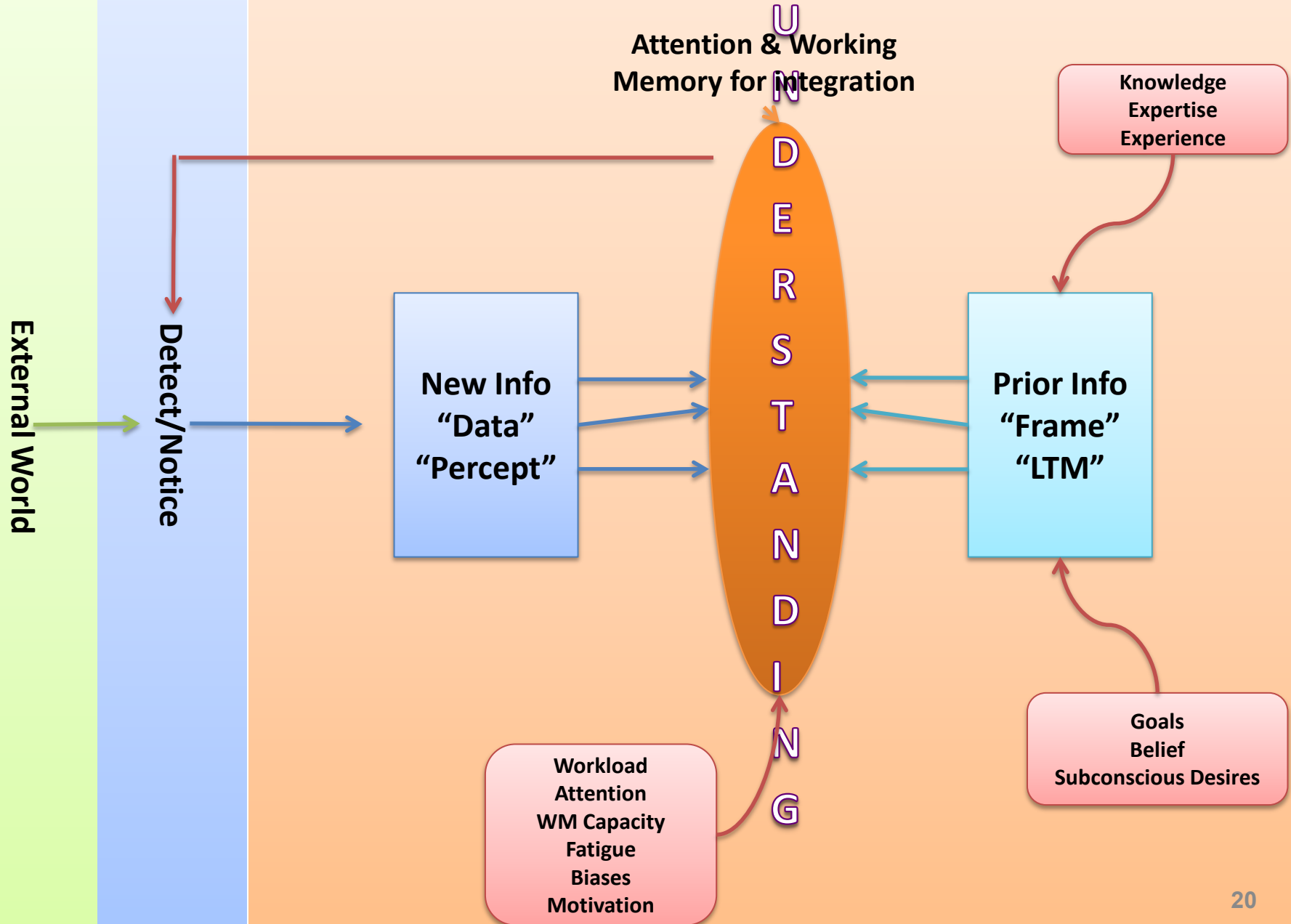
# ***Understanding* - Scope in NPP internal procedural events**

*Understanding* is the evaluation of current conditions to assess the plant status or to diagnose the underlying causes of any abnormalities.

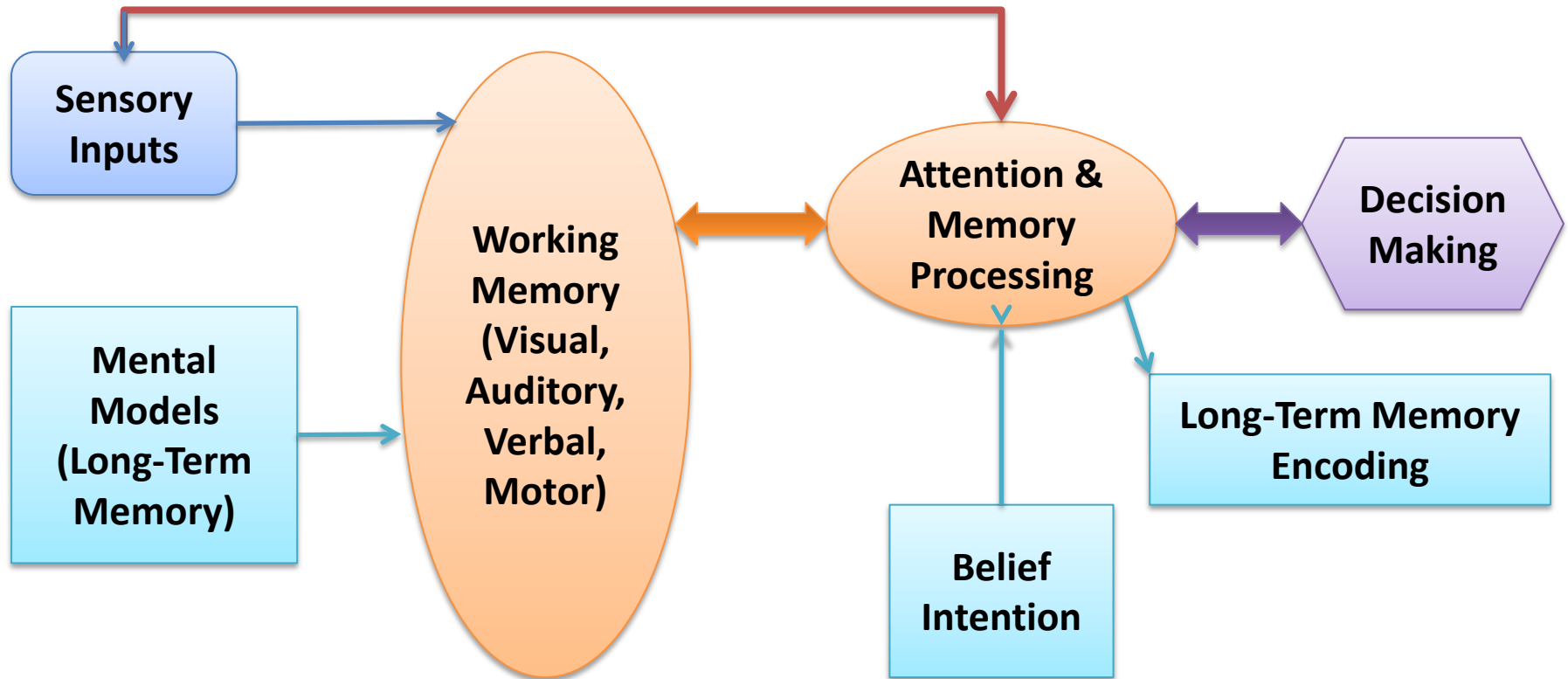
## ***Scope of Understanding* in NPP internal procedural events**



# How human achieves Understanding

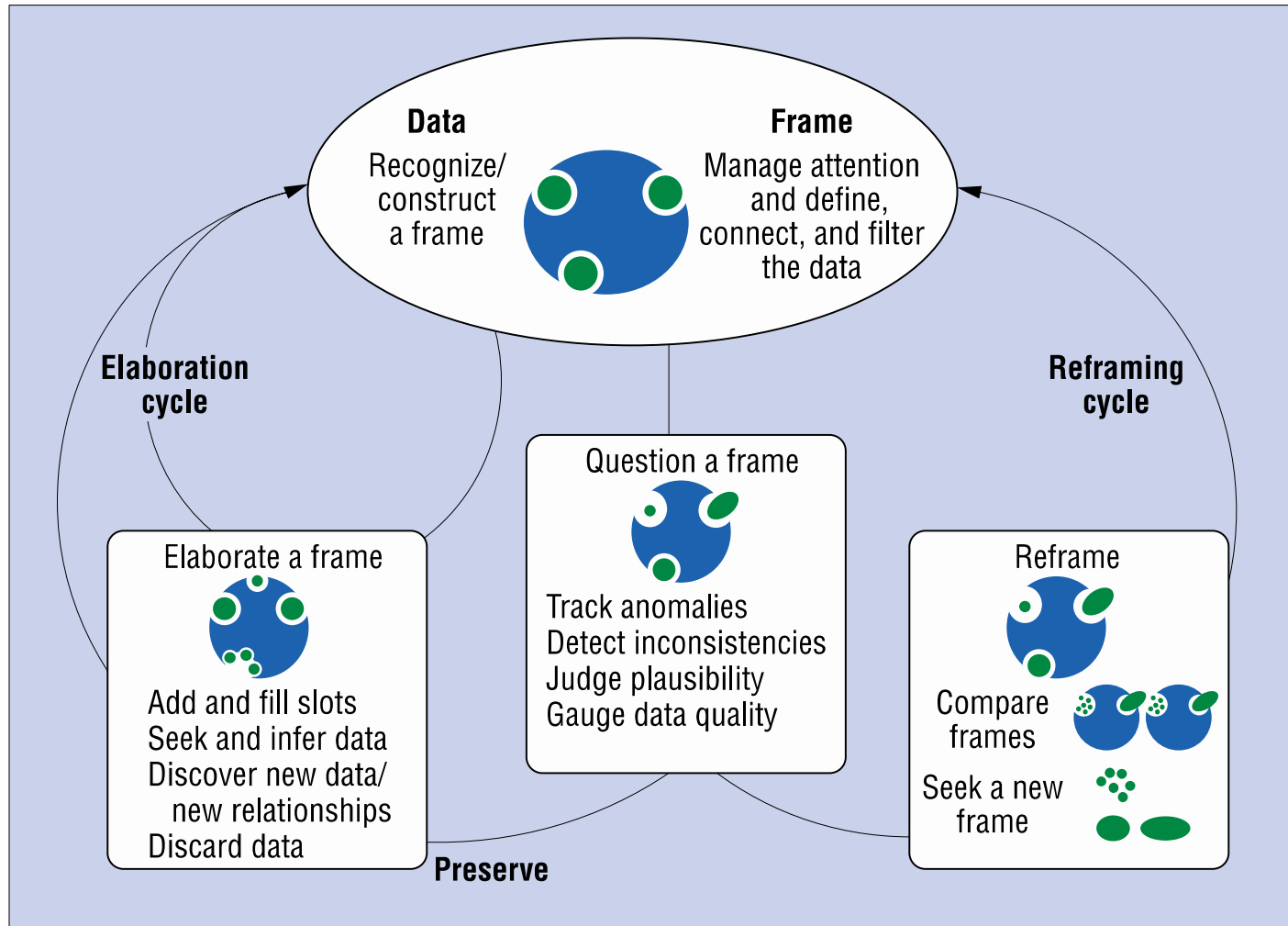


# Dynamic process of understanding in complex tasks





# Cognitive process for understanding



(Klein et al, 2006)

# ***Understanding*– Cognitive mechanisms that makes the function reliable**

**Data content-** meaningful information, not misleading or conflicting

**Mental model (frame)** - Mental model is developed through training and experience

**Integration of mental model and data** - Mental model is integrated with data to generate understanding

**Attention and Working Memory** – Attention control ensures all parts of the cognitive process for understanding are achieved; Working memory is to be managed for its resource limitations.

**Belief process** - Beliefs modulate the integration process

# *Understanding*– Error causes and proximate causes

## **Proximate Cause - Incorrect data**

- Information available in the environment (including procedures) is not complete, correct, or otherwise sufficient to create understanding of the situation

## **Proximate Cause - Incorrect integration of data, frames, or data with a frame**

- Improper aspects of the frame selected for comparison with the data

## **Proximate Cause – Incorrect frame**

- Frame or mental model inappropriately preserved or confirmed when it should be rejected or reframed

# *Understanding*– Effect of PIFs

## **Proximate Cause - Incorrect data**

- Information available in the environment (including procedures) is not complete, correct, or otherwise sufficient to create understanding of the situation

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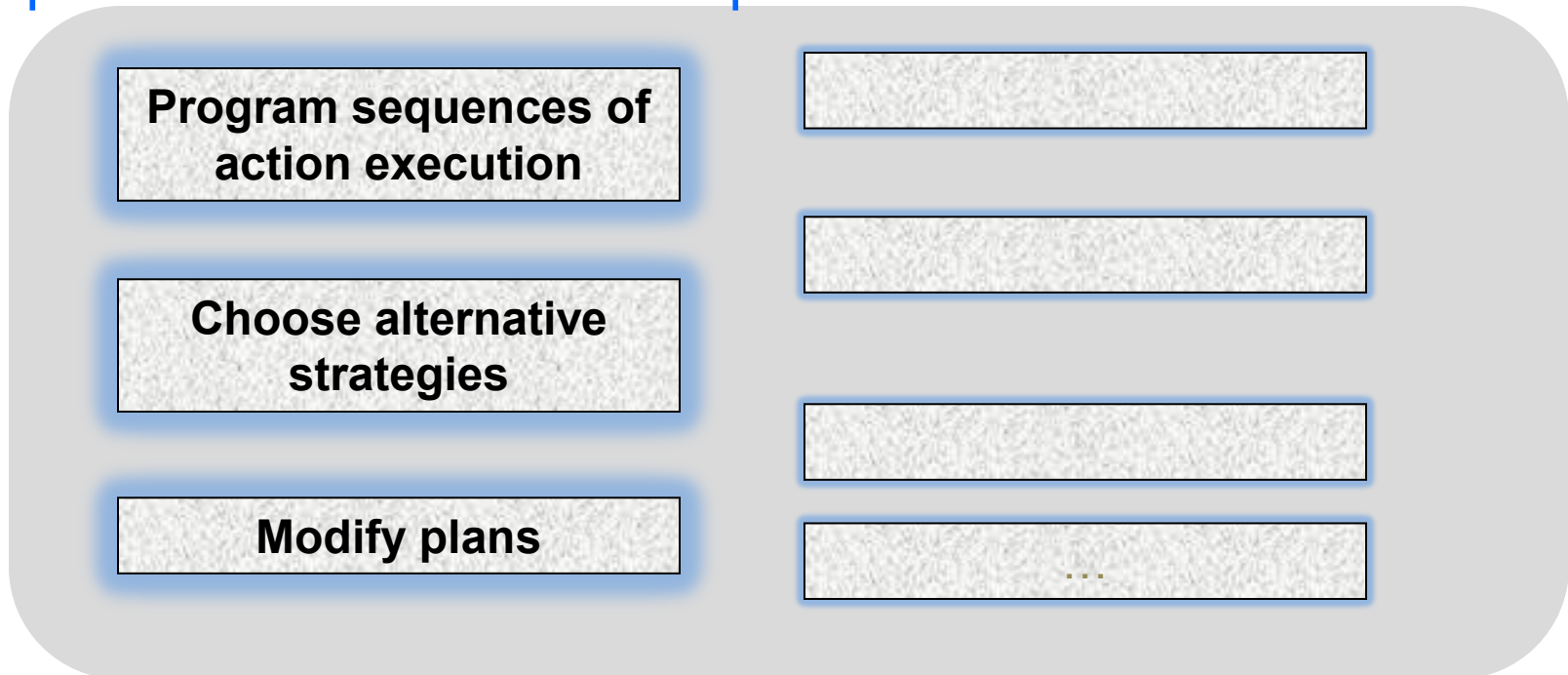
## **PIFs**

- Complexity
- HSI
- Workload
- Training
- Workload
- Complexity
- Fatigue

# ***Decision-making (DM) - Scope in NPP internal procedural events***

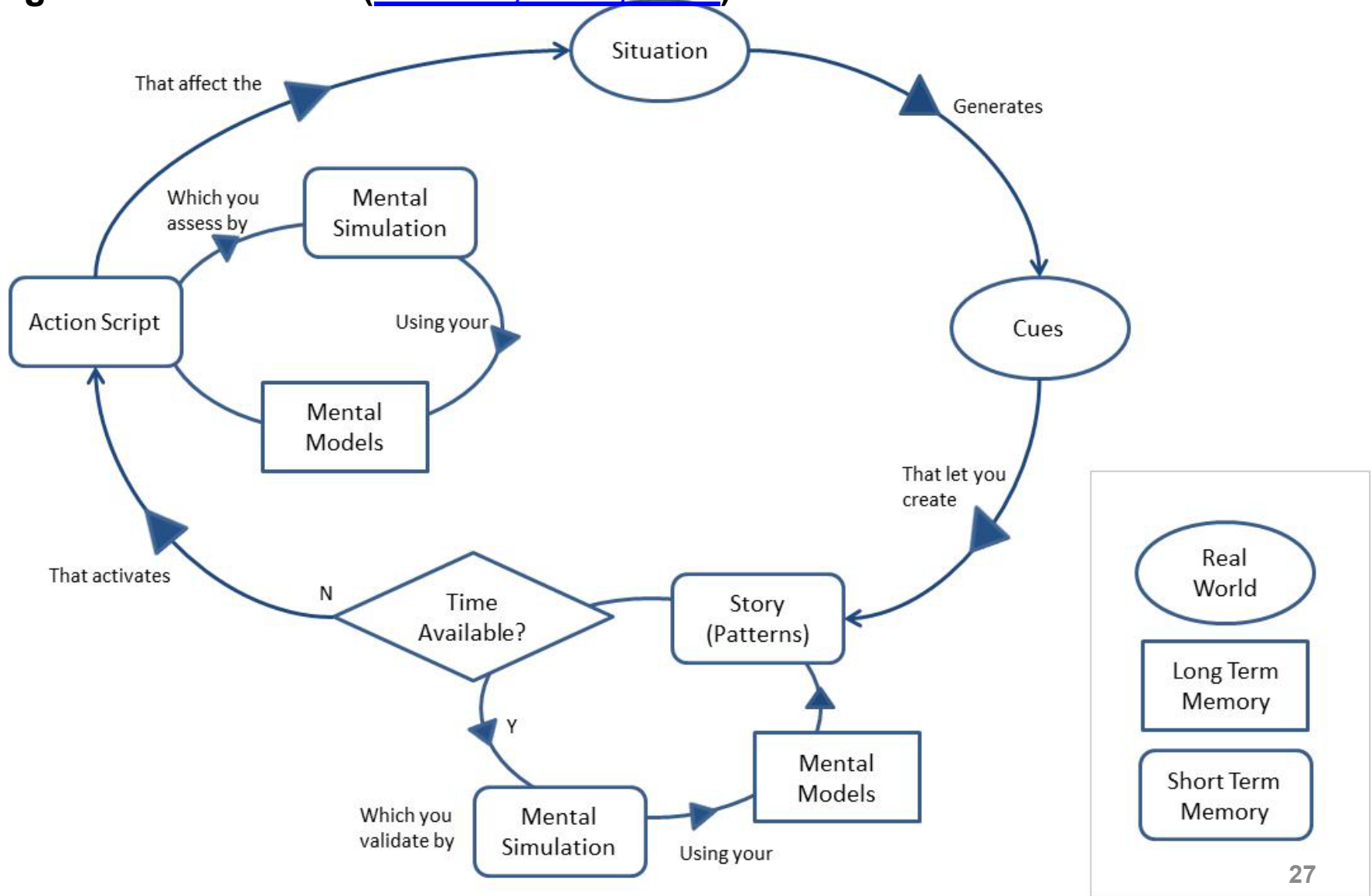
*DM* is the judgment of what should be done and the decision to do it.  
*DM* within an NPP is characterized as involving experts and being largely driven by procedures in internal, procedural events.

## ***Scope of DM in NPP internal procedural events***



# DM – How the objectives are achieved

Integrated NDM model ([Greitzer, et al., 2010](#))



# ***DM* – What makes the function reliable**

**Goal management** – Decisions to be made have clear goals and can be prioritized.

**Pattern recognition** – Recognize the pattern of the situation/goals through training and experience.

**Mental simulation** – Assess the pattern and the outcome of the decision.

**Inhibition of bias and wishes** – Biases and wishes interfere *DM*.

**Attention and working memory** - Focus on information pertinent to *DM* and bind relevant information.

# **DM – Error causes and proximate causes**

## **Proximate Cause - *Incorrect Goals or Priorities Set***

- Goal conflict. A conflict may arise in the operator's mind between the goals of safety and the continued viability of the plant.

## **Proximate Cause - *Incorrect Internal Pattern Matching***

- Not updating the mental model to reflect the changing state of the system.

## **Proximate Cause - *Incorrect Mental Simulation or Evaluation of Options***

- Inaccurate portrayal of the system response to the proposed action. This failure mechanism manifests in the operator incorrectly predicting how the system will respond to the proposed action.



# DM – Effects of PIFs

## **Proximate Cause - *Incorrect Goals or Priorities Set***

- Goal conflict. A conflict may arise in the operator's mind between the goals of safety and the continued viability of the plant.

## **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.

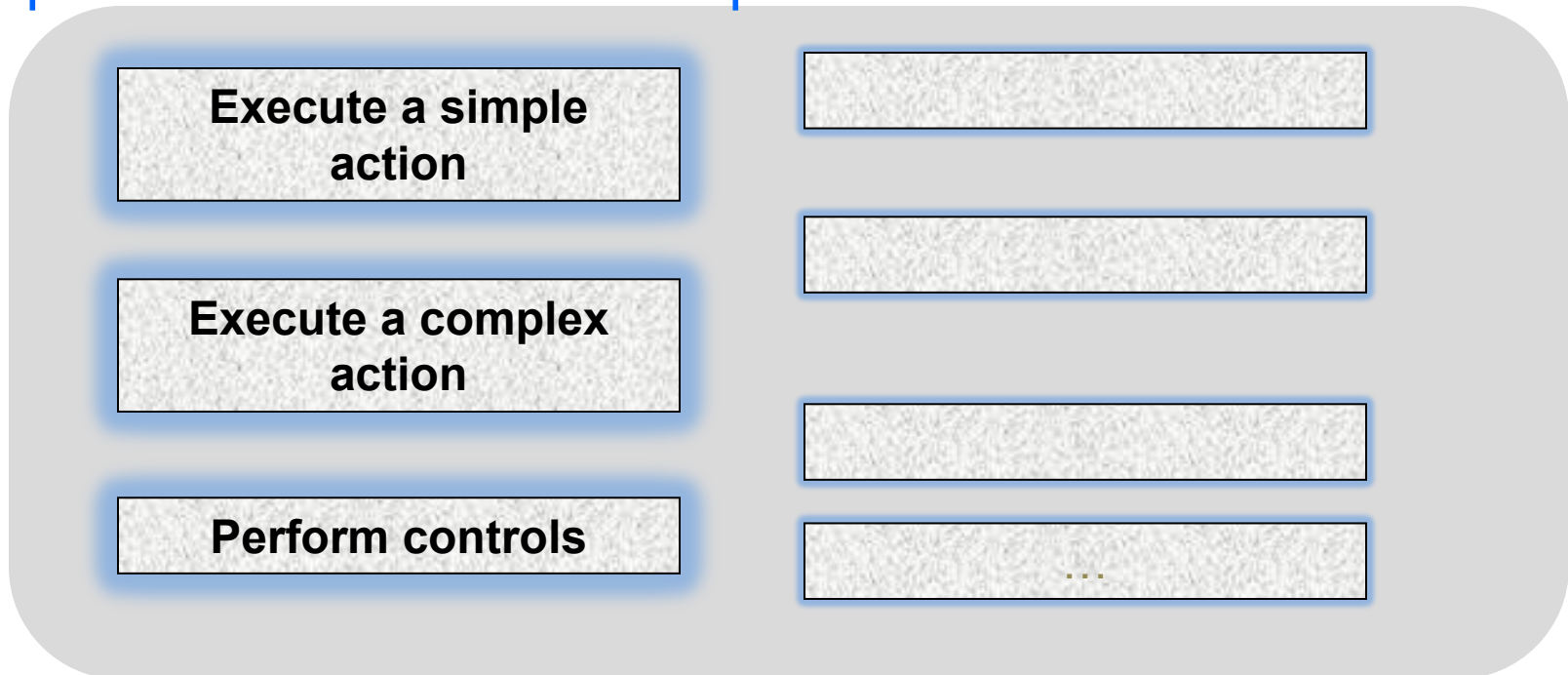
## **PIFs**

- Task complexity
- Workload
- complexity
- Complexity
- Workload
- Training

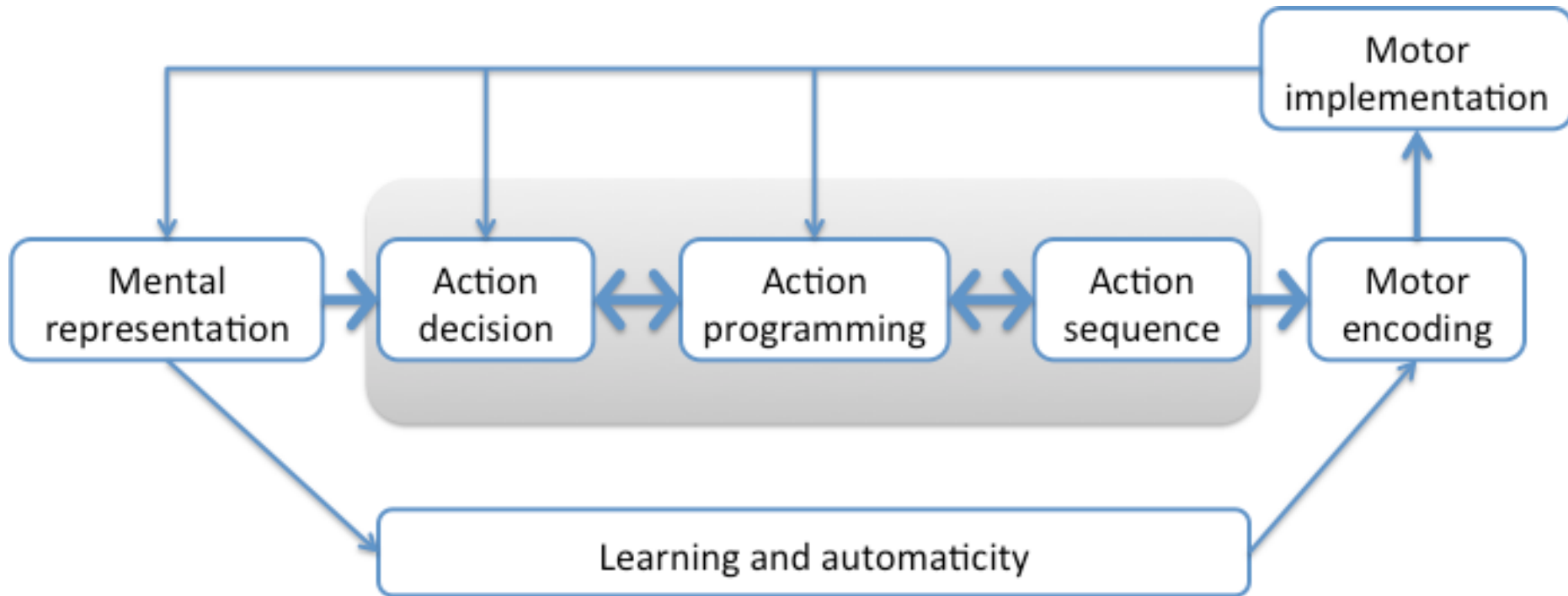
# Action execution - Scope in NPP internal procedural events

*Action 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



# 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)***

- 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)

## **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

Human  
response  
in PRA

EOPs, SAMGs, Spurious actions, In-MCR, Ex-MCR, LPSD, ...

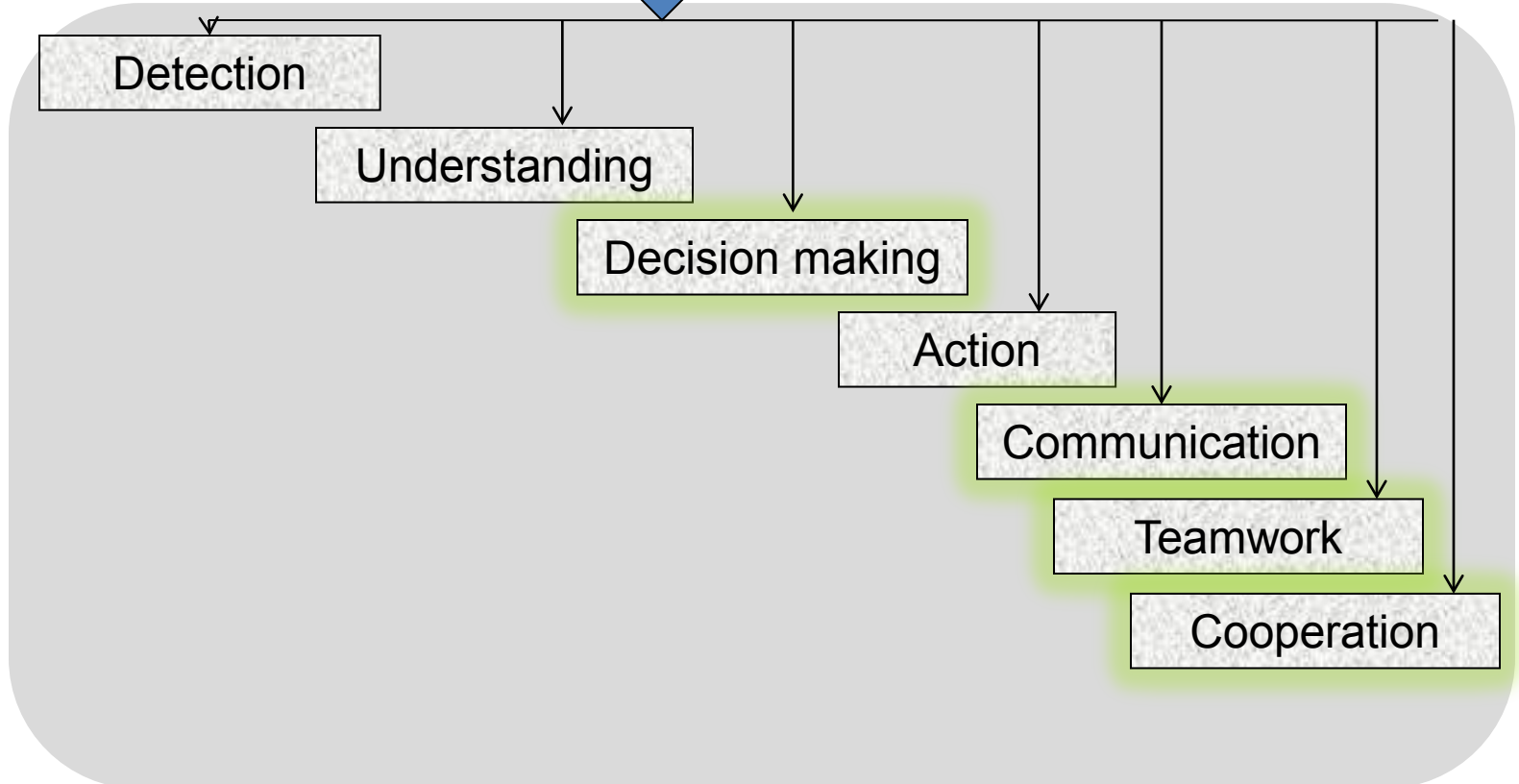


Human tasks

Attend to alarms, planning, cooperation ...



Cognitive  
Functions



# 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

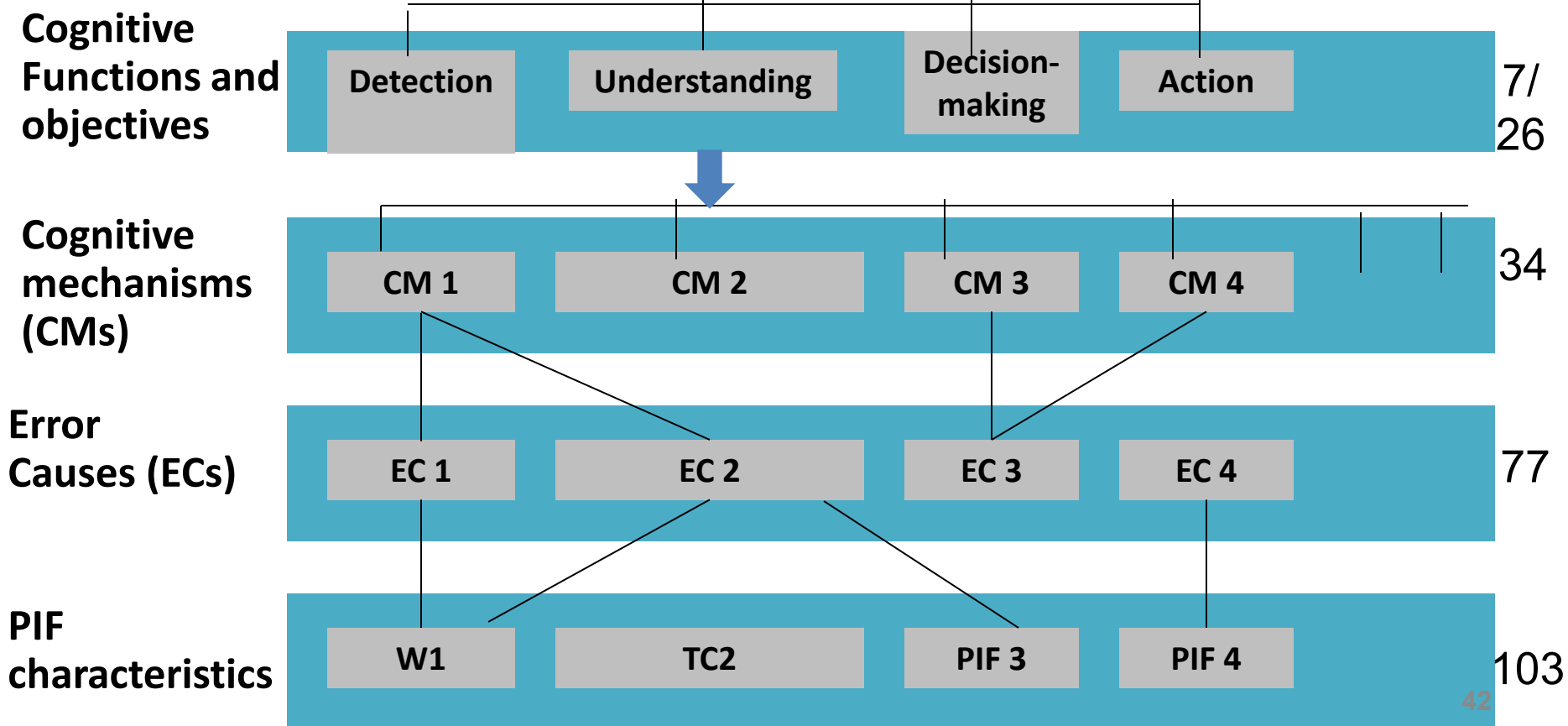
For each cognitive function, we identified the PIF characteristics that challenge the cognitive mechanisms and trigger the error causes.

## 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.

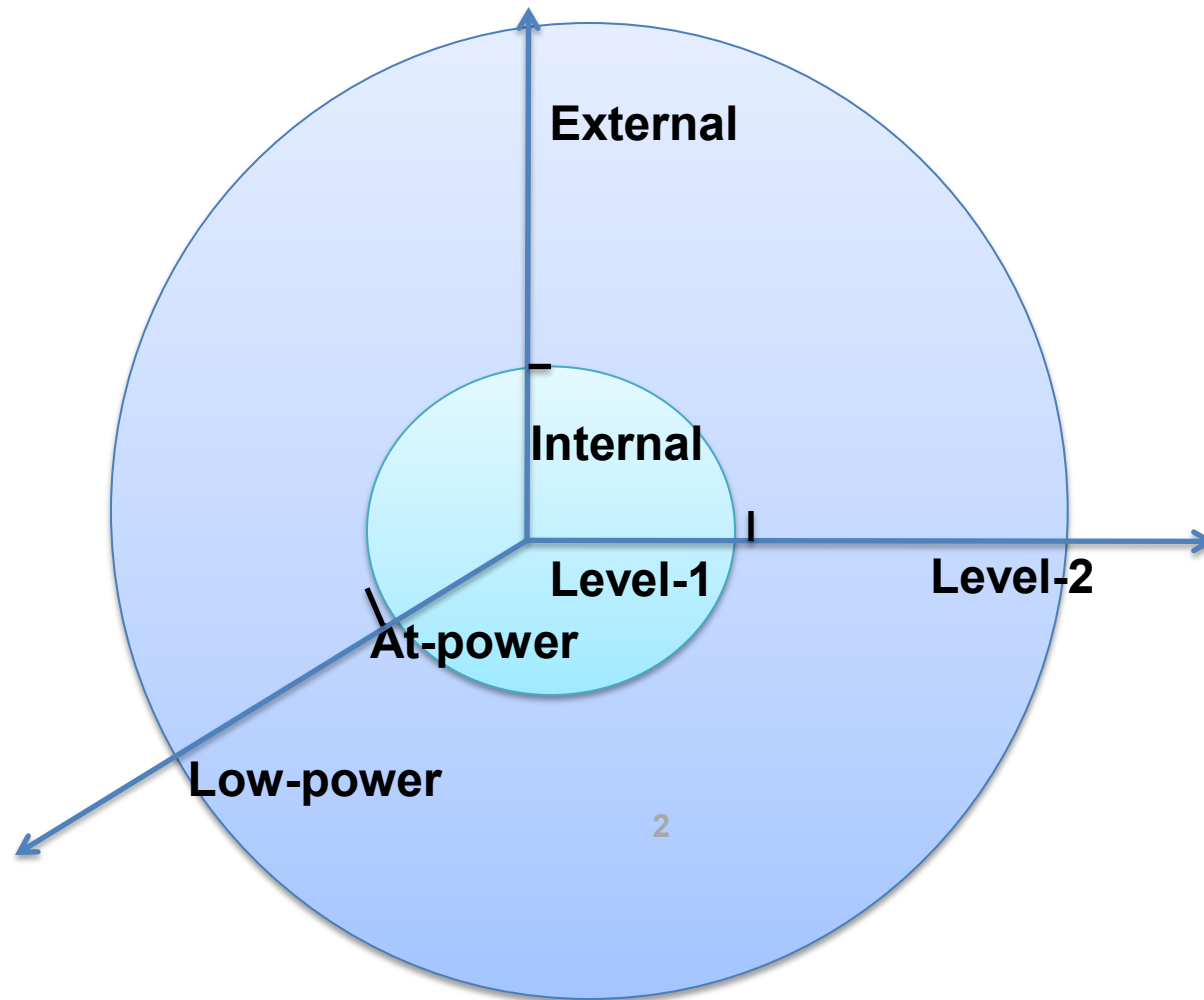




# The methodology of an Integrated Decision-tree Human Event Analysis System (IDHEAS) – A generic HRA methodology for NPP applications

Jing Xing, James Chang  
RES/DRA/HFRB

# Risk-informed HRA applications in the NRC





# IDHEAS products

## Product

## Intended applications

Cognitive basis  
for human error  
analysis

- Technical basis for HRA
  - Human factors engineering
- 

IDHEAS Generic  
methodology for  
NPP applications

- Risk-informed HRA applications of all hazards and scopes
- 

An IDHEAS method  
for internal, at-power,  
procedural events

- Risk-informed HRA of Internal, at-power, procedural events

# Outline

- I. Introduction – goal, scope, and approach
- II. Task analysis structure
- III. Proposed methods for HEP quantification
- IV. Path forward

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# Research goal and requirements

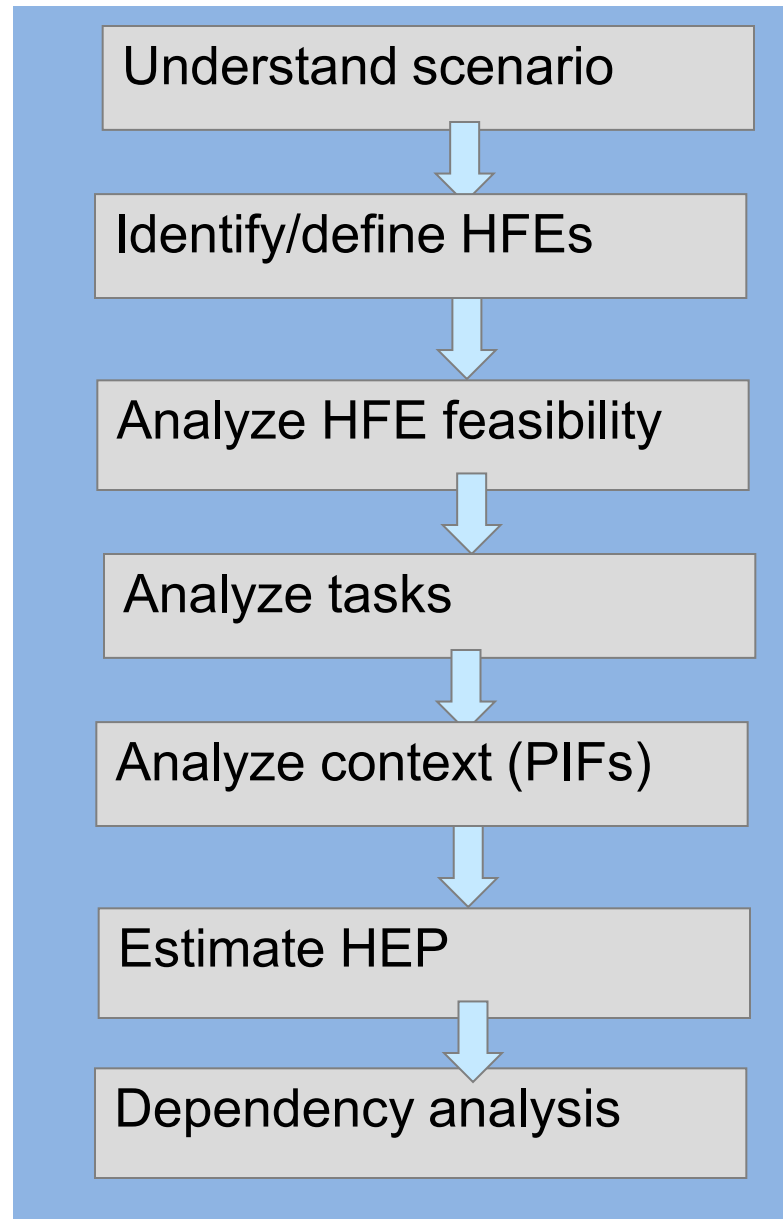
## Goal –

Develop an integrated HRA methodology applicable to all HRA domains in NPP operation.

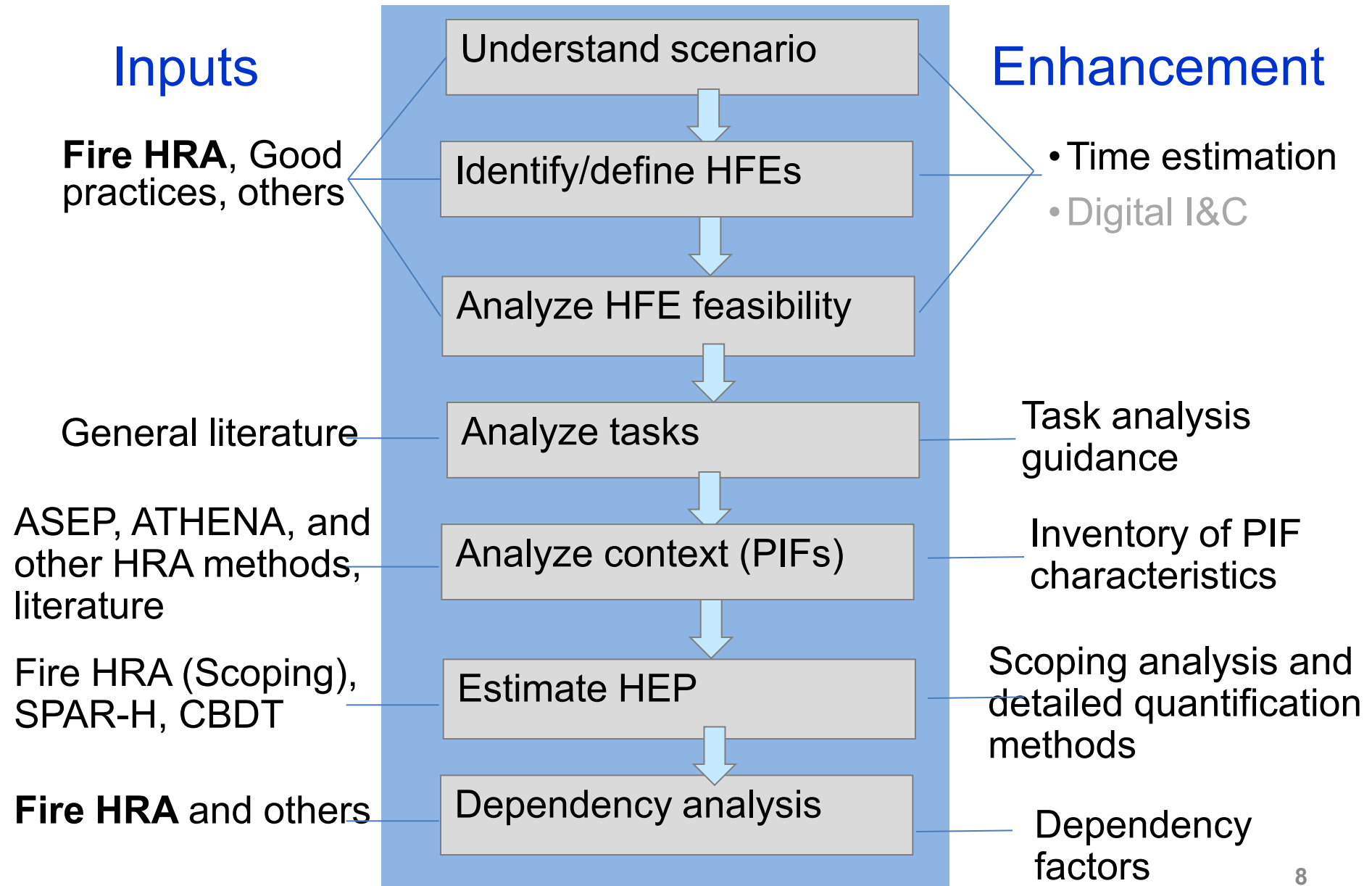
## Requirements –

- 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 state-of-practices.

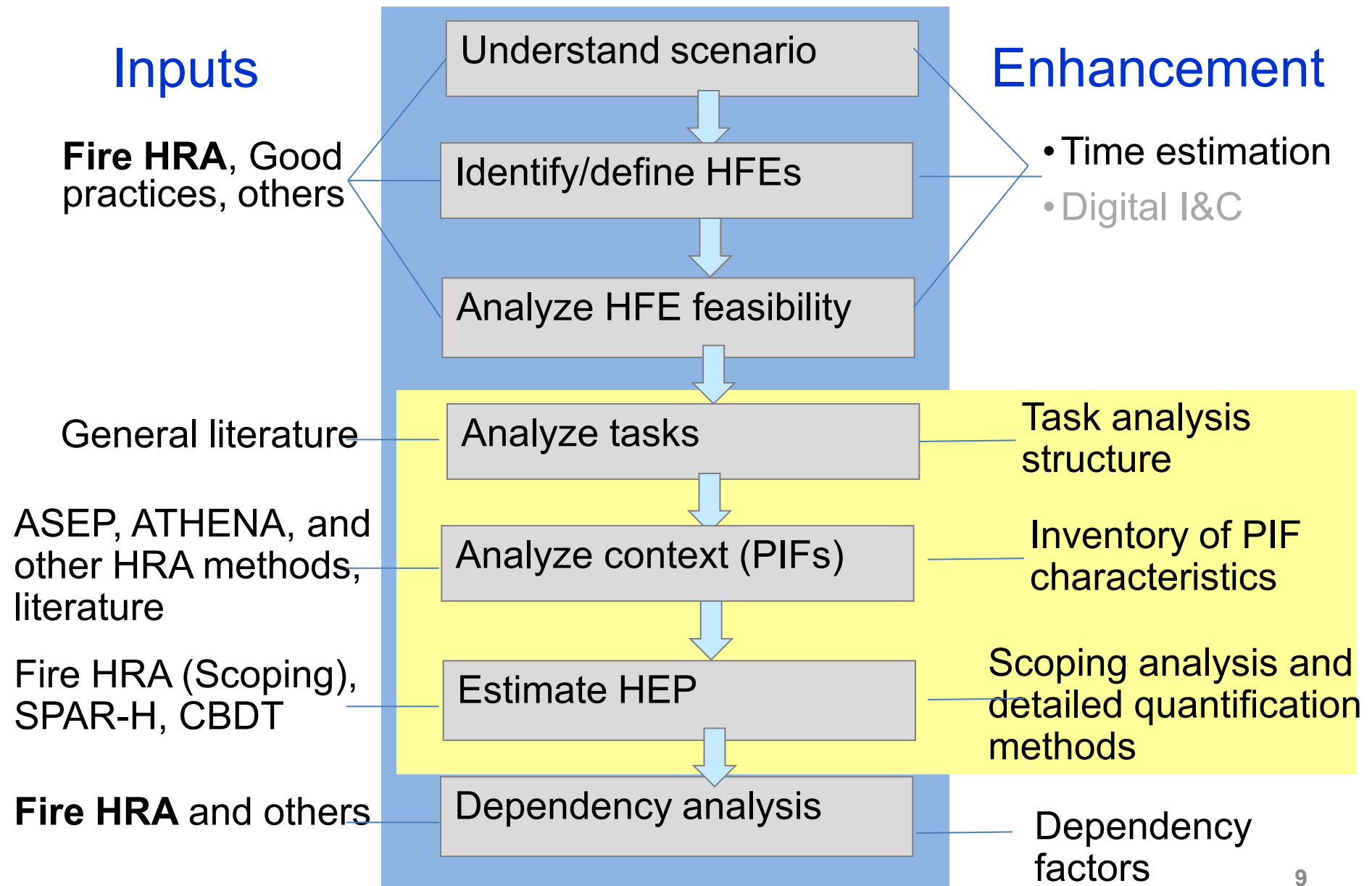
# IDHEAS Generic Methodology



# The scheme of the methodology development

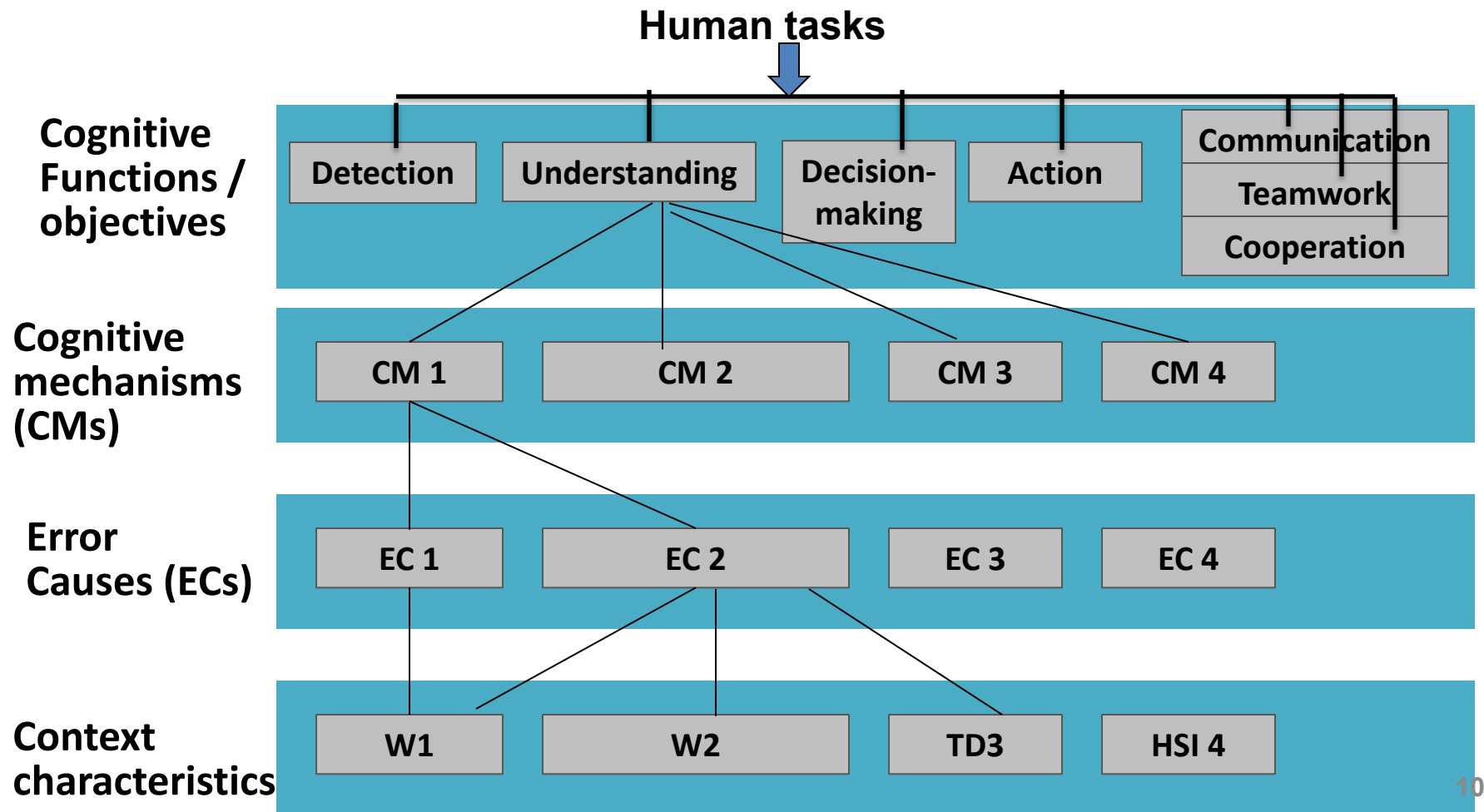


# The scheme of the methodology development



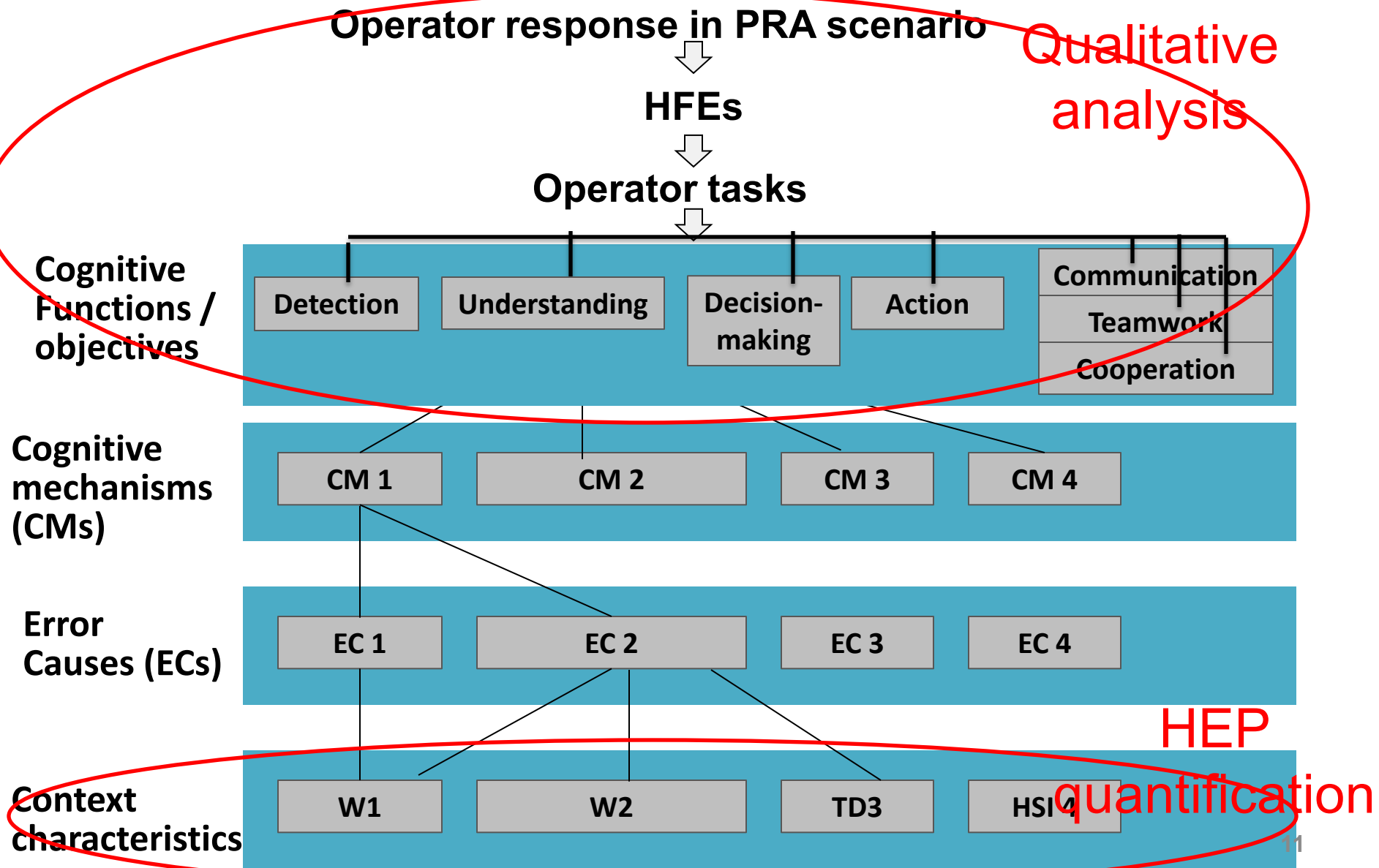
# Technical approach - From the cognitive basis to a generic HRA method

## The cognitive basis -





# Technical approach - From the cognitive basis to a generic HRA method



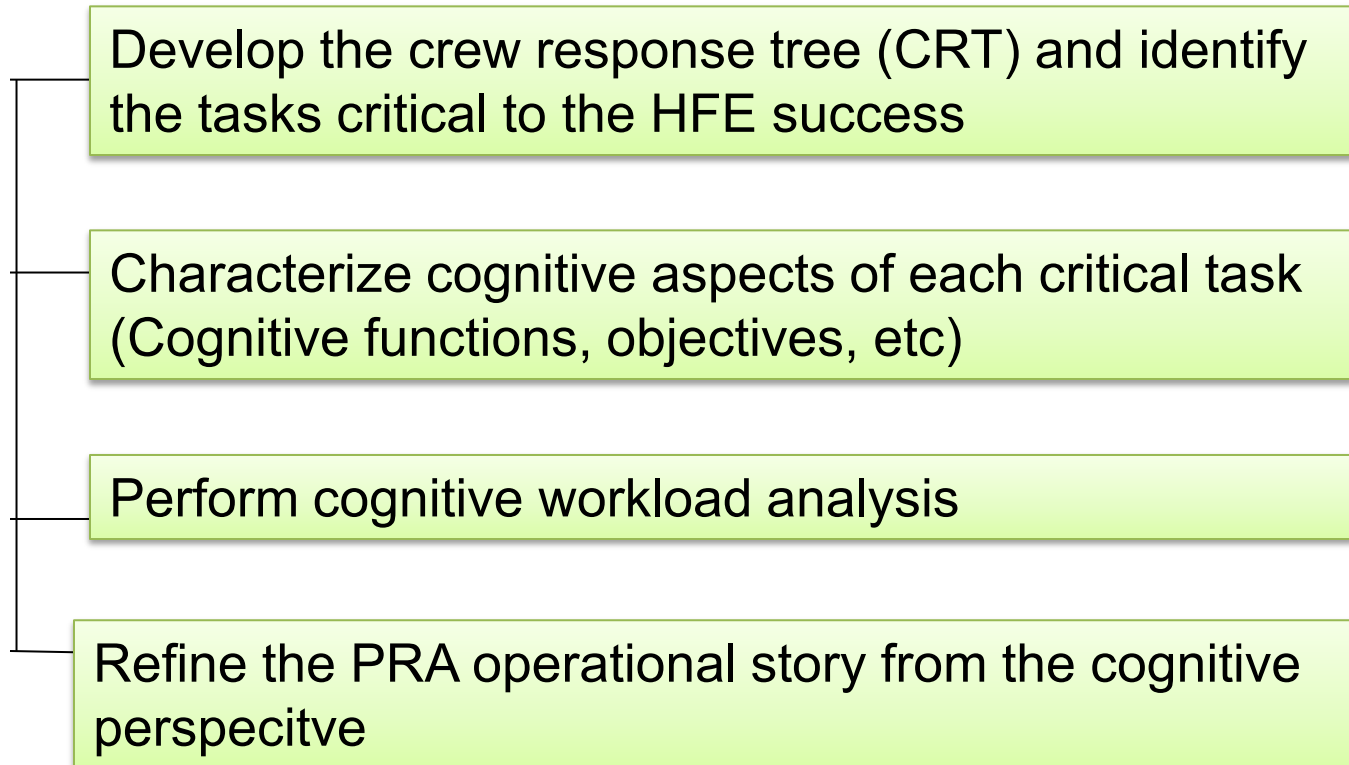
# Technical approach - From the cognitive basis to a generic HRA method

- **Qualitative analysis** – a procedure or guidance to represent the PRA scenario in human-centered tasks and the associated cognitive characteristics (i.e., cognitive functions, objectives).
- **Context analysis** – Realism of the PIF characteristics that challenges cognitive functions in NPP operational context
- **HEP estimation** - A method to structurally use the task and context information to estimate human error probabilities

# Outline

- I. Introduction – goal, scope, and approach
- II. Task analysis structure
- III. Proposed methods for HEP quantification
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# Task Analysis Structure

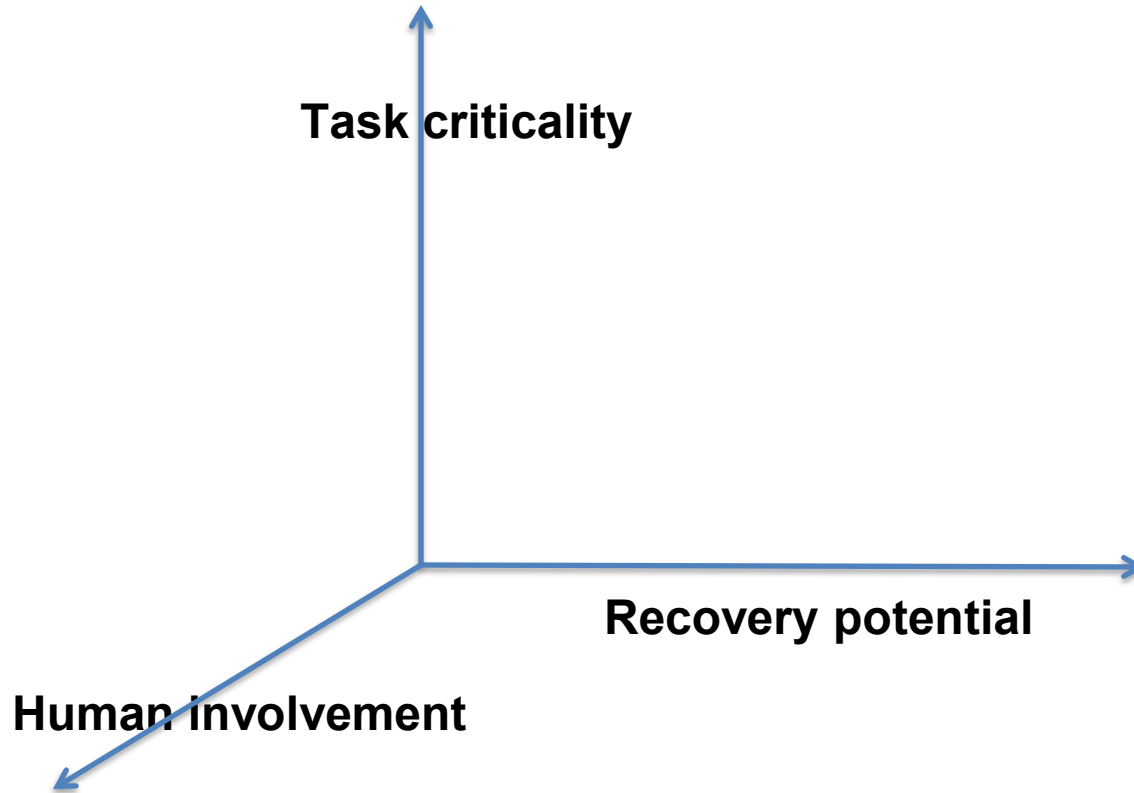


# Develop a crew response tree for the HFE

Graphically represent crew tasks and relation between the tasks along the progression.

# Identify the tasks critical to the HFE success

Identify and represent safety-critical tasks for quantification; failing each critical task leads to failure of the HFE.



# Characterize cognitive aspects of critical tasks

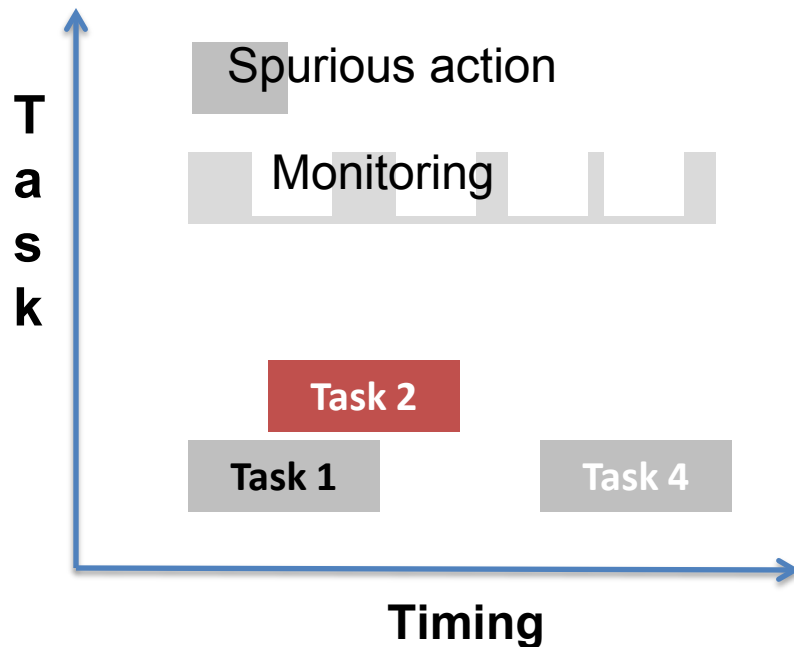
Identify cognitive characteristics of every critical task.

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., cooldown RCS but not exceeding 100 °F/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 guidance	Guidance used to perform the tasks.
Time available	(Performed in HFE feasibility analysis)
Personnel	Personnel who performs the task or specific task objectives.

# Perform timing and workload analysis

Assess cognitive workload that challenges cognitive functions.

## Timing of the tasks



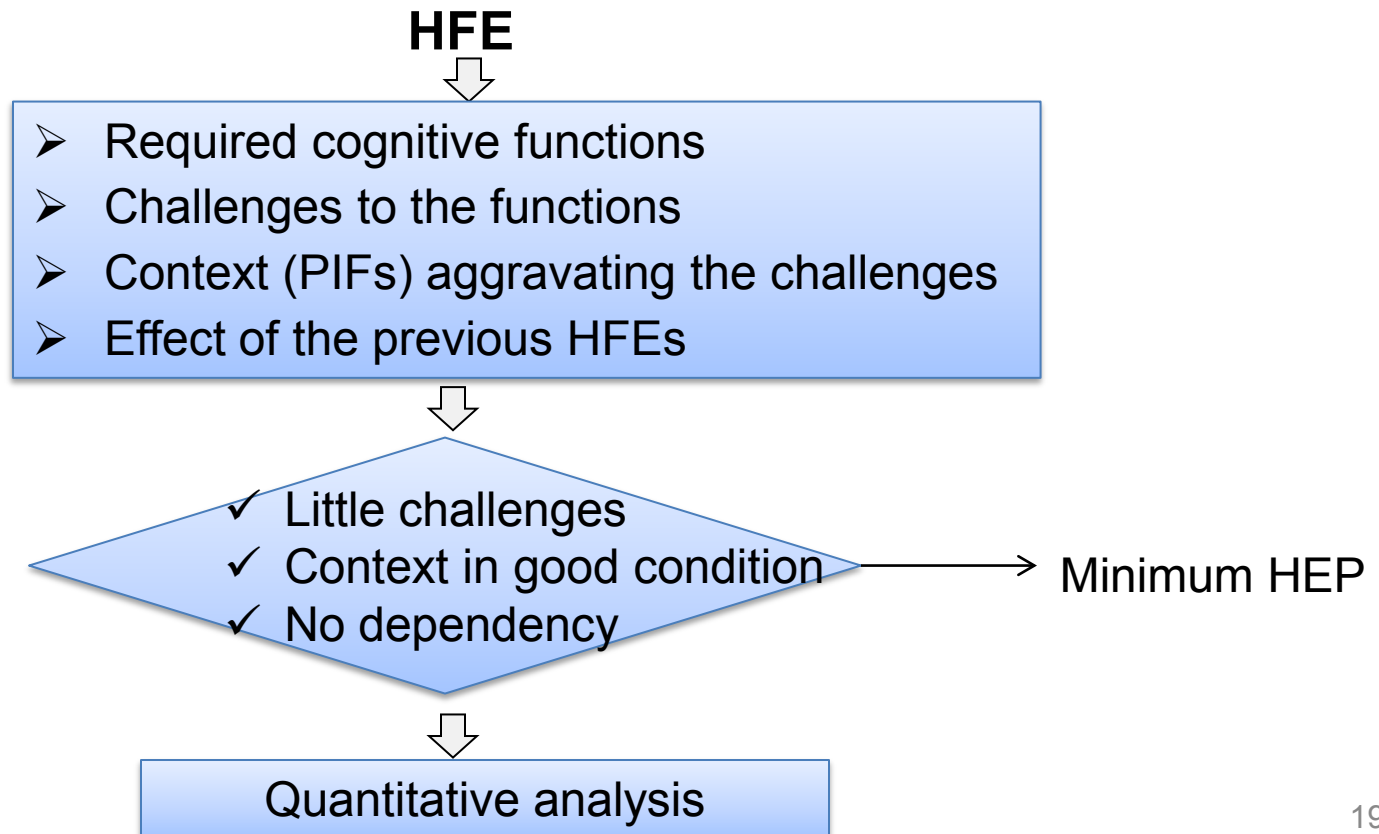
## Workload characteristics

- W1 - Multitasking
- W2 – Unfamiliar scenario
- W3 - Interruption / distraction
- W4 - Complex, sustained cognitive demand
- W5 – Time demanding



# Refine the operational story

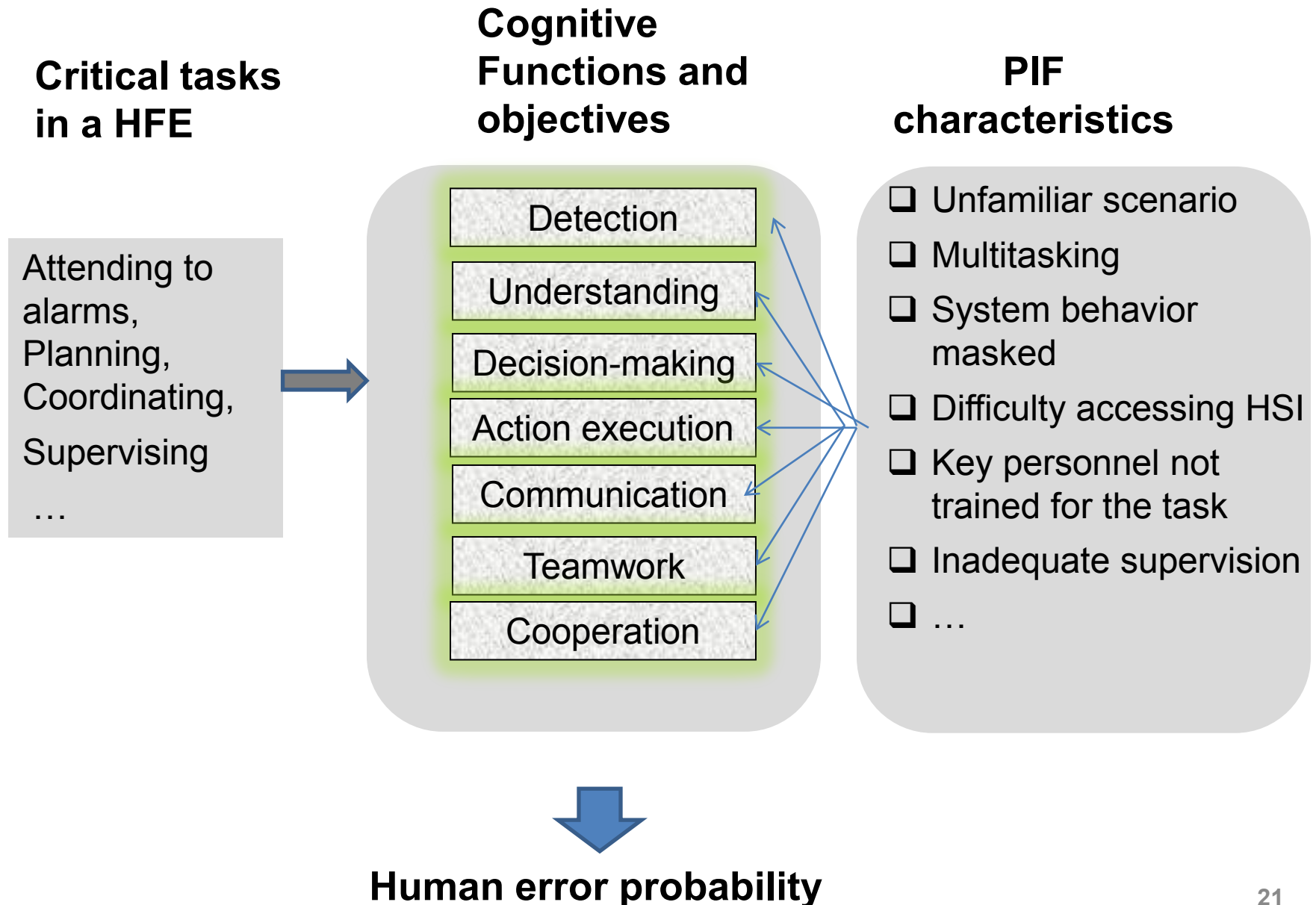
- 1) Refine the PRA operational story to have a coherent understanding of the HFE cutset from human-centered perspective
- 2) Screen out very low probability HFEs (little or no challenges).



# Outline

- I. Introduction – goal, scope, and approach
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# Quantification approach



# Inventory of PIF characteristics

## **Cognitive workload**

- Parallel, intermingled, cognitive tasks
- Unfamiliar scenarios
- Interruption / distraction
- Complex, and sustained cognitive activities
- Time demanding

## **Task complexity**

## **HSI / environment**

## **Procedures / guidance**

## **Training**

## **Work process**

## **Organizational factors**

# Example PIF Characteristics for *Understanding*

## **Task characteristics**

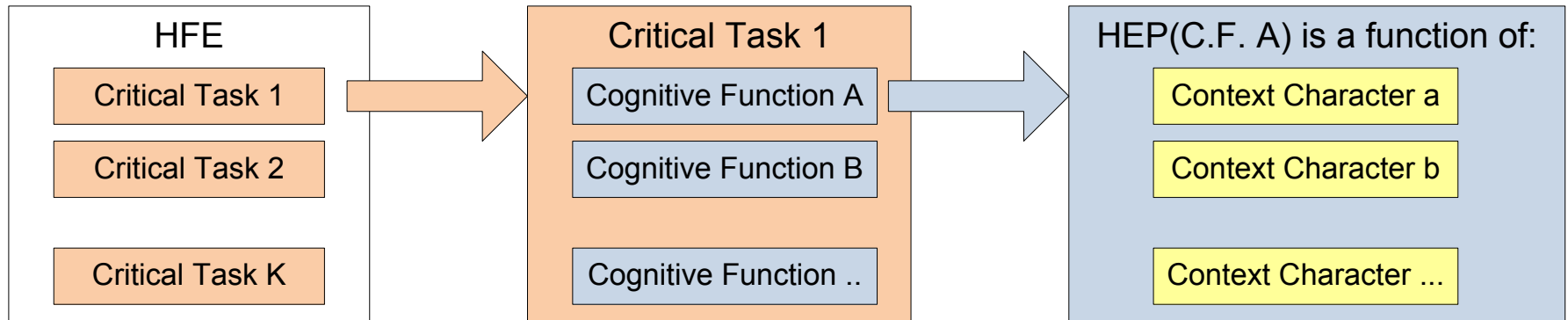
- System behavior is unexpected or unexplained
- System behavior is not apparent due to cue masked
- Distributed information across time - Situations that require integrating information over time periods

## **HSI / environment**

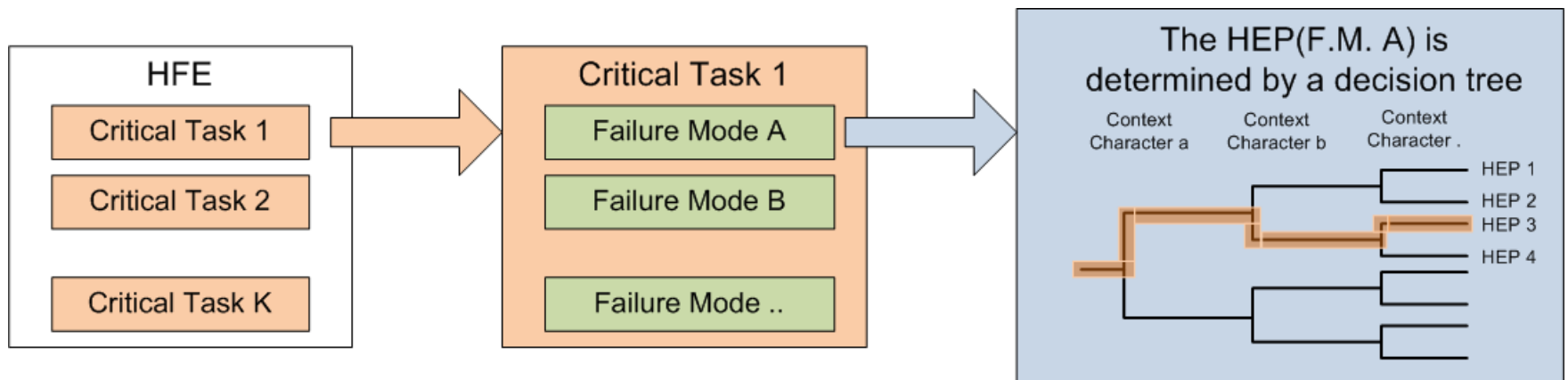
- Ambiguous / misleading information due to design (control logic) faults or I/C malfunctions
- HSI resets variables that are not known to operators
- HSI failure modes may not be anticipated by operators
- Distributed information across HSI for integration

# Two methods for HEP quantification

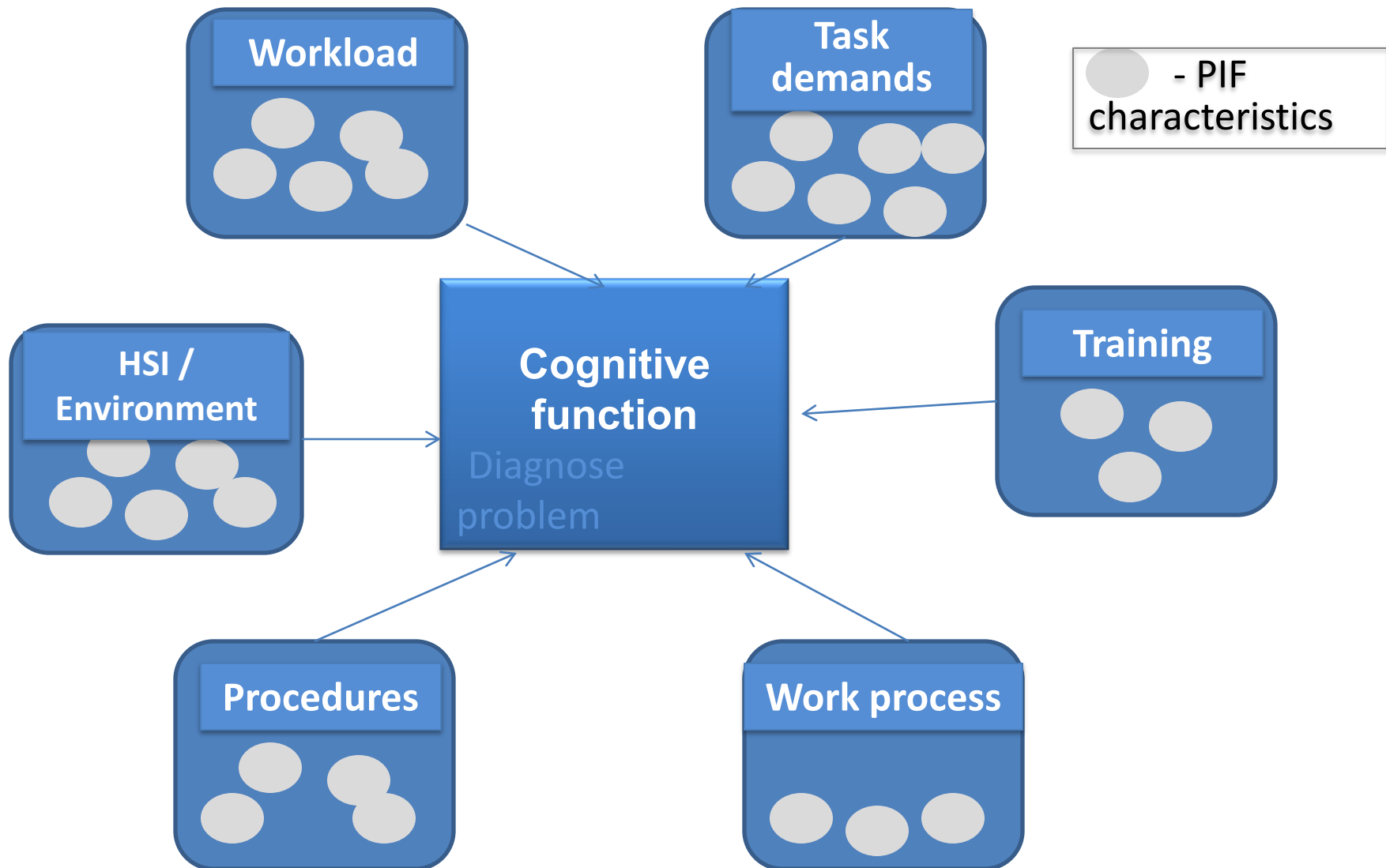
## Scoping analysis – Determine the HEP range



## Detailed failure-mode analysis – Estimate HEPs

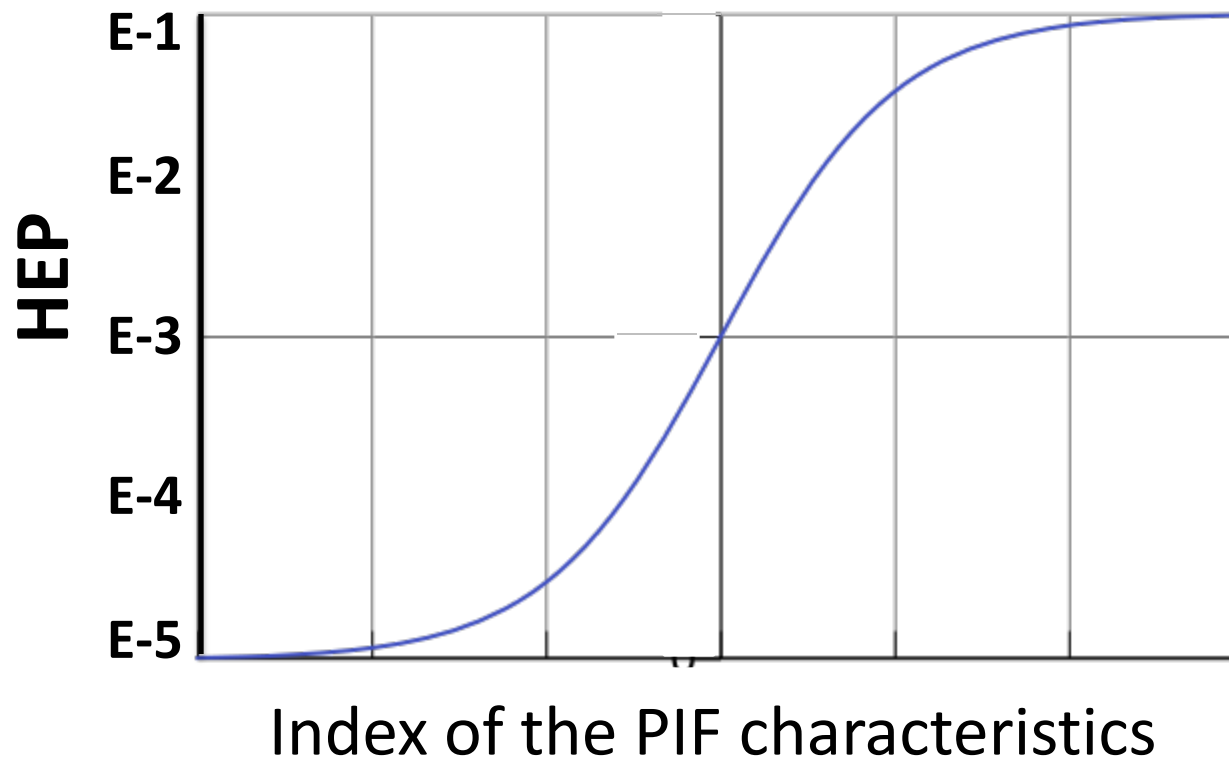


# Scoping analysis



# Scoping analysis

- Scoping analysis is to rank and group the failure probability of each cognitive function critical to the success of the task
- A HEP range is determined by an index of PIF characteristics





# Scoping analysis – Concepts of calculating the index of PIF characteristics

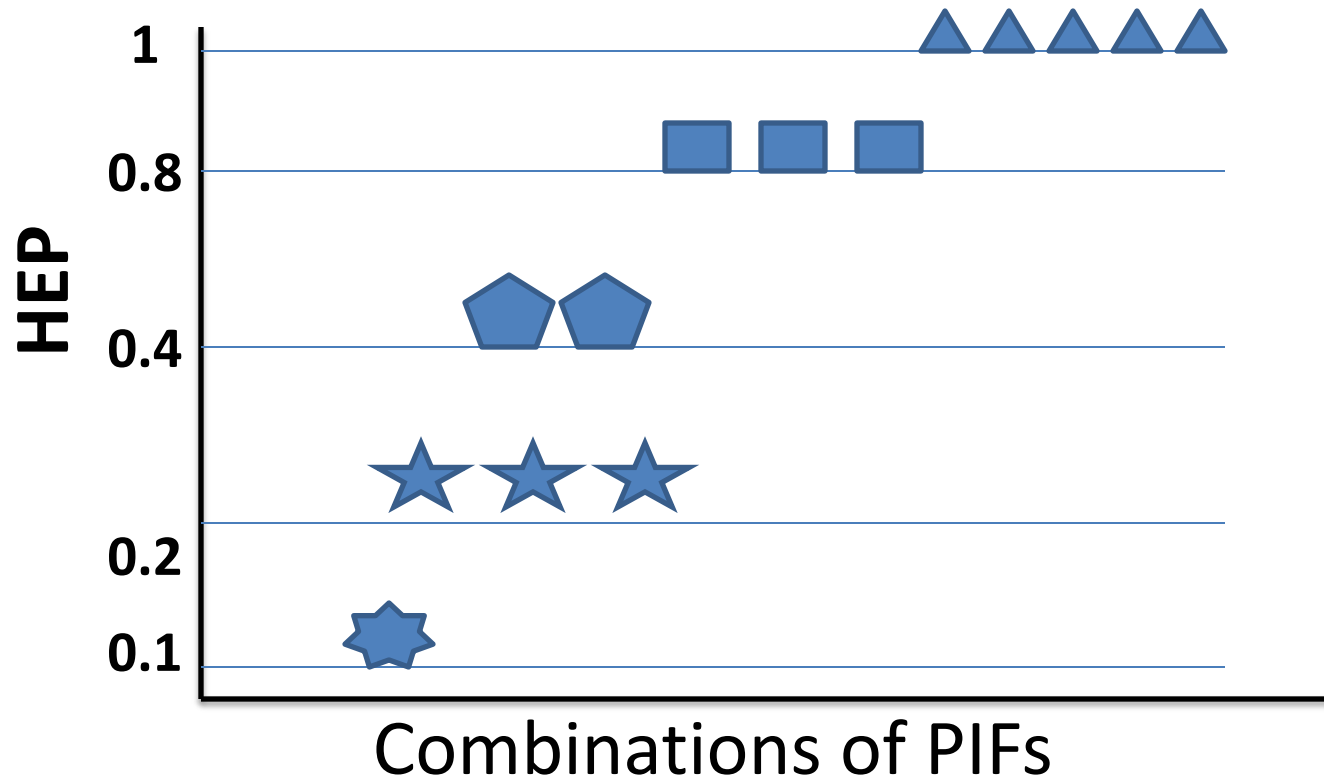
**Approach** - Conceptual model development, math-fitting and simulation, expert judgment

## Concepts being explored –

- 1) Linear summation – Add the number of the PIF characteristics
- 2) Weighted summation – Use domain experts to assign weights to the PIF characteristics for every cognitive function
- 3) Winner-takes-all - Select one or several the most significant PIF characteristics for every function
- 4) Interaction – Consider the interaction of the PIF characteristics

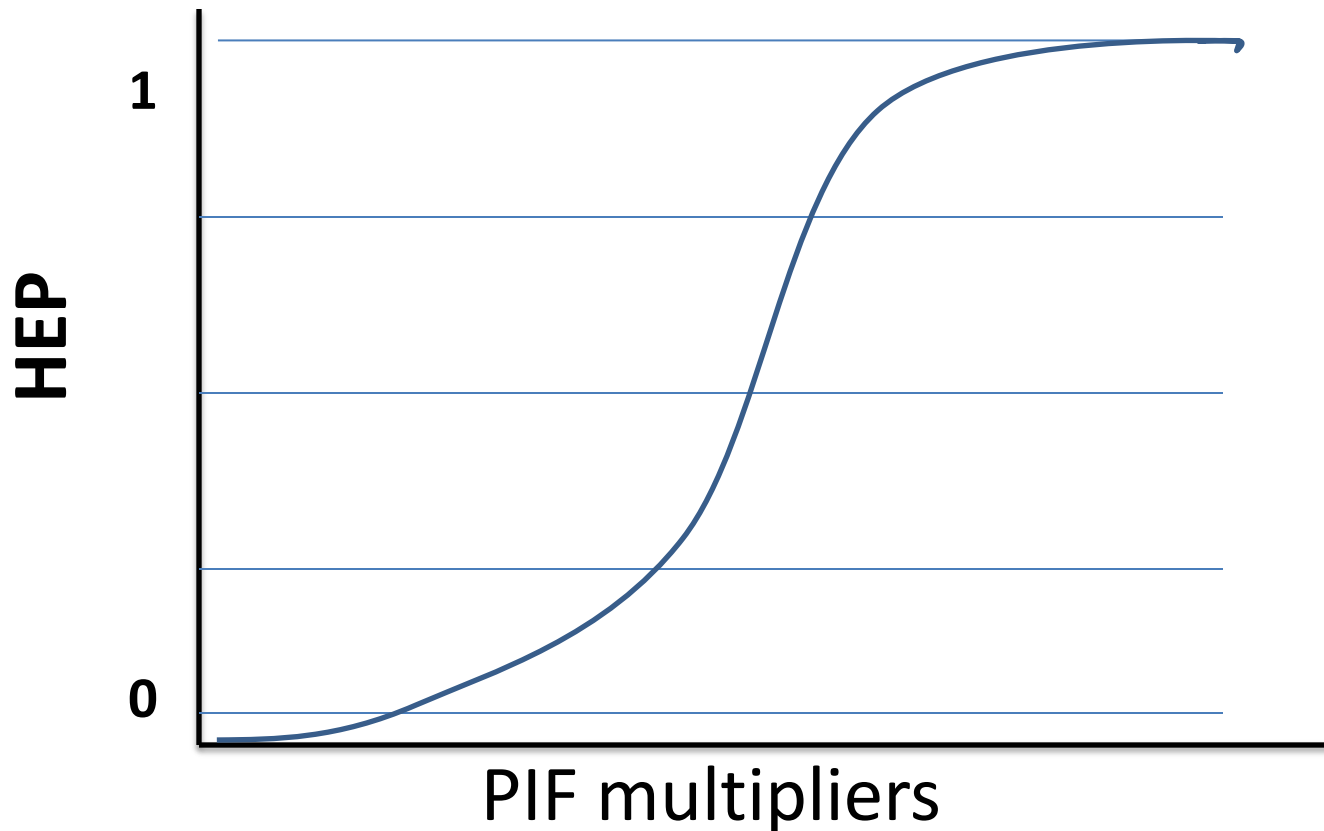
# Scoping analysis in Fire HRA

- Scoping analysis is for four types of human actions: INCR, EXCR, Alternative shutdown, and spurious actions
- Five PIFs are modeled: Fire effect, time in fire, execution complexity, time available, time margin

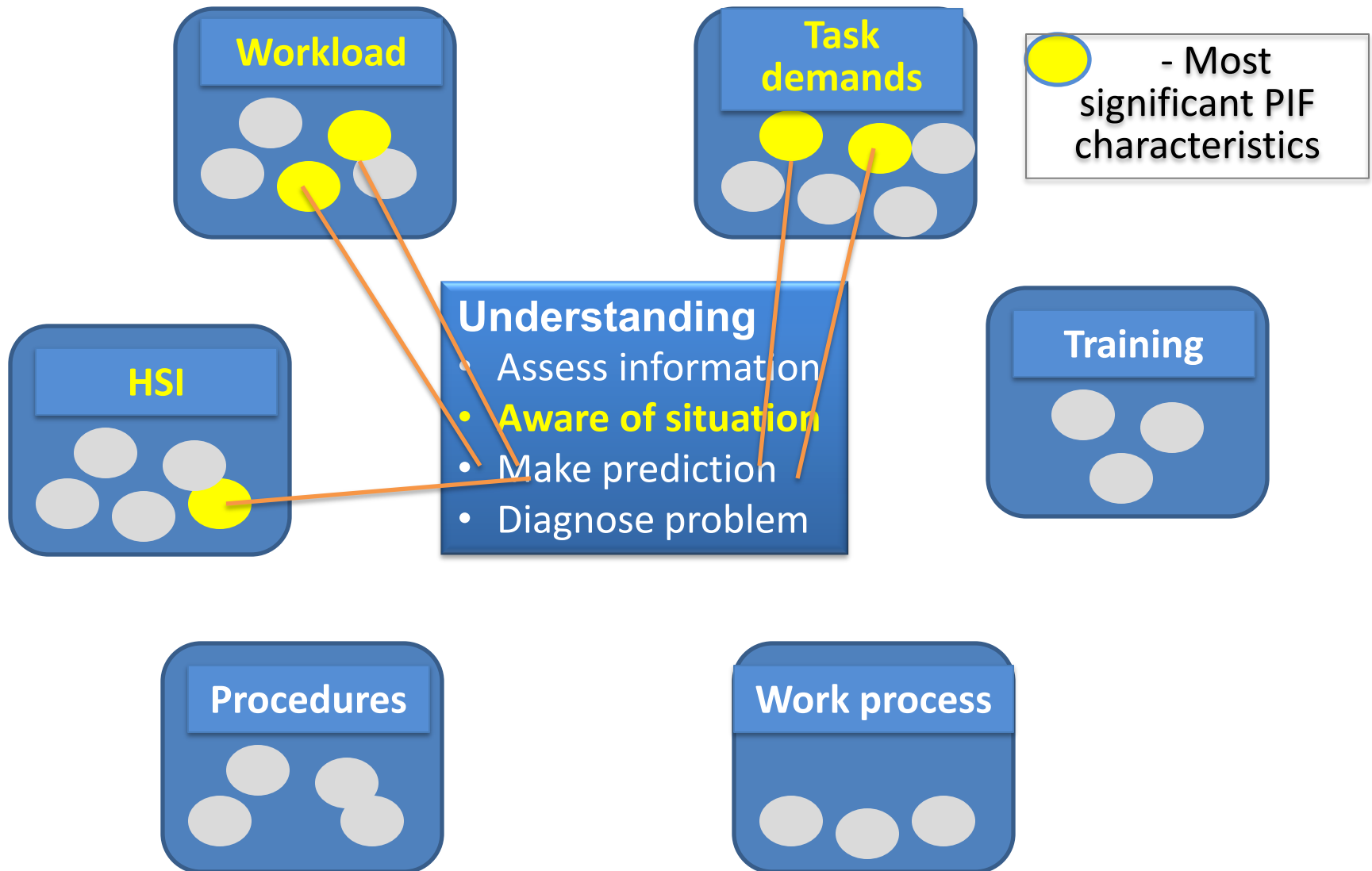


# SPAR-H quantification

- SPAR-H models two cognitive functions: Cognition (Detection & Understanding & Decision-making) and execution
- HEP is determined by the multipliers of eight PIFs and the base HEP.



# Detailed failure-mode analysis



# Objectives of cognitive functions

Objectives of a cognitive function are the types of cognitive subtasks to achieve the function.

Objectives were identified by classifying human activities required by NPP systems into generic cognitive tasks (studied in the literature).

## Example objectives for *Understanding*

- Assess and verify information
- Develop coherent understanding of the information
- Maintain situational awareness
- Make predictions and expectations for the upcoming situation
- Diagnose problems

# Generic task failure modes

Generic task failure modes represent possible types of failure of cognitive task objectives.

## Example task failure modes for the *Understanding* function

Objectives	Generic failure modes	CFMs for internal at-power events
Assess and verify information	Not assess / verify conflicting or ambiguous information	Critical data misperceived
Maintain situational awareness	Fail to maintain situation awareness	Critical data not checked with appropriate frequency
Diagnose problems	Diagnose the wrong causes to the problems	
	Incomplete diagnosis	

# Represent a failure mode in a Decision Tree (DT)

A DT consists of branches representing the context characters that are **most relevant** to the failure mode for the specific task domain.

The internal event IDHEAS method has DTs for the 14 CFMs. To develop DTs for task domains other than internal at-power events:

- If a failure mode is an internal CFM, use the existing DTs in the internal event IDHEAS method and modify it as needed by
  - 1) examining the character list to identify additional significant characters,
  - 2) adjusting the DT branches.
- If a failure mode is not an internal CFM, develop the DT by
  - 1) examining the context character list, and
  - 2) selecting the characters that most significantly contribute to the failure mode.

# HEP estimation

Obtain the HEPs in the scoping and detailed failure mode analysis

## Short-term goals:

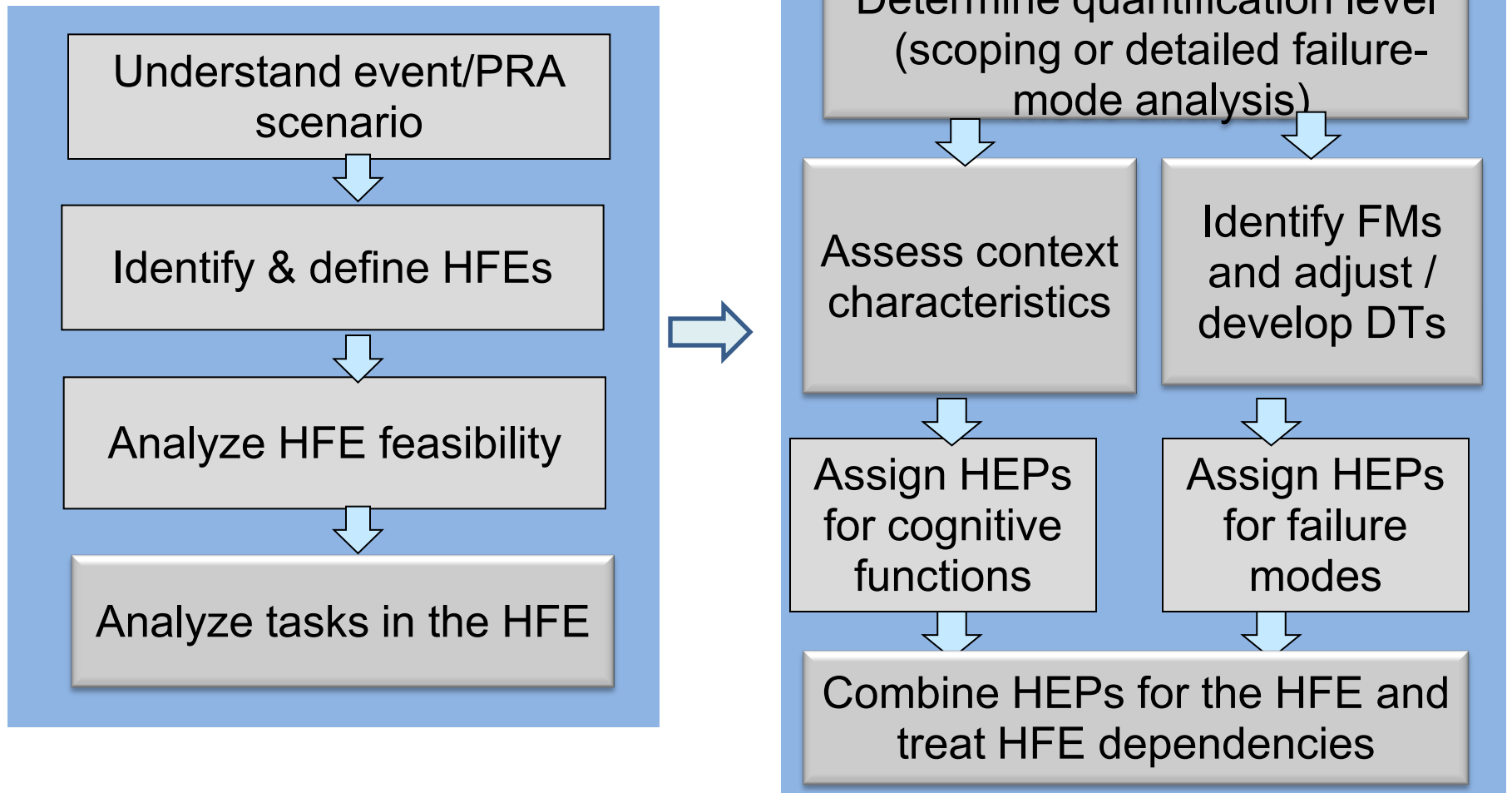
- Obtain HEP estimates through expert judgment;
- Provide guidance for expert elicitation of HEPs;

## Long-term goals:

- Data-driven HEP estimation - Use the data from SACADA and other data sources to calibrate HEPs.



# Implementation of the methodology



# Status and path forward

- 2012 – Developed the basic framework
- 4/2013 – NRC development team formed  
(HRA/PRA staff from RES, NRR, Regions)
- 4-7/2013 – Work out the scoping analysis method
- 8-12/2013 – Test the methodology in selected  
elements of Level-2 PRA

# Summary

- The generic IDHEAS methodology is an integration of state-of-practice HRA methods with enhancement.
- The methodology is intended to be applicable to all HRA domains in NPP.
- The methodology needs to be explored with its intended applications (e.g., LPSD, Level-2 PRA).
- Further development and refinement of the methodology will be made through exploration, piloting, and testing.