Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
560th Meeting

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Friday, March 6, 2009

Work Order No.: NRC-2707 Pages 1-177

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

+ + + + +

560th MEETING

+ + + + +

FRIDAY

MARCH 6, 2009

+ + + + +

ROCKVILLE, MD

+ + + + +

The committee convened in Room T2B3 in the Headquarters of the Nuclear Regulatory Commission, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., Dr Mario Bonaca, Chair, presiding.

COMMITTEE MEMBERS PRESENT:

MARIO V. BONACA, Chair

SAID ABDEL-KHALIK, Vice Chair

J. SAM ARMIJO, Member-at-Large

JOHN D. SIEBER

SANJOY BANERJEE

JOHN W. STETKAR

DENNIS C. BLEY

COMMITTEE MEMBERS PRESENT: (CONT.)

DANA A. POWERS

WILLIAM J. SHACK

MICHAEL T. RYAN

OTTO L. MAYNARD

HAROLD B. RAY

CHARLES H. BROWN, JR.

MICHAEL CORRADINI

GEORGE E. APOSTOLAKIS

NRC STAFF PRESENT:

TANNY SANTOS, Designated Federal Official

VALERIE BARNES

CHRISTINA LUI

FRED BROWN

GARETH PARRY

ERASMIA LOIS

ALSO PRESENT:

RUSSELL SMITH

MITCHEL TAGGART

TODD NEWKIRK

JEFF JULIUS

ANDREAS BYE

SALVATORE MASSAIU

JOHN FORESTER

VINH DANG

TABLE OF CONTENTS

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

8:29 a.m.

CHAIR BONACA: The meeting will now come to order. This is the second day of the 560th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following; Draft Final Regulatory Guide 5.73, "Fatigue Management for Nuclear Power Plant Personnel"; International Human Reliability Analysis Empirical Pilot Study; Future ACRS Activities/Report of the Planning and Procedures Subcommittee; Reconciliation of ACRS Comments and Recommendations; Subcommittee Reports and Preparation of ACRS Reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Tanny Santos is the designated Federal Official for the initial portion of the meeting. We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. A transcript of portions of the meeting is being kept and it is requested that speakers use the microphones, identify themselves and speak with sufficient clarity and volume so that they can readily heard.

So we will move now to the first item on

our agenda, which is Draft Final Regulatory Guide 5.73, "Fatigue Management for Nuclear Power Plant Personnel and Mr. Stetkar will lead us through this presentation.

MEMBER STETKAR: Thank you, Mr. Chairman. You're going to hear a presentation this morning from Staff, NEI and the Professional Reactor Operators Society regarding Reg Guide 5.73 on Fatigue Management. Just a minor background. We had a Subcommittee meeting on this subject on -- it seems so long -- Tuesday, I guess it was. It seems so long ago. The Reg Guide pertains to implementation guidelines for rules that have been published in 10 CFR Part 26, Subpart I regarding managing fatigue.

The rule was published March 31st, 2008 and it's to be implemented -- Subpart I is to be implemented by October 1st. So we're getting close to the implementation date here. I'm sure the staff will go over a bit of the history and the status of the Reg Guide. There's been quite a bit of discussion about this. We're a little bit short for time, so we're going to try to keep a little bit of the history short.

There are two substantive exceptions that the Staff has taken to some NEI guidelines and I think

we're probably going to focus a bit on that because there's some discussion. With that, I'll turn it over to Valerie Barnes.

MEMBER APOSTOLAKIS: That sounded scary. We're short of time. We have an hour and a half.

MEMBER STETKAR: Well, we have the Staff. We have NEI and the Professional Reactor Operators making their presentations, so --

MEMBER APOSTOLAKIS: I'm sorry.

MEMBER SIEBER: We can rest in the middle of it.

MEMBER STETKAR: There are no rests in the middle of this. Grit your teeth.

MS. LUI: Good morning. My name is Chris Lui and I'm the Director of the Divisional Risk Analysis from Office of Nuclear Regulatory Research. Today, as John has indicated, you are going to hear a presentation from three different parties. These particular Reg Guides, Draft Reg Guide in Final Review has been in the making for a couple of years and we have numerous interaction with the industry. So today we're going to focus on two -- I mean, two technical issues that are -- that seem to have generated a fair amount of discussion.

And in front of you we'll have Val Barnes.

She's a Senior Level Advisor from Office of Nuclear Regulatory Research and Dave Desaulniers, he has moved onto Office of New Reactors, even though prior to his current position he's really the main person who's been doing the rulemaking for Part 26 and also he's been -- he's been a leader for the development of the Reg Guide.

And we also have Howard Benowitz from OGC to support us on this particular discussion. Today we're going to really focus on the Reg Guide which is really to implement the intent of Part 26, Subpart I, so we're going to be focusing our discussion on the Reg Guide today.

MS. BARNES: Okay, thanks. I wanted to start out, as Chris mentioned, explaining a little bit more that we have had staff changing roles since we began developing both the rule and since we got started on working on the Regulatory Guide and I have Dave here at the front with me to be able to answer historical questions about how we ended up where we are with respect to the Rule requirements. So you'll find me referring a fair number of questions to Dave.

Topics briefly that we need to cover today is the history of the Reg Guide, a brief overview of what the fatigue management requirements are in

Subpart I with an emphasis on the requirements with which the areas of disagreement are associated. We'll talk in some detail about those areas of disagreement with the implementation guidance that the Regulatory Guide endorses and that document is NEI 06-11 and then at the end talk real quickly about implementation and publication schedules.

As a little bit of background, in 1982 the NRC published a policy to limit work hours for nuclear power plant personnel. It focused on work hour limitations and the majority of licensees in the industry incorporated it into their technical specifications. In 1999 we had a petition for rulemaking from an SRO who requested that we have enforceable requirements for managing fatigue because in practice the work hour limits in the Guideline -- in the Policy Statement were not always being implemented as the NRC had intended originally.

And then as you know, of course, we had terrorist attacks of 9/11 which put a large number of our licensee's security personnel on very long work hours for very long periods. So a number of factors went into the Commission's decision to approve a rulemaking related to fatigue management. We started public meetings at that point in time. I think we

held 16 between -- on fatigue alone, between 2000 and 2005. We got the proposed rule published, held additional public meetings as the staff developed the Draft Final Rule requirements, published the Final Rule in 2008 and recognizing that implementing the fatigue management requirements was going to be complex, we also started holding public meetings with NEI and other stakeholders in 2006 to start to work on developing the Reg Guide.

For the time that I've been involved in the Reg Guide development process, I know that we've gone through seven drafts that NEI has submitted in 2000 -- in 2008, in October we published the Draft Guide. We've made the Draft Final Guide that you're reviewing today available on the website so that our licensees have plenty of time to implement the majority of it. And we are looking at an October 1st implementation date for the fatigue management programs required by the Rule.

Okay, Subpart I, just for a little background, as I mentioned, applies only to nuclear power plants, none of the other licensees and entities that we regulate and so an important point here is that the fatigue management requirements don't apply to plants under construction.

The fatigue management program is organized basically into two sets of requirements. One set applies to everyone who has unescorted access at nuclear power plants and then there's a more restrictive set of requirements that applies to what we call covered workers. The covered worker who are also subject to the general fatigue management requirement, the covered workers are subject to work hour controls and this is a subset of folks who have an escorted access at our power plants and they include maintenance and operations personnel who are involved in risk significant activities at the site.

We've got chemistry and health physics techs, usually one per shift, who are assigned to the emergency response organization who need to be subject to the work hour controls. We have a fire brigade member and it's only the fire brigade member who is knowledgeable about the effects of fire suppressants, et cetera, and safe shutdown capabilities. And then we have security force personnel, not the administrative staff, of course, but primarily the armed folks and then in addition, individuals who direct the risk significant maintenance and operations activities are also subject to the work hour controls. And that's only the individuals who are on site

engaged in on-site directing.

We have four kinds of work hour controls. We have requirements associated with scheduling. For example, we want our licensees to avoid backward rotating shifts because those contribute to excessive amounts of fatigue. We have work hour limits that are very similar, a little bit relaxed from the work hour limits that were included in the NRC's original policy statement. We have requirements for rest breaks and rest breaks mean the amount of time that individuals have to be not performing any duties for the licensee between work periods.

Under the Policy Statement, that period of time was only eight hours. The new rule requires that the rest break between shifts is 10 hours. In addition, we also have requirements for covered workers to have a certain minimum number of days off. And I'm going to spend some time on the days off requirements because this is where we've got the areas of disagreement with the guidance.

The purpose of the days off requirements is to guard against cumulative fatigue. The work hour controls, we expect, will be effective at hopefully preventing acute fatigue or the fatigue that comes from working, you know, long hours that is easily

resolved from, you know, a good night's sleep. Whereas cumulative fatigue is different from the standpoint that it can develop over relatively short periods of restricted sleep. And the sleep restrictions that can cause performance decrements, impairment from fatigue, can start showing up if someone even misses an hour or two of sleep a night over a long period. They accumulate what we call a sleep debt.

And cumulative fatigue is more insidious than acute fatigue because as time goes on, people stop feeling tired, and they don't recognize that they're fatigued and -- but their performance is still impaired. So actually, industry, staff and the stakeholders worked on a number of different ways to try to prevent -- to prevent cumulative fatigue. Industry, in the public comment period, actually proposed that we consider minimum days off and that's how we ended up where we are, requiring the minimum days off.

Now, they're very complex and the reason that they're complex is because we worked extensively to make them flexible, flexible enough for licensees to be able to do what they need to do and at the same time that the plant staff that we care about, the

covered workers, have opportunities to recover from sleep restrictions, from cumulative fatigue.

So the minimum days off requirements that apply differ depending on whether the plant is up and operating or in an outage. They depend on whether the covered worker is working an eight, 10 or 12-hour shift. Obviously, people who are working a normal eight-hour shift have more opportunity for restorative sleep and so our expectation is that they would less subject to cumulative fatigue than people who are working regular 12-hour shifts. And then the minimum days off that are required also vary by job duty group. So we have different days of for maintenance, et cetera.

Over a shift cycle, which can be a period up to six weeks. A shift -- you know what a shift cycle is. During normal operations, the requirement is that people who are working eight-hour shifts have to --

MEMBER BROWN: Valerie?

MS. BARNES: Yes.

MEMBER BROWN: Not everybody knows what a shift cycle is.

MS. BARNES: Thank you. I appreciate that.

MEMBER BROWN: I'm probably the only one.

MS. BARNES: Okay, a shift cycle is a period of repeating shifts and days off the planned schedule. So, for example, for operators, most of our licensees plan shift cycles that are six weeks long and include in that shift cycle, one week in the training simulator, where they're, you know, polishing their skills for emergency response and so on, up to six weeks. And six weeks, based on the input that we've had and the staff's research, is about the longest shift cycle that's in use out in the industry.

MEMBER BROWN: What happens at the end of the shift cycle?

MS. BARNES: They start a new one.

MEMBER BROWN: Okay. So the rest period and the time off and all the breaks and all that other type of stuff is within that six week period.

MEMBER BLEY: And you're shifting --

MEMBER BROWN: No, I got that. I just wanted to have some idea of what the thought process was here. Okay, that's fine.

MS. BARNES: And the other requirements, the work hour limits and so on, apply all the time. It's the minimum days off that depend on the shift cycle concept, applying the minimum days off

requirements. And so over a shift cycle, however the licensee defines it, which in the Rule can be no more than six weeks in length, but can be shorter, it's permitted to be shorter, we've got folks that are working eight-hour shifts required to have one day off a week and as you can see, the more hours per day that people work in the different job categories and on the different shift schedules, the more days off that are required under the rule.

In addition, we have a further requirement that the days off that people get have to be distributed within the shift cycle so that plant staff, the covered workers are getting at least one day off in any nine-day period. So for example, if someone over a six-week period is required to have five days off, this last bullet, this last requirement, would prevent licensees from working them 12-hour shifts for five weeks in a row and then, you know, then giving them a week off at the end of a shift cycle. The idea here is to distribute the days off so they've got time to rest and prevent the buildup of cumulative fatigue.

MEMBER APOSTOLAKIS: Where do these numbers come from?

MEMBER CORRADINI: That's what I was

thinking.

MEMBER APOSTOLAKIS: A, is there -- it is experience, is it a model, especially when I see two, three days off, a week for 12-hour shifts, by job, maintenance, two, operations two and a half. I mean, that sounds like somebody had the calculator someplace.

MS. BARNES: We all have calculators.

MEMBER APOSTOLAKIS: Are these a matter of -- which would be fine, but I'm trying to understand. Are these a matter of lots of experience and people say, "Well, gee, you know, we have observed A, B, C, D and a lot of people have published papers and reports", followed by some sort of negotiation with industry? Where does this two and a half come from? It sounds awfully specific for a field that is not, I mean.

MR. DESAULNIERS: Well, I think you've probably accurately summarized it in that it is a combination of science and practical considerations that bring you to these specific numbers. The staff reviewed recommendations from a broad number of other fields. We studied an extensive amount of research and we also, as Val had indicated, went through 16 plus public meetings where we took a look at what are

the practical considerations that go into shift scheduling as well as looking at, again, the breakdown with respect to what are the characteristics of the particular job functions in terms of potential for fatigue to effect them, so you see some differences between, for instance, maintenance as opposed to security. And those were all factored into the -- ultimately, the numbers that give you a work week of anywhere from 48 hours to 60 hours given these various considerations with the ultimate objective if we want to insure that there's adequate days off there that prevent fatigue from building up over the long term.

MEMBER APOSTOLAKIS: But I know that there is -- yeah.

MEMBER STETKAR: Dave, we have to be a little bit careful, I think a bit because of the time, but I also want to make sure that we're careful about what is in the Rule and what is under discussion for the Reg Guide. These numbers are actually in the Rule, aren't they?

MR. DESAULNIERS: Fixed in the Rule.

MEMBER STETKAR: Okay, so it's okay to question that basis for them but they're not up for negotiation right at the moment.

MEMBER APOSTOLAKIS: Still, I'm just

curious. Two, two and a half, three, there's a precision that is implied there that I can't see how it can be justified.

MS. BARNES: You know, I would want to make the offer that in terms of the bases for the Rule, what's in the Rule itself and how we arrived there, and how -- you know, all the different considerations into as, you know, what we have ended up with in the Rule text, you know, we'd be happy to come back and brief you on the Rule itself.

MEMBER APOSTOLAKIS: I think I got my answer.

MS. BARNES: Yeah, yeah, okay.

MR. DESAULNIERS: But it is practical considerations that bring you to some of the specifics in relation to the science.

MEMBER BROWN: An eight-hour shift is eight hours and one day for the -- over the six-day period and then the one day off, however that cycle works. Is that what the --

MS. BARNES: These are upper limits, so --

MEMBER BROWN: No, I just -- that's just an example. I'm not trying to get precise.

MS. BARNES: Yeah, that would be the idea. You know, our preference is eight-hour shifts, 40-

hour weeks and --

MEMBER BROWN: You want people to sleep.

MS. BARNES: We do. We want them to have time off work to sleep.

MEMBER BROWN: That's fine. Everybody loves that. But what's to make sure they take advantage of it? I mean, how do you know they don't stay up and watch Jay Leno at midnight before they come back in.

MS. BARNES: Absolutely, that's right.

MEMBER BROWN: Is somebody standing over them and making sure they get their eight hours of sleep?

MS. BARNES: Of course not. Well, I agree. I just wanted to make sure I understood the calibration of the Rules and all the other stuff.

MS. BARNES: And reality.

MEMBER BROWN: And reality, yeah.

MS. BARNES: Right. I mean, there's nothing to stop someone from moonlighting at Burger King.

MEMBER BROWN: Yeah, that's done.

MS. BARNES: Right, but we do address that in the -- or we attempt to address it in the training requirements, that people are -- the kinds of training

that we're requiring people to have under the fatigue management program. Who knows if they'll implement or not but the training is required to talk about the different kinds of fatigue, practices that can interfere with sleep. I mean, the Rule does put responsibility on the individuals who are working at our plants.

MEMBER BROWN: Yeah, I understand that.

MEMBER BLEY: But isn't there another piece? We don't watch to see if they're drinking either. But if you see signs of that under fitness for duty, you're -- I don't think you've talked about if you see signs of fatigue. There's a process for --

MS. BARNES: That's correct.

MEMBER BLEY: -- examining people.

MEMBER BROWN: Okay, so that's built into the --

MS. BARNES: Yes, it is.

MEMBER BROWN: Management always ought to be looking at that. That's --

MS. BARNES: That's lots, right. Lots of requirements in it, yeah.

MEMBER APOSTOLAKIS: Isn't it unusual to have such numbers in a Rule?

MS. BARNES: No, not in work hours

requirements, internationally and in other industries.

MEMBER APOSTOLAKIS: Usually the numbers are in Regulatory Guides, aren't they?

MS. BARNES: No.

MEMBER BLEY: No, not for regulations.

MEMBER APOSTOLAKIS: Not in those rules but in other rules that I know, they say specify this and then somebody else in the Regulatory Guide says it's two. Here it seems to be --

MEMBER SIEBER: This is traditional Rules.

CHAIR BONACA: Let's move on.

MEMBER BROWN: Excuse me, what did you say, Jack?

MEMBER SIEBER: Traditional state work rules and you need to have it out front in rule form to be able to determine whether you're in everybody's correct space.

MR. DESAULNIERS: Work requirements for pilots, truckers, railroad engineers are all specified in regulation.

MEMBER CORRADINI: Okay, that's --

MS. BARNES: In the law itself.

MEMBER CORRADINI: That's what I was going to ask about, a comparison.

MS. BARNES: Right.

CHAIR BONACA: Let's move on.

MS. BARNES: Okay, moving on to discuss the day-off requirements during outages, these are relaxed compared to what we require for normal operations. I'm not going to go over them. The scheme for allocating the minimum days off is also a little bit different. Another aspect of the minimum day off requirements that apply to outages is that the covered workers are allowed to stay on the relaxed outage hours to work more during outages but only over a 60-day period. If the outage isn't completed by the end of 60 days, the staff, the covered workers, go back on normal minimum days off, scheduling at the end of that 60-day period.

"The individuals who are eligible to work the relaxed outage hours are the individuals who are working on outage activities", and that's a quote from the Rule text itself and I'm emphasizing that because it's a key piece of the two exceptions that we're taking, the staff is taking in the Draft Reg Guide with regard to minimum days off.

MEMBER CORRADINI: Can you just say it again, since I didn't understand your point, I'm sorry. Could you just repeat that?

MS. BARNES: The covered workers, the

individuals who can work on the more relaxed outage hours, who are allowed to have fewer days off and work longer hours on the outages, the individuals at the site, who are allowed to work outage hours under the Rule are only -- are individuals who are working on outage activities. And the interpretation of who can be considered to be working on outage activities is subject to discussion.

MEMBER CORRADINI: Okay, thank you.

MS. BARNES: Uh-huh.

MEMBER MAYNARD: I just want to make sure I understand.

MS. BARNES: Okay.

MEMBER MAYNARD: That first bullet, they're not allowed to work -- they're not allowed to work them 60 consecutive days. They're only allowed to be on the relaxed schedule for a 60-day period, right?

MS. BARNES: Correct. And there's ins and outs associated with this -- with this issue as well, but that's the basic idea.

Okay, so as I said, the two areas of substantive disagreement are associated with these minimum day-off requirements in the Draft Final Reg Guide. Now, in the Draft Final Reg Guide, we also

have a fair number of additions and clarifications to NEI 0611 and there may be more than you're used to seeing. A number of those are in response, of course, to the public comments that we received that requested additions, particularly from IBEW who did a very thorough review of the Reg Guide and between the time that we published the Draft Guide which endorsed Revision E of NEI-0611 and this point in time where we're looking at the Draft Final Reg Guide, NEI, as part of their public comment, submitted an updated version.

So the Draft Final Reg Guide endorses Revision 1 to NEI-0611 and we have had to -- we had to add -- do some additions and clarifications because Revision 1 that we're now endorsing, had some additional guidance in it we hadn't reviewed before. So -- but those issues are not in contention. Okay.

MEMBER CORRADINI: Can I just say that back to you so I've got it because --

MS. BARNES: Thanks.

MEMBER CORRADINI: So what you're saying is that in the Final Rule or the Final Draft Rule and the Final Draft Reg Guide, the reference is now to a new NEI -- a revised NEI document.

MS. BARNES: Rev 1.

MEMBER CORRADINI: Okay, and that revised document has -- I don't want to put words in your mouth but has come more in line with what the anticipated -- I'm still cloudy at that point.

MS. BARNES: We had additional substantive exceptions to NEI-0611, Rev E.

MEMBER CORRADINI: Right.

MS. BARNES: Which is the one we were discussing in the Draft Reg Guide.

MEMBER CORRADINI: And then a new one showed up.

MS. BARNES: And then a new one showed up that's solved some of the problems except for these two --

MEMBER CORRADINI: Okay, that helps, thank you.

MS. BARNES: Okay, thanks. Okay, the two areas of disagreement are the NEI concept of periodic overtime which I'm going to be discussing in a little bit of detail, and the other area of disagreement is the applicability of the day-off requirements to operators who are working on the operating units at a multi-unit site that has one or more units in an outage.

MEMBER STETKAR: Let her get through it.

Let her get into it.

MS. BARNES: Well, it depends on the configuration of the control rooms and, yeah.

CHAIR BONACA: Just to check progress.

MEMBER STETKAR: We're doing okay.

CHAIR BONACA: You're doing okay?

MEMBER STETKAR: We're doing okay.

CHAIR BONACA: Good.

MS. BARNES: Okay, now, we've provided you a handout that gives you the actual language regarding periodic overtime that NEI has in Rev 1, if you want to look at the words. I'm going to summarize the staff's understanding of the position here with this slide. What NEI is proposing is that licensees would plan a shift schedule, for example, for the next six weeks that would include the required number of days off. Okay, this is for generally normal -- this is for normal operations. All right?

So they would plan out ahead who's going to be working when and when they would be taking their days off. And then, of course, as we all know, things break, events come up that require or that require staff to work extra hours, right? Nothing goes as planned, typically. And so the NEI position would be that for those unscheduled work hours that aren't in

the plan schedule, the worker, covered workers would work as much as needed to within the other work hour limit requirements. And then at least quarterly, they would go back and identify any covered worker at this site who had averaged more than 54 hours per week. They're not going back and looking to see whether people had gotten the days off that are required under the Rule. They're going to look and see if there were people who had worked very long hours, and then they're going to do a review of the circumstances, determine if they need to do a schedule change and put the situation into the Corrective Action Program.

So that's what NEI has proposed and certainly has some streamlined management advantages to the idea. The problem, as far as the staff is concerned is that this proposal could lead licensees, if they implemented it as it's written in NEI-0611, t violate the requirements of the Rule. So we can't agree with the periodic overtime concept. As discussed here in the first bullet, the proposal that NEI has made with regard to periodic overtime would permit people to miss their required days off without going through the formal process that's required in the Rule for waiving the work-hour controls. And I'm going to talk more about the waiver process which

allows licensees to waive the work hour limits, waive the minimum day off requirements, if there's a situation that's adverse to safety or security that requires people to be on site and work unplanned extra long hours, okay?

But under normal circumstances, we expect licensees to give people the days off that are required under the Rule and only to have them work on those days off if they meet the -- if the work itself meets the requirements for a waiver, in addition to which the staff's view is that we have built in many extra work hours above the goal that we're trying to reach in the Rule of the 48-hour average work week. There's extra hours available within the requirements of the Rule for people to work unscheduled, you know, extra work hours and flexibility so that it's not -- it's unnecessary to introduce this concept of periodic overtime which isn't in the Rule.

The NEI's response to the staff's concerns about periodic overtime is that they perceive that the Rule doesn't talk about work hours, doesn't use work hours as the determining factor in deciding which set of minimum day-off requirements apply. Their position is that the minimum day-off requirements are associated with a schedule and it doesn't matter

whether people -- I mean, that's a massive overstatement. But the concern is not that the actual hours that people work as much as it is the extent to which the licensees are able to manage work hours to stay within the limits and to stay on the schedule that they've planned.

The staff has a different position. We talk about our requirements for work-hour scheduling in an entirely different section of Rule. In the part of the Rule where we're talking about work-hour controls, we are establishing the minimum day off requirements there and our concern is that depending on how many hours our covered workers are working, we want them to have adequate days off to rest and to, you know, mitigate whatever cumulative fatigue they've developed from working long hours. And as far as we're concerned, we don't care whether those long hours are scheduled or unscheduled. Our concern is that people have time to rest and catch up on their sleep.

MEMBER STETKAR: Val, you don't have a slide on it, but it's -- I think it's important for the other members who were not in the Subcommittee meeting to hear just a little bit about the waiver process because you kind of went through the waiver

process and it's a little bit key.

MS. BARNES: Sure, all right.

MEMBER STETKAR: So if you could just give a little --

MS. BARNES: I have it later on, but I'd be happy to do it now.

MEMBER STETKAR: If it's later on, I missed it, so --

MS. BARNES: No, that's fine. You're correct.

MEMBER CORRADINI: I was going to say to help me because that's kind of where you were getting to where there was a disagreement. So your biggest point is if they had somehow been able to envelop the waiver process, you'd be okay with the NEI requirement. That is if somewhere in the rescheduling of the unscheduled hours, the waiver process was invoked and used appropriately, things would be okay. Am I interpreting that --

MS. BARNES: That is correct.

MEMBER CORRADINI: Okay, fine.

MEMBER MAYNARD: I think the intent is that the waiver needs to be done before the hours are worked.

MS. BARNES: Before the extra hours are

worked.

MEMBER MAYNARD: As opposed to after is probably where the main difference is.

MS. BARNES: That's right and the waiver requirements in the Rule are different from what was permitted under the Policy Statement. Under the Policy Statement, licensees were able to write blanket waivers. So at the beginning of an outage, they would issue a memo under their tech specs which was allowed that would say, "Okay, everyone on site is going to go on outage hours now and the limits that are in the policy statement and our tech specs no longer apply". And so we would have situations at some licensees during outages where we would have people working 12-hour days for four or five or six weeks in a row with no days off whatsoever under the former waiver process.

The waiver process in the -- the waiver process in the current rule doesn't permit blanket waivers any more. You can't take an entire group or an entire department or crew of people and write a memo and waive the work hour limits. In addition to the requirement that the need for the waiver has to be based on safety or security, we also have requirements that each individual who's going to be given

permission to work extra hours has to be evaluated by the supervisor on -- we have a number of dimensions that this evaluation has to cover, essentially to determine whether the individual is going to be able to safely perform the work activities that are planned to be performed under the waiver or whether there need to be some controls and conditions like extra peer checking for the work that the individual may be doing or in some cases, the conclusion might be that this particular individual shouldn't be allowed to work these extra hours on our risk significant structure systems and components.

So that's how the waiver requirements work now.

MEMBER STETKAR: Val, I may have missed it but -- and the waiver, this waiver interview is a face-to-face interview.

MS. BARNES: With a supervisor.

MEMBER STETKAR: So it's not the supervisor who is sitting down and making a unilateral determination. It's actual face-to-face.

MS. BARNES: Right, thanks, yeah.

MEMBER STETKAR: Thank you.

MS. BARNES: Now, in terms of -- just to back up for a second.

VICE-CHAIR ABDEL-KHALIK: I don't understand one thing. If you go back to Slide 14, the first bullet, what is being asked there, to prepare the shift schedules so that people are consistently working anywhere between 48 and 60 hours a week, depending on their job function and length of their shift? Is that what's being asked for?

MS. BARNES: Go ahead.

MR. DESAULNIERS: Okay. Right. I believe this bullet is referring to the requirements in 26.205(c) of the Rule which basically says that there is a scheduling requirement that meets basic objective of preventing impairment due to the duration, sequencing, and frequencing of the schedule, so that there will be a schedule set that's consistent with basic shift scheduling principles. That is a separate -- the point being, I think, this is a separate requirement for what's planned versus the requirements that then apply to what's actual.

VICE-CHAIR ABDEL-KHALIK: But a utility can meet the minimum days-off requirement putting out a shift schedule where people are consistently working 48 to 60 hours a week.

MS. BARNES: Absolutely.

MR. DESAULNIERS: Yes, that's correct.

MS. BARNES: That is correct.

MR. DESAULNIERS: Yes.

MS. BARNES: And it would meet the requirements of the Rule.

MR. DESAULNIERS: Actually, what Val was explaining here, too, and I perhaps misstated it, she's describing an NEI -- a piece of the NEI guidance as to the way they would approach -- they would interpret the rule and how they would implement it. So, perhaps --

MEMBER STETKAR: To keep on schedule here. NEI will have an opportunity to explain their position to us.

VICE-CHAIR ABDEL-KHALIK: That's fine.

MS. BARNES: I mean, the intent is that you know, and the expectation is that the shift schedules will stay around on an average no more than 48 hours a week. And we have requirements in the Rule that if they are regularly exceeding about those -- about that level of work hours, they do have to do reviews, and I think this is where the idea of the reviews associated with anyone who is consistently averaging more than 54 hours came from.

They have to do reviews. It has to go into their corrective action program, would be

inspected under -- could be inspected under our PI&R, Problem Identification & Resolution Inspection Procedures and so on. So the Rule permits it. It doesn't encourage it but it could occur but we would want both the licensee and we would expect to look at why, what's going on, yeah.

MEMBER BROWN: Can I -- one question, I guess you -- I would expect that there's got to be a balance on the safety versus you're getting work and cost benefit and all that other kind of stuff. You don't want people to kill themselves or other people but yet you also have emergent conditions where you have to have -- where people have to work more than their normal 40-hour, 48-hour whatever --

MS. BARNES: More, that's right.

MEMBER BROWN: -- the period is.

MS. BARNES: Right.

MEMBER BROWN: And the only question I don't understand out of this is, does the licensee have the flexibility to achieve that balance on his side, okay?

MS. BARNES: Our perception is for sure.

MEMBER BROWN: Let me finish, okay?

MS. BARNES: Oh, I'm sorry.

MEMBER BROWN: In a efficient manner that

doesn't -- you know, that he can deal with and get the work done. I mean, this is assuming he's responsible. If he's irresponsible, different issue. I guess, you know, somebody's got to be monitoring to make sure something goes on and -- auditors or regulators or whoever.

But can he do -- can the licensee do that in order to not bring the place to a halt? And I say that only because my dad worked for the railroads, and repaired diesel engines at night and the diesel shops, would come to a grinding halt when one worker would start, you know, complaining about something because he was cleaning up somebody else's work space instead of the electrician, whatever. So I used to hear the stories all the time and it was just a real problem because it was an imbalance. And so it's a matter of I just was curious is this perceived by the industry and the licensees, is this a reasonable compromise that there's a balance or is this really a head-knocker?

MS. BARNES: I'm going to give two answers to that. One of them is, that's why it's taking so long to get the Rule and the Reg Guide.

MEMBER BROWN: So it is a head-knocker.

MS. BARNES: And why the Rule itself is so

complicated is because all the way along we've been attempting to build the flexibility into the Rule to make sure that licensees can get the work done that needs to be done. So that's -- you know, that's the broader answer to the question that you're asking.

The more specific answer with respect to waivers is that there's a lot of flexibility as well as to what determines a safety or security need for a waiver. And you know, entering an LCO is a safety basis for granting waivers. If half of your security force goes out with the flu, and you need to have your remaining trained officers come in to maintain the security at the plant, that's a basis for a waiver. So --

MEMBER BROWN: The licensee executes the waiver?

MS. BARNES: Yes.

MEMBER BROWN: Okay, and then it's subject to audit if he was abusing it.

MS. BARNES: That's right.

MEMBER BROWN: Is that the case?

MS. BARNES: That's right.

MEMBER BROWN: All right, that's --

MS. BARNES: Yeah, and go ahead.

MR. DESAULNIERS: I'd like to add to that,

too, and just I think perhaps, correct a minor misstatement, Val, earlier when it's correct that the minimum day-off requirements end up with an average work week of 48 to 60 hours, but our expectation isn't for 48-hour work weeks. As stated back in the Policy, we still anticipate that the typical work week in the US, even for power plant workers, will be on the average of 40 hours a week, 40, 42.

So, really, the minimum day-off requirements allowing an average of 48 to 60, allow an average eight to 20 hours per week of flexibility for the emergent --

MEMBER BROWN: That was my next question. So the normal exception is 40 hours.

MR. DESAULNIERS: For safety or security reasons.

MEMBER BROWN: Okay, all right. I quit.

MEMBER STETKAR: We have about 25 minutes to get through the staff's presentation and there's another basic concept that we have to get to, so --

MS. BARNES: Right, thanks, John. Okay. So this is an example of the amount -- the requirements in the Rule that demonstrate the kinds of hours that licensee personnel can work without violating the Rule to address these kinds of emergent

issues. We built in what we think is a fair amount of padding. This slide talks about a little bit more detail with regard to our views that the minimum day-off requirements are -- can be applied very flexibly and that there are lots of work hours available to address emergent circumstances even before you get to the need to do a waiver and the -- the staff's view anyway that the licensees have adequate flexibility now to be able to distribute these extra work hours that they're permitted to use under the Rule before they get to a waiver, however they need.

And then we've -- this is where I had intended to talk about the waiver process. We've already discussed that but the point is that, you know, if they use up -- you know, if they need to use the extra work hours that are permitted under the Rule, they still have the waiver process available for safety and security issues. What we don't want to see which would be permitted with the periodic overtime concept in NEI-0611 is individuals missing their days off without going through the waiver process, without having the waiver process included in the decision about whether or not individuals can be permitted to work their days off.

So that's -- in the Draft Final Regulatory

Guide, we took this same position in the Draft Guide back in October. After additional public meetings, discussion and input, the staff has retained the same basic position we had in the Draft Guide, but what we've done in the Draft Final Regulatory Guide is include more detailed guidance on how to manage the minimum day off requirements that had appeared in our conversations with stakeholders and licensees that wasn't clear from the Draft Guide that we hope will increase our licensee's ability to more effectively make use of what is permitted under the Rule without violating the day-off requirements.

MEMBER BROWN: Okay, so your position is no periodic overtime, work within the existing rules.

MS. BARNES: Right.

MEMBER BROWN: Okay.

MS. BARNES: Maybe I should have started with that.

MEMBER BROWN: I mean, I just wanted to distill it down to something --

MS. BARNES: Yes, that's it.

MEMBER BROWN: Okay, I take it somebody else doesn't agree with that.

MS. BARNES: Correct.

MEMBER STETKAR: We'll hear from the

industry.

MEMBER BROWN: Okay.

MS. BARNES: Right. The second issue where we have a disagreement relates to operator work hours that are permissible under the Rule for operators that are working on an operating unit at a multi-unit site where we've got one or more units in an outage. As I mentioned previously, the Rule only attempts to have individuals subject to the more relaxed outage, day-off requirements only if they're working on outage activities.

When we were developing the Rule, early on, and through even the beginning of the development of the Regulatory Guide, the staff's position was that any time an individual touched the operating unit, that that individual was not eligible for outage work-hours. I'm sorry that I have to talk about this in a backward fashion but it's --

MEMBER BROWN: Can you repeat that?

MS. BARNES: Yes. The staff's conception of who was eligible to work outage hours, the more -- you know, have less time -- have more hours available to work, who was going to be working longer hours during an outage, the staff's idea was that licensees would be able to set aside a skeleton crew of

operators, for example, and maintenance personnel who were dedicated to the operating units while the rest of the staff, as needed, on site, was free to work outage hours and go off and work long hours to get the outage completed, but that there would be at least a skeleton crew of covered workers whose sole responsibility, whose primary responsibility, was to maintain the safety of the operating unit and so our going in position, including in the Rule itself, was that if an operator had been working outage hours, they were not eligible to work on the operating unit because they were at greater risk of having developed cumulative fatigue because they had been working operating hours.

MR. DESAULNIERS: Outage hours.

MS. BARNES: Outage hours, thank you. Okay, so during the course of all of the discussions we had on the Regulatory Guide, the staff agreed in the end that skeleton crew concept was not likely to be as easily implemented as we had intended and agreed with the guidance in NEI-0611 that maintenance personnel and operations personnel who are working on common systems, even though they may be touching an SSC associated with the operating plant, would be eligible to be on outage work hours, so they could

work the longer hours.

However, even in the Draft Regulatory Guide and still on the Draft Final Reg Guide, we've retained the position that the licensed operators who are assigned to the operating unit, should not work the longer work hours that are possible for individuals who are working on the outage. Okay? We want to keep a certain set of operators on the operating units less subject to cumulative fatigue.

And the staff's position on -- the staff's position that we need operators on the operating units to be fully rested at least to the extent that the Regulation insures that, is based on experience, operating experience as well as policies NRC has published about how operations need to be conducted in the control room and in terms of identifying who those operators need to be on the operating unit, who should stay rested, we went back and looked at the shift staffing requirements that the NRC has published in 10 CFR 50.54. We have a number of requirements there.

There is a table in the Regulation itself that establishes the number, the minimum number of licensed reactor operators and senior operators who have to be assigned to manage the operations on operating units and the number of RO's and SRO's

required depends on how many units are at the site as well as the configurations of the control rooms.

For example, some dual-unit sites have a shared control room. Some dual unit sites have separate control rooms. We've got -- we've got three-unit sites, some of which have shared control rooms, some of which have three separate control rooms and so on. And the number of operators in the 50.54(m) table depends on how those control rooms are configured and how many of them there are.

In addition, 50.54(k) generically requires that for any operating unit, the licensee has to assign one operator at the controls whose primary job is monitoring what's going on with the plant and insuring that it's safe, in addition to which they're required to have a senior operator in the control room area also for any operating units. So we looked at the table and these additional requirements to develop the staff position in the Regulatory Guide, which is demonstrated in this table.

This is a table that talks about how many RO's and how many SRO's the staff thinks should remain on operating hours that need to be less tired than operators who have been on outage hours might be, depending on the configuration of the control room and

so on. So for example, if we've got a two-unit site with one unit in an outage and we've got either one control room or two control rooms, the staff's position is that there should be one senior operator in the control room at all times, consistent with the Regulation, who is -- has been working only operating hours, so is more rested, one RO and then the licensee should maintain available, whether they're in the control room or not, a backup operator and a backup SRO for this circumstance. So that backup operator and backup SRO, who are not required by regulation to actually be in the control room, can be off at the work control center working on outage activities. They can be out in the plant overseeing outage activities, but if the two who are playing those fundamental safety roles in the operating unit need relief, those are the guys you pull back to the control room so that at all times, we've got rested operators managing the operations of the operating units because outage activities can frequently have an adverse impact on what's going on on the operating units. So we want to --

MEMBER BROWN: So the extra guys can work outage. They can work in the outage activities but not outage hours.

MS. BARNES: Correct, yeah.

MR. DESAULNIERS: The print is small, so you might want to describe the parenthesis in case why we have -- these may not be clear from our handout or on the screen.

MS. BARNES: Yeah, thanks. What's in parenthesis is the number of operators that's required under 50.54(m) for operating plants. So you can see we've reduced -- we aren't reducing the number of operators that are required. What we're doing is identifying a subset of operators on the operating unit who would stay on operating hours, which is less than the number that's required under the Regulation. Let's go.

MEMBER STETKAR: Back up to the preceding slide before that, because that's the crux of what we're going to hear in a moment --

MS. BARNES: Uh-huh. Thanks. So the position in NEI 06.11 is they agree or we are all in agreement that one RO and one SRO for each operating unit or depending on how the control rooms are configured, should stay on operating hours. The NEI position is that operators who provide relief for those -- for those operators who are assigned to the control room, could be any operator who's been working

outage hours. The staff's position, as I said earlier, is that those relief operators also need to have been working outage hours, I mean, operating hours.

MEMBER BROWN: Operating, not the outage, so that's the difference in positions.

MS. BARNES: That's the difference in positions, right. Okay, and again, as a result of discussion and consideration of the public comments that we got on the Draft Regulatory Guide, the Draft Final Regulatory Guide doesn't change the fundamental staff position that the operators on the operating unit need to be more rested but rather we've included some additional guidance that should make implementing this a little bit easier and these are examples of what we've done in the Draft Final Guide. We've relaxed the requirements for operators to transition from outage activities onto the operating unit to serve as the operator control -- at the controls or the senior operator in the control room.

As I mentioned earlier, operators who may be playing that backup position, we've clarified that it's fine for them to go out and work on outage activities as long as they have the days off required for normal operations and then we're also agreeing

with NEI's view that operators who have been working outage hours in some circumstances should be able to provide backup to the operating crew for short periods and we've provided some guidance associated with that.

So the difference in our positions at this point in time is very small, but the staff believes it's still important. As we -- yes.

MEMBER ARMIJO: I have just a basic question on the covered workers, just an order of magnitude, because they're defined by workers who work on risk significant activities only and I believe nuclear safety is the underlying risk you're worried about. What fraction of a site work population are covered workers, either during an outage or during, you know, normal operation? Is it 10 percent, 20 percent, 50 percent? You know, let's say 1,000 people on site. How many are covered by this regulation?

MR. DESAULNIERS: Well, I'm not sure I can accurately represent it in terms of percentages. I'll just explain it more qualitatively in that with respect to -- when we're talking about risk-significant activities, that's shorthand for saying that the SSCs that were covered under the maintenance rule that were identified as high safety significance in general, operating or maintaining those, and as --

would be risk-significant activities and that as a result, your operators that are performing hands-on operations are covered.

As a practice, what we're hearing from the industry representatives is that most maintenance personnel will be covered because they're not going to attempt to differentiate between those that are working on risk significant activities and those that are not, though that is allowed by the rules should they choose to go that route. With respect to the --

MEMBER ARMIJO: With regard to the flexibility, everybody is covered.

MR. DESAULNIERS: Right. You've got a limited scope of HP and chemistry folks because those are the only ones that are required as part of the minimum compliment for your emergency response organizations, so you're not talking about all your radiation protection technicians in that case. Does that help?

MEMBER ARMIJO: Yeah, I'm just trying to get -- basically, everybody on site is covered.

MR. DESAULNIERS: Security if they're armed --

MEMBER ARMIJO: I'm just trying to get -- it's basically everybody on site gets covered.

MR. DESAULNIERS: No.

MEMBER ARMIJO: But it's not a small fraction of the employees either. It's a large fraction of the employees.

MS. BARNES: Maintenance and operations, yeah.

MR. DESAULNIERS: It's a large fraction of maintenance and operations and --

MEMBER ARMIJO: I'll ask the NEI guys when they come up what they think.

MR. SMITH: Actually, I could address that now if one of these microphones -- Russell Smith. Virtually, all of your operations --

MEMBER CORRADINI: You have to identify yourself.

MR. SMITH: Russell Smith, NEI. Virtually, all your operations personnel are included. There may be some exclusions for say a rad waste position operations. That's in the small percentage. I'd say 90 percent of your maintenance staff, once again, you'll exclude housekeeping, maybe a painting staff, a cleanup crew or a crew that works outlying buildings.

Chemistry, that's the on-shift chemistry, so that's about two-thirds of your chemistry. Even

though it's only position, you've got to rotate. You never know when the emergency plan is going to hit. They're all qualified. They'll all be covered, so about 60 percent. RP, a little higher percentage. You usually have three or four RP techs per unit on site. Once again, they're all qualified to be the ERO position. You don't know when the emergency is going to hit, so you have to keep them all covered. So that's 70 percent RP.

MEMBER ARMIJO: Basically, I was just looking for sort of an order of magnitude. Is it half the staff?

MR. SMITH: I'd say 50 to 60 percent of the staff. Engineering is excluded totally.

MEMBER ARMIJO: Engineering also gets excluded. Thank you. I'm sorry.

MS. BARNES: No, that's fine. I'm done. We've covered the points in the last slide here. I just want to wrap up by saying that I greatly appreciate the Committee's scheduling us in and the Subcommittee willing to provide us with a letter sooner than rather than later because we are absolutely intending to get the Final Regulatory Guide out no later than May 31st and so we greatly appreciate the input that you're going to provide us

here in a timely fashion.

And are there any other questions?

MEMBER APOSTOLAKIS: Why are you looking at me?

MEMBER BLEY: I have one.

MS. BARNES: Yes, sir.

MEMBER BLEY: Have you thought about -- could there be any negative side to this identifying two or four of the people on the operating crew who are required to be under the operating hours requirements in terms of effects on teamwork that sort of thing, especially if somehow this leads to people having to slip. I don't think that is slip from shift to shift or something, so you're not keeping the same people all together all the time?

MS. BARNES: We heard PROS presentation, of course, which Mitch will make a briefer version of today. We've heard discussion of impact of team -- you know, the impact of having, perhaps, split shifts in the control room, previously to this, during the development of the Rule and the response so far among the staff, particularly to the presentation from PROS that Mitch will offer, is that you know, it's valid concerns and we're interested in hearing more about it. I think you know, at this point in time, the

staff will probably have questions for PROS because it's not clear to us how having assignments for different days off requirements adversely impacts the implementation of the super-crew concept. So we will be asking for some additional information but at this point in time, it's not clear to us -- it's not clear to us how it is that that is happening. It's not clear that they're on -- why they need to be on different schedules simply because they have different days off.

MEMBER BLEY: Okay.

MS. BARNES: But it's a good concern. I mean, it's a good concern that was raised.

MEMBER BLEY: This is a Reg Guide so it's -- a particular utility could come in with a plan that might differ somewhat and request approval on it if they could provide arguments that --

MS. BARNES: They wouldn't even need to come in. You know, they would be -- yeah, because it is a Reg Guide. They'd be able to implement but we -- you know, and then we'd look at it, but you know --

MEMBER BLEY: That's what I meant.

MS. BARNES: Right, if teamwork is an overriding concern, of course, licensees can put all of their operations personnel on the same MDO when

operating MDO.

MEMBER BLEY: Okay, thank you.

MEMBER STETKAR: Any other questions, comments? Valerie, Staff, thank you very much.

MS. BARNES: Thank you.

MEMBER STETKAR: You made it under the deadline and good participation. We'll hear from Russell Smith from NEI.

MR. TAGGART: I guess I'll go first. Good afternoon or morning. My name is Mitch Taggart. I am the Vice President of Professional Reactor Operators Society. I'm also a licensed operator at Calloway Plant and was previously licensed at Sequoia. And first of all, I want to mention why we're raising this issue or these issues are safety first. We feel as an industry we've done a very good job of safety in our outage performance. The two issues I have are associated with outage.

The Rule will make utilities change the way we schedule our manpower going in to and coming out of an outage. Utilities will change a successful past practice and could impact our ability to operate safely. The first issue is definition of unit outage. And I'll just let you know this is also in the Rule and in the Reg Guide. The outage unit is defined as a

reactor disconnect from the grid. Our recommendation is to change that to allow up to one week prior to disconnecting from the grid and up to 75 percent following reconnection to the grid.

Some advantages for that purpose --

MEMBER STETKAR: Let me interrupt you for a second.

MR. TAGGART: Yes.

MEMBER STETKAR: That last bullet is important for our meeting here is that the definition is actually in the Rule, so this change would, indeed, require a change to the Rule.

MR. TAGGART: That is correct.

MEMBER STETKAR: And it's beyond, to some extent, our deliberations regarding the Reg Guide.

MEMBER APOSTOLAKIS: This is the last item.

MR. TAGGART: That's right, the very last item there, this is in the Rule. The definition is in the --

MEMBER STETKAR: The definition of an outage is in the Rule, so you can't change that. You can't change the scope of an outage without the Rule change.

MR. TAGGART: And one of the reasons we're

presenting this is we were informed that quality control and quality assurance would be addressed adding into the rule and that's why we had the opportunity to raise this issue now.

Some advantages for the beginning of the outage, the crew adjustment going into the outage both forgetting the individuals working the outage schedule and then working together, another issue. And the preparation, this is probably one of the most -- the best thing the industry has done with respect to getting prepared for an outage over the last 10 years, we actually do simulator time, real time simulator shut-down of the plant with the crews. They go in and physically do the procedures, they turn over to another crew. We actually perform a shut-down in the simulator, so they'll see that first-hand before they actually go in and shut down the plant.

And each time we do it, we learn new things about how we want to -- and we've become more efficient.

MEMBER SIEBER: Most plants that I'm familiar with also do the start-up that way, too.

MR. TAGGART: Yes, yes, we do. We do preparatory time for all the major activities.

MEMBER SIEBER: It makes a big difference.

MR. TAGGART: Yes, sir, it does. Yeah, it's not the first time you've seen the activity, it makes it a whole lot better when you get to see it for a --

MEMBER SIEBER: If you practice a short time.

MR. TAGGART: Right, and then also being prepared, helps reduce the stress level in the control room because when things don't go well, stress goes up for the individual performing it and just as important, the individuals that are supervising them, the stress level goes up and when that stress level has been elevated, it has a tendency to stay around for awhile and that also basically goes throughout the rest of the outage.

And just as a side note, stress for me personally is the biggest input to fatigue. My sleep pattern is disrupted no matter how I work on a rotating shift but when the stress factor is high, that's when it's worse for me for fatigue. Advantages for after the outage, all our major equipment that operations puts into service is after we put the breaker in from the secondary site and that gives us an opportunity to -- in case we have an issue with one of those pieces of equipment to have individuals there

to help us restore that piece of equipment back to service.

And also, the idea of the stress, if we come out of an outage successfully, we have a tendency to be successful during that run. If an outage doesn't go well recovery-wise, it seems like the problems perpetuate throughout the room. And the next slide, PROS is not recommending any change to the 60-day requirement that's already in the outage stipulation for hours. We would incorporate that week prior to and that 75 percent after into the 60 days. Any questions on that --

MEMBER ARMIJO: Yes, I have a question. What would prevent the management of the site to just simply say, "Hey, that's a good recommendation, we're just going to do it anyway"? They're not in violation of the Rule. They're going beyond the rule.

MR. TAGGART: No, we would violate the 54-hour average or the recommendation in the Rule if we would have -- some of our crews would actually work more than 54 hours average for the week for the cycle prior to the outage.

MEMBER ARMIJO: Right, so actually, they can't -- they couldn't -- a utility couldn't arbitrarily just say, "Hey, that's a good idea".

MR. TAGGART: Right, we could do that but it would be -- basically a corrective action in our corrective action program for -- that we're going to say we're not going to resolve and that's not -- that doesn't work well.

MEMBER ARMIJO: Yeah, okay.

MR. DESAULNIERS: Pardon me, David. Just a point of clarification. The Rule does not specify a specific 54-hour limit as a requirement. So that's not a violation if individuals average above 54 hours. It's just a basis for looking at it on an annual basis.

MR. SMITH: And I believe the Rule requires us --

MR. DESAULNIERS: For whether or not there's actual performance impact.

MR. SMITH: Right. I think the rule requirement on 54 hours is we're annually to report that in a -- and review the situations around that. So it is a requirement to identify them and identify them to the Commission and review it.

MR. TAGGART: Thank you, Dave. Any other questions on that? The next one sounds similar but it's a little bit different. The next issue is associated with the definition of outage unit and this

would be associated with a multi-unit site with shared licenses. I mentioned a common control room. It would be any plant that has the ability for an operator that's licensed on one unit to be also licensed on a second unit. And what we're recommending taking the current definition is defined as only the reactor that is disconnected from the grid and we are recommending that the outage unit be defined as outage site. And that would allow individuals to be all included in the outage hour limitation. And this would be associated with the Regulatory Guide.

VICE-CHAIR ABDEL-KHALIK: Let me just try to understand.

MR. TAGGART: Yes.

VICE-CHAIR ABDEL-KHALIK: Your position is consistent on both issues. You're essentially asking that operators be allowed to work longer hours than what the rule allows.

MR. TAGGART: During an outage period, yes, sir.

VICE-CHAIR ABDEL-KHALIK: Is that consistent?

MEMBER SIEBER: Yes.

MEMBER MAYNARD: Not longer. It's -- the

rule allows longer hours during the outage period. They're asking to redefine the outage, period, and allow --

MR. TAGGART: Give us the flexibility --

MEMBER MAYNARD: -- it to be the sites on an outage rather than just a specific unit.

VICE-CHAIR ABDEL-KHALIK: But in general, the net effect of your position on both issues is that operators would be allowed to work longer hours.

MR. TAGGART: There would be a period of time. You know, if you started before the current definition of --

MEMBER RAY: This is minimum days off is the issue. It's minimum days off that's the issue between outage and --

MR. TAGGART: We want the flexibility to put all personnel on the three days off and for operations three days off in a 15-day period during the outage period.

MEMBER BROWN: That means you're more consistent with the NEI position or with the staff position? Okay, you're not -- you don't agree with the staff position. You have something different.

MR. TAGGART: Correct, yes.

MEMBER BROWN: All right, I'm sorry,

that's what I was trying to get to, where the disconnects are or disagreements.

MR. TAGGART: Okay. And PROS recommendation for the outage unit would -- like I say, is for the site and the advantages, going to the next slide. The site would have one Rule to manage during an outage because the individuals that are going to be managing this Rule, you're looking at one. I will be doing this while I'm not the outage unit or operating unit supervisor.

So it's going to be difficult to figure out who can and who can't work these particular hours. And needless to say, my activities are already pretty well spelled out for me and this is going to be one additional that I'm going to have to work through. More personnel supporting the outage; right now with the present ruling there will be more people required to support the operating unit. With those more people to support the operating unit, they're going to come from the outage and what that effects is the activities on the outage. We'll have less people performing them, so now you have critical activities on the outage being performed by less people. So now the workload has gone up.

And outage activities, in my opinion are

more risky than operating the unit at 100 percent power. When you get into a condition where you're just a few minutes away from a core boil condition, that's risk and that's where I want to be able to concentrate my resources.

MEMBER SIEBER: There's also risk in hanging clearances and making mistakes.

MR. TAGGART: Yes, sir, yes, there is.

MEMBER SIEBER: Draining, venting, refilling, and all of that, all the planning for that occurs outside the current outage period.

MR. TAGGART: Yes, it does.

MEMBER SIEBER: And it's a lot of work.

MR. TAGGART: Yes, sir, it is.

MEMBER BLEY: Mitch, I want to take you back to the question Said asked.

MR. TAGGART: Yes.

MEMBER BLEY: I think given most outages are now closer to three weeks than two months, I would guess and I'm not sure, PROS would be happy with the 60-day total limit. You'd just like to start a couple of weeks before the outage but it would still be less than 60 days for almost every outage.

MEMBER MAYNARD: That's what he said, that they weren't proposing a change to the 60 days.

MR. TAGGART: No, that's correct.

MEMBER STETKAR: They're just proposing the definition of when the time clock for an outage starts.

MR. TAGGART: Starts the hours because of the restriction associated with the fatigue rule and violating the --

MEMBER STETKAR: But again, we have to keep a little bit on schedule here. To get that change implemented requires a change to the Rule or --

MR. TAGGART: And we understand that and we will pursue -- if not successful here, then we will pursue this the --

MEMBER STETKAR: Well, we can't change the Rule, so you're not going to be successful here.

(Laughter)

MEMBER STETKAR: We get the concept but we don't write rules.

MR. TAGGART: Okay, and then that last bullet for advantages for the multi-unit is communication. Communication is the key for success. Preparation is basically, just making sure how you're going to communicate with the individuals involved in the activity. If communications are with multiple people instead of basically just one individual across

the site or the group that's involved, the tendency for an error goes up.

So what will happen is the individuals working different shifts will have to communicate with other individuals or different individuals on the operating unit compared to the outage unit over a time period.

VICE-CHAIR ABDEL-KHALIK: Let me say, I don't understand that.

MR. TAGGART: When you're talking --

VICE-CHAIR ABDEL-KHALIK: I mean, imagine two situations; one scenario where we're consistent with what's being proposed and the other scenario where we're consistent with what you are proposing. The crew that is consistent with what you're proposing has fewer days off than the crew here.

MR. TAGGART: That's what I'm talking about communication. I will be talking to the same individual in the operating unit if I'm performing an outage activity instead of talking with two or three over a two to three-day period, depending on who is covering that shift. Because if you rotated on different shifts, the individual you talked to for Monday might not be the same person that's working Tuesday but your test goes over Monday and Tuesday.

So now, I have to communicate with two crews.

MEMBER BLEY: I think you didn't start with the story you told us at the subcommittee meeting. They're taking whatever crew structure they have now and for the outage going down to putting -- redistributing those people into four crews that will stay on the same 12-hour shift all the way through the outage.

MR. TAGGART: Right.

MEMBER BLEY: So if I work from --

MR. TAGGART: Yeah, I can explain this.

MEMBER BROWN: Always turning it over to the same people and --

MEMBER BLEY: Yeah, and you're always working the same hours every day.

MR. TAGGART: It's called a super crew concept. I apologize.

MEMBER STETKAR: That's the way it's done now.

MR. TAGGART: So basically you're talking to the same individuals across the period of time, which eliminates some confusion with communication.

MEMBER RYAN: Okay, so given that, would you just back up and restate why this one-week lead time, this extra lead time you're talking about is

important to --

MR. TAGGART: The prep time the week prior to, an analogy I've got out it's kind of like a Broadway production. You take months and months of developing this production, but you do dress rehearsal just before the actual opening night. Well, that's the same thing for us. We're months and months of preparation for an outage. We do our preparation that week before. We actually go in and do just like a shutdown in a simulator.

We had the people there that are able to cover the shift for the operating unit because if we started to shut down --

MEMBER RYAN: Well, that's the part that really sort of gets on this point that which just covers it. You have practice in the communications with now instead of that one person with the two, the three or whatever it might be, is that right?

MR. TAGGART: And likely you wouldn't have anybody to communicate with because they're on a different shift. That's one of the problems of not having the prep time and I --

MEMBER STETKAR: I'm going to have to cut you off. This gets into kind of outage management dynamics and again, we can't change the definition.

MEMBER RYAN: I understand that, but --

MEMBER STETKAR: And we need to give Russell enough time here to give NEI's --

MEMBER RYAN: If we can't change it, it doesn't mean it's not important to me.

MEMBER ARMIJO: Well, it doesn't mean that we can't comment.

MEMBER RYAN: Yeah, we can comment. I understand that. So that's why I asked.

MR. TAGGART: And that's basically the two issues I have. Thank you, Jim.

MEMBER APOSTOLAKIS: Very different Stetkar.

MR. SMITH: I do appreciate the time. My name is Russell Smith. I'm a Project Manager with NEI. I have been working with NEI for about a year, 27 years with Luminant Power that runs the Comanche Peak Station. Overturned Luminant Power at the end of this year and become even more involved with this Rule. But I've been the leader of the work hours task force for NEI. Previously, I've held a license for 22 years as an SRO. I gave that up in 2006.

I've been a member of management in system engineering, maintenance management. My last job was the Director of Operations for Comanche Peak. That

went from 2003 to 2007. Just a few things we'll discuss. I wanted to give you a idea that the industry is implementing this Rule. The Rule is what the Rule is. October 1st of this year it's going to be effective and we will be in compliance with it. This is just an overview of what we've done to get ready. We've issued NEI-0611 Revision 1 in October 2008. That was in accordance with the comment into the comment period for the current Draft Reg Guide. We have done -- I went back and counted -- 20 revisions to this document since 2006. So there has been a lot of communication between the NRC staff and the industry through this Rule.

We've done two workshops. First, every utility is assigned a project manager for this Rule. This is an extremely complex rule. You know, we schedule outages but this is just as complex as scheduling an outage. Now, we have to have software. We have to have people trained in scheduling techniques that meet the Rule. We brought about 50 of those utility project managers in, in a one-day period, trained 25 of them. The next day we trained the other 25 on what the aspects of the Rule and what they're going to go implement at their sites.

That was done in March of last year. In

May of last year we brought in about 200 utility and vendor personnel. The staff came and presented at the workshop. We certainly appreciated that and got some information about the Rule and that was really a training workshop for those individuals.

In February, we had a second workshop, about 150 utility and vendor personnel. Once again, staff came and presented the Draft Reg Guide and their inspection plans going forward. And this was more an implementation workshop. We got down to the nuts and bolts of how we were going to implement this. We expect to do another workshop with the industry in the summer to go over the pilots that have run in the spring.

The industry themselves, the fitness for duty procedures and policies are being updated. In fact most utilities I've talked to, they are updated. They may not be implemented yet but they're just waiting for their execution date. Work hours, tracking software is in development and I say in development. None of it has been rolled out and put into production yet. We're still understanding the complexity of the Rule and trying to interpret that and into a software world and we are in development. We do anticipate pilots of that software this spring.

Staffing increases. This does restrict the number of hours we have with our resources and we will be required to increase staff and those have been taking place. Two major areas that that staffing increase is involving is our security forces and our operating staffs, licensed operators and non-licensed operators.

Training, there's a great deal of training required by the Rule. INPO has taken on the generic training for the industry. September 2008, if you have taken a general employee training at one of our sites for badging since September of 2008 that uses the Nantel/INPO system, you have been trained no fatigue management and cycles and sleep and rhythms and all the training that is required by the Rule. INPO is doing an additional training for the industry and that's on the fatigue assessments and that's the waiver portion.

Also the employee campaigns, this will impact the paychecks of our employees so we have to teach them on the reasons why we're changing their paycheck amounts. So that's taking some time. Two exceptions that we'll talk about, eligibility for the outage, we've heard a lot about that and then we called it periodic overtime in the NEI guidance but it

really boils down to what's your definition of a worker's schedule.

You've seen the -- NRC has presented the outage minimum days off. The industry position only effects multi-unit stations. The industry position is, if you work at a multi-unit station, virtually every person at that station is working outage activities. Now, you've got to realize minimum days off is a average over a block of time. So the way we look at that in industry is if you worked outage activities over that block of time, and it's either a 15-day block of time or a one-week block of time, then you're eligible, your working outage activities during that block, you are eligible then under the Rule for the relaxed outage minimum days off.

So we took the position in our NEI document that if you worked outage activities during the block, then you're eligible. If you were only assigned operating unit activities through that time, you were not eligible. Clearly we thought within the Rule. We had discussions with the staff. It was clear to us that the staff expected a minimum crew staffing to be maintained ineligible for the relaxation in the minimum days off and that's where the Revision 1 of NEI 06.01 included the minimum

staffing being one RO, one SRO, which when you look at 10 CFR 50.54 and let me make clear, 10 CFR 50.54 is a minimum site staffing. I think that's the name of the table. It doesn't talk about minimum crew staffing for operating unit versus non-operating. Now, there's some guidance documents and some notes that says, as a minimum, if you're in operating then you have to have an operator at the controls and a senior in the control room. So but that's a basis for where we got the one and one.

So why do we have our position? Really, the Rule gives us management techniques for fatigue whether you're at power or in operation. Our expectation is that our operators are fit for duty when they're assigned the normal power unit or whether they're assigned the outage unit. And the 60-day period allows an -- a reduction in the minimum days off only. Now, there's 10 or 11 requirements in this Rule that have hours ceilings, they have break requirements, training, behavioral observation, self-declaration, reviews, reports. None of those items get relaxed during an outage. The only requirement that has an allowance for relaxation is the minimum days off. So we feel for the 60 days the people are going to be fit for duty, it's an appropriate

management barrier for that, our people during outages at multi-unit sites should be eligible for them.

So our Rules allows that for 60 days it's only one of the many defenses. So what is the impact of two-to-two or one-to-one? It really changes the way the industry is going to perform outages with our operating crew staff. And we heard that from Mitch. Any time you treat people differently it's going to impact your performance of that personnel. We know that's a fact. So, we'll have a crew of operators that are working one set of schedules and we'll have a group of operators that are working another set. So it gets back up to our first bullet and I believe someone said earlier, what's the cost benefit here?

So we know what the cost is, right? We're going to treat people differently. When you talk about two and two, you're probably talking 50 percent of our control room staff will be on this schedule, 50 percent on this one. When we're talking one and one, 25 percent on this, 75, so it minimizes it, but you're going to be treating them differently. So that's the cost. You're going to have teamwork issues. You're going to have communication issues.

We're unclear of what the benefit we get out of that cost. In fact, we suspect there is no

benefit in that. There's a lot of cost and schedule difference complexity, communication, teamwork, no benefit. The 60 days, the management of fatigue, all the other items in that Rule insure that the safety and the management of fatigue is maintained. So that's our issue with outage minimum days off. Comments or questions for -- yes, sir.

MEMBER ARMIJO: Do you object to the -- this Reg Guide going out in the current form? Does NEI object to the issuing of this Reg Guide in its current form?

MR. SMITH: NEI is in disagreement with the two exceptions that the Reg Guide takes.

MEMBER ARMIJO: Thank you.

VICE-CHAIR ABDEL-KHALIK: I guess I have a question and, perhaps, it's best addressed by the staff. The logic behind having different minimum days off requirements for licensed operators assigned to an operating unit versus licensed operators assigned to a unit in an outage, is what? Do you think that there is a higher sort of level of cognizance that would be required for the operators assigned to the operating unit?

MS. BARNES: Yes. We think that the likelihood that operators will develop -- the

possibility they're going to develop cumulative fatigue, right, with the consequent impact, negative impact on communications, decision-making, ability to monitor and pay attention, all the other kinds of consequences of fatigue will be reduced for operators working on the outage unit. So our intention -- you know, in terms of teamwork, they can be adversely impacted by not having adequate rest or they can be adversely impacted by splitting up the crews.

VICE-CHAIR ABDEL-KHALIK: Let me just follow the logic there.

MS. BARNES: Yeah.

VICE-CHAIR ABDEL-KHALIK: Don't you think that there is a time during the outage especially near the end of the outage when operators are doing reactivity manipulations, where a higher level of cognizance may be required by the operators who are handling the unit in outage than maybe required even by operators on the operating unit?

MS. BARNES: And we would hope that the operators they would assign to handle those kinds of activities would have greater --

VICE-CHAIR ABDEL-KHALIK: But that's not covered in what you're recommending in this Guide, right?

MS. BARNES: Uh-huh. We wouldn't be required to put that --

VICE-CHAIR ABDEL-KHALIK: So your logic really doesn't fit together. Could you, perhaps, elaborate?

MS. BARNES: On what the logic is?

VICE-CHAIR ABDEL-KHALIK: No, on whether or not the logic actually falls apart because there is a situation where higher level of operator awareness may be required to do reactivity manipulations on a unit that has been in an outage than may be required for a unit that's operational.

MR. BROWN: If I could help, this is Fred Brown, Office of NRR. The Rule draws a distinction between normal outage hours, normal MDO and outage MDO. And the Rule applies additional flexibility to the industry during the outage period, which came about through the rulemaking process. Within the Guide, we're not in a position to change the structure of the Rule which has the interesting, you know, characteristics that you just described. So what we're doing within the Guidance is trying to maintain as much of the operating crew not subject to the chronic fatigue issues as possible within the construct of the Rule.

And that's why we believe two RO's and two SRO's which we think is appropriate for responding to transient conditions, responding to accidents leading the emergency response is appropriate. But the basic issue that you're pointing to is in the construct of the Rule and not the Guide.

VICE-CHAIR ABDEL-KHALIK: But still, I mean, if people strictly adhere to what you're proposing that would be really counter to the logic, the underlying logic, of what you're trying to propose.

MEMBER MAYNARD: I think we're using the wrong rationale here. First of all, the way I look at the Rule it was intended for outage periods you have relaxation. It wasn't because outage activities are not as significant. It's to put a limit on it and for this duration, you kind of change the Rule, but then you go back. It's not an issue of -- that those activities aren't as important or as -- and in fact, from an operator's standpoint, I'll tell you that I would rather be at 100 percent power normal operations than I would during an outage and also there are four things that could probably happen in an outage that would cause you problems.

I think it's more the 60-day period puts a

limit on how long you can do it, but I think it's the wrong rationale to say that from a safety standpoint you need to be more rested on the operating plant than you do on the other. I think that's --

VICE-CHAIR ABDEL-KHALIK: That's what I'm trying to get at. Find out what the underlying logic is.

MEMBER SIEBER: IN an outage, the opportunities to mess something up and injure workers and plant people is pretty high because you're moving a lot of equipment, building scaffolding, staging equipment and a lot of communication has to go on; whereas, in normal operations, this kind of activity, that involves hands-on workers, is far less.

MEMBER MAYNARD: And also, if the relaxed hours and the operating schedule is a symptom of fatigue of the operators and stuff, I mean, current practice, there's been a long history that I think can be drawn from the stuff that I think the 60-day limit is fine. So you go back to where you have maybe more minimum days off and stuff like that, but you -- I just think we're using the wrong logic for trying to separate out whether you're on the operating plant or on the outage plant there.

MS. BARNES: I might -- certainly the

recommendation or the questioning here is associated with splitting crews or is it an argument that permitting operators to have relaxed outage hours when there's a higher risk or an equally high risk during outages the concern, or --

MEMBER MAYNARD: My concern is on having separate rules when you say that it's because one has a higher safety significance than the other, because I don't think that's true. I think the 60-day period for the outage duration, I think provides more than adequate constraint for fatigue and stuff there. So mine is more -- I don't think there's justification for having separate rules for the operating versus the non-operating plant. I think the key is, as long as you have some type of 60-day limit or some time frame there overall to where you can't just do this year-round declaring that you're in an --

MS. BARNES: Right, and that's in the Rule.

MEMBER RAY: Right, and that's still within the 60 days.

MEMBER MAYNARD: Right, because fewer than outside of the outage.

MS. BARNES: I just wanted to point out that this parsing of work groups is consistent

throughout the whole Rule. We've got maintenance people on who are covered workers and some who aren't. We've got, you know, maintenance people, so that the parsing and splitting up having -- you know, we're not going to have maintenance people on the same schedules during an outage as our operators are because maintenance people are allowed to work much more than the operators are. So the --

MEMBER MAYNARD: Well, we're certainly not going to change the Rule here. Personally, I think it has to be revisited but that's a different --

MEMBER STETKAR: And I think we need to -- we're running over here. I think the discussion is really good but a lot of it does, in fact, gravitate back to elements of the Rule itself, which --

MEMBER SIEBER: Well, maybe we should address that.

MEMBER STETKAR: And perhaps we -- I mean, that's for our deliberation later, but as far as what goes into our letter, but with respect to the discussion for the Reg Guide itself, is there anything else that anybody needs?

MEMBER POWERS: Let me ask just a question on philosophy, not specifically on any of the provisions. And I'm directing it generally here. A

lot of the prescriptions and whatnot I saw the quantitative numbers, were justified based on judgment, experience, some on -- apparently on academic studies. But Mr. Taggart came in and said, "Well, there's another dimension here and there's another experience base here. And so I'm asking, how does that get factored in? Do you have to become a sociologist and publish a paper on this? I mean, what you said makes sense to me. How do we factor in your experiences into developing these numbers and judgments and things like that?

MR. TAGGART: Sir, if that's directed to me, I would say the only way you could figure out how this impacts you is do it. And I've done over 15 outages and as a personal, this is just from me, not from PROS, I'd rather work straight through. I'd rather work all days because I don't get interrupted on the activities that have been given to me, meaning I take a day off. I come back in, the plant's completely different and I had no clue, I got to catch back up.

I'd rather not go home and sit around in the middle of the night because I typically work midnights, and lose a day of where I'm at when I come back to the outage. And I've seen it where my job,

I've got months of preparation, the day I have to take off, that job comes up. Now somebody else is going to do that activity without the preparations I had and I can't help them.

It makes you feel helpless. And that's worse fatigue for me because I'm sitting at the house wondering how that thing went. I've got to come in the next day and find out. And it's frustrating. So our limitations during the outage actually frustrate me more than anything.

MEMBER SIEBER: Point's well-taken.

MEMBER STETKAR: Dana, that's good. We've got -- Dave needs to make a point and that comment, again, it comes back to the Rule because those numbers are all in the Rule.

MEMBER ARMIJO: Given the Rule, though, the Regulatory Guide should provide as much flexibility to the operators as possible because I think there's at least some of us think there's some unfortunate things in the Rule that didn't -- that we've got to live with until the Rule gets changed if it can be changed.

MEMBER STETKAR: Dave.

MR. DESAULNIERS: To answer the question about how some of these considerations are factored

in, we believe that we have factored them in through the process that we that we've gone through in developing this Rule. As noted in the introductory remarks, we conducted 16 public meetings and throughout that process, Professional Reactor Operators Society was an active participant and we've solicited their input throughout this process.

So many of the comments that we considered in developing the Rule came from our reactor operators in this country as well as considerations in the literature. But we believe that we did, you know, a fairly effective job of soliciting and gaining that input in the development.

MEMBER ARMIJO: That's kind of what I wanted to hear.

MEMBER RAY: Yeah, I can just endorse that. As somebody who participated in another role, this thing has received an enormous amount of debate and input by everybody.

MEMBER STETKAR: Thank you all. I think we've had probably more discussion than we anticipated. Thanks a lot for everyone, the staff, NEI, PROS for the presentations. With that and only 16 minutes late --

MR. NEWKIRK: Tom Newkirk, IBEW. Thank

you for the meeting. The Reg Guide, we had 42 comments and most of them were looked at and answered. We appreciate the public -- the robust public opportunity up to this point as we move forward. Since we do reside with two-thirds of the nation's reactors, we have a pretty heavy interest in this Rule and I'm going to be narrow into what we're here to talk about.

To PROS, we've definitely tried to get the two-week outage definition to define it two weeks before, two weeks after. That's been through public participation and we didn't get it. So just to let you know, we did formally try to get that definition. We do support periodic overtimes that NEI is putting in 06.11. It is -- after careful review, that's where we're going to land on that issue and also for the multi-unit staffing, very controversial and we're still dealing with that in the field, what's a proper answer to that.

And NBOs are pretty important subjects, whether in operations or outages and hopefully we come to a resolution that everybody can live with on the multi-unit sites. But definitely the periodic overtime is something that will happen and I do believe the Rule will capture the NBO violations if we

do have planned schedules that don't go as planned and 06.11 will take care of it as it's written. So, I'll be quiet. I'd like to talk more but I know you're busy.

MEMBER STETKAR: No, no, no, and I apologize for not -- I'm glad you had the opportunity.

MR. SMITH: John, we did not get to give the NEI perspective on periodic overtime but I'll make any time available that the gentlemen want any time today. You can call me back if you have a break and I can certainly give you that perspective. Thank you.

MEMBER STETKAR: Thank you. And with that, only 18 minutes late.

CHAIR BONACA: We'll take a break until 25 of 11:00.

(Whereupon, a short recess was taken.)

CHAIR BONACA: Let's get back into session, and the next item on the agenda is the International Human Reliability Analysis Empirical Pilot Study.

And Dr. Apostolakis will take us through it.

MEMBER APOSTOLAKIS: Thank you, Mr. Chairman.

This is a briefing today. We are not

considering a letter. As most of you know, maybe the newer members do not, the issue of human reliability analysis has been of great interest to this Committee. It's one of the last areas in risk assessment where there are significant differences in the various models that various groups are proposing or have proposed.

We sent the letter to the Commission a few years ago, recommending that the staff start thinking about the possibility of identifying a property of models for HRA, human reliability analysis, for classes of problems. They came back and said if there is one model for everything, that would also be great, but it gives this flexibility.

As part of that, the staff, the Commission issued an SRM, in fact, directing the staff to do this and they explicitly, as I recall, said that their staff would be working with us. Or we should be working with them.

The staff proposed, as part of this effort, to run an exercise, a human reliability exercise up at Halden simulator in Norway. They briefed us before they started the exercises and now today they're going to tell us -- they'll talk about some of the preliminary conclusions they have drawn

from this.

I want to remind the Committee that in our letter of April 2007, we stated that -- the staff calls this the empirical study. We said that this empirical study is part of the -- we view this empirical study as part of the broader effort to collect everything regarding the validity of HRA models and then we noted that the study may provide useful, qualitative information in crew performance and the factors that influence it. However, the Committee says the empirical study by itself would probably not be sufficient to develop meaningful quantitative estimates of the probability of errors. And I believe today, we'll hear about qualitative.

The conclusions are those you guys made. Correct me later, if I need correction.

Before we start --

MEMBER BLEY: Yes, Mr. Chairman, I need to say that I was involved in this study with the NRC team during the Athena work, so I won't participate in the discussion.

MEMBER APOSTOLAKIS: Okay, thank you, Dennis.

So Chris, you will start?

MS. LUI: Chris Lui, Research. Today, as

George has indicated, that we are in front of you to discuss with you the -- I mean the status and the summary and conclusions, insights that we have gained from these international benchmark exercise.

About a couple of months ago, we had a review about all the other activities that we are doing in support of the SRM regarding the Commission has directed the ACRS to work with the staff. So this is one component of the larger program. And as George has indicated, in October 2007, we did come in front of the Subcommittee to give you a description of the project and we're also very fortunate today that we have our international partners here and they will be part of the presentation you will hear today. So it really gives you an opportunity to get a lot of technical insights from the people who are directly participants of this study.

MEMBER APOSTOLAKIS: Thank you, Chris. Are any of the international here -- you three people?

MR. PARRY: In the past.

(Laughter.)

MEMBER APOSTOLAKIS: So who is next?

MS. LOIS: I'll start out and Jeff Julius will help me in the introductory part of it and then as we close the Halden people will --

MEMBER APOSTOLAKIS: And Jeff is with?

MS. LOIS: Jeff?

MR. JULIUS: Jeff Julius, Electric Power Research Institute, representing industry.

MS. LOIS: Okay, the objective is to give a status report on the empirical study.

Quickly, why we did the study is to give us an opportunity to assess the HRA methods and practices in light of simulator data. And we'll try to correct the HRA methods and identify strengths and weaknesses and develop a technical basis for improving the methods and their application. I emphasize the application because it seems what is common is practices are equally important as well as the strengths of the models and the methods.

And as mentioned, this study is also -- will be used to address the Commission direction on HRA models. The reasons is because, as Dr. Apostolakis mentioned, we have differences in the underlying frameworks and data and as well as the quantification algorithms that are used in HRA and there is evidence that different methods may yield different results and insights.

And I note here in actuality, the models are based on formal and informal theories about how

failures can occur, but they have not been tested with empirical data.

In the regular applications we use measures such as sensitivity analysis and risk-informed insights to enhance the robustness of the HRA results.

MEMBER POWERS: Doctor, let me ask you a question. Are all the methods that are going to be applied in this empirical study of U.S. origin or are they various countries?

MS. LOIS: Actually, many countries are participating. But the NRC's testing methods that are used in the regulatory applications and NRC and contractors that are helping us to test those methods and the methods that are being tested is ATHEANA, the SPAR-H and ASEP and THERP which are the major methods that are used by the staff to address issues related to regular decision making. At the same time, the industry is using testing, the major methods that are there, they are using for regulatory applications.

MEMBER POWERS: So your focus is on the comparison among methods that are actually used in the NRC regulatory process?

MS. LOIS: Mainly, yes.

MEMBER APOSTOLAKIS: But there would be

comparison with others?

MS. LOIS: Yes.

MEMBER APOSTOLAKIS: You're going to talk about that teams are participating?

CHAIR BONACA: One thing that is important, if I remember, there was a plan to have U.S. crews, if I remember, Philadelphia Electric, going to the stimulator and running their own procedures. I understand this is what happened.

MS. LOIS: But we're going to provide a status on that. We're in the process of identifying a plan or some plans that would allow us to go in, in a way to replicate the study in some kind of format. I don't know, the same study may not be -- the same scenarios may not be the best way, but similar scenarios. We hope that will happen. We had the previous efforts, but did not become true, but on the other hand, at Halden other teams are willing to do that as soon as we have a potential plan that would be --

CHAIR BONACA: My suggestion would be during your presentation you may want to comment on the validity of comparisons and how different they may be if you had the U.S. crews run it.

MEMBER APOSTOLAKIS: Just to make it

clear, we're talking about two things here. One is the crews that are actually, I'm assuming, actually doing it. And there are no Americans there.

MR. PARRY: Right.

MEMBER APOSTOLAKIS: And then we have groups that are using models to analyze and evaluate whatever those data and that's where you have U.S. teams and the NRC from the industry using their appropriate models to analyze the data.

MS. LOIS: And the idea is to test the methods rather than simulate crew performance in Europe and here.

MEMBER APOSTOLAKIS: But that's inevitable though. Eventually, you get together and you say well here is what we found with ATHEANA and maybe somebody else will say we use something else, then somehow you have to understand why there are differences of similarities, right?

MS. LOIS: Exactly.

MEMBER APOSTOLAKIS: Yes.

MS. LUI: George, may I offer something else. Chris Lui.

I think we actually have a couple of different aspects that we have talked about. And these are particular programs. Just for clarification

purposes, we do have models and teams that will use the model to develop not U.S.-based model. For example, MERMAS, it's an EDF. It is a French model. The other thing is --

MEMBER APOSTOLAKIS: Wait, okay, who is using MERMAS?

MS. LUI: The French.

MEMBER APOSTOLAKIS: Only the French.

MS. LUI: But we do have international aspect here. And the other things that we have is a separate project that's called the HRA model differences. That's -- the internal depth of the project is really to figure out -- I mean the appropriateness of the implementation of the various models that we can use in the regulatory domain. So that we have just started and that's ongoing.

And the third piece, just most recently that we have received an SRM based on the risk-informed, performance-based regulatory briefing to the Commission back in the February time frame. In that particular SRM, there is a particular tasking, who is that, to look at whether we'll be able to use a U.S. crew to be on the simulator so they'll be able to collect that information.

So these are particular exercises. You

will hear later on that we try to implicitly model the two differences into the model, but we are on a separate path to look at whether there will be opportunities for us to actually collect U.S. data.

MEMBER APOSTOLAKIS: This issue of using a U.S. crew, do they really have to go to Halden, is that the only place where we can --

MS. LOIS: No, Halden is really -- Halden has the expertise to collect the data and analyze the data.

MEMBER APOSTOLAKIS: Right.

MS. LOIS: So then Halden is willing to collect the data locally.

MEMBER APOSTOLAKIS: Let's say you convince an American utility to offer a crew.

MS. LOIS: Yes. Halden experts will come and collect the data.

MEMBER APOSTOLAKIS: Where, here?

MS. LOIS: States.

MEMBER APOSTOLAKIS: I thought it was unique simulator they had in Halden?

MS. LOIS: The expertise on how to collect data --

MEMBER APOSTOLAKIS: It is.

MS. LOIS: We could also collect the data,

but we would have to develop it.

MEMBER APOSTOLAKIS: I understand.

MS. LOIS: It's a whole discipline on its own.

MEMBER APOSTOLAKIS: The ultimate goal is to finally say here is what you should do in this situation, right?

MS. LUI: I just want to let you know that we are investigating, because are a couple different components in that, crew availability, facility expertise in collecting information. So we actually are formulating a couple of different options. We'll be happy to come and discuss with you once we have done more -- I mean once we have worked that out.

MEMBER APOSTOLAKIS: I'm waiting for that happy day when you comes come here and say here is the model for this case and the ACRS writes a letter that says you can only triumph.

(Laughter.)

MS. LOIS: For this slide, I'm just reminding the ACRS that addressing the HRA issues and improving the HRA methods and practices has been a very lengthy focus of the NRC.

With that, I would like to allow Jeff Julius to talk a little bit about --

MEMBER APOSTOLAKIS: One other question. I understand that all these elements of the components, as Chris called them, ultimately lead to the conclusion which would be what the SRM asks. But if the Commission asks us why is it taking so long, what would we say? Why can't we do this in two years?

MS. LOIS: What is the length?

MEMBER APOSTOLAKIS: The SRM said tell us which models are applicable to what classes of products. That's where we're going. We have a meeting with the Commission coming up in June. What if a Commissioner asks me, this is what we said. We said it two or three years ago and you guys seem to need another five, ten years. Why does it take so long?

MS. LOIS: If you recall, last October that we briefed you on what we planned to do for addressing the SRM on HRM model differences, our plan is to come here in June and tell you which way -- how we are going to converge. Are we going to have one approved method or a toolbox of methods, etcetera. On the basis of that, we believe that by the end of 2010 we're going to have (a) answer --

MEMBER APOSTOLAKIS: So it will be December of 2010 to supplement what Dr. Powers --

MS. LOIS: And given the breadth of this study and the --

MEMBER APOSTOLAKIS: When did we get the SRM, 2007?

MS. LOIS: October of 2007.

MR. JULIUS: Late.

MEMBER APOSTOLAKIS: So it was two to three years.

MS. LOIS: I think that's very expeditious, given the amount of time it takes.

MEMBER APOSTOLAKIS: Thank you.

MS. LOIS: Jeff.

MR. JULIUS: Yes, the industry efforts to improve these human reliability analysis methods and techniques, EPRI started researching human reliability back in the mid-'80s in the ITE days, but most recently in the year 2000, the Human Reliability Analysis Users Group was founded and its charter is to promote consistency between users and to promote a convergence among the methods. So we started on this a while ago and through our efforts in the group, we're working on a software tool that embodies now EPRI and some of the NRC methods.

Our users within the industry are slowly converting their models. Some of them had, for

example, SLIM mod models, and they're going to some of the more common EPRI approaches.

In addition to the software and the work within the U.S. utilities, we're working with the NRC and are involved with activities to provide comments on the HRA guidance documents. We're working with all the benchmarking project, both on the assessment team and helping design the experiment, as well as the analysis showing here's what the U.S. industries do.

Our major effort this last year has been on this joint EPRI-NRC project to develop human reliability analysis methods for fire to support the NFPA 805 transition. I think this looks like it's going to be a good blueprint for activities that we did for future HRA projects and this briefing on this project will be coming to the ACRS in a future session.

We are currently working with the NRC on the collaborative work on the SRM project to pick a single model or a toolbox of models.

MS. LOIS: Here I am just noting the directions we have given the recommendations by the SRS, the Commission direction on HRM, were no differences and based on the one Chris just mentioned. And this came in February 18th.

MEMBER APOSTOLAKIS: This is February 2009?

MS. LOIS: Yes.

MEMBER APOSTOLAKIS: It doesn't seem like it.

MS. LOIS: This is a result of research briefing with the Commission.

MEMBER APOSTOLAKIS: Oh, the Office of Research.

MS. LOIS: Office of Research briefing the Commission on that, the risk-based.

MS. LUI: It's actually an Agency-wide briefing, so we have Research, NRR, NRO, FSME, and NSSS. It's an Agency-wide briefing on the risk-informed, performance-based regulatory approach.

MS. LOIS: Okay?

MEMBER APOSTOLAKIS: Yes.

MS. LOIS: This schematic describes on a very high level how the study has been executed. We start out with defining this analysis, actually the experiment and design and the methodology that we developed on how to go about it. And then we prepared a tremendous amount of information that was sent to the various HRA analysts that would like to test their method. And we have tremendous interaction with the

peers through significant amount of time to make sure that they understand the basis of the scenarios as well as the information about the crews and their ways of performing, addressing human action at the simulator.

MEMBER APOSTOLAKIS: Let me understand this. On the left, as you look at it, you have HRA analyses and summary of predictions. On the right, you have the simulator.

Now as I recall in those experiments, what you do is you record the time that certain things happen.

MS. LOIS: Not always.

MR. PARRY: Among other things.

MR. JULIUS: That's initial data collection.

MEMBER APOSTOLAKIS: Give me one more thing that you record?

MR. PARRY: Observed behavior.

MR. JULIUS: And you get feedback from the crews, so they come in -- you'll hear that in the next presentation.

MEMBER APOSTOLAKIS: What does summary of predictions mean?

MS. LOIS: Okay, so when the analysts send

us and we have what we call the assessment group and it's a group of five or six people, Jeff Julius, Gareth Parry, Vinh Dang, Andreas Bye, and myself. Did I miss any body? John Forester.

So we receive the analysis, for example, the THERP analysis. They send it to us and we try to understand what they do, how they executed the analysis and in a way we summarize it and then we send it back to the teams and say is this what you are saying? Because we would like -- we have to put everybody analysis at the same plane, make sure that we understand --

MEMBER APOSTOLAKIS: My problem is that I think there is a disconnect between the predictions and the data collection. Data collection means you are dealing with things that you can observe. Okay? It's about the time of doing something.

MR. PARRY: Yes, I think it will become clearer though when you see John Forrester's presentation.

MEMBER APOSTOLAKIS: Okay. How many presentations do we have?

MR. PARRY: Five.

MEMBER APOSTOLAKIS: Five?

MR. PARRY: Yes.

MR. JULIUS: But both the predictions and the empirical data are a mixture of qualitative and quantitative and that's been one of the difficulties in setting up the study.

MEMBER APOSTOLAKIS: That's the problem.

MS. LOIS: And in a way, what we do here, it's a blind study, so we try to see what people did from an HRA perspective and then collect the data from a crew perspective and then there's tremendous interaction here in the comparison.

MEMBER APOSTOLAKIS: What do you mean by blind study?

MS. LOIS: I mean we don't know what -- how the crews behaved when we do the --

MEMBER APOSTOLAKIS: Oh, but you do know what predictions?

MS. LOIS: Yes, at the end, when we do the comparison. At the comparison level, so there's a lot of work going on before the comparison. Okay?

So I believe as I just discussed, we started out with the data -- I'm sorry -- so the experiments were done in November-December of 2006, created two steam generator tube ruptures and one is difficult and one easy and two for loss of feed. And then we defined the human -- what is it -- HFE, human

events, human failure events for each one and we defined for the STGR about seven scenarios and for loss of feedwater, four scenarios.

We completed phase one. What I'd like to note here is that we had -- it's been published in a Halden report and it's going to be published in a NUREG/International report soon. But the pilot also was - it sounded really good - by Barry Kirwan, who is internationally known for validating studies, HRA validation studies.

Phase two we just completed and we just beginning of this week we had another meeting, all HRA teams and organizations participated. The meeting was very, very successful. It was really very fascinating to see how much people are willing to improve their methods and practices. We even discussed the idea of a hybrid method among not only nationally, I mean domestically, even at the international level, and noting here that we had external reviews. This time we had John.

MEMBER APOSTOLAKIS: So are your international partners agreeable to the idea of a toolbox, even if it is not their own model?

MS. LOIS: They did not reject the idea.

(Laughter.)

It's really fascinating to see.

MEMBER APOSTOLAKIS: Would you be willing to take say the EDF model if you find that your models are no good or do you draw the line some place?

(Laughter.)

MS. LOIS: I'm sorry. I believe that although we learn a lot about the MERMAS model, I believe that it really needs -- it may need --

MEMBER APOSTOLAKIS: No, no, no. I'm not asking you to comment on MERMAS.

MS. LOIS: Yes.

MEMBER APOSTOLAKIS: I'm just asking when you guys get together, is everyone, including non-U.S. participants agreeing that there is a need for a toolbox, because the Commission is the U.S. Nuclear Regulatory Commission. We can't tell them what to do, but do they agree this is a noble cause?

Next step, there is a number of models out there. We have a few here in America. Do you think that people as a result of this will most likely try to improve their own model, rather than, for example, everybody saying gee, ATHEANA is such a great model, we will all use it? Most likely the first, right?

MS. LOIS: They are open to the idea.

MEMBER APOSTOLAKIS: I don't know about

that.

MR. JULIUS: Most likely the first because it's easiest to do.

MEMBER APOSTOLAKIS: That is a major factor, yes, you're right.

Okay.

MS. LOIS: So we are briefing you today and we hope that we have documented what we call Phase Two which is the HHDR scenarios. In September, but I'd like to note that the results of this study are going to be preliminary because we have to look at the loss of feedwater scenarios in order to have more conclusive results.

The meetings that we have, the two meetings now help tremendously the analysts to do a better documentation and better HRA analysis, so we'll find out how that goes.

MEMBER APOSTOLAKIS: The next meeting is in June you said?

MS. LOIS: In June, we have committed ourselves to come to the subcommittee to say what -- how -- kind of indicate how we're going to address the SRM.

MEMBER APOSTOLAKIS: Okay.

MS. LOIS: With that, I will introduce

Andreas Bye and Salvatore.

MEMBER APOSTOLAKIS: Andreas has been here before. It's good to see you again, Andreas.

I believe the other one too, I've seen you before.

MR. MASSAIU: Yes.

MEMBER BLEY: We apologize for the name tags.

(Laughter.)

MR. BYE: My name is Andreas Bye. I'm from the Halden project. I'm head of industrial psychology department there.

MR. MASSAIU: My name is Salvatore Massaiu. I'm also working in the same division.

MR. BYE: So we are going to brief you a little bit on the data, what we did in Halden. As Erasmia said, we had a simulated SGTR and the loss of feed scenarios. This is in the PWR, Westinghouse-type simulator. with Westinghouse procedures based on Westinghouse standard packages. So it's quite similar to U.S. things.

MEMBER APOSTOLAKIS: So the crews were from where?

MR. BYE: The crews were from Sweden, yes. If I could just reply a little bit to that point,

this generalizability thing that we have, as I said, we have Westinghouse procedures, but we are also now as Erasmia said going to look into this. We are coming here and to repeat some of this study to look at the differences. And we also have another project where we want to classify the characteristics of the operational, detailed operational cultures of the Swedish crews and the U.S. crews, so that we can know what we can generalize from Halden studies to U.S. and to all the other countries and what not. So that's a project going on as well.

Okay, summary of the data. We have developed a new data analysis approach that optimizes the comparison of the HRA methods predictions to empirical and empirical observations. And I think that this really improves the usefulness of some of that data for HRA purposes. And the findings from the experiment, from the data was that there is a lot of crew-to-crew variability. It's not only plant to plant. It's a lot of crew-to-crew variability. And it's a lot of significance of teamwork factors, and also important event dynamics in determining crew performance.

I would also like to say that focusing on empirical data and operation details, operation of

data really has facilitated very constructive discussions between the HRA teams because the meetings are discussing why this method did this and that and why not and based on very detailed operational descriptions instead of just fighting about overall concepts. So it has been very, very constructive discussions between the teams, I understand.

MEMBER APOSTOLAKIS: Is it fair to say that the commonly-used models do not include crew-to-crew variability?

MR. PARRY: That is fair to say for certainly the first generation models, they certainly don't.

MEMBER APOSTOLAKIS: So that would be already a constructive conclusion?

MR. PARRY: That's one of our conclusions.

MEMBER APOSTOLAKIS: Yes. Very good.

MEMBER POWERS: Well, I mean the significance depends -- I mean they can have a great deal of variability in a number -- it doesn't span the importance of the number. Suppose something varies by a factor of 10^3 and the number is 10^9?

MEMBER APOSTOLAKIS: Yes.

MEMBER POWERS: I mean what difference does it make?

MEMBER APOSTOLAKIS: In this case it does, I think.

MEMBER POWERS: They didn't say that.

MEMBER APOSTOLAKIS: No, they did say that.

They didn't say the extent to which, but I think it's really significant.

MR. PARRY: We can come back to the numbers and the methods later.

I'll amend my remark that one of the first generation methods does indeed have crew-to-crew variability and that's the time-reliability curve because that, in fact, is a reflection of crew-to-crew variability and time to some extent.

MR. BYE: Okay, the data analysis process has been ongoing from individual observations to HRA reference data, that we have the observations raw data, audio-video, a lot of simulator logs, also a lot of interviews and self-ratings and questionnaires. But in this project, we have used mostly audio-video and simulator logs because we are interested in detailed operations around the important phase, around failure events.

And then we come to the crew and HFE performances for each crew, such as failure, for

example, on the HRA, description of the operation, and also the observed performance-shaping factors. And from that we aggregate to overall HFE performances on aggregated operational descriptions and aggregated driving factors of the behavior.

So this is the last point that is compared, really in detail, qualitatively, with the predictions from the HRA methods.

Salvatore?

MR. MASSAIU: Yes. So we started from many crews and we had to aggregate to the HFEs because that was what HRA methods are predicting.

And we had many crews, 14, in this case, most of these cases. You will find 14 different ways of operating while a single failure probability and the single safety factors.

So the first thing to do was to try to find similarities between crews. And in this table you'll find we identified some patterns, and we see how many crews did things that way. For example, if you take the top level box, we saw that this HFE is about cooling down and those crews, the majority of crews use only the SG PORVs because this team data was not available due to the specific scenario.

Also, you have some crews that try to use

steam dump likewise. They forgot all that. And these can be described as another group.

This is important for two reasons. One, that you need to keep the details of operations because the process is dynamic, and so the crews are operating differently, depending on the entry conditions of previous actions. And the second point is that we had to identify the drivers of performance for the HFE. And if you can go to the next slide.

VICE CHAIR ABDEL-KHALIK: Just one question. Did the crews run the scenarios only once each?

MR. MASSAIU: Yes. We had two different scenarios.

VICE CHAIR ABDEL-KHALIK: No, I mean for each scenario, let's say steam generator tube rupture.

MR. MASSAIU: Yes, just one.

VICE CHAIR ABDEL-KHALIK: So they ran it just once, so all of these observations are based on one set of data collected for each crew running each scenario once.

MR. BYE: So all crews run all conditions, all sort of prepared conditions, so we have that at base case SGTR, and the complex SGTR and all crews around both of those.

VICE CHAIR ABDEL-KHALIK: Right, did the crews know ahead of time the nature of the transient?

MR. BYE: No, they didn't.

VICE CHAIR ABDEL-KHALIK: So they didn't know it's a steam generator tube rupture, for example, they did not. Even after they ran the base case and what is coming later is the complicated case, they know -- they didn't know what the complicated case was going to be?

MR. BYE: The sequences of the scenarios are balanced or randomized due to not telling learning effects, for example.

MR. MASSAIU: So in this case they would a SGTR scenario and then a loss of feedwater and then an another rational SGTR scenario and then another rational loss of feedwater.

MEMBER BLEY: And just a factual point, when you said randomized, as I understand it, they really do, so somebody might do the complex one first and then the simple one and then the other two, so there's no alignment, so when they look across crews, they can see if they pull out that learning effect.

MEMBER ARMIJO: Isn't that important if you run a complex steam generator tube rupture event, and then later run a simple event, you're going to, I

would guess, perform much better than if it was the other way around.

MR. MASSAIU: Yes, he didn't know about the experimental design, you would be concerned about that because of the learning effects or carryover effects, as they're called.

And this case is not that important. In fact, it was not always the case that we had learning effects.

VICE CHAIR ABDEL-KHALIK: Was there any communication between the crews?

MR. MASSAIU: No.

VICE CHAIR ABDEL-KHALIK: Scenarios.

MR. MASSAIU: No, because they stayed three days and every week we had two crews, so they met only one day, but they didn't meet actually, and we told them not to talk about this experiment to the rest of the crews.

VICE CHAIR ABDEL-KHALIK: Thank you.

MEMBER APOSTOLAKIS: John?

MEMBER STETKAR: Out of curiosity, I understand all of the effort that you went to to make sure that you had randomized, you ran losses of feedwater and tube ruptures. Did you also pepper the scenarios, intersperse any things like routine reactor

trip or loss of off-site power, things that are completely outside the scope of your nominal data collection-type scenarios? Or was it only restricted to that set?

MR. MASSAIU: We had experiments some years ago and I'm trying to remember.

MEMBER STETKAR: Although the difficult/easy, am I getting SFE feedwater or tube rupture event, were they more fully randomized with other things that were -- perhaps not necessarily relevant to the -- your particular data collection concerns.

MR. BYE: I don't think this one, actually.

MR. MASSAIU: Not in this one

MEMBER APOSTOLAKIS: What did you say? What was the answer?

MR. MASSAIU: Not this time. Because we had two crews every weeks.

MEMBER APOSTOLAKIS: Okay. Great.

MR. MASSAIU: And so the next step is that most of the matters analyzed the performance, PSF, performance-shaping factors, and our challenge was to start with 14 different performances to end up with a unified rating of the list of factors. So we chose a

generally agreed list of factors of -- a set of factors that we know they are driving performance of the crews. And many HR related are using these factors. And based on the operation of the case, we developed a methodology to rate these factors which is relevant for actuary uses. So our scale, in this case, N for nominal, and would be minus 1 is a negative driver, zero, not a driver. And we didn't use positive drivers in these tests which would be captured by the nominal concept.

MEMBER APOSTOLAKIS: Why is experience zero? Experience is not a driver?

MR. MASSAIU: Because the crews did a different level of experience. And the performance was not influenced by that. Experience changes, in the level of experience, did not result in changes of the quality of performance.

MEMBER BLEY: This is after the event, right?

MR. MASSAIU: After events, yes.

MEMBER APOSTOLAKIS: This is a conclusion, the rating is a conclusion?

MR. BYE: Yes, but the rating is adapted to the HRA rating. The nominal is really -- it's sort of a -- you go from a low number in actuary methods

and you want nominal, then you have low numbers. So if you don't have deviations in the experience, so then we cannot -- we didn't see anything.

MS. LOIS: So it isn't that for -- this is a general conclusion. This is just an example to describe how we rated the crews. When we say experience is zil, that means that for that particular human action it appeared that the experience or the training was not a major driver for that could result help in a human failure.

MEMBER APOSTOLAKIS: What is that event again, the tube leaks?

MR. MASSAIU: The cool down.

MEMBER APOSTOLAKIS: Does this make sense to people who have actually run plants?

MEMBER STETKAR: Yes. This was a scenario that was complex, so it started with a steam line break and then it had a tube rupture that was kind of hidden underneath it that already identified the tube rupture and racked up the steam generator, then they went to do the cool down to match pressures. They were in that part of the procedure and that's pretty straight forward kind of step.

MEMBER APOSTOLAKIS: And training is nominal. Does training and experience, don't they

overlap?

MR. MASSAIU: All crews did receive the same training.

MEMBER APOSTOLAKIS: I don't understand why one is N and the other is zero.

MR. MASSAIU: Because all crews are equal in training, but not in experience. So there are experienced teams and there are less experienced teams. Training relevant to the scenario was the same.

MEMBER APOSTOLAKIS: That is provided by you?

MR. MASSAIU: No.

MEMBER APOSTOLAKIS: And the team dynamics was negative?

MR. MASSAIU: Team dynamics was not only that, but it was also the main driver for the HFE.

MEMBER APOSTOLAKIS: The main driver, can you explain what that means?

MR. MASSAIU: It means that the larger, total effect on the HFE, meaning that it had a larger direct and indirect effect. It also means that the team dynamic issues had an influence on other of these factors. For example, one typical combination is that a lack of supervision creates more complexity, makes

the --

MEMBER APOSTOLAKIS: Let's look at this. It says three, crews waited too long for local actions. Why are you calling that a team dynamic?

The metric standard, why is that a team dynamic? What do you mean by team dynamics? Is it the communication, the coordination?

MR. MASSAIU: The communication, in this case, was a separate factor defined strictly as exchange of information, sending and receiving information. The issues of coordination will be under team dynamics and issues of supervision will be under team dynamics. So the most difficult issues defined in team dynamics are supervising, supervisor quality, leadership and control, and coordination.

MEMBER APOSTOLAKIS: So there is an implicit assumption there or maybe some analysis somewhere else that the crews waited too longer because of these things.

MR. MASSAIU: Yes.

MEMBER APOSTOLAKIS: That's the conclusion they drew?

MR. MASSAIU: Yes, because it's the duty of the shift supervisor for these crews to remind the crew to work expeditiously because they have to

isolate and work and to mind about the letter in the operator.

MEMBER APOSTOLAKIS: Is that something also that's not in the current models, team dynamics?

MR. PARRY: That was an explicit parameter.

MR. MASSAIU: The last thing we did was to take all the HFEs in the study and to rank them in terms of difficulty based on the number of failures that we said, the number of near-misses, and the problems that were identified. This is just an example. We are fitted for all HFEs and we have the ranking in the slides from most difficult to easiest. And in this case just examples from 5B1 which was the most difficult one which related to the lack of a relevant indication.

MEMBER APOSTOLAKIS: So the difficulty ranking is something that is a conclusion from this? It's not your job.

MR. MASSAIU: No.

MEMBER BLEY: Could I ask just another factual thing. As I understand, it also included a real thorough de-brief with the operators on the crew, even if they didn't fail, having them explain what things got them a little confused and which things

didn't, so it had a lot of information from the particular crews who did this, built into the result.

MEMBER ARMIJO: Could you explain what a near miss is on your chart?

MR. MASSAIU: Yes, in many cases, our HFEs almost -- all HFEs we study are different on time criteria, so that the time we need to do the relevant actions, otherwise it would be considered as failing.

MEMBER ARMIJO: Okay.

MR. MASSAIU: It's not only that they were slow, normally they were slow if they had some operational problem - operating valve not opening fully as it was in the procedure. So it's not only slow people are bad in this case.

MR. BYE: We will use this ranking -- will also be a starting point for Vinh is coming later to tell us more on the results.

VICE CHAIR ABDEL-KHALIK: Is this a procedure problem or is it an operator problem?

MR. MASSAIU: Which one?

VICE CHAIR ABDEL-KHALIK: When you have something that's a near miss or a failure.

MR. MASSAIU: It's a mix, it's not so easy to -- all the crews have the same procedures, so the difference in the point of view is the single crew.

VICE CHAIR ABDEL-KHALIK: But, you know, if you have a poorly-written procedure it would contribute to the failure of even the most experienced and most talented crew.

MR. PARRY: It depends on whether the procedures can cover every possible scenario and particularly with complex cases, so yes, there's an element of that.

MS. LOIS: But it hasn't been observed, so what we see here is some crews are accomplishing the action within the time needed, etcetera. And some even more expeditiously using the same procedures. And there are some other crews that really are struggling to understand and accomplish the action. That's why we say to the crew with the ability. Same training, same procedures, and yet you see a difference in the performance of the crews, especially for the difficult sections.

MEMBER STETKAR: Erasmia, just so I understand. You said some crews are not accomplishing the desired goals with the time available. To me that criterion depends, whether that's a good or bad thing, depends on what so-called the desired goal is and what the time is. If the desired goal is to stop injection within ten minutes, and somebody doesn't do that, but

the fact that keeping injection running for 15 or 20 minutes doesn't do anything except use up more water from the RWST. It's not clear to me that that's -- it's a failure in the sense that they didn't do what you wanted them to do within the time constraint that you set for that task, but it isn't necessarily a failure in the same sense of as not tripping the reactor within two minutes or something like that.

So did you try to differentiate -- when you call something a failure, did you try to put some sort of qualification on what that means?

MR. PARRY: I think the difference is that really the failure criteria that we put in was somewhat artificial, particularly if you think about it in a PRA context.

MEMBER STETKAR: That's the point that I was trying to get to.

MR. PARRY: They are artificial for that. But nevertheless, what we're learning from this though is the way people behave and what influences them. So it's not -- there's not a one-to-one correspondence.

MEMBER STETKAR: And I didn't mean to be negative. I think it is really, really useful information to learn the variability in the

performance as a function of time. It's just --

MEMBER MAYNARD: It has to be factored in as to the importance of that variability. It's one thing if a crew knows that something needs to be done within 20 minutes and they've been trained to and if they fail or succeed on that, that's one thing. But if the desired goals, they should be able to get it done within 20 minutes, but that's really not something that they're trained to -- there are going to be differences there. So some of those are important, some are not, depending on --

MEMBER STETKAR: That's right. On the other hand, from a research perspective, if we're not looking at the universe of possible scenarios, and you're trying to understand how people perform in the real world, and that there are -- there could be fairly substantial variabilities in their response times under conditions where you might not otherwise expect that variability, that's important, an important thing to learn, whether or not the variability for this particular scenario really makes a difference in terms of ultimate reactor safety.

MEMBER MAYNARD: It's somewhat complicated because sometimes the people who did it in 20, it might actually be better performance than somebody

that does it in ten. They maybe do it a better, more thorough job.

MEMBER STETKAR: And that should come through the crew debriefs at the end, you know, why did you --

MS. LOIS: Quickly, some of those limitations for the SGTR, human failure event definition, we tried to accommodate for the loss of feedwater where we looked at PRA objectives, how failure has been defined from a PRA perspective, etcetera. It is an issue in this study, the empirical study that we tried --

MEMBER APOSTOLAKIS: As someone was saying at the previous session, there are three more presentations.

(Laughter.)

Some people should behave.

MS. LOIS: Okay, shall we move on?

MEMBER APOSTOLAKIS: I'm learning from my colleagues. I'm learning.

MR. MASSAIU: We can quickly conclude?

MEMBER APOSTOLAKIS: Yes, please.

MR. MASSAIU: The analysis of the simulations was special. We did use different ways of looking at the data, different methods that we also

have developed. And because we had to compare the results of the simulations with the predictions, probably something that has not been done before. And we think we achieve very good results. And just to give you something about the substantive results is that we have seen a lot of strong interaction with the process dynamics and the group performance and we saw the importance of the team op factors in the performance of the crews. And also the fact of the procedure did not go over all situational variations and these are the causes of these variability.

MEMBER APOSTOLAKIS: So this is now I guess sending a message in the future, the model that we're using somehow has to accommodate these things. Is that correct?

MR. MASSAIU: Yes.

MEMBER APOSTOLAKIS: I'm focused on that ultimate problem. You know what you said?

MR. MASSAIU: I'm sure.

MEMBER APOSTOLAKIS: Thank you very much.

MEMBER ARMIJO: One last question, just for clarification. The procedures that you used in these experiments, are these the standard procedures that these operators used in their real jobs?

MR. BYE: Yes.

MEMBER ARMIJO: So there was maybe some deficiency from the standpoint of covering these variations in their procedures that maybe should go back and look at that?

MR. BYE: Yes, sure. There are some lessons learned there.

MEMBER APOSTOLAKIS: You said they were Westinghouse procedures?

MR. BYE: Yes, they were based on the Westinghouse package. They are based on the home plant procedures, but they're adapted to our simulators.

MEMBER APOSTOLAKIS: Good. Thank you very much.

MEMBER BLEY: George, something that might be of interest to the Committee, in other areas we've been wondering about the new kinds of control rooms, but the difference here, the operators came from a normal kind of control room into the Halden simulator which looks a lot more like the new advanced control rooms and it's got a big front-wall panel and it's got individual computer monitors with touchscreens, I think. I think they're touchscreens.

Some were touchscreen. In any case, it's -- they really did change those environments and from

what I heard it didn't affect them very much.

MEMBER APOSTOLAKIS: Who are you and why are you addressing this Committee?

(Laughter.)

MR. FORESTER: My name is John Forester. I'm from the Sandia National Laboratories and I'm one of the assessment team members on the empirical study.

MR. DANG: I'm Vinh Dang from Paul Scherrer Institut in Switzerland. And I'm also a member of the SSM group.

MEMBER APOSTOLAKIS: And an MIT graduate.

John, go ahead.

MR. FORESTER: Thank you. This presentation, actually, we'll respond to your question abut how we did the comparison, how we focused on the qualitative analysis.

So again, this is on how we performed the qualitative analysis which involved taking the HRA team predictions and doing a qualitative analysis on that and then comparing it with the crew data. So that's what I'll describe. So this is essentially a discussion of the methodology.

This is an overview, again, basically talking about how we performed the qualitative analysis, how we summarized each of the HRA teams'

qualitative predictions on each of the human failure events and then we compared that with the crew data and then we summarized those results of the comparison and our analysis, our qualitative analysis, what the HRA teams have done and looked at performance characteristics of the methods. So I'll describe that and the PG&L findings.

MEMBER APOSTOLAKIS: Would you be careful there with the microphone. We don't want our court reporter to faint.

MEMBER SHACK: Don't rub paper over it. It makes a lot of noise.

MR. FORESTER: Okay, as part of what the HRA teams did, they performed their analysis, they analyzed each of the human failure events, and we asked three main things from those HRA teams. We wanted them to identify what they thought would be the main driving factors, the main performance shaping factors, based on their method which was what would affect the crew performance on that HFE. We also asked them to give us a discussion of what they thought would happen operationally during that scenario and for a particular human failure event.

So would the crews be having trouble with the procedures? Would they be having trouble with the

indications? And again, it's an operational description of that. And then finally, of course, we asked them for the human error probability.

Now once we had this information, in order to be able to compare what the HRA teams predicted, in order to be able to compare what the crews had done, we wanted to translate their -- what they identify as the important drivers and what was driving their human error probabilities into the same set of performance-shaping factors that we used for the crews. So we wanted a common terminology in order to be able to make the comparison. And I'll jump ahead to one slide here and then I'll come back.

This is, as you can see, comparable to the slide that Salvatore showed where he had represented the crew data. This represents, this shows one of the tables that we created, again, based in this case on the EPRI cause-based decision tree analysis for a particular event.

MEMBER APOSTOLAKIS: He didn't have a minus 2.

MR. FORESTER: Well, minus 2 is a possibility and minus 1 is a possibility. So this is a -- in this case there was a -- these were stronger forcing contexts, or strong drivers, and I just wanted

to show that that was a strong factor.

MEMBER APOSTOLAKIS: So there is a scale within each one of these?

MR. FORESTER: No, you're right. I probably should have had a minus 1. At one time we had a stronger and we had to revise that. This is why we did these tables.

So you can see, we had the same set of performance-shaping factors and we look at what the HR18s did based on the driving factors that they identified, and we tried to fit them into this set -- these sets of factors and in this case you can see, this is one of the most difficult events that all the crews failed. You can see there were three main drivers that were identified, based in the context of this method.

MEMBER APOSTOLAKIS: So what is it that you are presenting and what is it that Mr. Massaiu presented?

MR. FORESTER: He presented this representation for the crews, for the aggregated crew information for a particular human failure net. I'm doing the same thing, although I'm doing it for the predictions for one of the human error -- for one of the HRA methods.

MEMBER APOSTOLAKIS: I'm sorry, I missed that. Thank you.

MR. FORESTER: So this is what we used to compare with the crew data. So we want to see how well the CBDT approach did in terms of identifying the driving factors compared to the crew data. We developed this table and then we look, we compare it to what we saw in the crew data.

MEMBER ARMIJO: So you created this table after you talked to the crews?

MR. FORESTER: No, this is the methods people.

MEMBER ARMIJO: Okay.

MR. FORESTER: They were trying to predict what the crews were going to do and they had no idea what the crews were going to do.

In addition, we did not know what the crews had done either. So when were doing these evaluations and translating the information from the HRA teams, we did not know what the crews had done either.

MEMBER APOSTOLAKIS: So these guys didn't do well when it came to team dynamics?

MEMBER ARMIJO: I read it they predicted that because it was so complicated they wouldn't do

well.

MEMBER APOSTOLAKIS: NA means not addressed.

MEMBER BLEY: But he read -- say John created this table.

MEMBER APOSTOLAKIS: Yes.

MEMBER BLEY: He read the analysis by the HRA team.

MEMBER APOSTOLAKIS: right.

MEMBER BLEY: And what's up here is what the analysis said.

MEMBER APOSTOLAKIS: And what I'm saying is that if I compare now with the data, there is a problem there because this analysis says that --

MR. PARRY: This methodology does not address --

MEMBER APOSTOLAKIS: This methodology does not address --

MR. PARRY: But you can't compare the previous graph because it's a different event.

MEMBER BLEY: It's a different event.

MS. LOIS: It's a different event, but what George is saying is correct. The methodology is not helping the analysts to identify team dynamics as part of --

MEMBER APOSTOLAKIS: Which we knew all along. Come on, this is not -- this is nice to see to compare.

VICE CHAIR ABDEL-KHALIK: So the people who generated this table knew exactly what the scenario was going to be. And based on their understanding of the scenario, they went ahead and generated this table without having the benefit of seeing any of the data.

MR. FORESTER: That's correct.

MEMBER APOSTOLAKIS: That was interesting.

MS. LOIS: Not only that, but it has been identified as a main driver.

MEMBER APOSTOLAKIS: So this should not be confused with the SLIM-similar evaluation where they have the PSS and they assign a weight.

MR. FORESTER: No.

MEMBER APOSTOLAKIS: This is not a weight, this is for this event, for this scenario, for the elements of this factor.

MR. FORESTER: In the HFE analysis.

MEMBER APOSTOLAKIS: Yes.

MR. FORESTER: And if they didn't cover the factor like team dynamics, then they're not going to be very good.

MR. PARRY: But I think, also, there's another thing with this method is that some of those things that are zeroes are probably questions that are not asked, because of the structure of the trees, because you're already going down a path that's going to give you a failure.

I think that's part of the -- it's part of what's built in the method. It doesn't mean to say that the factor is not dealt with by the method. It's just irrelevant for this calculation.

MEMBER APOSTOLAKIS: Okay.

MR. FORESTER: And I will say again, the assessment team had not seen the Halden result and once we made this evaluation and created these tables, and also we summarized their operational stories that they provided us, again, explaining what they thought would go into it. We sent it to those teams to those teams to see if they were in agreement with how we interpreted things. So if we had misinterpreted something, then they had the opportunity to respond.

And we also used all their HRA documentation. We looked in every way we could to see what they thought was going to be happening in this scenario. And once we had this information, we compared the predictions to the crew data. Again, we

compared the PSF ratings to see if they -- did they agree on the positive factors and the negative factors and what would be driving performance. We looked at their operational expressions to see if their story agreed with what we saw in the crew data. And then the last thing we did was, as you noticed Salvatore presented information where we had ranked the various human failure events in terms of difficulty.

So then we wanted to compare the HRA teams' human error probabilities, their rankings essentially, to those HFE difficulty rankings to see if at least the HEPs corresponded to the ways, the difficulty ranks of the way the crews performed. And Vinh is going to show you some data on that. So I just wanted to illustrate the methodology.

And the last thing we did was after we had done this analysis and made the comparison, one of our goals here is to be able to characterize a method, look at their strength and weaknesses and we are interested in the predictive power of the method. So we wanted to do an assessment of how well they identified the driving factors, how good were their operational expressions. And we do this at a general level at this point. Was there general agreement? Did they miss? We had basically described what they

predicted and what actually happened and show where they missed, and provided discussion on that.

And then we also looked at how well their HEPs tended to correspond with the difficulty. In some cases, they might not have come very close on the actual human error probability because we did have data on whether crews failed or succeeded in a couple of cases. But we would then look to see, but even if they weren't particularly right on the human error probability, did they have a trend in the sense that -- did they seem to rank the more difficult HEPs higher, the ones we identified as being more difficult where those HEPs tended to be higher, and where they tend to be lower for the easier ones. So we looked at that general correspondence.

Then we looked -- in doing this analysis and trying to understand what the method addressed and how well they got to the kinds of things -- of what was going on in the scenarios, we tried to see is it a guidance issue? Is one of the shortcomings of the method as related to the guidance they've provided? Would additional guidance be helpful to this method? So we looked at insights on the guidance that was provided and we'll go into more detail on that.

And we also looked at the traceability of

the method, was it easy to determine, you know, so you can understand what happened. Is there good traceability in your documentation? Again, we talked about general strengths and weaknesses and we also looked at the benefits of the method for identifying the problems that could be fixed if they were identified correctly, benefits for error reduction. So these are sort of our ways to characterize the methods after we were done.

And we're going to have a lot more on conclusions. Here are just a few of the general findings, not surprising. I think all the methods identified some of the important factors. In some cases, however, they would miss. They would not identify some of the important ones. They would, in terms of the human error probability, sometimes they would over or underestimate the difficulty of the human failure events. They'd make optimistic predictions in some cases and pessimistic, and you'll get a sense of what that was like.

In terms of the factors that was driving this variability in terms of their ability to predict was going on, I'll just mention three for now. But one thing had to do with the depth of the qualitative analysis that was done. So to really build or predict

what crews are going to do in an accident scenario you need to understand carefully how the cues for their actions were going to be evolving over time in the scenarios, how they're using the procedures. And it takes a pretty good in-depth understanding of that in order to be able to make reasonable predictions. I think that seems straight forward. So that is important. And one thing we've noted is that not all the methods provide the kind of qualitative guidance that's needed.

Another issue is the performance-shaping factors that are included in the method. Obviously, if you don't address some of the performance-shaping factors, then you may not do a very good job in terms of predicting performance.

And one of the last things we noticed was that making judgments about these performance-shaping factors is not always straight forward, that there's maybe some subtle distinctions in terms of picking the levels of a performance-shaping factor which would ultimately affect the human error probability. Additional guidance on that would be useful.

So I think that's enough at this point because we'll see -- then we'll show some of the quantitative data and Gareth is going to provide a

full set of conclusions.

MS. LOIS: We are not going to show any of the backup.

MR. FORESTER: Right.

MS. LOIS: Okay.

MR. DANG: So John has basically addressed how we evaluated the methods in terms of how well they identified the factors that affect the likelihood of failure.

My presentation deals with how are the numbers, how good are the numbers that are coming out.

For the qualitative comparisons, we make two types of comparisons. In many decision applications of the PRA results, the importance of the ranking of the HFEs, the ranking of the HFEs is what's important. So we make a comparison of the rankings of the HFEs according to these predictions and we compare that to the rankings based on the reference data. This is the ranking data Salvatore has discussed.

Secondly, of course, we also look at the HEPs themselves and how they did. There are significant limitations to these quantitative results, in particular, the very small number of observations we have, a maximum of 14 observations. The overall evaluation of the HRA methods then is based on both

the qualitative insights and these quantitative insights. With respect to these two, we feel that the qualitative performance of the methods should be weighted more heavily.

This slide shows you the range of the predictive mean HEP. So let me explain what you are seeing. For each HFE we plotted the 14 results. The box is including the 12 central values. So we exclude one at the top and one at the bottom. And we have ordered the HFEs here in terms of the difficulty. So in the aggregate what we're seeing here is that the methods predicted the two most difficult HFEs, those to the left, as being the most difficult. And then as you go to the right, the difficulties should go down and we also have less data on the right in terms of a number of observed failures and so on. So there's less distinction in the difficulty there. In fact, in terms of difficulty, 1A, 2A, and 2B are actually tied to a subjective error likelihood. And you see here that the predictions basically are saying these are about the same.

MEMBER APOSTOLAKIS: So, is there any progress in the exercise?

MR. DANG: I would say it's significant progress.

MEMBER APOSTOLAKIS: I still see a couple of orders of magnitude or even more.

MR. DANG: Three to four.

MEMBER APOSTOLAKIS: Okay, so 25 years, two orders of magnitude down, maybe in another 25 years. Is this still significant variability that we should worry about? Yes, it is.

MR. PARRY: It is.

MEMBER APOSTOLAKIS: So --

MR. PARRY: But we're also understanding the sources of that variability.

MEMBER SHACK: These are 14 teams using how many different methods?

MR. DANG: Twelve methods.

MEMBER BLEY: But a couple of the methods were used twice?

MR. DANG: Right.

MEMBER SHACK: So it's 14 teams using 12 different methods, is that right?

MR. DANG: Yes.

MEMBER SHACK: Now are the little circled things, red circles --

MR. DANG: Those are the major outliers, yes.

MEMBER SHACK: Okay.

MR. DANG: You see that some of the other ones that I've excluded, for example, above -- the sixth one from the left, the outliers are actually quite close to the box. The three are the most significant outliers and the qualitative information and the analyses that we do of the submissions allow us to determine why that outlier is out there, whether it's an assumption of the analysis, whether it's a feature of the method that's causing that.

MEMBER SHACK: Okay.

VICE CHAIR ABDEL-KHALIK: Would a dataset based on 14 data points be useful in assessing the results of various models for which the predictions vary over two orders of magnitude?

MEMBER CORRADINI: Thank you. That's what I was wondering.

MR. PARRY: We are not drawing major conclusions based on these quantitative numbers.

MEMBER ARMIJO: These are just facts.

MR. PARRY: Well, they're a sort of rough reference, but I think they are an indication that at least there is a downward trend here. I mean that's -- you should read too much into the numbers.

MEMBER APOSTOLAKIS: If I did the following in a PRA, I used one model and I get a

number. Then I would -- could I say I have significant model of certainty, so I will take a factor of 15 up and down to cover the possibility that my model is not the right one. Would that be consistent with this?

MR. PARRY: No, it wouldn't because I think what you find is that the different analysts made different assumptions.

MEMBER APOSTOLAKIS: Yes, but when I make my own assumptions, I'm not sure that mine are the best.

MR. PARRY: No, you don't, but at least if you are using a different model, you would probably make the same assumption when you would find different models.

MEMBER APOSTOLAKIS: There is some inconsistency here that the difference between the lower bound and the upper bound in the box is roughly two orders of magnitude, sometimes it's a little less, sometimes a little greater. Would I have a more realistic PRA if I took the results say for one model and I went up and down my factor of 10?

MR. DANG: As you know, in a sensitivity analysis, we do that.

MEMBER APOSTOLAKIS: I don't want to do

sensitivity analysis.

MR. DANG: The second thing is that the analysis --

MEMBER APOSTOLAKIS: It appears at this point --

MEMBER SHACK: Why don't you go to the next slide?

MEMBER APOSTOLAKIS: I don't want to go to the next slide. At this point, with this state, normally, this is what I would do.

MR. DANG: One moment, please. The second thing that is important to note is that these are the mean values of the predictions. They are obviously uncertainty distributions associated with each of these values. We haven't plotted it because it would make a mess.

MEMBER APOSTOLAKIS: But did anybody give you uncertainty that covered this whole thing? No.

MR. DANG: Not that large, but large uncertainties.

MEMBER APOSTOLAKIS: Let's go to the --

MEMBER POWERS: The way you've plotted it it appears to me that there's tendency toward bias, that is that one model consistently gave a lower bound and one gave consistently the upper bound or things

like one tended to be always be at extremes, either high or low.

MR. DANG: We see all of this, so I mean it's not possible to say that the lower value is always one method and another method is consistently pessimistic or something like that.

We are analyzing --

MEMBER POWERS: Which means the bias about the spread. For one model, they consistently -- is spread away from the average of the other models?

MR. PARRY: I don't think we looked at it, but I don't think that is.

MR. DANG: We are in the process still of analyzing the results for each method individually, and I have one slide actually coming up a bit later that shows you what that would look like.

MEMBER APOSTOLAKIS: Would that slide be more informative if you used different colors for the methods, because then we would be able to see what --

MEMBER POWERS: Not to me, it would not.

MEMBER APOSTOLAKIS: It would be to me because if say one model is red and I see red jumping up and down and all these events, that tells me something. If I see red always being near the top, that tells me something else.

MR. DANG: Yes, we have such plots. I mean we're analyzing such plots and we're trying to determine why they're bouncing up and down, if they are bouncing up and down. Another thing that we look at, of course, which is, of course, of interest is how much the methods discriminate among the HFEs.

MEMBER APOSTOLAKIS: Sure.

MR. DANG: When the HFEs we believe to be equally difficult, we don't want them to be differentiating between those, but we do want them to have high values for 5B1 and 1B. So we do that on an individual method basis and the discussions that we've had with the teams on Monday through Wednesday of this week were really to present the initial impressions and evaluations and to get feedback from them also as to why they think the values were off.

MEMBER BLEY: Can I ask, when this all started, I think there were two things going on and we're talking about one of them here. One is this kind of benchmark thing, the empirical study. The other part I thought, and I'm not sure where this stands, is there was the hope that these kind of exercises where we're doing scenarios that are the sort of things we try to model in PRAs, there was a hope we could learn from this how certain factors

affect human performance so that we could all incorporate in our model. I am not sure if that level of resolution --

MS. LOIS: Actually, what John told, it's a lot of that.

MEMBER BLEY: Close enough to that?

MS. LOIS: Yes.

MEMBER BLEY: Okay.

MS. LOIS: And in a nutshell, there are some indications that already people are using some of the insights that incorporate the PRAs. If you have a live PRA, they could use some of those.

VICE CHAIR ABDEL-KHALIK: If one were to go back and use the influence factors deduced from the data, in the various models, would the range of variability still be two orders of magnitude?

MR. DANG: We haven't done that exercise. Of course, in applying the method, if you know the results, if you know the result when you apply the method, it's a little bit difficult.

VICE CHAIR ABDEL-KHALIK: But that's a different question though.

MR. DANG: Yes.

VICE CHAIR ABDEL-KHALIK: In a sense that okay, I want to separate the effect of knowing ahead

of time what these influence factors are and if you give them correct influence factors, for the various models, would you still predict two orders of magnitude variability between the models?

MR. DANG: I think, as I said, we have not done this year. It's not really within the scope of what we plan to do, but I'm sure that it will be done because it's a very interesting exercise. The other thing that is interesting is if you know this data, including the drivers and the performances that were observed, what would you predict? How do you take that into your analysis? You saw a sparse data, nevertheless, right? You saw one crew failing out of 14 or something like this with a discussion of why this occurred. What do you judge from that and how does that affect your quantitative analysis? So that's another aspect that with the data that's in the report -- so I believe this data that we're providing will be used for that. We're not exactly sure who will do that and under which framework, but it is certainly of interest. It's a very interesting set of data.

This plot shows you the 95th bounds of the HEPs derived from the empirical data. It's a Bayesian update based on the minimally informed.

MEMBER APOSTOLAKIS: Wait, you are deriving human error from the empirical data?

MR. DANG: Yes.

MEMBER APOSTOLAKIS: How do you do that?

MR. DANG: We have evidence, we have counts of failure. We take a minimally-informed prior and we update it.

MEMBER APOSTOLAKIS: Really? With all these 14 exercises, the two scenarios?

MR. DANG: For each HFE, yes.

MEMBER APOSTOLAKIS: I'd like to see that analysis. Do you have anything written yet?

MR. DANG: I will have that written up.

MEMBER APOSTOLAKIS: Go ahead.

MR. DANG: What you see on the right-hand side are very large uncertainties. Those are the zero failure cases. When you don't observe any failure, and you have a very small data set, you have a huge uncertainty range on the Bayesian result. I think that's consistent with what you would expect.

On the left, the event is quite narrower because we are observing failures in this small data set, but still it's uncertain. What's to be noted, of course, is that some of the methods are optimistic when we look in the left of the plot, they're below

the fifth percentile and that's part of our exercise or part of our analysis is to determine why this is, whether it's being driven by assumptions or by method or a combination of both.

MEMBER APOSTOLAKIS: You're still not showing the uncertainties of those models?

MR. DANG: Exactly. We're not showing that.

MEMBER SHACK: Now the pluses are one method?

MR. DANG: The pluses actually happens to be the geometric mean of all of these predictions.

MEMBER CORRADINI: And the diamonds?

MR. DANG: The diamonds are the mean values of the Bayesian posterior. And they're not very strongly depicted because they're very sensitive to the choice of prior.

MEMBER STETKAR: I was going to ask, you kind of glossed over the fact that you took a minimally, I think you characterized it as the minimally-informed prior. Do you really mean a flat prior between zero and one?

MR. DANG: We did not do that analysis. I received feedback that we should and we have actually done it in the meantime, after the preparation of

these plots. The results, in terms of the bounds are not very different. The means move a little bit like a factor of two, sometimes a factor of three. But the general conclusions as to which methods , which predictions are optimistic and pessimistic and relying within the bounds, basically doesn't change.

MEMBER APOSTOLAKIS: So which prior did you use?

MR. DANG: This is a log normal prior with the fifith percentile at 10^{-4} and the 95th at .3. So it's a very broad log normal. And the Jeffreys is giving basically a very, very similar result.

We've also done it classically, treating it as classical statistics.

MEMBER APOSTOLAKIS: With zero failures?

MR. DANG: Exactly. The problem with the zero failure cases are not as wide. You're seeing the Bayesian plots.

MEMBER POWERS: If I understand what I think I'm looking at, it looks to me like relative to your estimates, everybody is very optimistic about performance.

There are sporadic cases of where they're pessimistic, but I mean the bulk of the values are all very optimistic. Is that correct?

MR. DANG: I haven't counted the values below the fifth percentile bound, but most of them lie within the bounds.

MEMBER APOSTOLAKIS: What? No.

MR. DANG: Not below the means. I'm not counting the values below the means because we don't -- we don't believe the evidence is very strong for that mean.

MEMBER POWERS: The only ones I could see are the blue diamonds, okay?

MR. DANG: Yes.

MEMBER POWERS: And it looks to me like most of that is below the blue diamonds, whatever that is. MR. DANG: Exactly, and that's we think the appropriate comparison is a comparison to whether you're within the bounds and not whether you're above or below the diamond.

MR. PARRY: But you really shouldn't get hung up on the blue diamonds. Let's talk about item, event 4A. It's a very simple action. You would expect to get success in that action. It's terminating SI. But basically we have zero failures in 14 crews, so that's really not very strong evidence. That's what is driving that mean. The previous one, the 5B2 is also very simple. It's

closing a valve given that you've got indications it's open.

So in that case, we have zero failures in seven crews. So that's why it is higher than the other one.

MEMBER CORRADINI: So just to talk through that so then how do you get then, since you had zero failures in 14 crews, how did you get the failure?

MR. DANG: That's the Bayesian update process.

MEMBER POWERS: My problem is this, I have people coming in here telling me how fast they'll hit a scram button. They have tested it 50 times in the simulator. They never have a failure. They do the human reliability analysis and they tell me there's a three percent failure, possibly of failure, and that's conservative. The question is do I believe them or not? And based on what you show here, I would say there's three percent failure that they calculate by human reliability analysis. If I had to bet, and I do have to bet is optimistically.

MEMBER SHACK: If I had 50 out of 50 successes and I applied the same method, I would get a fairly low estimate.

MR. DANG: Exactly. With the Bayesian

update, if you have more evidence, you would not get this 10^{-2} --

MEMBER POWERS: My trouble is evidence from simulators and that's not the same as in a reactor.

MR. PARRY: Andreas has a point to make.

MR. BYE: Andreas Bye. If I may make a small point about the two difficult HFEs, 5B1 and 1B. They are really HFEs that are very difficult -- the scenarios we used, was used to test masking issues in the simulator and these are way more difficult than what you would find with the standard PRA, I would say.

And also, there may be a little artificial time, but they are -- maybe they give us a lot of qualitative insights for how the methods were applied, but to compare the numbers are maybe a little bit artificial speaking in PRA terms.

MR. FORESTER: I think in my mind, and I'm sure the team would agree, I don't think we're ready to state that these methods are normally going to produce optimistic values.

MR. PARRY: No.

MEMBER BROWN: Optimistic, you mean positive response or not taking a response?

MR. FORESTER: Too low an error rate probability. They think the failure is probably is much lower than it actually is.

MEMBER APOSTOLAKIS: If I see nothing else and all I see is this, I have to go with the data.

MR. PARRY: I really didn't want to show you this.

(Laughter.)

MR. FORESTER: As Andreas just pointed out, we're in the context of the simulator study here and not everything is perfect.

MEMBER APOSTOLAKIS: But it also makes sense, John, people tend to be optimistic.

MR. FORESTER: They may believe they'll be great all the time, so that bias may exist.

MEMBER APOSTOLAKIS: The moment they are appointed to this Committee. Vinh, you wanted to say something?

MR. DANG: Yes, I did want to say something. It shows almost, it's a factor of five bigger for having seen zero in 14 instead of zero in 7. So the mean values we would have preferred not to show you because we think that they are in a sense misleading, but we knew that if we did not present those mean values and we showed you the balance only,

you would ask us what the mean values are. So for your benefit, we have presented those mean values.

We really believe in the bounds and not in the mean values. It depends on your description that you choose.

MEMBER STETKAR: I know we're running short on time.

MEMBER CORRADINI: You are.

MEMBER STETKAR: This update, you told me it took a log normal whatever it is. What evidence did you use to update that, the actual crew performance results, zero out of 14.

MR. DANG: Yes.

MEMBER STETKAR: Not any input from the other little circles, the dots, the HFE --

MR. DANG: Just what we've seen in the simulator.

MEMBER STETKAR: Okay, thanks. I don't understand this at all then, but we need to go on.

MEMBER BLEY: A bunch of those had zeros. Different posteriors, so there was more evidence than just whether they succeeded or failed.

MR. DANG: There is more evidence because five and two is only seven observations, whereas --

MR. PARRY: No, he's saying there should

be something else.

MEMBER STETKAR: There should be something else. It looks fine.

MEMBER APOSTOLAKIS: Anyway, this is a victory result. Next slide. Are you going to make it worse now?

MR. DANG: No. As you can see, we prefer to discuss the comparisons in terms of how they did against difficulty and not against the mean values. This is an example of one method's performance against difficulty.

Pretty much this is close to an ideal result in terms of the prediction, meaning the top-most difficult actions are up there and then you go through a flat range and the outlier for this prediction is 4A where it's relatively high. But otherwise, that's a good result against difficulty and that's all I want to say.

MEMBER APOSTOLAKIS: Very good. Thank you.

MEMBER ARMIJO: Did any of these methods really hit it right on, across the board?

MR. PARRY: No.

MEMBER ARMIJO: None, okay.

MR. DANG: But they all did not do like

that. So just to sum up then, we know that there are limitations in this quantitative data, the reference HEPs. We believe that it's nonetheless useful to make the comparison, but not to draw too many conclusions from how they did against the numbers. For us, the quantitative comparison rounds out the overall evaluation of the method and it focuses us on certain HFEs and looking at it qualitatively why they predicted low or high because otherwise you have a lot of differences.

MEMBER APOSTOLAKIS: But it really would be interesting to see whether a model consistently outside some limit or was, you know -- I appreciate it's so early and premature to do that.

MS. LOIS: I believe when we have the loss of feedwater, an analysis that was done with the themes being more important about the plant and the crew. I think that they help us to better understand the analysis. That's why we really are very hesitant to put another inference in this quantitative analysis.

MEMBER APOSTOLAKIS: Moving on to the next -- oh, I'm sorry.

MR. DANG: Just one last statement.

MEMBER APOSTOLAKIS: Sure.

MR. DANG: The other reason to cautiously look at the quantitative results is that these are only on the HFEs of a pair of steam generator tube rupture scenarios. So we don't really know how the performance of the methods would be in other types of scenarios where the difficulties are different and pose different challenges for the operators.

Thank you.

MEMBER APOSTOLAKIS: Thank you, Vinh. Gareth, you are closing this?

MR. PARRY: Yes.

MEMBER APOSTOLAKIS: Can you do it in ten minutes?

MR. PARRY: I will try my best, if you will allow me to.

(Laughter.)

MEMBER APOSTOLAKIS: This guy has been before this Committee before.

MEMBER POWERS: Then he should know that's not an excuse.

(Laughter.)

MR. PARRY: I've got to say that when I first heard about this exercise, I was very skeptical that it would provide useful information, but being involved in with has confirmed for me that actually

this is a very valuable exercise, and particularly, the use of simulators and the way it's been used in this particular study.

I think that it has provided a lot of insights and these have already been touched on, related to human behavior that we can use to improve the HRA methods we have.

First and foremost, I think, is understanding the context for the crew actions, particularly in the dynamic sense. Let me give you an example here. HFE 2A is the cool down of the steam generator in the base case which is a pretty normal one. One thing we saw was that there was variability in the way crews did this. There was variability because the boundary conditions of entering that step were different in terms of the initial temperature of the RCS. You don't get that unless you understand the dynamics of the scenario.

And 5B1 was another one where, in fact, it's a -- they closed the PRB, but it hasn't closed but the indication is that it's closed. In that case, the fact that it hadn't closed by a very small amount which kept the pressure hanging up which really meant that there was no indication that there was still a leak in the RPV which would tell them to close the

block valve. Without understanding that, you will get the wrong answer for 5B1.

The other thing, as we mentioned earlier is recognizing the significance of crew-to-crew variability. And it's not just in the times, it's in the way they operate, the way they actually address the particular scenario. Some of this is obviously driven by the boundary conditions and the way they enter it, but there's also an inherent difference in the way the crew is behaving.

Now the other thing is it does give us some means of identifying potential failure mechanisms, although we really didn't find many failures in this, but you can see behaviors that could under certain circumstances lead to failure.

Now one thing to note about --

MEMBER POWERS: I struggle to understand your emphasis on the crew-to-crew variability. I mean variability -- I mean they're not automatons.

MR. PARRY: Right.

MEMBER POWERS: They do things differently.

MR. PARRY: Right.

MEMBER POWERS: To get the right answer.

MR. PARRY: Let me carry on to my next

point, okay? We have to relate this to some other HRA methods and the HRA methods take all these factors into account in different ways. For example, the human error probability that you estimate in the context of a PRA typically represents the average taken over the aleatory variables which would be the crews in this case. And also it usually does it in terms of a bounding or a representative context in terms of plant conditions, so that the dynamics are sort of -- is simplified and the crews are averaged. That's the only point I'm trying to make is that a lot of the methods deal that way.

The crew-to-crew variability is not considered for most methods, although I think some methods like ATHEANA, MERMAS, for example, they will address the different ways that crews might operate under certain circumstances.

MEMBER STETKAR: And you glossed over one thing. Two things. There's crew-to-crew variability for a precisely defined scenario.

MR. PARRY: Right.

MEMBER STETKAR: And there's scenario-to-scenario variability within the definition of your nominal conditions.

MR. PARRY: Right. We have to recognize

that HRA methods will behave that way.

The other thing is that many of the methods do not explicitly consider failure mechanisms. Some do, others do not. So while we get a lot of information from this study, it's not directly translatable into HRA methods.

MEMBER APOSTOLAKIS: But as you know -- I am a little concerned here. When I last looked at the all this, the Navy, for example, worries about things like that, submarines. There's a whole literature out there in dynamics and how crews perform and all that. I hope that we're not going end up with a recommendation here to do more research.

MR. PARRY: I don't think -- well, not from me.

(Laughter.)

MEMBER APOSTOLAKIS: If it's necessary, it seems to me you ought to start thinking about it now because it will be really very bad if in 2010 we say well, gee, this is a major factor and we have to do more research.

MR. PARRY: It depends on what you mean by doing more research. If it means how do we factor this into the methods, I think that's something different. I don't think --

MEMBER APOSTOLAKIS: As you said, crew-to-crew variability and the team dynamics are not in most of these HRA models.

MR. PARRY: Right.

MEMBER APOSTOLAKIS: If we have to include them --

MR. PARRY: that's a question that we'll have to answer --

MEMBER POWERS: What is the possibility in 2010 that they will not say do more research?

MEMBER APOSTOLAKIS: That is a possibility, you say?

MEMBER POWERS: What is the possibility that they will not say --

MEMBER APOSTOLAKIS: Well, if at least we have a recommendation that this is a model that seems to be applicable for this particular class of problems, and then you say, I'm not asking to shut down all research. But doing research should not be the major recommendation because that's not very good.

MEMBER POWERS: Haven't they gotten what we wanted to see which is these human reliability models are not orthogonal to each other.

MEMBER APOSTOLAKIS: Well, they may not be at 90 degrees, but --

MEMBER POWERS: I can take this all, put it into one and I'm within a factor of 10, and they're probably all optimistic.

MEMBER APOSTOLAKIS: That's what I meant. If I take somebody's model result and I go a factor a 10 up and down, and although of course, if I happen to be near the end and I got by a factor of 10, then I'm really making a mistake.

I hope these guys are going to give us some advice. Other issues are raised, it seems to me, you know, reasonable people can handle them in meetings, but if you decide that team dynamics is very important, I am scared. The literature out there is huge and John probably knows more than I do of his background.

MR. FORESTER: There is, as you say, there's a huge literature. I don't think -- and this is just my opinion and I don't want to commit it at any strong level, but there's a -- you have to be practical, I think, in terms of what HRA seems to deal with and what they can predict.

MEMBER APOSTOLAKIS: Absolutely.

MR. FORESTER: And there's some very subtle aspects to team performance that HRA just will probably never be able to address. So I think we'll

do as good as we can with what's possible, but that doesn't mean -- a lot more research is probably not going to help us any because there's limitations in terms of being able to predict what they're going to do.

MEMBER APOSTOLAKIS: What I have in mind is we had a presentation here, in fact, that may be a month or two ago. There is another group within the Office of Research working with EPRI that is addressing the issue of uncertainty or sensitivity analysis, model uncertainty and so on. This is a prime example of model uncertainty, is it not?

MR. FORESTER: Yes.

MEMBER APOSTOLAKIS: So I'm trying to make a connection now. How can I use your results or your insights in that context?

MR. PARRY: And I think we can't say that at this stage.

MEMBER APOSTOLAKIS: I know.

MR. PARRY: I think we'll have to make an assessment of whether it's going to significantly affect the results that we use for certain applications and that's really all we can tell you right now.

MEMBER APOSTOLAKIS: I understand. I'm

thinking ahead.

CHAIR BONACA: We are trying to wrap up the presentation.

MEMBER APOSTOLAKIS: We still have ten minutes.

CHAIR BONACA: It's okay. I'm not saying --

MEMBER APOSTOLAKIS: This is an important point. I mean we should give our views on this as we go along.

MR. PARRY: Okay, next step, as you noticed, there was significant variability in the quantitative results. I have to say though this is a lot less than what this group studied, but there's a good reason for that because this was a much better defined set of scenarios and much better defined problem.

The thing that struck me initially when I looked at the variability was that it was present for all the easy cases, HFE4A and the difficult ones, which were 1B and 5B. However, since we've been looking at the various analyses, we've been able to understand why this variability exists in 1B and 1A, 1B and 5B1, for example. And it's to do with the assumptions and it's a very simple one, that I can

tell you about. 5B1 is that I think not many people made the connection that the indication that pressure, that the pressure was going to remain hung up as opposed to decrease. They made the assumption that the pressure would decrease, they would get an immediate step in the procedure that would tell them to close the blocked valves. So I think that's relatively simple to understand. And that's another confirmation of the fact that you really need to understand the event dynamics.

Of course, from a PRA standpoint we don't normally 6 percent open valves with -- they're either open or they're closed, so I'm not quite sure of the relevance of that for PRA predictions, but I mean it's still, it certainly is an indication that we need to understand the dynamics.

Again, we have some outliers and I'm afraid I've let the cat out of the bag on this one. HFE 1A for ATHEANA was an outlier and had a very high failure probability for something that was actually quite straight forward. However, I have to say that the ATHEANA team did a very good analysis of this job and the reason they were high was based on an assumption that the operators would not trip the reactor which meant that they didn't have time to

isolate the steam generator under these artificial boundary conditions that we put on the HFEs. So again, that's an insight that we get from understanding the results.

The last point was already made, I think, that there's variability is not correlated across the HFE, so it's not, you know, one method here and another method is there. There are some criss-crossing.

We really shouldn't be too surprised that there is variability because the methods that we tested here are a very different basis, ranging from the ones that look at what I would loosely call failure mechanisms at a fairly detailed level and I'm sure the authors of the methods might argue with that characterization, but they're really looking at roughly they could be called a failure mechanism. So this is methods like ATHEANA, MERMAS and CBDT at a somewhat different level.

There are other methods that just look for generic failure types. These are methods like CREAM and HEART. And then there are the task analysis approaches like THERP and ASEP. And then at the extreme end, I suppose, is the pure PSF approach where you just take a method and adjust it, and SPAR-H.

The point about these methods is that in applying them they require you to do different degrees of qualitative analysis and the depth of understanding of human behavior. And that, I think, is one thing that we're finding, that if you're really trying to model the situation, you need to understand it very well.

This is just a few factors that can affect variability between methods. First of all, does the method even -- is it able to capture the significant influences on behavior, one that's based on say small number of PSFs, if the PSF is missing, sorry, if an important PSF is missing, then obviously the method isn't going to capture it.

There is a question of whether some of these methods are inherently pessimistic or optimistic or whether it's the way that they've been applied as optimistic or pessimistic. There is a question of whether the team that applied the method was experienced with that method. We haven't really tested that. Also, is a question of how much do you really need to understand about human performance to apply a method.

And I think finally, again, we keep coming back to this, but the depth of qualitative analysis

that you undertake to understand everything you can about the scenario is crucial for really trying to get a good handle on this.

Next one. Oh yes, so this is talking about the differences in terms of the qualitative analysis required. In some methods, and I would say things like ATHEANA and MERMAS, you really do need to understand the depth of what's going on to try and identify that the different modes of operation of the crew is to look at the failure mechanisms. At the other end, something like SPARH what you're doing is you're focusing on trying to determine the strength of a PSF, absent really thinking of failure mechanisms.

One thing I think we have come to a preliminary conclusion about is that the guidance for performing qualitative assessment that's systematic and thorough appears to be inadequate for most methods. And for some more than others, I think, for the more -- I would say for the simpler methods, they probably require more guidance because we can see that maybe some incorrect assumptions were made or incorrect assignments.

If you don't have good guidance, what it's going to lead to is a lack of reproduceability and traceability of the results. And that's one thing we

really need to provide in the application in these methods.

Okay, so let me say these are very preliminary findings. I guess just reiterating what I just said, that all methods, particularly the most simplified ones need additional guidance on how to develop the qualitative analysis, in particular, what you need to look for, what are the operational conditions that influence performance, how they're related to procedures and training.

A very important point, I think, is guidance on how to discuss these issues with the operators and the trainers to get important information. So I think in a room, if you've never been to a plant particularly, you're not going to understand the dynamics and the context of the situation. You're not going to understand how it plays out against the procedures. So this is a very critical point that needs to be done even for the simplest methods.

For the methods that depend on PSFs then we need more guidance on how to judge the level and the influence of the PSFs. Finally, I think we need guidance on how to document the quantification because in some cases we were finding it -- some methods are

very easy to fit, like actually SPARH is very easy to figure out the quantification, just look at the factors and you count them. What you might not know is why they chose the fact that they did which is I guess related to the previous point.

But for some other methods, it's not so easy and I will have to say that ATHEANA is one of them where it's not so easy in some cases to understand the quantification.

MEMBER BLEY: I have a question for you, not about that. The first half of your slide. I know they don't have an experiment that does this. It might be interesting to have one, but from the way things looked when you read the analyses by all the methods, can you say anything about what you think might have happened if they all had the same detailed qualitative analysis to base their actual use of the method?

MR. PARRY: At this moment, I cannot say that.

MEMBER BLEY: It would be interesting.

MR. PARRY: It would be.

MEMBER BLEY: Do it together or something.

MR. PARRY: Right, right. Yes, we may still -- I think we would still have some variability,

clearly, but hopefully not as much. I mean and that's really why we're stressing the need to do the qualitative analysis.

Some methods -- finally, on this slide that they may need to include additional PSFs, but it's not absolutely clear yet. As a final point, actually, I really should let Erasmia do this because she's the one that's going to do this work, not me. This is how the study results are going to address the SRM. So I'll hand it over to you, Erasmia.

MS. LOIS: The results of the study will be used to support how we're going to act. We have developed tremendous insights for both the actual methods and how they're used and also how the analysts are applying the methods. Again, it seems like some of the variability does come from the experience of the analysts or the time they have to develop an understanding of what's going on in the scenarios.

So the study will be used to potentially identify methods that are acceptable to specific regulatory applications and under different improvements to those methods and limitations on their use that hits down the SRM and explore the development of a hybrid, hopefully, collaboratively with EPRI. And as well as the required scale for the application

methods.

Thank you very much.

MEMBER APOSTOLAKIS: Any comments from the members?

VICE CHAIR ABDEL-KHALIK: I just have one comment to make. I think I heard that insights from this study on human behavior will be drawn, that we can use to improve the various models. Are there any insights that we can draw from this study to improve the operator performance? And how do you go about doing that? Rather than improving the model.

MEMBER APOSTOLAKIS: But that is topic we are dealing with.

MR. PARRY: I am sure Andreas would probably be a better person to answer that one, if he wants to.

MEMBER APOSTOLAKIS: You are a master.

MR. BYE: Andreas Bye. I think in general this experiment shows us a lot about crew performance that we report in the project. This is the general purpose of all of our experiments is to find out what can improve and human performance in control rooms. So that's side of it is covered kind of like the general purpose of all of our experiments that give feedback to regulators and to plants and how things

can be improved.

MEMBER APOSTOLAKIS: Any other comments from the members?

Staff? Public? Mr. Chairman, back to you, 18 minutes early.

CHAIR BONACA: Thank you. Thank you for the presentation.

MEMBER SHACK: You can tell time just about as well as anything else.

(Laughter.)

CHAIR BONACA: And with this, we will take a recess for lunch, and come back at 1:30.

(Whereupon, at 12:33 p.m., the meeting was recessed.)

Summary of Overall Conclusions

ACRS PRA Full Committee Meeting
March 6, 2009

Presented by
Gareth Parry

Confirmation of the Value of Simulator Exercises

- Provide insights on issues related to human behavior that can be used to improve HRA methods:
  - Understanding of the context for the crew actions, including its dynamic aspects (HFE 2A and 5B1)
  - Recognizing the significance of crew to crew variability
  - Identifying potential failure mechanisms
- HRA methods take these into account to varying degrees
  - HEPs in the context of a PRA represent the average taken over the aleatory variables (e.g., specific crew) and bounding or representative context (e.g., plant conditions)
  - Crew to crew variability is not considered for most methods
  - Many methods do not explicitly consider failure mechanisms

Variability in Quantitative Results

- Despite the care taken to provide a detailed description of the scenarios, the HEP evaluations show significant variability, though less than in the ISPRA study
- The variability was present for both the easy (e.g., HFE 4A) and the difficult (e.g., HFE 1B and HFE 5B1) HFEs
- Some variability is explainable by differences in assumptions
- Some outlier estimates (e.g., HFE 1A for ATHEANA) are understood
- The variability is not correlated across the HFEs (i.e., the highest HEP for different HFEs is not from the same analysis)

Understanding the Sources of Variability

- Variability should not be unexpected since the methods have very different bases, including:
  - Identification of failure mechanisms at a fairly detailed level (e.g., ATHEANA, MERMOS, CBDT)
  - Identification of generic failure types (e.g., CREAM, HEART)
  - Task analysis (e.g., THERP, ASEP)
  - PSF approaches (e.g., SPAR-H)
- The different methods require differing degrees of qualitative analysis and depth of understanding of human behavior

Understanding the Sources of Variability (cont'd)

- Factors affecting variability include:
  - The capability of method to capture the significant influences on behavior
  - Inherent pessimism or optimism of the method
  - Whether the method has been applied as intended
  - The team experience in HRA and with the method applied
  - The degree of expertise in human performance needed to apply the method
  - The depth of qualitative analysis undertaken to understand the underlying dynamics of the scenario and factor it into the estimation

Differences in Qualitative Assessment

- The nature of the qualitative analysis required is different from method to method
  - At one extreme, the qualitative assessment is focused on identifying failure mechanisms, including the contextual factors that drive them
  - At the other, it is focused on determining the strength of a PSF
- The guidance for performing a qualitative assessment that is systematic and thorough appears to be inadequate for most methods
  - Leads to lack of reproduceability and traceability

Initial Findings

- All methods, but particularly the more simplified methods, need additional guidance on:
  - How to develop the qualitative analysis
    - What are the operational conditions that could influence performance and how will they relate to the procedures, training, etc.
    - Guidance on how to discuss these issues with operators and trainers to obtain important information
  - How to judge the level of PSFs
  - How to document the quantification
- Many methods need to include additional PSFs to adequately predict crew performance

Use of Study Results to Address SRM

- The results of this study, and the follow-on for the LOFW scenarios, will be used to identify the strengths and weaknesses of the various methods in order to:
  - Identify methods that are acceptable for specific regulatory uses
  - Identify improvements to those methods
  - Identify limitations on their use
  - Development of potential hybrid methods
  - The required skill set for application of the methods

Predicted HEPs and Quantitative Comparisons

ACRS Full Committee Meeting

March 6, 2009

presenter: V.N. Dang, PSI, Switzerland

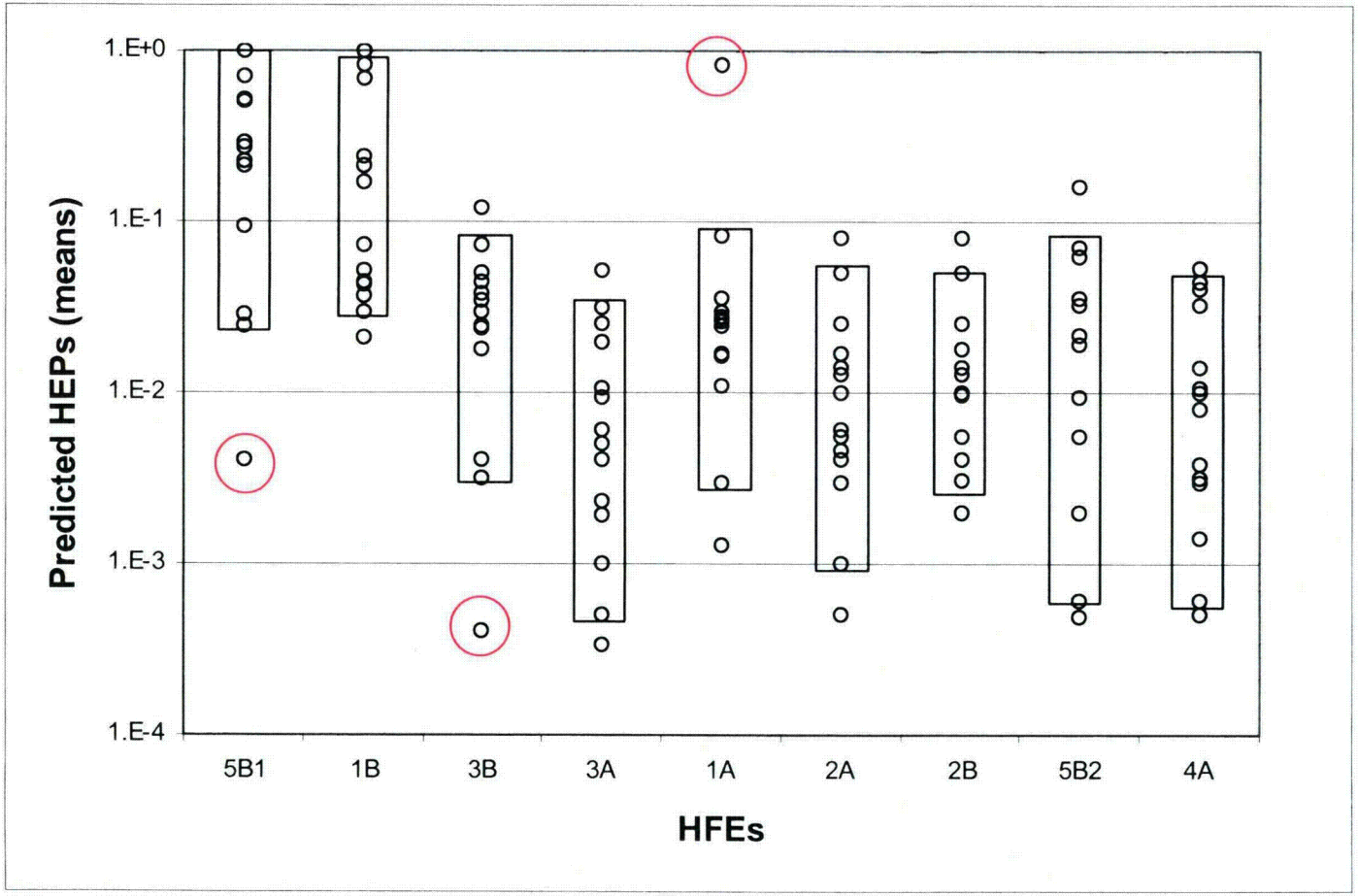
Empirical HRA Study Results
"Quantitative" comparisons

- Two types of quantitative comparisons between HRA predictions and empirical data
  1. predicted ranking vs. empirical ranking
  2. predicted HEPs vs. empirical HEPs

- Significant limitations of quantitative results, especially the small set of observations
  - Quantitative comparisons supplement the qualitative comparisons and insights
  - The overall evaluation of the HRA methods is based on both qualitative and quantitative insights
  - However, the qualitative insights should be weighted more strongly

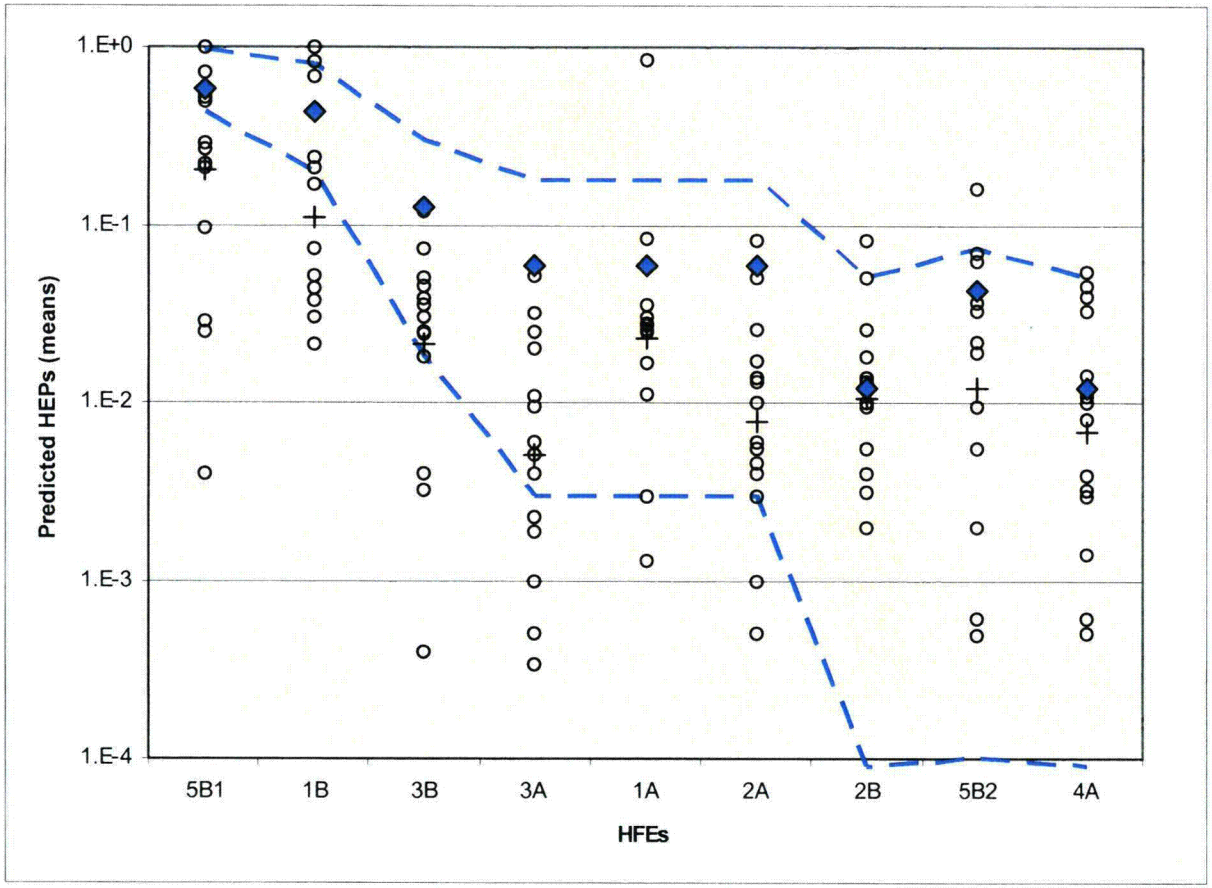
Range of predicted mean HEPs

Boxes drawn around range, 1 maximum value and 1 minimum value excluded from each range.



- After exclusion, most ranges span < 2 orders of magnitude
- Many outliers relatively close to the range.
- Exceptions are highlighted.
- These are being examined to determine causes
  - method or assumption or combination

Predicted HEPs vs. empirical HEPs (Bayesian results)



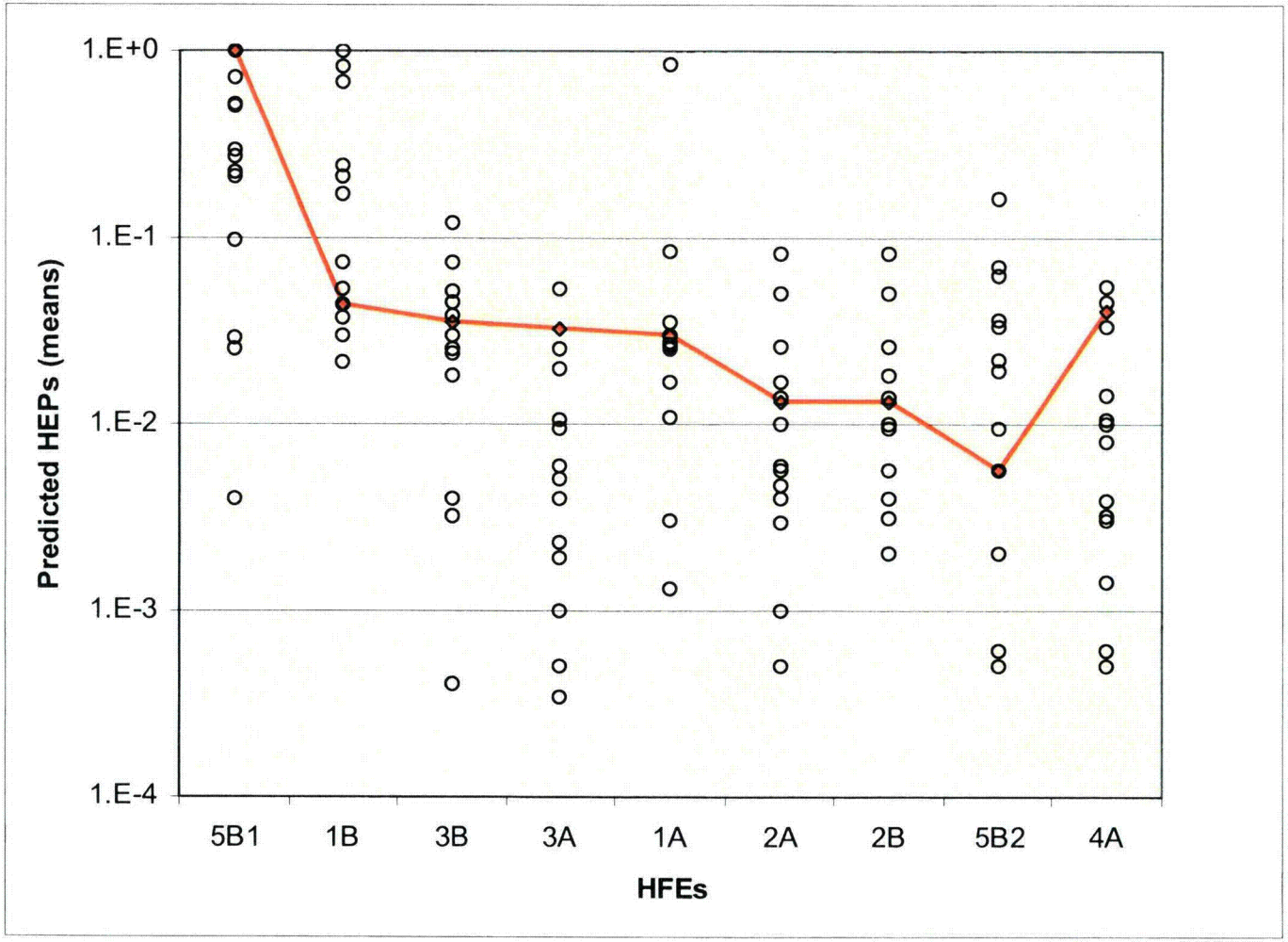
- **Many methods underestimated HEPs of difficult HFEs** (5B1 and 1B, also 3B, 3A)
- **Rest of HFEs: nearly all predictions (mean values) fall within bounds, but very broad bounds**
- **Consistency of predicted ranks**
  - **(by individual method)**
  - **separate, important criterion for HRA methods**

Breadth of Bayesian confidence bounds are due to small data set.

This show limits of comparisons based on empirical (Bayesian) HEPs.

Consistency of predictions against difficulty

"Difficulty" ranks combine failure counts and qualitative analysis of observations



Conclusions : quantitative comparisons

- Some quantitative data, subject to significant uncertainties, was obtained. A Bayesian analysis was performed.
- Empirical reference data (qualitative and quantitative)
  - a unique aspect of this study
  - allowed comparisons and evaluations of the methods that were not possible in previous benchmarks.
- Caution is warranted in interpreting the quantitative comparisons results
  - uncertainties in this reference data
  - the limited number of HFEs
- Qualitative evaluation remains the more valuable outcome of work so far

  quantitative comparison "rounds out" the overall evaluations of the methods

Due to limitations of the quantitative data, one should not select among the HRA methods based on these quantitative comparisons.

Qualitative Analysis and Comparison with Halden Crew Data

ACRS PRA Full Committee Meeting
March 6, 2009

Presented by
John Forester

Sandia National Laboratories

Overview

- How we performed the qualitative analysis
  - Summarized each HRA method's qualitative predictions of crew performance on each human failure event (HFE)
  - Compared with crew data
  - Summarized results of the comparison and addressed performance characteristics of the method
- General findings

Summarized HRA Team Qualitative Results

- Translated driving factors (PSFs) identified from method results into common set of PSFs identified as relevant for this study
  - Different methods address different PSFs
  - Capture the factors predicted to affect crew performance in a common terminology (Summary Table of Driving Factors)
- Summarized their "operational expressions or stories"
- Assessment team **had not** seen the Halden results
- Summaries were sent to each team for review
  - Addressed any team comments

Summary Table of Driving Factors

EPRI Caused Based Decision Tree (CBDT) Assessment of HFE 5B1

PSF	Comments	Influence
Adequacy of time	Inadequate given the available cues and when another opportunity to check pressurizer pressure comes up in the procedures	-2 (MD)
Time pressure		0
Stress		0
Scenario complexity		0
Indication of conditions	Since pressurizer pressure will not immediately show pressure to be decreasing, it was assumed that the crew would not immediately recognize the stuck open PORV. The PORV position indication shows closed even though it is open.	-2(MD)
Execution complexity		0
Training		0
Experience		0
Procedural guidance	Crew does not get another direction to check pressure (when it will be meaningful) until they enter ECA-3.1, which is expected to be too late given the time frame.	-2(MD)
HMI		0
Work processes		N/A
Communication		N/A
Team dynamics		N/A
Scale for PSF Rating	*N= Generally good, 0= Not a driver, -1=minor negative driver, -2 = strong negative driver, MD= Main negative driver, N/A= not addressed by the method*	

Compared HRA Team Predictions to Halden Crew Data

- Compared PSF ratings from HRA teams to those in crew data (for each HFE)
  - Did they agree on positive and negative PSFs and the driving factors
- Compared operational expressions/stories
  - Did their operational story agree with what occurred in the crew data?
- Compared ranking of HRA team human error probability (HEP) predictions to HFE difficulty rankings
  - Did the HEPs (rankings) correspond to the way the crews performed?

Summarized the Results of the Comparison – Addressed Performance Characteristics of the Method

- Discussion of predictive power of the method
  - Identification of driving factors
  - Predicted operational expression
  - Assessment of HEPs
- Insights on guidance and traceability
- General conclusion on the strengths and weaknesses of the method based on the comparison
- Insights produced by the method for error reduction

General Findings

- All methods identified some of the important factors that drove crew performance
  - But most HRA analyses failed to identify important factors for some HFEs
- Several methods significantly over- or underestimated the difficulty of some HFEs
  - Many methods tended to make optimistic predictions for the more difficult HFEs
  - Some methods provided relatively pessimistic values for the easier HFEs
- Factors driving variability between HRA team predictions:
  - The depth of the analysis to develop qualitative understanding
  - The performance shaping factors (PSFs) used by the method
  - Judgments of the degree of influence of the PSFs

Backup slides

Example of Specific Finding

- Inconsistency in interpretation of the diagnosis component of a human action.
  - Some methods (e.g., SPAR-H, ASEP, THERP, CBDT) have an explicit diagnosis component.
  - Seems to have been interpreted as a high level "figure out what the accident is" activity
    - It's an SGTR – ignored diagnosis for later HFEs in scenario
  - Lower level cognitive activities, such as interpreting the plant status in the context of the step by step procedure are not being given enough attention
  - Simulator experiments show this to be important
- Can hurt the predictive power of the method

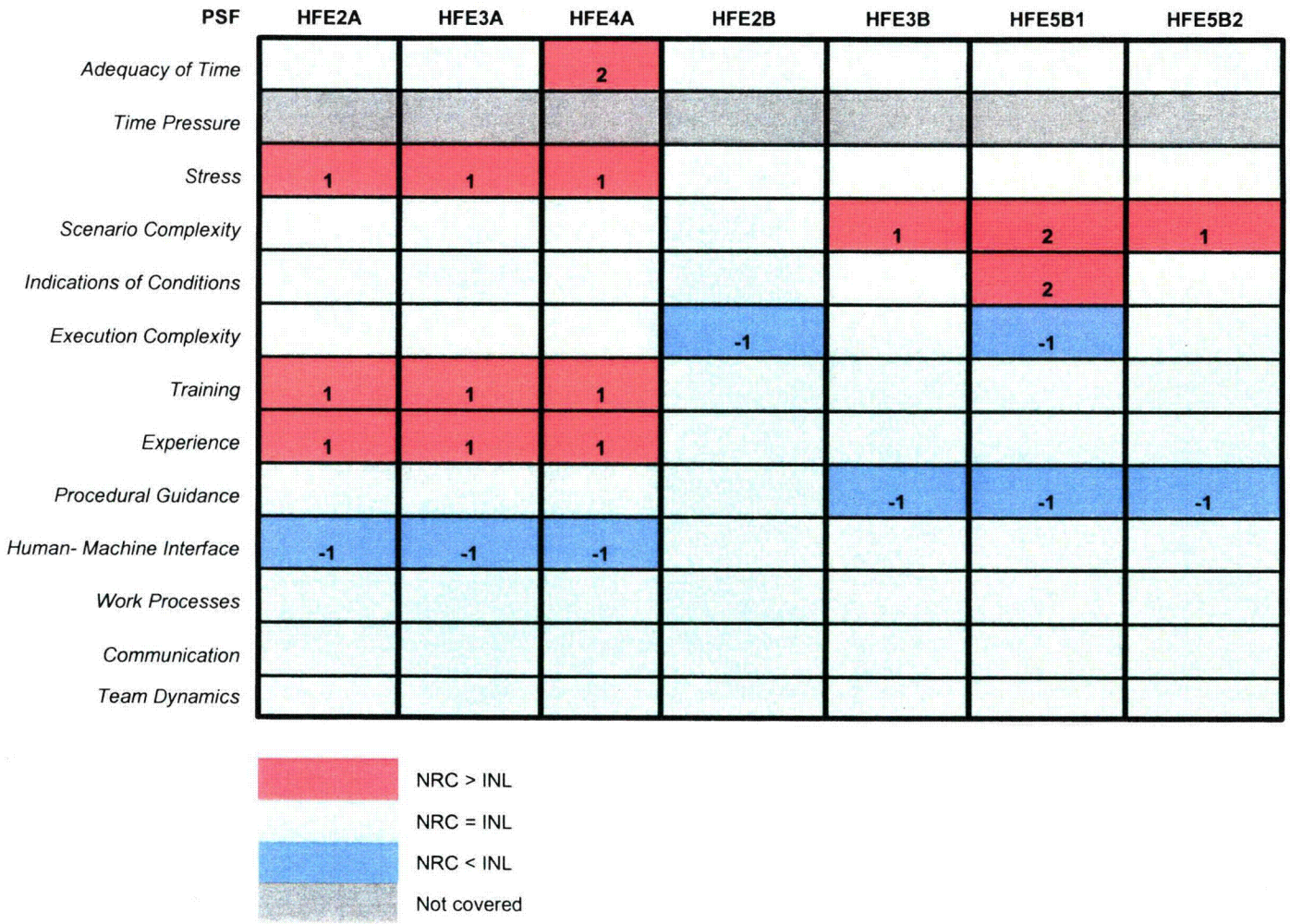
Difference (DT+ASEP - Halden)

PSF	HFE2A	HFE3A	HFE4A	HFE2B	HFE3B	HFE5B1	HFE5B2
Adequacy of Time							
Time Pressure							
Stress	-2	1	-2	-1	-1	-2	-2
Scenario Complexity	2	-1	-1	1	1	3	-1
Indications of Conditions	-3			-3			
Execution Complexity		-1	-3		-1	-3	-1
Training						1	
Experience							
Procedural Guidance	-1	-3	-3	-3	-3	1	
Human- Machine Interface	-1			-1			
Work Processes							
Communication							
Team Dynamics							

DT+ASEP > Halden - Method optimistic
DT+ASEP = Halden - Agreement
DT+ASEP < Halden - Method Pessimistic
Not covered

Difference in Rating for PSFs Between Two Applications of SPAR-H

Difference (NRC - INL)



The International HRA Empirical Study
Phase 2 Empirical Results

Presentation to:
Advisory Committee on Reactor Safeguards
Rockville, MD - 6 March 2009

Salvatore Massaiu
Andreas Bye

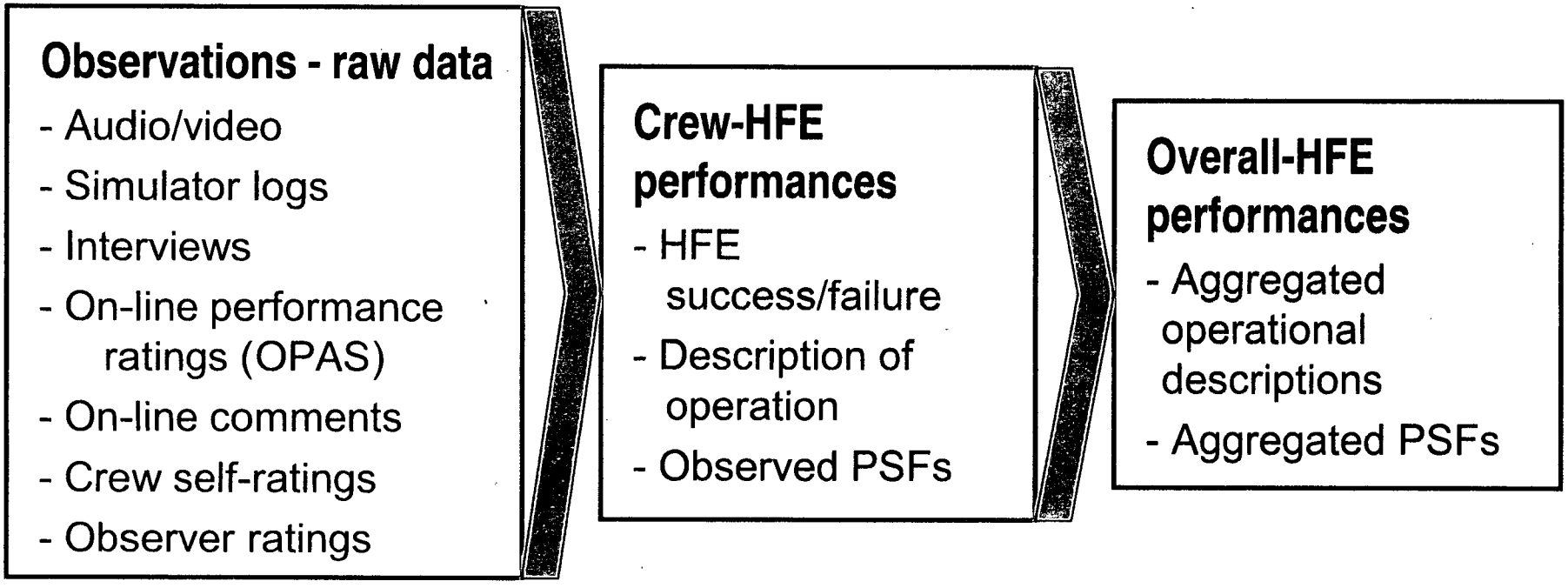
Industrial Psychology Division
OECD Halden Reactor Project

Summary

- A new data analysis approach has been developed that:
  - optimizes the comparison of HRA methods predictions to empirical observations
  - improves the usefulness of simulator data for HRA purposes
- The experiment identified:
  - the extent of crew-to-crew variability and the significance of teamwork factors
  - the importance of events dynamics in determining crew performance

Data analysis process

- From individual observations to HRA reference data



Aggregated operational descriptions - HFE 2B

Mode	Crews	Result	Deviation/comment
These crews only use SG PORVs (as dump is not available due to steam line isolation)	A, C, D, F, I, K, L, M, N.	Cooldown completed in 5-7 minutes	- Crew D enters step 7 already meeting the table conditions and does not need to cool down. - Crews A and C do not cool down at maximum speed (7:10 and 8:05 respectively)
Wait for completion of local actions for isolation before starting step 7 (wait 2 to 6 minutes)	B, G, J.	Full ruptured SG at start of cooldown, but normal cool down time (5-7 min.)	- Crews J does not cool down at maximum speed (7:25)
These crews tried to use steam dump, forgetting the steam line isolation. Afterwards they used the SG PORVs	E, H.	Cool down in 9:12 (E) and 11:50 (H).	

Aggregated PSFs - HFE 2B

PSF	Comment	Rating
Time pressure	No time pressure for almost all crews	0
Stress	Signs of stress carried over from the previous phase in 2 crews with difficulties	-1
Scenario complexity	Some crews encountered difficulties in understanding why the dump was not working	-1
Indication of conditions		N
Execution complexity	Some crews had problems with operating the SG PORVs at maximum or setting them correctly upon completion	-1
Training	Generally good training on cooldown	N
Experience	Experience level did not differentiate between performance levels	0
Procedural guidance	The crews typically based their cooldown strategy on following the procedure.	N
HMI		N
Work processes	Mostly thorough work. Some minor issues on not reading notes and warnings for 2 crews who exhibited operational difficulties.	N
Communication	Normally good communication. Some problems in information exchanges for the less performing crews (also captured under the PSF 'Team dynamics')	N
Team dynamics	Less well performing crews (but also some well performing) showed lack of adequate leadership and support (e.g. SSs too involved, too passive), and/or lack of coordination and discussion. 3 crews waited too long for local actions, 4 other teams with poor team dynamics performed less well.	-1(md)

Legend: md = main driver, -1 = negative driver, 0 = not a driver, N = nominal-positive driver

HFEs difficulty and ranking

HFE	Near misses	Failures	Difficulty	Comment on difficulty
1A	-	1/14	…	…
2B	4	0/14	…	…
5B1	-	7/7	Very difficult	[…] the RCS pressure for 6 out of 7 crews was increasing when applying E-3 step 18 ("check RCS pressure – increasing", the step directly after the end of depressurization) or at least stable when applying step 19 ("Check if SI flow should be terminated"). Only after the HFE time window clearer indications of RCS leakage will appear to the crew. This is the most difficult HFE of this set.

HFEs Ranking: 5B1 > 1B > 3B > 3A > [1A, 2A, 2B] > 5B2 > 4A

Conclusion

- The reference data (empirical results format) allow the comparison of both factorial and scenario-based HRA methods:
  - Accounts for the dynamic nature of crew performance (operational descriptions, observational PSF ratings)
  - Not a mere table comparison (operational details, comments on what and why)
- Significant crew-to-crew variability:
  - Strong interaction with process dynamics
  - Importance of teamwork factors
  - Procedures do not cover all situational variations in detail

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Status Report: Benchmark Study of HRA Methods Using Control Room Simulator Data

Erasmia Lois, PhD
Human Factors and Reliability Branch
Division of Risk Analysis

Presentation to:
Advisory Committee on Reactor Safeguards
6 March 2009

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Study Objectives

- Assess HRA methods and HRA practices in light of NPP control room simulator data
  - Characterize the methods
  - Identify strengths and weaknesses in predicting simulator results
  - Provide the technical basis for improving HRA methods and their application
  - Support addressing Commission direction on HRA

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

The Issue

- Differences in the underlying frameworks, data, and quantification algorithms of HRA methods yield different human error probabilities and different insights regarding the potential drivers of error/failure
  - Models are based on formal and informal theories of error but have not been tested with empirical data.
  - In regulatory applications sensitivity analyses are used to enhance the robustness of HRA results.

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Efforts to Improve HRA

- Development of improved guidance (NUREG-1792, *HRA Good Practices*, and NUREG-1842, *Evaluation of HRA Methods Against the Practices*)
- Interactions with national and international experts to pursue testing and benchmarking of HRA methods
- Support for Halden Reactor Project (HRP) initiative to invite signatory organizations to participate in an effort to "benchmark" HRA methods on the basis of simulator data
- Data collection which includes events and simulator data produced at the Halden simulator

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Industry Efforts to Improve HRA

- EPRI HRA Users Group founded in 2000
  - Charter is to promote consistency between users, and Promote convergence of methods
  - Developed a software tool with EPRI & NRC methods
- Working with the NRC
  - Comments on HRA guidance documents (NUREG-1792, *HRA Good Practices*, and NUREG-1842, *Evaluation of HRA Methods Against the Practices*)
  - Halden Benchmarking Project – Assessment & HRA Analysis Teams
  - Joint Fire HRA Project (good blueprint for new HRA projects)
    - Will brief ACRS soon
  - Collaborative work on SRM on HRA models
    - Will brief ACRS in June

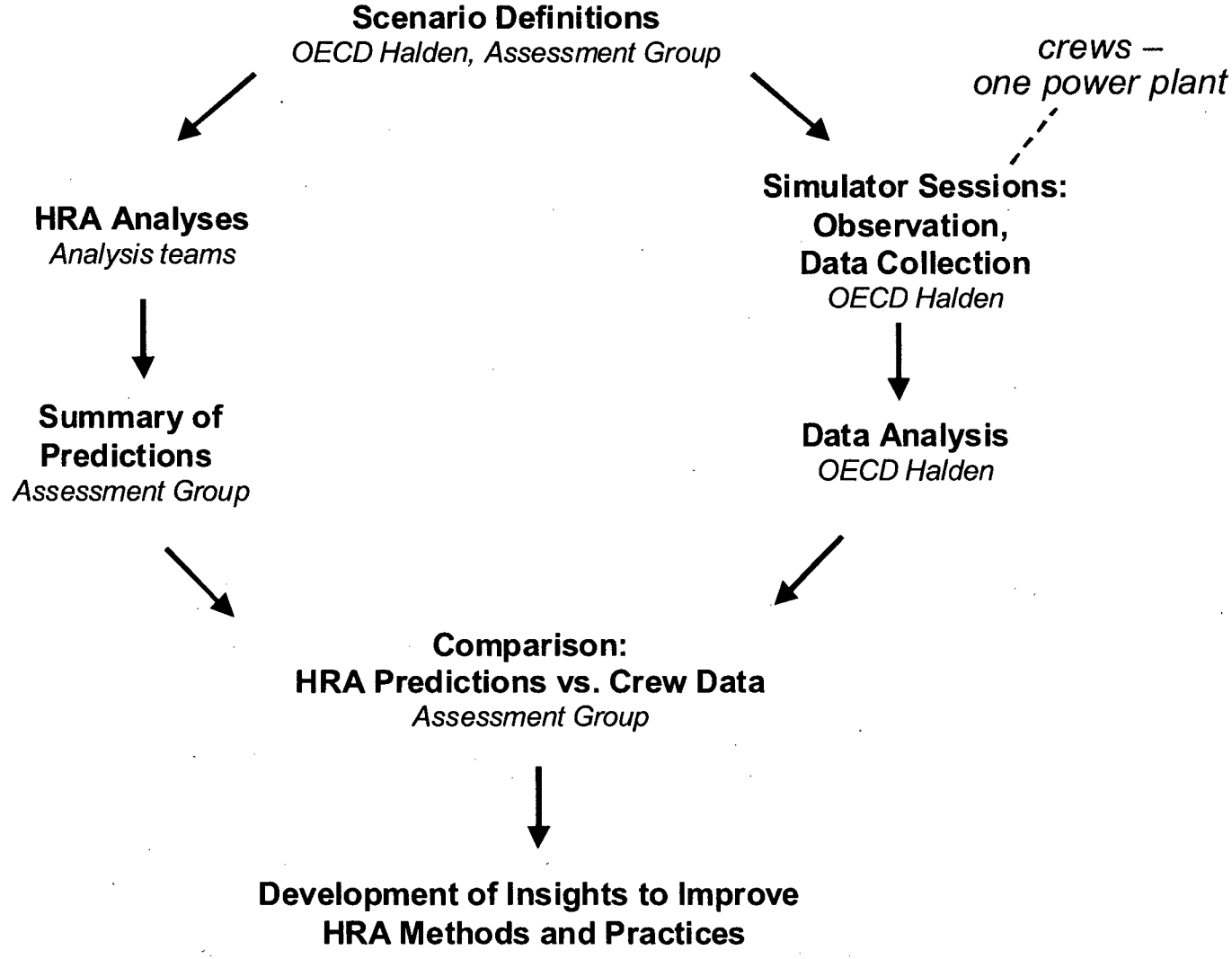
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Recommendations and Directions

- ACRS recommendations to compare the fundamental assumptions of HRA models used by both the NRC and industry
- Commission direction to ACRS to "work with staff and external stakeholders to evaluate the different human reliability models in an effort to propose either a single model for the agency or guidance on which models should be used in specific circumstances," Nov 8, 2006
- Recent Commission direction "to continue to pursue possibly working with EPRI, INPO, and/or international partners to test U.S. nuclear plant operating crews' performance in a variety of situations and keep the Commission informed on the progress in developing a human reliability analysis (HRA) database and benchmarking projects," February 18, 2009

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Tasks of the HRA Empirical Study



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Status of the HRA Empirical Study

- Simulation runs performed at HRP during Nov-Dec 2006
  - Two steam generator tube rupture (SGTR) and two loss of feedwater (LOFW) scenarios
  - Selected four human actions for each SGTR scenario and two human actions for each LOFW scenarios
- Phase 1: Pilot Completed in 2008
  - Used two SGTR human actions to establish the method
  - Established method for crew performance data collection in a format suitable to HRA
  - Established method for evaluating HRA results
  - Compared HRA results to HRP data for the two human actions
  - HRP report (HWR-844), to be published as NUREG/IA-0216, Spring 2009
  - Pilot had external review (Barry Kirwan)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Status of the HRA Empirical Study

- Phase 2: Data collection and analysis of seven SGTR human actions
  - Completed and hold meeting with participants, 3/2-4/2009
    - 14 HRA groups participated (12 domestic and foreign organizations)
    - HRA teams were open to the idea of improving their methods/practices on the basis of evaluation/feedback
    - Discussed the idea of a hybrid method or "tool box approach"
    - External reviews participated in the meeting
      - comments very constructive and positive for the study

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Status of the HRA Empirical Study

- Phase 2 (cont)
  - ACRS briefing, March 2009
  - Document in draft HRP report, September 2009, and in NUREG/IA, September 2010
- Phase 3: Analysis and documentation of the LOFW human actions
  - Most teams have submitted their analysis of LOFW human actions
  - HRP has completed simulator observations.
  - Now comparing analytical results to HRP data, due Summer 2009
  - International meeting on LOFW results scheduled for Dec 2009
  - Documentation of Phase 3 results expected in Spring 2010
- Complete documentation of the study by Sept 2010

Fatigue Management

Mitchel Taggart
Vice President of PROS

PROFESSIONAL
REACTOR
OPERATOR
SOCIETY

PROS advocates safety first

- We feel, as an industry, we have done that with respect to our outage performance over the last several years
- Rule will make utilities change the way they schedule their man power on the front end and back end of an outage
- Utilities will change a successful past practice and could impact our ability to safely execute an outage

First Issue

- Unit Outage – currently defined as reactor unit disconnected from the grid

- PROS recommended change: up to one week prior to disconnecting the reactor unit from the grid and up to 75% turbine power following reconnection to the grid

- This would require a rule change

Advantages Beginning of Outage

- Crew adjustment to outage schedule and themselves (new crews)
- Preparation/Familiarization in the simulator prior to commencing the shutdown (real time simulator shutdown vice just snap shots at key stages)
- Being prepared helps keep the stress level as low as possible in the Control Room (stress will never be eliminated, but being prepared keeps it in check)

Advantages After the of Outage

- Allow major equipment to be tested/placed in service prior to releasing support personnel
- Sufficient personnel available to handle the given emergent issues that can occur following an outage
- The better a site deals with outage recovery (resolve emergent issues) the fewer challenges experienced during the cycle

PROS is not proposing any change in the work hour allowance of 60 days provided in part 26.205 (d)(4) of the ruling for outages.

Second Issue – Multiunit Sites

- Outage Unit – currently defined as only the reactor that is disconnected from the grid
- PROS recommended change: outage unit would be changed to outage site so multiple unit facilities with combined control rooms would be able to modify all the site personnel schedules to accommodate the outage.
- This would require regulatory guide change

Advantages

- The site can manage work hours using a single set of rules
- More personnel supporting the outage – would need 50% more operators on operating unit to comply with reg guide
- Critical outage activities will have adequate oversight and maintain present outage proficiency – reg guide would result in less people to support the outage
- Communications between work groups will be better if working the same schedule – minimizes stress which is a major contributor to fatigue

Draft Final Regulatory Guide 5.73 "Fatigue Management for Nuclear Power Plant Personnel"

Valerie Barnes, Ph.D.
Senior Technical Advisor for Human Factors
Office of Nuclear Regulatory Research
March 6, 2009

Topics

- History of Regulatory Guide (RG) 5.73
- Overview of Subpart I and draft final RG
- Areas of substantive disagreement with NEI 06-11, Rev. 1
- Implementation and publication schedules

History of RG 5.73

- 1982 NRC policy on work hours
- 2002 Rulemaking plan approved
- 2005 Proposed rule published
- 2006 Public meetings on RG began
- 2008 Final rule published March 31
- 2008 DG-5028 published for comment in October
- 2009 Fatigue management provisions must be implemented October 1

3

Subpart I: Managing Fatigue

- Applies only to plants in operational phase
- Requires a fatigue management program for everyone with unescorted access to protected areas
  - Training
  - Self-declaration procedures
  - Fatigue assessments

4

Additional Requirements for "Covered Workers"

- Work hour controls required for
  - Maintenance (risk-significant activities only)
  - Operations (risk-significant activities only)
  - Chemistry (ERO only)
  - Health Physics (ERO only)
  - Fire Brigade (effects of fire suppressants)
  - Security (armed)
  - Individuals who direct risk-significant maintenance and operations

5

Work Hours Controls for "Covered Workers"

- Work hours scheduling
- Work hour limits
- Rest break requirements
- Minimum days off

6

Minimum Days Off Requirements

Cumulative fatigue – the increase in fatigue over consecutive sleep-wake periods resulting from inadequate rest.

7

Minimum Days Off Requirements

Vary according to:

- Plant state (operating or outage)
- Shift duration (8, 10, or 12 hours)
- Job duties
  - maintenance
  - operations, health physics, chemistry, fire brigade
  - security

8

Minimum Days Off Requirements
(Normal Operations)

- In each shift cycle, an average of:
  - 1 day off/week for 8-hour shifts
  - 2 days off/week for 10-hour shifts
  - 2-3 days off/week for 12-hour shifts, by job duties
    - maintenance: 2
    - operations, HP, chemistry, fire brigade: 2.5
    - security: 3
- Days off must be distributed to provide at least 1 day off in any 9-day period

9

Minimum Days Off Requirements
(Unit Outages)

Maintenance	1 day off in any 7 days
Operations, HP, chemistry, & fire brigade	3 days off in each non-overlapping 15-day block
Security	4 days off in each non-overlapping 15-day block

10

Minimum Days Off Requirements
(Unit Outages)

- Covered workers are limited to 60 consecutive days of outage scheduling
- Covered workers are subject to outage controls "while working on outage activities"

11

Draft Final RG 5.73

- Revisions related to two areas of substantive disagreement with NEI 06-11, Rev. 1
- Additions and clarifications to NEI 06-11, Rev. 1, in response to public comments and new guidance

12

Areas of Disagreement

- Both relate to applying the minimum days off (MDO) requirements
  - Concept of periodic overtime
  - Applicability of MDO requirements to operators working on the operating unit(s) at a multi-unit site with one or more units in an outage

13

Periodic Overtime Guidance in NEI 06-11, Rev. 1

- Plan a shift schedule that would include the required MDO
- Permit unscheduled work hours, as needed
- At least quarterly, identify individuals who have averaged >54 work hours/week
- Review the circumstances, determine if a schedule change is needed going forward, document in the corrective action program

14

Overview of Staff Position on Periodic Overtime

- Could lead to violations - guidance in NEI 06-11, Rev. 1, if implemented as written, would
  - Exclude unscheduled work hours when determining the applicable MDO requirements [10 CFR 26.205(d)(3)]
  - Permit covered workers to miss required days off without a waiver [10 CFR 26.207]
- Unnecessary - regulation includes flexibility for periods of unscheduled work hours

15

Scheduled vs. Actual Hours Worked

- Rule addresses shift scheduling requirements separately from work hours controls
- MDO requirements are one set of work hours controls
- Work hours include any duties performed for the licensee, whether the hours are scheduled or unscheduled

16

Flexibility for Emergent Work Provided in Work Hour Limits

- Rule permits covered workers to work as many as
  - 16 hours in any 24-hour period
  - 26 hours in any 48-hour period
  - 72 hours in any 7-day period

17

Flexibility for Applying MDO Requirements

- MDO requirements can be met based on average daily work hours over a period of up to 6 weeks
- Licensees have the flexibility to transition between shift cycle lengths to accommodate emergent work
- Over a shift cycle, a covered worker may work
  - an average of 9 hours/day, 6 days/week = 54/week
  - an average of 11 hours/day, 5 days/week = 55/week
  - for some categories of personnel, 13 hours/day, 5 days/week = 65/week
- Licensees have the flexibility to distribute these extra work hours as necessary to accommodate emergent work

18

Flexibility for Granting Waivers

- Licensees are permitted to grant a waiver of the work hour controls to prevent or mitigate conditions adverse to safety or security
- Licensees are not permitted to allow individuals to miss required days off without a waiver

19

Draft Final RG 5.73

- Retains staff position in DG-5026 that the concept of periodic overtime is unnecessary and, if implemented as written, could cause licensees to violate the regulation
- Includes more detailed guidance on methods to implement the MDO requirements that the staff would find acceptable

20

Operator Work Hours during Outages at Multi-Unit Sites

- Rule permits fewer days off during outages "while working on outage activities"
- Rulemaking intent - any time covered workers perform duties on or for an operating unit, they would be subject to operating MDO requirements

21

Regulatory Guide Relaxation

- In DG-5026, staff agreed that maintenance and some operations personnel working on common systems are eligible for relaxed outage work hour controls
- Disagreed that the licensed operators responsible for an operating unit can be considered "working on outage activities"

22

Policy Bases for Staff Position

- NRC policy and guidance on control room operations
  - 1989 "Policy Statement on the Conduct of Nuclear Power Plant Operations"
  - 2008 Regulatory Guide 1.114, "Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit"

23

Regulatory Basis for Staff Position

- 10 CFR 50.54(m)(2)(i) establishes minimum shift staffing requirements for ROs and SROs on an operating unit based on
  - the number of units
  - control room configurations
- 10 CFR 50.54(k) requires one "operator at the controls" of any operating unit
- 10 CFR 50.54(m)(2)(iii) requires a "senior operator in the control room" of any operating unit

24

NEI 06-11, Rev. 1, and Staff Positions on Operator Outage MDO

- NEI 06-11, Rev. 1 – One RO and one SRO per operating unit should have operating MDO with short-term relief provided by operators who have been working outage hours
- Staff – The "operator at the controls" and the "senior operator in the control room," and the operators who relieve them (depending on number of units and control room configurations) should have operating MDO

25

Minimum Number of Individuals Per Shift Working Nonoutage Schedules for Onsite Staffing of Operating Nuclear Power Units during Outages[1]

Number of operating nuclear power units[2]	Position	Two-unit site		Three-unit site				
				Two control rooms				
		One Control Room	Two Control Rooms	Single Control Room Unit in Outage	Single Control Room Unit and One Unit Served by Dual Control Room in Outage	One of the Two Units Served by Dual Control Room in Outage	Two Units Served by Dual Control Room in Outage	Three Control Rooms
One	Senior Operator	2(2)	2(2)		2(2)		2(2)	2(2)
	Operator	2(3)	2(3)		2(3)		2(4)	2(4)
Two	Senior Operator			2(2)		3(3)		3(3)
	Operator			3(4)		4(5)		4(5)

[1] Numbers in parentheses are minimum shift complement required by 10 CFR 50.54(m)
[2] For the purpose of this table, a nuclear power unit is considered to be operating when it is connected to the grid.

26

Revised Staff Position in Draft Final RG 5.73

- Draft final RG modifies the staff's position in DG-5026 by
  - Relaxing requirements for operators transitioning onto the outage unit to provide long-term relief
  - Permitting operators working outage hours to provide short-term relief for operators on the outage unit under certain circumstances
  - Clarifying that the back-up operators for the operating unit may work on outage activities, except the operator at the controls and the senior operator in the control room required by regulation

27

Implementation and Schedule for Publishing Final RG 5.73

- Fatigue management requirements must be implemented no later than October 1, 2009
- Staff published the draft final RG to support licensee preparations
- Final RG will be published no later than May 31, 2009

28


UNITED STATES NUCLEAR REGULATORY COMMISSION
Discussion
29