



**UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001**

December 7, 2010

MEMORANDUM TO: ACRS Members

FROM: John Lai, Senior Staff Engineer */RA/*
Reactor Safety Branch – B
Advisory Committee on Reactor Safeguards

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS
SUBCOMMITTEE ON RELIABILITY AND PRA REGARDING
VARIOUS HUMAN RELIABILITY ANALYSIS METHODS ON
OCTOBER 18, 2010, IN ROCKVILLE, MARYLAND

The minutes for the subject meeting were certified on December 1, 2010. Along with the transcripts and presentation materials, this is the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc w/o Attachment: E. Hackett
C. Santos
A. Dias

cc w/ Attachment: ACRS Members

Certified By: John W. Stetkar
Certified on December 1, 2010

**ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF THE MEETING OF THE SUBCOMMITTEE ON RELIABILITY AND
PRA ON VARIOUS HUMAN RELIABILITY ANALYSIS METHODS
ON OCTOBER 18, 2010 IN ROCKVILLE, MARYLAND**

INTRODUCTION

On October 18, 2010, the ACRS Subcommittee on Reliability and PRA held a meeting in Room T-2B3, 11545 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to discuss the various human reliability assessment methods. Mr. Girija Shukla was the designated federal official for this meeting. The subcommittee received no request from the public to make oral statements. The subcommittee chairman convened the meeting at 1:00 pm and adjourned at 5:29pm.

ATTENDEES

ACRS Members

John Stetkar, Subcommittee Chairman
Dennis Bley, Member
Michael Ryan, Member

ACRS Staff

Girija Shukla, Designated Federal Official
John Lai, Cognizant Staff Engineer

NRC Staff

Erasmia Lois, RES/DRA
Susan E. Cooper, RES/DRA
Y. James Chang, RES/DRA
Erasmia Lois, RES/DRA
Christiana Lui, RES/DRA
Sean Peters, RES/DRA
Nathan Siu, RES/DRA

Others

Vinh Dang, PSI, SWI
John Forester, SNL
Stuart Lewis, EPRI
Ali Moseleh, University of Maryland
Johanna Oxstrand, INL
Gareth Parry, ERIN
April Whaley, INL
Dana Kelly, INL
Katrina Groth, SNL
Amir Afzali, SNC

The presentation slides and handouts used during the meeting are attached to the transcripts. The presentations to the Subcommittee are summarized below.

SUMMARY OF THE MEETING

OPENING REMARKS BY CHAIRMAN STETKAR

John W. Stetkar, Chairman of the ACRS Subcommittee convened the meeting by introducing the ACRS members present. Chairman Stetkar stated that the purpose of this meeting is to discuss the status of the Human Reliability Analysis methods development, as part of our continuing interactions under SRM M061020 issued in November of 2006. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for the deliberation by the full Committee. The rules for participation in the meeting were announced as part of the notice of the meeting previously published in the Federal Register. Chairman Stetkar acknowledged that the Committee has received no written comments. Representative of EPRI requested time to make oral statements regarding today's meeting.

STAFF PRESENTATION

Christiana Lui of RES/DRA stated that the SRM was in place in May 2006, but because resource considerations from both the RES and ACRS, the staff really did not start tackling this issue or planning for the current study until late 2008 and the beginning of 2009. The staff plans to have a series of three to four meetings, more in the form of workshops in the next 12 months or so.

She stated that the materials prepared for today's meeting are largely based on the interactions with the ACRS in April this year. In addition to addressing the questions that they have heard and asked to address, the staff also wants to share more complete thought process with the ACRS right up front, so it's more transparent to ACRS regarding all the considerations that have gone into the work so far.

Christiana stated that the staff had a lot of collaborations with industry and also had international participation in the work that the staff is doing.

Stuart Lewis of EPRI stated that EPRI is the representative of the industry in terms of participating with the NRC as a stakeholder in the development of or the adaptation of HRA methods to satisfy the SRM.

EPRI has developed the SHARP framework which describes what constitutes a HRA and identifies the characteristics of HRA in the past. EPRI has developed a tool called "HRA Calculator" to help facilitate performing a human reliability analysis. The HRA calculator actually includes a number of different methods for human reliability analysis. It allows the analyst to address both pre-initiator and post-initiator human failure events. The HRA Calculator is widely used and widely accepted in the nuclear industry.

Erasmia Lois of NRC staff stated that the SRM directed the ACRS to "work with the staff and external stakeholders to evaluate the different human reliability models in an effort to propose a single model for the agency to use or guidance on which models should be

used in specific circumstances". She stated that the current focus was to start with addressing the issue for a detailed internal event/at power PRA/HRA, and converging with EPRI on HRA methods and practices. In the future, the method should be expanded to other scenarios and modified for screening/scoping analyses. The method should gain acceptance from PRA/HRA and human factors experts and practitioners.

She stated that the objective of today's meeting was to discuss the following:

1. Why not choose an existing method?
2. Is it a "hybrid"?
3. How the needs of different domains (e.g. LPSD) will be handled?
4. Would the approach be suitable for regulatory applications using existing PRAs?
What could be the impact on existing PRAs?
5. Would it be suitable for new PRAs?

The current thinking to address quantification and plan for the next meeting will also be discussed.

She stated that people involved are those with interdisciplinary expertise of PRA, HRA, nuclear power plant operations, and people who are working in the HRA area, human factors and cognitive psychology experts.

She also discussed the challenges and schedules. She stated that the methodology to be developed will support several activities such as human actions evaluation, guidance for staff review of risk-informed license requests for current and future plants, and will be used for new PRAs and especially Level 3 and industry applications.

John Forester of SNL described the outline of his presentation. It included the results of evaluation of HRA methods and current thinking on a "hybrid" approach. He stated that they did a survey of NRC staff to see what they were doing using the HRA in terms of regulatory applications, and what kind of issues they were coming up with. He described the criteria used to review methods, including validity, empirical validity and quantitative performance, variability, and resources. He stated that they examined different inputs sources in NUREG-1792 and NUREG-1842. They also looked at applications experience and practicality from NRC and industry. The results from international studies in the Halden Reactor project were also examined. . He mentioned a few of the major insights from the empirical study. They did see significant variability in results across the different HRA methods. In one case, they had one method applied by two different teams, and saw variability there too.

Vinh Dang of PSI presented findings of the main conclusions of the method evaluations. All the methods have some significant shortcomings, and they certainly have different strengths. One example of the tradeoffs is simplicity versus the ability to represent a broad range of HFEs and performance conditions. Qualitative analysis is a shared weakness; some methods are much better than others.

He stated that mixing and matching of methods is one of the two common practices in HRA. THERP is an example. Another reason for mixing and matching methods is the different contexts. In a shutdown PSA with the long time windows, one method is not particularly suitable. Therefore different methods are often applied for full power and shutdown PSA. The second practice is "adjustments" of methods relative to reference

method guidance. The practice varies from a documented set of rules to applications by analyst's discretion. These practices also affect consistency of estimated HEPs and their validity.

Vinh Dang then discussed the evaluation of features of the existing methods. These methods included using time reliability curves for decision/diagnosis, using prescriptive rules for analysis (use worksheets), using binary quantification inputs for decision, using multiple level quantification inputs, and using narrative-based failure mechanisms.

He then discussed the implications of the HRA evaluations to address the SRM. The suggestions include extending guidance for qualitative analysis, support for analysis and representation of failure mechanisms in some detail, PSF rating guidance to support comprehensive analyses which generate repeatable and traceable results, and improving technical basis by linking the HRA accepted models of human performance.

John Forester discussed the "Hybrid" approach. He said that the approach is to capitalize on the strengths of the existing methods, and also use what information they have on the psychology, the data and models. There was an emphasis here to build on cognitive psychology, and there's a particular kind of activity that they have been trying to accomplish and build a model now called a human response model, which was called a "mid-layer" model previously.

The model is building on an explicit connection on the following:

- the human failures leading to a human failure event (HFE) (proximate cause)
- the underlying psychological failure mechanisms
- the factors driving the failure mechanisms (PSFs and plant/scenario conditions)

It also used ATHEANA concepts for identifying and incorporating contextual aspects associated with human performance.

The model is also building on the causal structure of the Cause Based Decision Tree (CBDT) method for quantification.

Therefore, it is the goal that the structure is going to improve validity, consistency, traceability criteria they see as being important.

Ali Mosleh of the University of Maryland stated that his presentation was to capture the essence of the ideas and methods in a formal, structured and visible way.

He discussed the search for the proximate causes in psychological literature and use of psychological literature for proximate causes, mechanisms, and PIFs. He gave an example of how the process worked applying literature to proximate cause. He presented the assignment of PIF to PCs through psychological mechanisms and discussed examples of context-specific instances of generic proximate causes.

He summarized his presentation by saying that the mapping of generic PCs to PIFs is not as complete as the other reports but it's in reasonable shape. The mapping of the proximate causes of generic psychology to a nuclear power plant environment proximate cause has also been done, but the group has not reviewed that. The group is developing a logic structure to complete the casual model and support quantitative approach.

Gareth Parry of ERIN Engineering discussed the HRA quantification method that generates the HEP associated with a HFE.

He stated that the model should have a sound basis consistent with the cognitive psychology and behavioral science disciplines; secondly, be practical and applicable directly to the HFEs defined in the PRA; thirdly, provide the user with the tools to identify the critical elements of context (PIFs) used for the quantification of HEPs; and fourthly, facilitate intra- and inter-analyst consistency and reliability.

He said that the justification for the quantification tool is really the set of cognitive mechanisms and their links to the PIFs, and back to the proximate causes.

He described the approach on how to construct a decision tree based on the model criteria discussed earlier.

For each decision tree, the proposed approach is to rank the end points by the HEPs, and by the combination of the PIFs, and then reach consensus on two bounding cases for this tree, and interpolate. He said the quantification model will be a consensus model and discussed the use of the model.

He said that the focus was on causal approach because it provided a more rational basis for addressing dependency between HFEs occurring on the same accident sequence cut set.

He then gave an example on the backup slide to show how the tree worked.

DISCUSSION OF AGENDA ITEMS

Members and the EPRI representative discussed EPRI's role in the HRA development. Stuart Lewis stated that EPRI has tried to take a more active role in some of the technical elements. In particular, bring in Gareth Parry to help use the cause-based decision tree method as a starting point to identify areas where they could be strengthened.

Members and staff discussed the possibility of using integrated framework to show how the method would indeed support an actual human reliability analysis in the developed schedule. The staff stated that the method may be applied to a pilot study such as level 3 PRA pending the Commission's direction.

Members and John Forester discussed the variability of predicted HEPs. The examples for the LOFW event on the backup slides showed that the HEPs varied by an order and a half in magnitude and about two orders of magnitude for the SGTR event. The staff stated that the qualitative analyses that were being done just were not comprehensive enough and they often weren't structured well enough for people to use them consistently. John Forester suggested that this issue needs to be addressed.

Members discussed the data collected by the French with the presenters. Vinh Dang stated that they are simulator data and not so HEP oriented. The data are viewed as an input to their qualitative process to capture the behavior.

Members discussed with the presenters what the outcome of applying different methods for a consistent qualitative description of the scenario would be. Gareth Parry responded that if the methods did not know how to translate the qualitative information into quantification, the answers still would be different.

Members discussed with John Forester if the cognitive psychology expertise is needed to perform HRA. John replied that the information will be provided from the psychological models to the analyst. Gareth Parry said that the methods should tell them what questions to ask of the right people to get the information that they need to quantify.

Chairman asked if the “hybrid” model needs one HEP or many HEPs for a given scenario with the presenters. The presenters responded that once the quantification model is developed, hopefully it would give guidance on how to decompose the HFEs into the right subsets of conditions that need to be addressed. The relative timing of events would have to be addressed in the model.

Members discussed with the NRC contractor if broadening the base of understanding of human performance can help reduce the uncertainty. The presenter responded that the idea was really to cover all aspects, to the extent that the domain sciences allowed, and not to miss important aspects that need to be covered.

Members discussed the psychological literature reviews with the presenters. NRC contractor stated that there is a difference between the psychology of the real human performance and psychology in terms of group and crew performance and there is research done about crew dynamics. They are not sure how to fit this into HRA.

Member Bley asked whether we are getting a bigger catalogue of literature search results than we had or we are learning new things or just a better way to organize them. NRC contractor responded that they had separated the proximate causes to 30, condensed from 130 or so from psychological mechanisms from the literature.

Members had further discussions on the example of PIF-PC Map with the NRC contractor and presenter. They went through the proximate causes and PIFs in detail in the example.

Member Ryan asked how all this work feeds to an HRA. The presenter responded that they are beginning to feed the HRA process. The focus is identifying the ingredients that need to be integrated into an HRA process or procedure, and they are stopping at that level.

Member Bley commented that the research done on crew behavior was not in the reference list and that the staff is still working on that now according to this presentation. The other comment was where the naturalistic decision-making model is used in the development. The staff responded that the naturalistic decision-making model is presented in the backup slides and that became part of their big list of 130 mechanisms for failure.

Member Bley asked about the IDA and naturalistic decision-making process, Gareth Parry replied that wouldn't be an explicit loop type model. He would use that concept and thought process implicitly in designing the approach for quantification.

Members discussed the quantification tree with the presenters and other ideas for the use of the tree.

SUBCOMMITTEE DECISIONS AND ACTIONS

Following the staff and NRC contractors' presentations and discussions, Chairman Stetkar asked members if they had additional comments.

Members suggested that the staff should start documenting the modeling aspects and quantification approach; documentation on the subject is needed before the next meeting. Members would also like to see how the robustness and the uncertainty aspects of the model are addressed.

Next meeting will be scheduled next spring, pending the availability of the documents.

He then adjourned the meeting by thanking everyone for attending the meeting.

BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE

1. Staff Requirements Memorandum M061020 - dated November 8, 2006 (ML063120582)
2. Staff Requirements Memorandum M090204B - dated February 18, 2009 (ML090490812)
3. Halden Report, —The International HRA Empirical Study - Phase 2 Report - Results From Comparing HRA Methods Predictions To Hammlab Simulator Data On SGTR Scenarios||, OECD Halden Reactor Project, HWR-915, Halden, Norway, March, 2010 (ML102770646)

NOTE:

Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Rockville, MD, (301) 415-7000, downloading or view on the Internet at <http://www.nrc.gov/reading-rm/doc-collections/acrs/> or it can be purchased from Neal R. Gross and Co., 1323 Rhode Island Avenue, NW, Washington, D.C. 20005, (202) 234-4433 (voice), (202) 387-7330 (fax), nrgross@nealgross.com (e-mail).
