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CERTIFIED BY:
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
SAFETY RESEARCH PROGRAM
SUBCOMMITTEE MINUTES
MAY 4, 1999
ROCKVILLE, MARYLAND

The Advisory Committee on Reactor Safeguards (ACRS) Subcommittee on Safety Research Program held a meeting on May 4, 1999 in Room T-2B3, 11545 Rockville Pike, Rockville, Maryland with representatives of the U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research (RES). The purpose of this meeting was to hold discussions with RES and its contractors regarding the NRC safety research program including a special session on digital instrumentation and control issues. Dr. Medhat El-Zeftawy was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:30 a.m. and adjourned at 3:00 p.m.

ATTENDEES

ACRS

R. Uhrig, Chairman
M. Fontana, Member
T. Kress, Member
D. Miller, Member
D. Powers, Member
R. Seale, Member
W. Shack, Member
G. Wallis, Member

NRC

J. Calvert, RES
S. Bahadur, RES
T. King, RES
T. Jackson, RES
G. Lanik, RES
J. Rosenthal, RES
F. Eltawila, RES
E. Thornbury, RES
C. Ader, RES
A. Murphy, RES
R. Brill, RES
J. Kramer, RES
A. Thadani, RES
J. Persensky, RES
J. Craig, RES

OTHERS

B. Johnson, Univ. Of VA

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No written comments or requests for time to make oral statements were received from members of the public. A list of attendees is available in the ACRS office and will be made available upon request.

## OPENING REMARKS BY THE SUBCOMMITTEE CHAIRMAN

Dr. Robert Uhrig, Chairman of the Subcommittee, convened the meeting at 8:30 a.m. and stated that the purpose of this meeting is for the Subcommittee to review various elements of the NRC Safety Research Program and gather information for use in preparing the report to the Commission on NRC Safety Research Program. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate, for deliberation by the full Committee.

## NRC STAFF PRESENTATION

Digital System Reliability and Safety Modeling

Dr. Sher Bahadur, Office of Nuclear Regulatory Research (RES), stated that RES in Fiscal Year 2000-2002 will develop the technical bases for guidance and acceptance criteria for risk-informed regulatory decision-making on digital system reliability. This will include development of a probabilistic model and analysis methodology to arrive at the probability of unsafe failure of advanced digital instrumentation and control systems for use in PRA.

Mr. John Calvert, RES, stated that during FY 2000, RES will develop a digital research plan that will characterize operating issues from nuclear power plants and other industries, plant timing of modifications, industry technological trends, risk importance, and a prioritization scheme for advanced digital systems.

The NRC will use research results for technical basis, modeling/analysis methods for safety related digital systems in design review and integration with PRA. Qualitative and quantitative effects that could lead to system failure and potential unsafe conditions are hardware, software and hardware/software interactions. Another contributor could be extended to model external and operator interface/maintenance mistakes.

Mr. Calvert noted that safety-critical digital systems have similar modeling needs across industries. The focus is on operational phase with the given hardware and software design faults.

Dr. Barry Johnson, Professor at the University of Virginia, outlined a research program for safety-critical digital systems that is being performed at the University of Virginia Center for Safety-Critical Systems. The research objectives of this program include the following:

- Develop a reliability and safety assessment methodology for digital systems that considers the integrated hardware/software system, and allows for the inclusion of commercial of the shelf (COTS) hardware and software components

- Develop modeling and simulation techniques that support the assessment methodology to support the estimation of quantitative metrics and the evaluation of qualitative attributes.

- Develop a set of tools that supports the assessment methodology to use COTS software tools where feasible and create new tools where needed.

- Demonstrate the resulting approach and tools on real examples such as nuclear reactor protection systems (Virginia Power), railway systems (CSX and Federal Railroad Administration), and aircraft flight control (NASA and Boeing).

Dr. Johnson stated that computer systems are increasingly being used in life-critical applications such as flight control, nuclear reactors, railway, and medical applications. Designers need techniques to help ensure that proper design decisions are made during the design process, and regulatory agencies need approaches that can be used to assess the safety of systems before they are allowed to operate in the field. The safety models contain certain parameters that are often very difficult to estimate. Examples of such parameters are failure rates and conditional probabilities such as fault coverage. The proposed research program provides an assessment methodology that can be applied to safety-critical systems. The methodology considers permanent operational faults, transient operational faults, and design faults and uses hardware/software simulation as a method of estimating crucial parameters such as fault coverage. Such a methodology was applied to an existing railway Interlocking Control System (ICS).

Office of Nuclear Regulatory Research (RES)

Mr. Ashok Thadani, RES Director, stated that the 1999 ACRS draft report to the Commission regarding the RES safety research program is insightful and RES agrees with most of the recommendation outlined in the report. In general, the draft report is well focused and provides the correct information and it should be beneficial to the Commission for decision-making. RES's evaluation differs slightly in certain research areas such as fire protection and shutdown risk. Currently, RES does not have criteria for risk parameters or a success criteria for shutdown conditions. The RES staff will continue to work with the ACRS to achieve high level of understanding of the eleven research areas noted in the draft ACRS report .

Mr. Lloyd Donnelly, RES, summarized RES self-assessment program. He indicated that in the fall of 1997 as a result of the Commission's commitment to achieve a sound integrated planning process consistent with the requirement of the Government Performance and Results Act, the NRC established a planning, budgeting, and performance management (PBPM) process. The NRC FY-2000 budget and first performance plan, which is currently under review by the Congress, was in part developed using aspects of this process. The PBPM process is the

means by which the NRC intends to achieve its goal of becoming an outcome oriented performance-based organization. The process has four phases as follows phases as follows:

- Planning for setting the strategic direction
- Budgeting to determine the resources required for the plan of work
- Performance measurement to measure and monitor performance
- Performance assessment to assess progress and identify methods to improve outcome

As part of the performance assessment, RES has initiated its own self-assessment process. The objective of RES self-assessment is to increase RES contribution to the agency mission by defining desired outcomes, systematically examining work options ( new and existing) to achieve outcomes, and budgeting for work with highest outcome leverage. The first phase of RES sel-assessment process is effectiveness. This process led to a complete restructuring of the RES budget toward an outcome oriented process. This also contributed to an outcome based prioritization process which was used to inform budget decisions.

Mr. Thadani noted that the RES self-assessment process is being facilitated by Arthur Andersen. The process is budget driven and has a very compressed schedule. To set strategic direction, the following four parameters were identified:

- Goal areas (what are the major areas of focus)
- Vectors (where RES relative to where it want to be)
- Outcomes (success statements/Factors for each goal area)
- Metrics (how RES will measure success at the goal level)

Some of RES vectored goals include maintaining safety, enhance ability to make sound and realistic decisions that are timely and predictable, reduce unnecessary regulatory burden, increase public confidence, and increase internal effectiveness and efficiency. The RES budget narrative has been completely restructured to identify new outcome based planned accomplishments. Under each planned accomplishment are the issues, and under each issue are the research activities. The planned accomplishments are:

- Develop the technical bases to address identified or potential safety issues
- Develop and employ risk-information and insights to improve regulatory effectiveness
- Improve program/process efficiency and product quality
- Determine the regulatory significance of new technical information

- Improve analytical tools and data to support sound realistic decisions
- Prepare NRC to make timely future decisions
- Develop the technical bases to allow reductions to unnecessary licensee burden
- Enhance public confidence

Mr. Jack Rosenthal, RES, briefed the Subcommittee regarding the RES prioritization process. The objective of the prioritization process is to rank the technical research activities based largely on their relative contributions to outcomes. RES will employ the analytical hierarchy process (AHP), which involves numerical pairwise comparisons of choices before the decision maker to quantify the relative importance of these choices, to prioritize research activities. RES will use evaluation factors based on objective criteria to avoid vague terms such as "high", "medium", and "low". The evaluation factors are:

- The credibility of the available evidence that there is a problem or issue requiring research.
- The potential safety significance of the activity viewed in terms of the possible consequences should the design feature or program that is the subject of the research fail to function properly.
- The significance of the contribution of the activity to timely, realistic decision making.
- The degree of regulatory burden reduction which might result from the activity.
- The breadth and scope of applicability of the activity to licensees (i.e. the numbers and types of licensees affected).
- The degree of confidence that the research activity will be effective in decisive resolution of the issue.
- The degree of documented support from internal stakeholders.
- The level of industry support/participation in resolving the issue the research activity is addressing.
- The degree of leverage produced from participation in domestic and foreign cooperative research programs.

Examples of activity rating are:

A. Risk-informed Plant Assessment (high score)-
Credibility- operating experience

Safety Significance- core melt
Decision Making Significance- independent identification of issues
Burden Reduction Significance- reduced outage times
Scope of Licensees Affected- all reactors
Likelihood of Success- feasible
Documented Internal Support- Commission
Industry Participation- industry provide access only
Degree of Leverage- none

B. PUMA Experiments and Code Assessment (low score)-
Credibility- licensing experience
Safety Significance- no reduction in exposures
Decision Making Significance- more realistic tool for licensing
Burden Reduction Significance- life extension
Scope of licensees Affected- all reactors
Likelihood of Success- feasible
Documented Internal Support- Commission
Industry Participation- none
Degree of Leverage- none

The RES will keep the ACRS informed regarding the progress of the self-assessment process and the research activities in general.

Conclusion

The Subcommittee believes that to proceed with a risk-informed regulation attached with uncertainties while in the same time extending plant licenses for an additional 20 years could have adverse consequences to the NRC and the safety of nuclear power plants. The Subcommittee believes that a strong and comprehensive research program can provide the needed knowledge to reduce the uncertainties. The Subcommittee will recommend to the Full Committee to proceed with its report to the Commission as planned.

**Background material provided to the Subcommittee**

No documents were submitted to the Subcommittee prior to the meeting.

**Presentation Slides and handouts provided during the Subcommittee meeting**

The presentation slides and handouts used during the meeting are available in the ACRS Office files or as attachments to the meeting transcripts.

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NOTE: Additional details of this meeting can be obtained from a transcript available in the NRC Public Document Room, 2120 L Street, N.W., Washington, D.C. 20006, (202 634-3274, or can be purchased from Ann Riley & Associates LTD., 1025 Connecticut Ave, NW, Suite 1014, Washington D.C. 20036/(202) 842-0034.