January 13, 2004

MEMORANDUM TO: ACRS Members

FROM: Medhat El-Zeftawy, Senior ACRS Staff Engineer,
Michael Snodderly, Senior ACRS Staff Engineer,

SUBJECT: CERTIFICATION OF THE MINUTES OF THE JOINT MEETING OF THE ACRS SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND HUMAN FACTORS, OCTOBER 9, 2003 - ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued December 4, 2003, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

electronic cc: J. Larkins
S. Bahadur
H. Larson
S. Duraiswamy

MEMORANDUM TO: M. El-Zeftawy, Senior Staff Engineer
ACRS

FROM: Steve Rosen, Chairman
Human Factors Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON HUMAN FACTORS, OCTOBER 9, 2003. ROCKVILLE, MD

I do hereby certify that, to the best of my knowledge and belief, the minutes of the subject meeting held on October 9, 2003, are an accurate record of the proceedings for that meeting.

S L Rosen 11/5/03

Steve Rosen Date
Subcommittee Chairman

MEMORANDUM TO: M. R. Snodderly, Senior ACRS Staff Engineer

FROM: G. E. Apostolakis, Chairman
Reliability and Probabilistic Risk Assessment Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE JOINT MEETING OF THE ACRS SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND HUMAN FACTORS, OCTOBER 9, 2003 - ROCKVILLE, MARYLAND

I do hereby certify that, to the best of my knowledge and belief, the minutes of the subject meeting on October 9, 2003, are an accurate record of the proceedings for that meeting.

12/13/03

George E. Apostolakis, Date
Subcommittee Chairman

PRE-DECISIONAL

December 4, 2003

MEMORANDUM TO: G. E. Apostolakis, Chairman
Reliability and Probabilistic Risk Assessment Subcommittee

FROM: M. R. Snodderly, Senior ACRS Staff Engineer

SUBJECT: WORKING COPY OF THE MINUTES OF THE JOINT MEETING OF THE ACRS SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND HUMAN FACTORS, OCTOBER 9, 2003 - ROCKVILLE, MARYLAND

A working copy of the minutes for the subject meeting is attached for your review. Please review and comment on them at your soonest convenience. Mr. Rosen has already certified the human factors portion of the minutes. If you are satisfied with these minutes please sign, date, and return the attached certification letter.

Attachment: Minutes (DRAFT)

cc: Reliability and Probabilistic Risk Assessment Subcommittee Members
Human Factors Subcommittee Members
S. Bahadur
S. Duraiswamy
J. Larkins
H. Larson

CERTIFIED BY: G. APOSTOLAKIS
Certified On: 12/13/03
Certified by: S. Rosen
Certified on: 11/5/03

Issued:12/4/03

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
JOINT MEETING OF THE ACRS SUBCOMMITTEES ON
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND
HUMAN FACTORS
MEETING MINUTES - OCTOBER 9, 2003
ROCKVILLE, MARYLAND

INTRODUCTION

The ACRS Subcommittees on Reliability and Probabilistic Risk Assessment (PRA) and on Human Factors held a meeting on October 9, 2003, in Room T-2B3, 11545 Rockville Pike, Rockville, MD. The purpose of this meeting was to discuss seismic, digital instrumentation and control (I&C), and human factors research activities. The meeting was open to public attendance. Medhat El-Zeftawy and Mike Snodderly were the Designated Federal Officials for this meeting. There were no written comments or requests for time to make oral statements received from members of the public. The meeting was convened by the Subcommittee Chairman at 8:30 a.m. and adjourned at 5:50 p.m. on October 9, 2003.

ATTENDEES

ACRS Members

G. Apostolakis, Subcommittee Co-Chairman
S. Rosen, Subcommittee, Co-Chairman
M. Bonaca, Member
W. Shack, Member
J. Sieber, Member
M. El-Zeftawy, Designated Federal Official
M. Snodderly, Designated Federal Official

Principal NRC Speakers

S. Arndt, RES
S. Cooper, RES
M. Cunningham, RES
M. Evans, RES
J. Flack, RES
E. Lois, RES
A. Murphy, RES
P. O'Reilly, RES
J. Persensky, RES

Other Principal Speakers

D. Gertman, INEEL

There were approximately two other members of the public in attendance at this meeting. A complete list of attendees is in the ACRS Office File and will be made available upon request. The presentation slides and handouts used during the meeting are attached to the office copy of these minutes.

OPENING REMARKS BY CO-CHAIRMAN APOSTOLAKIS

George Apostolakis, Chairman of the ACRS Subcommittee on Reliability and PRA convened the meeting at 8:30 a.m. Dr. Apostolakis stated that the purpose of this meeting was to discuss seismic, digital I&C, and human factors research activities with representatives of the NRC Office of Nuclear Regulatory Research (RES). He said the subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee in support of the annual ACRS Safety Research Report. The rules for participation in the meeting were announced as part of the notice of the meeting published in the Federal Register on October 1, 2003.

DISCUSSION OF AGENDA ITEMS

Seismic Research

Dr. Andrew Murphy began by discussing a cooperative agreement with the U.S. Geological Survey. The cooperative agreement covers areal screening of liquefaction hazards, fault segmentation in evaluating fault specific earthquake potential, re-evaluation of ground motion models for central and eastern U.S. and Canada, and recurrence and uncertainty in central U.S. earthquakes. Dr. Murphy explained that this research is an excellent value and that the cost covers the level of effort to consider this research from a nuclear industry perspective.

The next topic covered by Dr. Murphy was work being conducted by the University of California at Santa Barbara. The Garner Valley downhole seismic array is a program initiated by the NRC which is now part of a major National Science Foundation program. Dr. Murphy then described the senior seismic hazards analysis curve. When the staff revised Appendix A to Part 100, the seismic siting rules, the U.S. Geological Survey pointed out that the knowledge of seismicity and various parameters in the Eastern United States was evolving. In the associated Statement of Considerations, the staff agreed to do a ten-year evaluation of the ground motion and propagation and its implications on hazard calculations.

Dr. Murphy spent the majority of the presentation discussing the different seismic hazard curves and how to possibly reconcile them. He discussed collaboration on seismic response of containments, assessment of degraded structures and components, and soil structure interaction for buried structures with the Nuclear Power Engineering Corporation of Japan. Dr. Murphy ended with continuing and emerging issues. He mentioned new data and interpretations involving the East Tennessee, Turkey, and Taiwan and new ground motion input guidance. Dr. Murphy said that new information regarding soil-structure interactions may implications on the review of the pebble-bed modular reactor. This is of less prominence now that the review of that reactor design has been put on hold.

General Comments and Observations From the Subcommittee Members

- Dr. Shack asked what impact not supporting the U.S. Geological survey work would have. Dr. Murphy explained that the funding has them look at the impact high frequency ground motions might have on nuclear power plant structures, such as switchgear and relays. Mr. Sieber asked about the frequencies they were looking at. Dr. Murphy said between 7 and 11 Hertz.

- Mr. Rosen asked why the Garner Valley work being performed by the University of California at Santa Barbara was applicable to the east coast. Dr. Murphy replied that they have worked closely with the Geological Survey to identify an eastern like soil column in a high seismicity area like Santa Barbara.

- Dr. Apostolakis asked what regulatory decisions before the Commission are impacted by the garner valley research. Dr. Murphy said it had implications on a potential revision to the seismic hazard methodology for the central United States and review of Early Site Permits.

- Dr. Shack asked if the EPRI and Livermore Seismic Hazard curves had converged. Dr. Murphy said that there was still an issue for decommissioning and spent fuel pools. Dr. Apostolakis asked when the issue would be resolved. Dr. Murphy said that RG 1.165 and 10 CFR 100.23 have helped to reduce the differences in the results of using either of the seismic hazard curves.

- Dr. Apostolakis requested a briefing of the PRA Subcommittee to discuss the different seismic hazards analyses and the work that was done at the U.S. Geological Survey in the Fall of 2004.

Digital I&C Research

Dr. Steven Arndt began by discussing the NRC Digital I&C research plan which was provided to the Commission in SECY-01-0155, August 2001. The research plan answered the need, highlighted in the NAS review, for a more systematic approach to developing information and regulatory guidance. Dr. Arndt then covered the four major program areas. Systems aspects of digital technology includes environmental stressors, digital requirement specifications, diagnostics and fault tolerance, and operating systems. Software quality assurance includes objective software engineering criteria and criteria for software testing. The third area covered was emerging I&C technology and applications and the final area was risk assessment of digital I&C systems. Dr. Arndt described research that is needed to develop an acceptable method for review of digital system reliability models. Dr. Arndt said that the following models are being investigated: University of Virginia fault injection methodology, University of Maryland software metric methodology, Halden BBN, RETRANS, and a failure modes and effects analysis by BNL.

General Comments and Observations From the Subcommittee Members

- Mr. Rosen asked about shared systems in the control room. Dr. Arndt discussed the use of multiple screens to integrate plant operations. Mr. Rosen was concerned that this may be the wrong approach and that a better approach would be for the operators to concentrate on fewer screens.

- Mr. Sieber commented that he separates risk-informing the digital I&C area into two aspects. One is the human-machine interface aspect, which he thought was ripe for probabilistic analysis. The other one is the reliability of the system itself, which in his mind is a second order effect. Mr. Sieber asked if any reliability work had been done for analogue systems. Dr. Arndt said that some limited work had been done but it has not

shown those systems to be risk dominant. This supported Mr. Sieber's comment that it was a second order effect.

- Mr. Sieber confirmed that digital control and protection systems are to remain separate just as analogue systems have been designed. Mr. Sieber then challenged Dr. Arndt and asked why we needed further research for digital system design if we planned on using the same analogue design approach. Dr. Arndt responded that some designers believe that analogue design criteria is too conservative and not realistic enough. Dr. Apostolakis raised the concern that there may be discontinuities that are very disturbing. Dr. Arndt brought up examples (i.e., Airbus event and THORAC-25) of such discontinuities.

- Mr. Sieber asked how do you model a digital control room when one is not physically available. Dr. Arndt said that there are some foreign digital control rooms and there are quite a few subsystems within the control room that are completely digital.

- Dr. Apostolakis asked where digital systems are used. Dr. Arndt responded that digital systems are used in the balance of plant systems at almost every plant. There are four plants with license applications for basically complete digital upgrades over the course of several refueling outages and four digital systems that have been approved by topical report for application to control ESFAS and RPS applications.

- Dr. Apostolakis asked if there were any reports on the DOE and Halden workshops. Dr. Arndt said there was a summary document of the DOE workshop and a set of the presentations from the Halden workshop. Dr. Arndt committed to providing a copy of each to the Committee.

- Mr. Sieber asked about the environmental qualification of fiber optic cables. Dr. Arndt replied that currently no fiber optic cables are installed inside containment but there is a question whether the assumptions used in an environmental qualification test program are applicable to fiber optic cable.

- Mr. Sieber asked for a copy of the 1997 National Academy of Science report on Digital I&C Systems.

- Dr. Apostolakis asked if BNL had a reliability model in mind. Dr. Arndt said BNL is using the Markoff model as their default. Dr. Apostolakis warned about the importance of critical review of the different reliability models being developed by BNL and the University of Maryland. Dr. Apostolakis asked for a briefing of the PRA and Plant Operations Subcommittees on digital failure assessment methods and system models.

HUMAN FACTORS SUBCOMMITTEE

Human Reliability Analysis Program

Mr. Steve Rosen, Subcommittee Chairman, convened the meeting at 1:00 p.m. He stated that the purpose of this meeting was to discuss human factors and organizational safety culture research activities with representatives of the NRC Office of Nuclear Regulatory Research (RES). The Subcommittee will gather information, analyze relevant issues and facts, and

formulate proposed positions and actions, as appropriate, for deliberation by the full Committee in support of the annual ACRS Safety Research Report. The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on October 1, 2003.

Dr. John Flack stated that the mission of the NRC program on Human Performance in nuclear power plant safety is to ensure that reactor safety is maintained through effective regulation and oversight of human performance in the design, operation, maintenance, and decommissioning of nuclear reactor facilities. This will be accomplished by identifying human performance issues important to public health and safety, increasing understanding of the causes and safety implications of these human performance issues, and then implementing the appropriate regulatory response to human performance issues. There are four key NRC areas to which the Human Performance program contributes: Reactor Oversight Process, Plant Licensing and Monitoring, the NRC's Risk-Informed Regulation Implementation Plan, and Emerging Technology and Emerging issues.

The planning process for the human performance program included a detailed review and analysis of important human actions contained in Accident Sequence Precursor program risk models (associated with licensee event or investigation reports), review of individual plant examination reports, and review of other reports where critical human performance actions are identified.

Mr. Julius Persensky , RES, stated that on November 1, 2001, the NRC/RES staff informed the Commission of the integration of Human Performance activities with the Human Reliability Analysis (HRA) research plan. RES staff believes that the integration of human performance activities with the HRA plan activities will improve the synergy among projects that are intended to enhance the data and data sources for establishing human error probabilities. Methods for converting data and information from published human factors and behavioral science literature into HRA for certain issues , such as the effects of fatigue on personnel performance, can be developed. Human factors reviews of operational experience reports may identify needed improvements to HRA techniques.

Mr. Persensky noted that some of the human performance activities in RES include development of regulatory review guidance, such as Revision 3 to Regulatory Guide 1.8, "Qualification and Training of Personnel for Nuclear Power Plants." The technical basis for the review of plant changes that credit operator action in place of automatic actions was developed to serve as a basis for a future revision to the Standard Review Plan's (SRP) Chapter 18 (Human Factors Engineering), and Chapter 19 (Probabilistic Risk Assessment). RES also supported NRR in reassessing the Commission's policy on fatigue of workers at nuclear power plants. In addition, RES developed a SRP chapter on human factors for the Office of Nuclear Materials Safety and Safeguards (NMSS) for use in the review of a mixed oxide (MOX) fuel facility.

Emerging technology issues are intended to prepare the agency for potential future activities that include control station design review guidance, deregulation, advanced reactors, and the aging workforce. Revision 2 to NUREG-0700 will incorporate the results of completed studies of advanced alarm systems, display navigation, computerized procedures, and issues specific to

hybrid control stations. Future development of NUREG-0700 will be sunset after publication of Revision 2.

A study to identify safety issues that might result from economic deregulation of the nuclear power industry was published as NUREG/CR-6735, "Effects of Deregulation on Safety: Implications Drawn from Aviation, Rail, and United Kingdom Nuclear Power Industries."

Currently, the nuclear industry is considering the licensing of new reactors, especially new designs such as the pebble bed modular reactor (PBMR). Current regulations that address human performance issues were developed for review of LWRs and ALWRs. New regulations and guidance may need to be developed to address the new concept of operations. Human behavioral modeling techniques, such as task network modeling and discrete event simulation, have been developed and tested by the U.S. Army and Navy. These tools need to be developed or adapted for use by the regulatory staff in the licensing of advanced reactors. For example, Exelon has already indicated that they plan to ask for a waiver from 10 CFR 50.54(m), the staffing rule for LWRs, to allow for fewer licensed operators at the PBMR. Decisions regarding staffing should be based on design features including function allocation, automation, integration, and plant-specific characteristics. This could result in a change to 10 CFR 50.54.

RES staff plans to develop insights report on the role of human performance in advanced reactors. The objective is to provide insights on the role of human performance in advanced reactor performance from a safety perspective. The insights report will identify human performance issues associated with operation and maintenance that require research, the need for new research facilities, and the need for regulatory review guidance. Some of the interim findings of the insights report include that the impact on human performance is not obvious for advanced systems, new technology can be poorly designed from a human factors engineering standpoint, and personnel do not use human system interactions (HSIs) in the way designers expect. New reactor concepts will significantly change human interactions.

RES staff continues to derive insights from operational experience reviews and capitalizes on international activities related to human performance through participation in the Halden Reactor Project and the Committee on the Safety of Nuclear Installations (CSNI) working groups on risk, operating experience and the special experts group on human and organizational factors. The staff also continues to participate in consensus standards committees and professional activities with the industry and other agencies. Some of the FY04 activities include guidance development for NRR, guidance development for the NRC Office of Nuclear Security and Incident Response (NSIR), human factors for new reactors gaps from insights report, MOX and gas centrifuge facility licensing , risk communications, Halden reactor project, and human performance safety indicator.

Mr. Persensky briefed the Subcommittee regarding a follow-up to the ACRS workshop on Safety Culture. He stated that in accordance with the Commission guidance, the staff does not conduct direct evaluations or inspections of safety culture as a routine part of assessing licensee performance. The staff relies on inspection procedures and the ROP to monitor some underlying elements of safety culture. The staff does not, nor does it plan to, assess licensee management competence, capability, or optimal organizational structure as part of safety culture.

Ambiguity exists with regard to the definition of safety culture and safety conscious work environment (SCWE). The two concepts are related, but safety culture is broader and includes SCWE. The staff has adopted the International Nuclear Safety Advisory Group (INSAG)- 4, definition of safety culture as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance." The NRC Policy Statement (May 1996) on "Freedom of Employees in the Nuclear Industry to Raise Safety Concerns without Fear of Retaliation", defines SCWE as a work environment in which employees are encouraged to raise safety concerns and where concerns are promptly reviewed, given the proper priority based on their potential safety significance, and appropriately resolved with timely feedback to the originator of the concerns. In the Staff Requirements Memorandum (SRM-SECY-02-0166-Options for Revising NRC's Process for Handling Discrimination), the Commission instructed the staff to continue monitoring efforts to measure and regulate safety culture, with the objective to develop measures that serve as indicators of problems with safety culture.

During the ACRS workshop on safety culture (June 12, 2003), the staff indicated that though they have means to assess several of the aspects of safety culture, they do not have a method to bring these together into a single document. The ACRS in its report of July 16, 2003, stated that the existing regulations provide an appropriate framework for monitoring the impact of licensee safety culture on performance. The staff in its response of August 21, 2003 to the ACRS report stated that monitoring international and domestic events and activities to develop objective measures will serve as a cross-check in confirming the appropriateness of the regulatory framework.

The NRC staff is monitoring activities in the international community such as the International Atomic Energy Agency (IAEA) and the Organization for Economic Co-operation and Development (OECD)/Nuclear Energy Agency (NEA). The IAEA recently issued INSAG 15, "Key Practical issues in Strengthening Safety Culture." The NEA has published two reports: "The Role of the Nuclear Regulator in Promoting and Evaluating Safety Culture" and "Regulatory Response Strategies for Safety Culture Problems." The NEA Special Experts Group on Human and Organizational Factors (SEGHOF) is working in the areas of management of change and scientific approaches to safety management. Other activities include INPO/Significant Operating Event Report (SOER) 02-04- November 11, 2002 (all plants doing self-assessments); and NASA (Columbia Accident Investigation Board report).

Mr. Persensky outlined two theoretical underpinnings models for safety culture developed by Dr. Schein; and Helmreich & Merritt. Dr. Schein 's model of safety culture consists of three elements (Artifacts, Claimed Values, Basic Underlying Assumptions). The Artifacts include visible products, behaviors, organizational structures and processes. Claimed values include strategies, goals, and philosophies. The Basic underlying assumptions include unconscious, taken-for-granted beliefs, perceptions, thoughts, and feelings. The Helmreich & Merritt model consists of team performance input factors, team performance functions, performance outcomes, and individual and organizational outcomes. Team performance input factors include individual aptitudes, operating conditions, professional subculture, organizational culture, and regulatory environment. Team performance functions include team formation and management, decision process, operating experience, communications, and response planning.

Mr. Persensky noted that some of the potential performance indicators for safety culture include Corrective Action Program (CAP), SCWE, and Human Performance. Potential performance indicators for the CAP could include issue history, condition report accuracy, timeliness of corrective action completion, etc. The SCWE indicator would indicate the volume and trend of NRC allegations, volume and trend of internally raised concerns, percent of anonymous concerns, and breach of confidence. The Human Performance indicator would indicate individual error rate, human error resulting in plant transient, results of management observations, outstanding procedure change requests, and industrial safety performance. Other open questions still remain such as the criteria and threshold to be used, risk implications, and regulatory approach.

Mr. Mark Cunningham, Ms. Erasmia Lois, and Ms. Susan Cooper, Division of Risk Analysis and Applications (RES), briefed the Subcommittee (s) regarding the HRA program overview. They stated that human performance is more complicated and less understood than most other risk contributors. Human error is frequently the cause of serious accidents and human failures are usually significant contributors to risk. HRA remains an important contributor to overall uncertainty in risk studies. Modeling and data of human performance has not reached the maturity level of some other PRA areas. New issues for PRA such as, advanced reactors and HRA for materials and waste, require an expanded knowledge base for HRA.

The current HRA research program accomplishments include the development of improved HRA technology (e.g., ATHENA), performing HRA applications that lead to more realistic results (e.g., pressurized thermal shock PRA, steam-generator tube rupture PRA, and fire risk-requantification), and developing lessons learned to support the regulatory activities.

Some of the issues currently being addressed include HRA practices such as consistency, applicability, and data. The limitations on data quality are recognized by experts as contributing significantly to the uncertainties of HRA. Other issues include HRA guidance development, and HRA knowledge for emerging needs such as materials and waste.

Ms. Lois described a 3-step approach for HRA guidance. Document 1- describes what are the driving influences on human performance in nuclear safety to set the stage for Document 2. Document 2- HRA Good Practices, provides technical guidance for performing and reviewing HRA (start with the ASME standard and go to lower level). Document 3- evaluates methods (first and second generation) capability to meet the attributes identifies in Document 2. Documents 1 and 2 are expected to be completed by June 2004, while Document 3 is expected to be completed by June 2005.

For the data development, a human performance information repository (INFORM) is being developed by INEEL for HRA and human factors. The current focus is on nuclear power plants operational experience with future plans to include other sources. The benefits of such approach are improved understanding of human performance, more realistic probability estimation, and to provide support to a variety of NRC activities. Other related activities include Halden, CSNI HRA data sharing activity. For CY 04 and beyond, the INFORM status will include updating of software, add more events, develop Bayesian type methods to use information, and continue collaboration with international activities.

Future HRA research program activities include new knowledge for emerging needs such as latent conditions, advanced reactors, Level 2, and external events; continue activities on data, guidance, and standards as needed; continue work on NMSS HRA; analyze information collected or generated to test and improve HRA models; and continue international interactions.

General comments and observations from the Subcommittee members

- Mr. Rosen indicated that approximately 50% or more of operating events are due to human factors and organizational weakness. He emphasized that the reliability of an organization is very important to the operation of nuclear power plants.

- Dr. Apostolakis noted that the ROP should include an indicator to alert the NRC regarding the failure of organizational safety culture.

- Dr. Apostolakis recommended that the significance determination process (SDP) could be used in the evaluation of human performance and risk implications.

- Mr. Rosen encouraged the NRC staff to pursue the convergence of one HRA model. Dr. Apostolakis concurred and cited the CREAM-model used in the NASA applications.

- Mr. Rosen indicated that in the HRA arena, expert opinion is important and urged the NRC staff to seek such information.

- Dr. Apostolakis and Mr. Rosen requested to see the HRA guidance documents (1,2,and 3) prior to finalization. RES staff agreed.

- The Subcommittee(s) members agreed to continue to follow-up on the progress of the HRA/HF research program.

SPAR-H Methodology

Dr. Patrick O'Reilly began by providing a brief history of the development of the SPAR-H Methodology. He explained that the purpose of the methodology was to improve HRA practices for use in the accident sequence program. The methodology was intended to handle actuation, recovery, and dependency through a consistent model of human behavior. Dr. O'Reilly then went over some of the major milestones in the development of the SPAR-H methodology. In 1999, performance shaping factors and human error probabilities were incorporated into the methodology. In 2002, an uncertainty analysis capability was provided and performance shaping factors for low power/shutdown conditions were evaluated. Dr. O'Reilly discussed specific applications of the SPAR-H methodology such as its use in analyzing operator performance during a SGTR at Indian Point 2 in February 2000. Dr. O'Reilly concluded with a discussion of the peer review of the methodology by internal and external stakeholders.

Dr. O'Reilly then turned the presentation over to Dr. David Gertman of INEEL. Dr. Gertman's presentation addressed the following topics: 1) why a new HRA methodology had to be developed rather than adopting an existing, familiar methodology, 2) comparison of the method to other methods of HRA and quantification, 3) validity of the method by comparison to experimental or experiential data, 4) justifications for the various performance shaping factors

(especially those that are different than those selected by other methods, those that are quite different than expected range of effects, and those not substantiated by a supporting data base), 5) 2003 accomplishments, and 6) comments to date on the draft NUREG/CR.

General Comments and Observations From the Subcommittee Members

- Mr. Rosen asked why time wasn't one of the summary level influencing factors. Dr. Gertman said it was an oversight and that time was included as an influencing factor in the draft NUREG/CR.

- Dr. Apostolakis asked if the influencing factors are assumed to be independent and if not are we double counting them somewhere. Dr. Gertman said they are not assumed to be independent and that the degree of double counting may be between 20 and 30%. Dr. Gertman felt there was a technical solution to the double counting problem. He suggested that if one could take a subset of say 10,000 LERs and look for the coincidence of pairs of shaping factors over this huge database of information then one would get the relative frequency of when complexity shows up with work practice problems or fitness for duties implicated along with poor ergonomics. From that one could infer the degree of overlap, and if one could do that, then they could come up with the equation to take care of the double counting problem. Dr. Apostolakis commented that this may be too ambitious of an approach at this time.

- Dr. Apostolakis asked if the SPAR-H methodology is being used by senior reactor analysts in the regions. Dr. O'Reilly said that it was used by senior reactor analysts during Phase 3 of the Significance Determination Process.

- Dr. Shack questioned whether human error probabilities in the range of 0.8 to two weren't really one. Dr. Gertman responded that by picking a non-nominal value you force the issue and it allows one to decide whether or not you need to do more analysis.

- Mr. Rosen asked if the SPAR-H methodology had been piloted and were the results found to be repeatable. Dr. Gertman said that in 1999 members of INEEL were asked to analyze the same event but there has not been an effort to have several users such as SRAs analyze the same event for repeatability. Mr. Rosen suggested that this would be a good idea. Dr. Gertman agreed but added that his present funding was to document the methodology so that utilities and other potential users can understand it. Dr. Cunningham added that, in Phase 3, the analysis is submitted to the licensee for their review.

STAFF AND INDUSTRY COMMITMENTS

The staff committed to supporting a briefing of the PRA Subcommittee to discuss the different seismic hazards analyses and the work that was done at the U.S. Geological Survey in the Fall of 2004. Dr. Arndt, RES, committed to providing a copy of a summary document of the DOE workshop and a set of the presentations from the Halden workshop. Mr. Sieber asked for a copy of the 1997 National Academy of Science report on Digital I&C Systems. Dr. Apostolakis asked for a briefing of the PRA and Plant Operations Subcommittees on digital failure assessment methods and system models.

SUBCOMMITTEE DECISIONS AND ACTIONS

Dr. Apostolakis recommended a follow-up meeting to discuss digital I&C reliability models. The Subcommittee decided that the information gathered would be useful in developing the annual Safety Research Report. The Subcommittee will reassess the need for future interactions after reviewing a first draft of the report in December 2003.

BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING

1. Subcommittee status report, including agenda.

2. Letter dated August 19, 2003, from Ali Tabatabai, Link Technologies Inc., to John Larkins, Executive Director, ACRS, Subject: Status and Next Steps - 2004 Research Report (For Internal ACRS Use Only)..

3. Draft SECY (PREDECISIONAL)–Regulatory Approaches to Safety Culture..

4. Staff Requirements Memorandum (SRM)–issued on March 26, 2003.

5. Task Group Report, dated June 13, 2003, "NRC Safety Culture & Climate."

6. Draft NUREG/CR, "SPAR-H Model," manuscript completed November 2002.

7. NUREG/CR-6833, "Formal Methods of Decision Analysis Applied to Prioritization of Research and Other Topics," October 2003.

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Note: Additional details of this meeting can be obtained from a transcript of this meeting available for downloading or viewing on the Internet at "http://www.nrc.gov/ACRSACNW' or can be purchased from Neal R. Gross and Co., Inc., (Court Reporters and Transcribers) 1323 Rhode Island Avenue, NW., Washington, DC 20005 (202) 234-4433.

mike S

Committee Management Secretariat, General Services Administration.

FOR FURTHER INFORMATION CONTACT: Andrew L. Bates, Office of the Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555; Telephone: 301–504–1963.

Dated: September 25, 2003.

Andrew L. Bates,

Advisory Committee Management Officer.

[FR Doc. 03–24852 Filed 9–30–03; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards; Joint Meeting of the ACRS Subcommittees on Reliability and Probabilistic Risk Assessment and on Human Factors; Notice of Meeting

The ACRS Subcommittees on Reliability and Probabilistic Risk Assessment and on Human Factors will hold a joint meeting on October 9, 2003, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Thursday, October 9, 2003—8:30 a.m. until the conclusion of business.

The purpose of this meeting is to discuss seismic, digital I&C, and human factors research activities. The Subcommittees will hear presentations by and hold discussions with representatives of the NRC staff and other interested persons regarding this matter. The Subcommittees will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Officials, Mr. Michael R. Snodderly (telephone: 301–415–6927) or Dr. Medhat M. El-Zeftawy (telephone: 301–415–6889) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted during the meeting.

Further information regarding this meeting can be obtained by contacting one of the Designated Federal Officials between 7:30 a.m. and 4:15 p.m. (ET). Persons planning to attend this meeting are urged to contact one of the above named individuals at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: September 23, 2003.

Sher Bahadur,

Associate Director for Technical Support, ACRS/ACNW.

[FR Doc. 03–24851 Filed 9–30–03; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards Meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment; Notice of Meeting

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment will hold a meeting on October 10, 2003, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows: *Friday, October 10, 2003—8:30 a.m. until the conclusion of business.*

The purpose of this meeting is to discuss the status of the probabilistic risk assessment research program. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and other interested persons regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Mr. Michael R. Snodderly (telephone: 301–415–6927) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted during the meeting.

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Dated: September 23, 2003.

Sher Bahadur,

Associate Director for Technical Support, ACRS/ACNW.

[FR Doc. 03–24853 Filed 9–30–03; 8:45 am]

BILLING CODE 7590–01–P

SECURITIES AND EXCHANGE COMMISSION

[Release No. 35–27726]

Filings Under the Public Utility Holding Company Act of 1935, as amended ("Act"); The Connecticut Light and Power Company (70–10163)

September 25, 2002.

Notice is hereby given that the following filing(s) has/have been made with the Commission pursuant to provisions of the Act and rules promulgated under the Act. All interested persons are referred to the application(s) and/or declaration(s) for complete statements of the proposed transaction(s) summarized below. The application(s) and/or declaration(s) and any amendment(s) is/are available for public inspection through the Commission's Branch of Public Reference.

Interested persons wishing to comment or request a hearing on the application(s) and/or declaration(s) should submit their views in writing by October 20, 2003, to the Secretary, Securities and Exchange Commission, Washington, DC 20549–0609, and serve a copy on the relevant applicant(s) and/or declarant(s) at the address(es) specified below. Proof of service (by affidavit or, in the case of an attorney at law, by certificate) should be filed with the request. Any request for hearing should identify specifically the issues of facts or law that are disputed. A person who so requests will be notified of any hearing, if ordered, and will receive a copy of any notice or order issued in the matter. After October 20, 2003, the application(s) and/or declaration(s), as filed or as amended, may be granted and/or permitted to become effective.

Notice of Proposal To Amend Charter Or, Alternatively, Waive Charter Provision; Order Authorizing the Solicitation of Proxies

The Connecticut Light and Power Company ("CL&P"), 107 Selden Street, Berlin, Connecticut 06037, a wholly owned public-utility subsidiary of Northeast Utilities ("NU"), a registered holding company, has filed a declaration ("Declaration") with the Securities and Exchange Commission ("Commission") under sections 6(a)(2) and 12(e) of the Public Utility Holding Company Act of 1935, as amended ("Act") and rules 54, 62, and 65 under the Act.

Currently, the ability of CL&P to incur or assume unsecured indebtedness is limited by a provision in its Certificate of Incorporation ("Charter"). The Charter provides that, except with the

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
JOINT MEETING OF THE SUBCOMMITTEES ON
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND
HUMAN FACTORS
ROOM T-2B3, 11545 ROCKVILLE PIKE, ROCKVILLE MD
OCTOBER 9, 2003

Contact: Michael Snodderly (301-415-6927, mrs1@nrc.gov)

-PROPOSED SCHEDULE-

	TOPICS	PRESENTERS	TIME
I.	**Opening Remarks**	G. Apostolakis, ACRS D. Powers, ACRS	8:30-8:35 a.m.
II.	**Seismic Research**	A. Murphy, RES	8:35-~~9:40~~ 9:30 a.m.
III.	**General Discussion**	G. Apostolakis, ACRS D. Powers, ACRS	~~9:40-9:45 a.m.~~
	BREAK		**9:45-10:00 a.m.**
IV.	**Introductory Remarks**	~~G. Apostolakis, ACRS~~ ~~J. Sieber, ACRS~~	~~10:00-10:05 a.m.~~ 9:30 a.m.
V.	**Digital I&C Research and Digital Systems Risk**	S. Arndt, RES H. Hamzehee, RES	~~10:05~~ 9:30 a.m.-11:55 a.m.
VI.	**General Discussion**	G. Apostolakis, ACRS J. Sieber, ACRS	11:55-~~12:00~~ 12:20 p.m.
	LUNCH		**12:00-1:00 p.m.**
VII.	**Introductory Remarks**	S. Rosen, ACRS	1:~~00~~ 20-1:05 p.m.
VIII.	**Human Factors and Human Performance Research**	J. Flack, RES	1:05-1:50 p.m.
IX.	**Organizational Safety Culture Research**	J. Flack, RES J. Persensky, RES	1:50-3:15 p.m.
	BREAK		**3:15-3:30 p.m.**
X.	**Human Reliability Research**	H. Hamzehee, RES	3:30-4:25 p.m.
XI.	**SPAR-H Model**	P. O'Reilly, RES	4:~~25~~ 40-5:25 p.m.
XII.	**General Discussion**	S. Rosen, ACRS	5:25-5:30 p.m.
XIII.	**Adjourn**	S. Rosen, ACRS	5:~~30~~ 45 p.m.

NOTE:

- Presentation time should not exceed 50 percent of the total time allocated for specific item. The remaining 50 percent of the time is reserved for discussion.
- 35 copies of the presentation materials to be provided to the Subcommittee

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
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IV.	**Introductory Remarks**	G. Apostolakis, ACRS J. Sieber, ACRS	10:00-10:05 a.m.
V.	**Digital I&C Research and Digital Systems Risk**	S. Arndt, RES H. Hamzehee, RES	10:05-11:55 a.m.
VI.	**General Discussion**	G. Apostolakis, ACRS J. Sieber, ACRS	11:55-12:00 p.m.
	LUNCH		**12:00-1:00 p.m.**
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IX.	**Organizational Safety Culture Research**	J. Flack, RES J. Persensky, RES	1:50-3:15 p.m.
	BREAK		**3:15-3:30 p.m.**
X.	**Human Reliability Research**	H. Hamzehee, RES	3:30-4:25 p.m.
XI.	**SPAR-H Model**	P. O'Reilly, RES	4:25-5:25 p.m.
XII.	**General Discussion**	S. Rosen, ACRS	5:25-5:30 p.m.
XIII.	**Adjourn**	S. Rosen, ACRS	5:30 p.m.

NOTE:

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MEETING OF THE SUBCOMMITTEE ON
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT
ROOM T-2B3, 11545 ROCKVILLE PIKE, ROCKVILLE MD
OCTOBER 10, 2003

Contact: Michael Snodderly (301-415-6927, mrs1@nrc.gov)

-PROPOSED SCHEDULE-

	TOPICS	PRESENTERS	TIME
I.	**Opening Remarks**	G. Apostolakis, ACRS	8:30-8:35 a.m.
II.	**Plan for Application of Formal Decisionmaking Methods in Integrated Regulatory Decisions**	P. Kadambi, RES	8:35-9:20 a.m.
	BREAK		**9:20-9:30 a.m.**
III.	**Overview of the PRA Safety Research Program**	M. Cunningham, RES	9:30-9:40 a.m.
IV.	**Program for Risk-Based Analysis of Reactor Operating Experience** A. ASP Program B. Industry Trends Support C. SPAR Model Development Program D. Reply to ACRS Letter on Risk-Based Analysis of Reactor Operating Experience	P. Baranowsky, RES	9:40-11:30 a.m.
	LUNCH		**11:30-12:30 p.m.**
V.	**Planned Activities in Development of PRA Methods and Standards** A. Integrated Uncertainty Research B. SAPHIRE Peer Review C. Low Power and Shutdown Risk	H. Hamzehee, RES	12:30-2:30 p.m
VI.	**General Discussion**	G. Apostolakis, ACRS	2:30-2:45 p.m.
VII.	**Adjourn**	G. Apostolakis, ACRS	2:45 p.m.

NOTE:

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON HUMAN FACTORS AND RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

OCTOBER 9, 2003
Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

NAME	NRC ORGANIZATION
Michele G Evans	RES/DET
Bakr Ibrahim	NMSS/DWM
VF Gostelb	RES/DET
Steven Arndt	RES/DET
Richard Eckenrode	NRR/DIPM/IROB
JOHN FLACK	RES/REAHFB
Molly Keefe	RES/REAHFB
Joe Gai	NRR/DIPM/IROB
J Persensky	RES/REAHFB
Autumn Szabo	RES/REAHFB
J. BONGARRA	NRR/DIPM/IROB
David Desaulniers	NRR/DIPM/IROB
Clare Goodman	NRR/DIPM/IROB
ERASMIA LOU	RES/DRAR/PRAB
Jane Jenny	RES/DSARE/REAHFB
STU MAGRUDER	RES/DRAA
Susan Cooper	RES/DRAA/PRAB
Dan O'Neil	RES/DRAA/PRAB
Pat O'Reilly	RES/DRAA/OERAB
Mike Cheok	RES/DRAA/OERAB

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON HUMAN FACTORS AND RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

OCTOBER 9, 2003
Date

PLEASE PRINT

NAME	AFFILIATION
SPYROS TRAIFOROS	LINK
CURTIS SMITH	INEEL
DAVID GERTMAN	INEEL
MARCIA McWREATH	GAO
~~Dan O'Neal~~	

INTRODUCTORY STATEMENT BY THE CHAIRMAN
OF THE ACRS SUBCOMMITTEE
ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT
11545 ROCKVILLE PIKE, ROOM T-2B3
ROCKVILLE, MARYLAND
OCTOBER 9, 2003

The meeting will now come to order. This is a joint meeting of the Advisory Committee on Reactor Safeguards Subcommittees on Reliability and Probabilistic Risk Assessment and Human Factors. I am George Apostolakis, Chairman of the Subcommittee on Reliability and Probabilistic Risk Assessment.

Members in attendance are Steve Rosen, Chairman of the Subcommittee on Human Factors, Mario Bonaca, Chairman of the ACRS, William Shack, and Jack Sieber.

The purpose of this meeting is to discuss seismic, digital I & C, and human factors research activities with representatives of the Office of Nuclear Regulatory Research. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee. Medhat El-Zeftawy and Michael Snodderly are the Designated Federal Officials for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the *Federal Register* on October 1, 2003.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting.

(Chairman's Comments-if any)

- An evacuation drill is to take place this morning. The drill is most likely to occur between 10 and 11 am and is expected to last one hour. All occupants of this room are expected to evacuate, including members of the public. Members and staff of the ACRS are to assemble in the area designated for the ACRS in the driveway between Eatzi's and the Two White Flint North building.

- To lessen the impact of the drill on today's presentations, I suggest that the seismic presentation end at 9:30 am and we immediately begin the digital I & C presentation until 10 am. After the drill we will continue the digital I & C presentation until noon.

- Thank you for your cooperation with this matter.

We will now proceed with the meeting and I call upon Dr. Andrew Murphy of the Office of Research to begin.

Master

U.S. Nuclear Regulatory Commission

PRESENTATION TO ACRS SUBCOMMITTEE ON EARTH SCIENCES & EARTHQUAKE ENGINEERING RESEARCH

Andrew J. Murphy, DET/RES

301-415-6011

October 9, 2003

Outline

- Seismic Program Contribution to NRC Performance Goals
- Earth Sciences
  - Research
  - Regulatory Guidance
- Earthquake Engineering
  - Research
  - Regulatory Guidance
- Continuing & Emerging Issues

Program Contribution to Performance Goals

- Make NRC activities & decisions more effective, efficient & realistic
- Reduce unnecessary burden on stakeholders

Earth Sciences

- U.S. Geological Survey
- Univ. of California at Santa Barbara
- Update of Probabilistic Seismic Hazard
- Code Benchmarking & IAEA CRP
- Regulatory Guides

US Geological Survey

- Cooperative Agreement for Research
  - Areal Screening of Liquefaction Hazards
  - Fault Segmentation in Evaluating Fault-Specific Earthquake Potential
  - Re-evaluation of ground motion models for central & eastern US & Canada
  - Recurrence & Uncertainty in central US earthquakes

UC Santa Barbara

- Garner Valley Downhole Seismic Array
- Initiated by NRC – now part of a major NSF program
  - Seismic array
  - Pore pressure array
  - SFSI Structure
  - Active Component
    - Shaker for frequency response
    - Shaker induced liquefaction

SSHAC Update

- Ten-Year Update of Probabilistic Seismic Hazard Estimates
  - SOC for Appendix A rulemaking
  - Two estimates still an issue
  - Evaluation of USGS 2003 methodology & estimates
    - Work initiated in August, 2003
    - Preliminary estimate at end of CY 2003
    - Staff evaluation in late Spring 2004
    - Staff recommendation on how to proceed Summer 2004

Earth Science Research (cont.)

- Hazard Code Benchmarking
- IAEA Coordinated Research Project
  - Effects of Near-Field Ground Motion

Regulatory Guides

- R.G. 1.132 – "Site Investigations for Foundations of Nuclear Power Plants"
- R.G. 1.138 – "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants"
- R.G. 1.198 – "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plants"

Earthquake Engineering

- NUPEC Collaboration on Seismic Issues
- Seismic Response of Containments with NUPEC
- Assessment of Degraded Structures & Components
- Soil-Structure Interaction for Buried Structures

Earthquake Engineering (cont.)

- Support for NMSS
  - Seismic Response for Dry Storage Casks
  - Dry Cask PRA
  - MOX Facility Review

Collaboration with Japan

- Soil Structure Interaction Program
- Concrete Shear Wall Test Program
- Energy Absorbing Supports Program
- Equipment Fragility Test Program
- Seismic Response of Containments
- NUPEC has been reorganized
  - Two new units

Earthquake Engineering

- Regulatory Guides
  - R.G. 1.92 – "Combining Modal Responses and Spatial Components in Seismic Response Analysis"

Continuing & Emerging Issues

- New Data &Interpretations
  - East Tennessee Seismic Zone (GSI - 194)
  - Implications of Recent Earthquakes – Turkey & Taiwan
  - Coordination of New PSHAs - US GS & EPRI
    - Evaluation & Use
- New Technology
  - Buried or Deeply Embedded Structures
    - Ground Motion Input Guidance
    - Soil-Structure Interactions – Building & Interconnects
  - Fragility of New Structures & Components

Master

United States Nuclear Regulatory Commission

Digital Instrumentation and Control Research and Digital Systems Risk

Steven A. Arndt
Division of Engineering Technology
Office of Nuclear Regulatory Research

October 9, 2003

OVERVIEW

- REVIEW OF DIGITAL I&C RESEARCH PROGAM
- PROGRAM EXTERNAL DRIVERS
- RESEARCH AREAS
- NEW REACTORS
- FUTURE PLANS
- SUMMARY

DIGITAL I&C RESEACH PLAN

- SECY-01-0155 NRC Digital Instrumentation and Control Research Plan Published in August 2001
- Answered the Need, Highlighted in the NAS Review, for more Systematic Approach to Developing New Information and Regulatory Guidance
- Endorses by the ACRS and Commission
- Includes Research in Four Major Areas

I&C Research Program Goals

- I&C Research Program has the goal of improving decision making by increasing the efficiency, effectiveness and realism
- In support of this goal
  - Develop more consistent approach to assessment
  - Develop more effective analysis tools
  - Develop new guidance and update existing guidance as appropriate (for example new version of RG 1.168 on Verification, Validation, Reviews and Audits for Digital Computer Software)
  - Support user requests

PROGRAM EXTERNAL DRIVERS

- NRR User Need, Provided in March, 2000 and Reaffirmed in July, 2002
- DOE I&C and HMI Working group Recommendations, May, 2002
- Halden Workshop on Digital System Reliability, December, 2002
- EPRI D3 Working Group establish, 2002

DIGITAL I&C RESEACH PROGRAM

- Four Major Program Areas
- System Aspects of Digital Technology
  - *Environmental Stressors*
  - *Digital Requirement Specifications*
  - *Diagnostics and Fault- Tolerance*
  - *Operating Systems*
- Software Quality Assurance.
  - *Objective software engineering criteria*
  - *Criteria for software testing*

DIGITAL I&C RESEARH PROGRAM

- Emerging I&C Technology and Applications
  - *Predictive maintenance and on- line monitoring systems*
  - *Advanced instrumentation*
  - *Smart transmitters*
  - *Wireless communication*
  - *Computer security*
  - *Technology Review and Infrastructure including; developing and maintain interactions and interfaces, standards work and the review new technology*

DIGITAL I&C RESEARH PROGRAM

- Risk Assessment of Digital I&C Systems
  - *Digital I&C Failure Data*
  - *Digital Failure Assessment Methods and System Models*
  - *Digital Reliability Assessment Methods and Integration in PRA's*
  - *Digital System Risk Guidance*

WHAT IS NEEDED IN DIGITAL SYSTEM PRA's

- Research is Needed to Develop an Acceptable Method for Review of Digital System Reliability Models
- Required is:
  - Understanding of the state of the data
  - Understanding of the strengths and limitations of system models
  - Understanding of how digital system models can be incorporated into nuclear plant PRA's
  - Guidance for what is acceptable

DIGITAL I&C FAILURE DATA

- Several studies have been done on available data from other fields (MIL-HDBK 217F, NUREG/CR-6734, Telcordia, LER database, etc)
- Some analysis has been done to show general trends in numbers and types of failures
- There is a need to develop agreed upon methods for analysis of limited data and integration of data from other domains

DIGITAL I&C FAILURE DATA (Cont.)

- Research program to develop in-house database for RES analysis and use
- COMPSIS international database
- EPRI interested in working with NRC in this area
- BNL review of the strengths and weakness of existing databases in terms of their use in reliability modeling

Digital Failure Assessment Methods and System Models

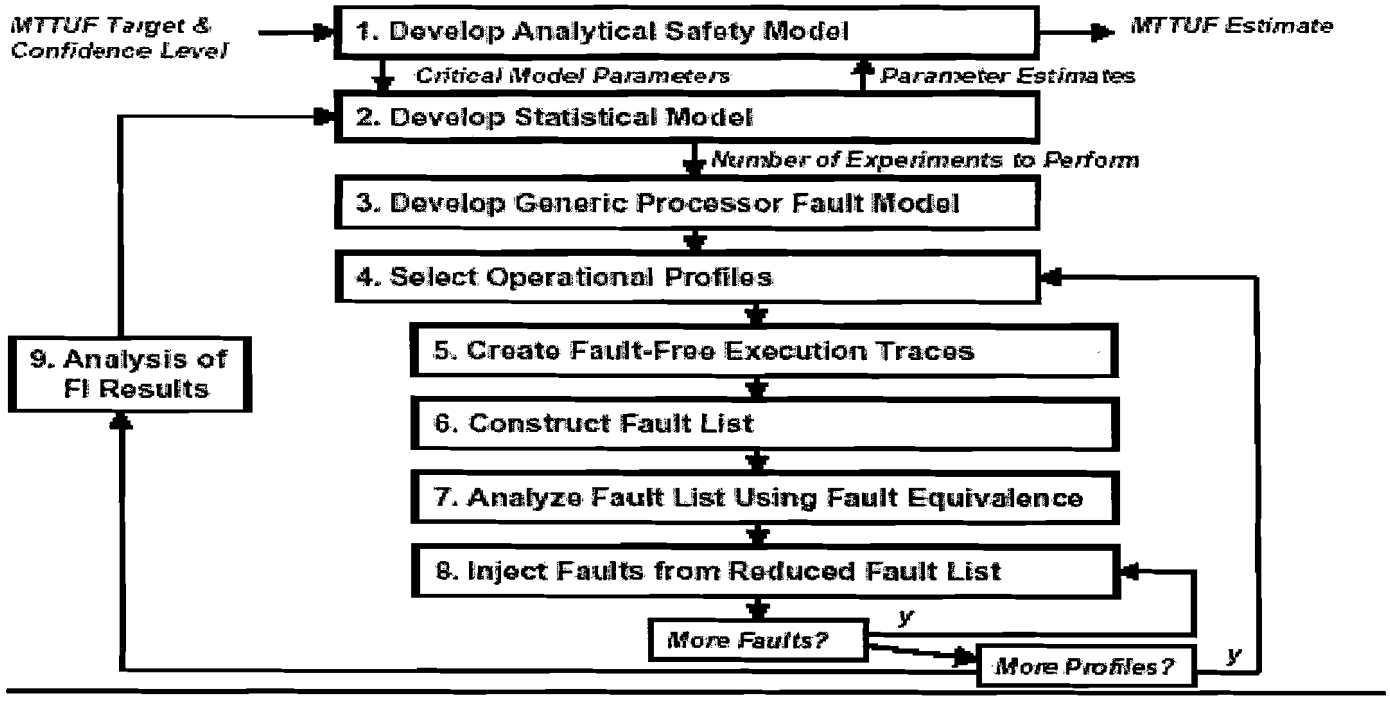
- Several Methods Currently Being Investigated
  - University of Virginia Fault Injection Methodology
  - University of Maryland Software Metric Methodology
  - Halden BBN and Model Based Reliability Research
  - RETRANS tool
  - FMEA (BNL)

Digital Failure Assessment Methods and System Models (Cont.)

- University of Virginia
  - Based on digital system coverage
  - Uses detailed system modeling and fault injection as a method to estimate mean time to unsafe failure
  - Has been successfully use in other domains
  - Calvert Cliffs Main Feed Water demonstration project

Digital Failure Assessment Methods and System Models (Cont.)

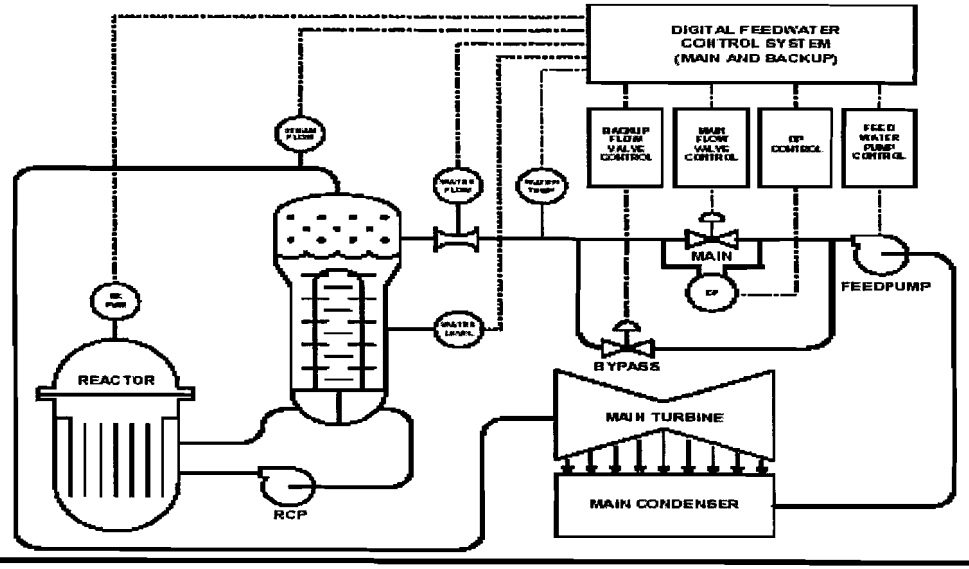
Coverage Estimation Process Overview



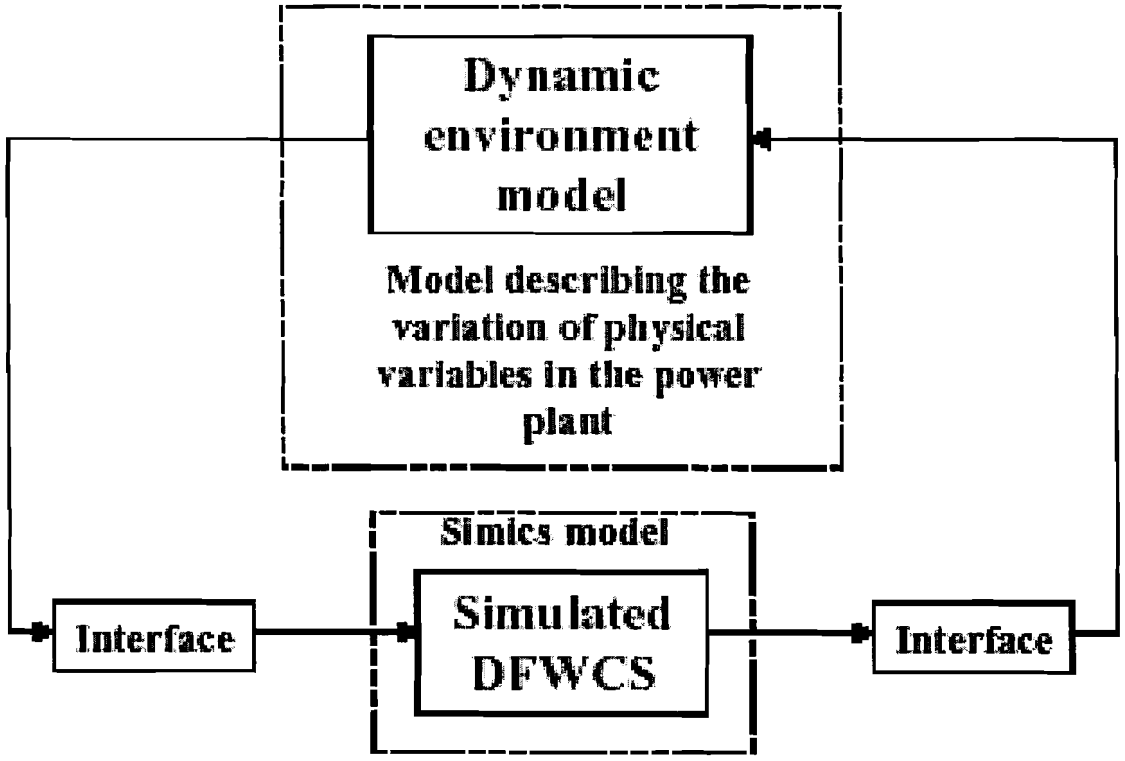
Digital Failure Assessment Methods and System Models (Cont.)

Overview of Calvert Cliffs DFWCS

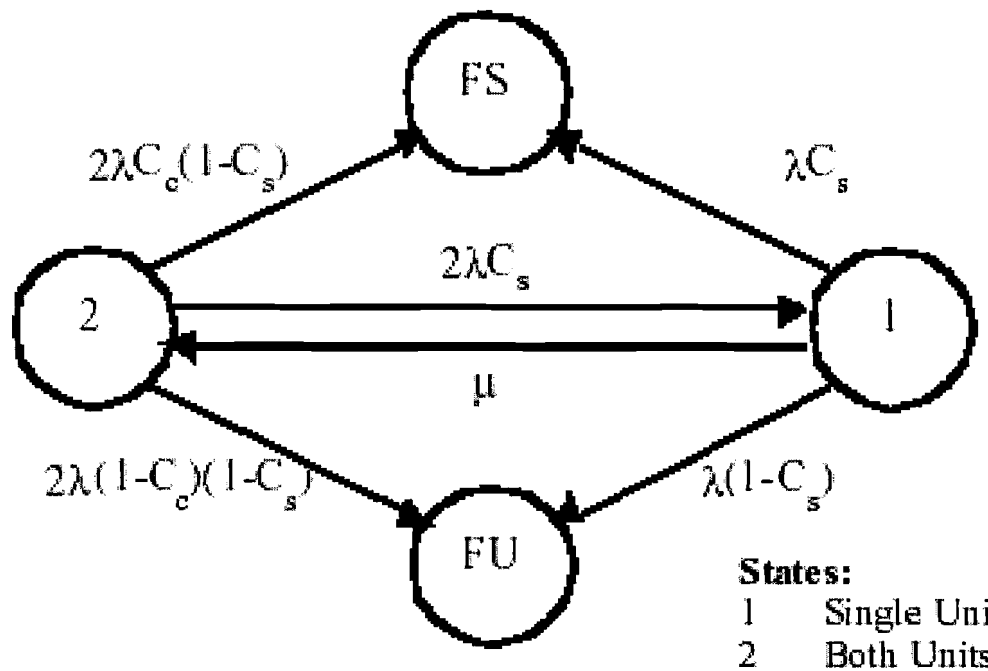
- Purpose: control the water level in its associated steam generator from ~1% to 100% power



Digital Failure Assessment Methods and System Models (Cont.)



Digital Failure Assessment Methods and System Models (Cont.)



States:

1	Single Unit Operational
2	Both Units Operational
FS	Failed-Safe
FU	Failed-Unsafe

Digital Failure Assessment Methods and System Models (Cont.)

- Assume λ = 100 failures/million hours

Controller: C_s	Compare: C_c	MTTUF, hrs	S_{ss}
0.8	0.9	72,200	0.82
0.9	0.9	140,000	0.90
0.99	0.9	1,367,000	0.989
0.8	0.99	80,200	0.84
0.9	0.99	153,800	0.91
0.99	0.99	1,490,000	0.99

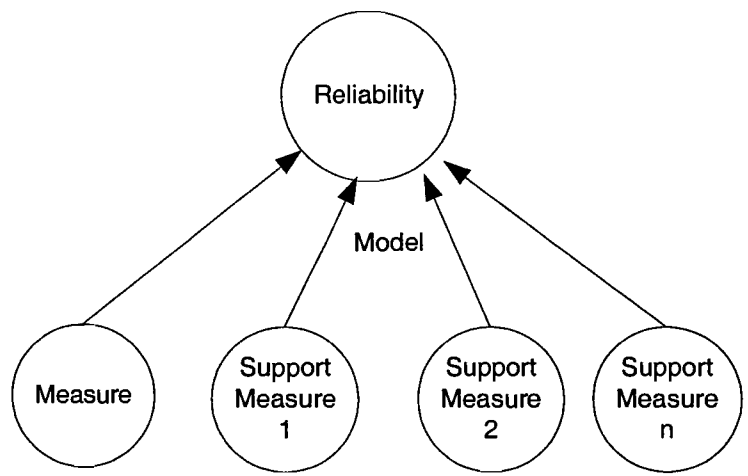
- Safety assessment process will focus on estimating C_s by injecting faults into the main DFWCS controller

Digital Failure Assessment Methods and System Models (Cont.)

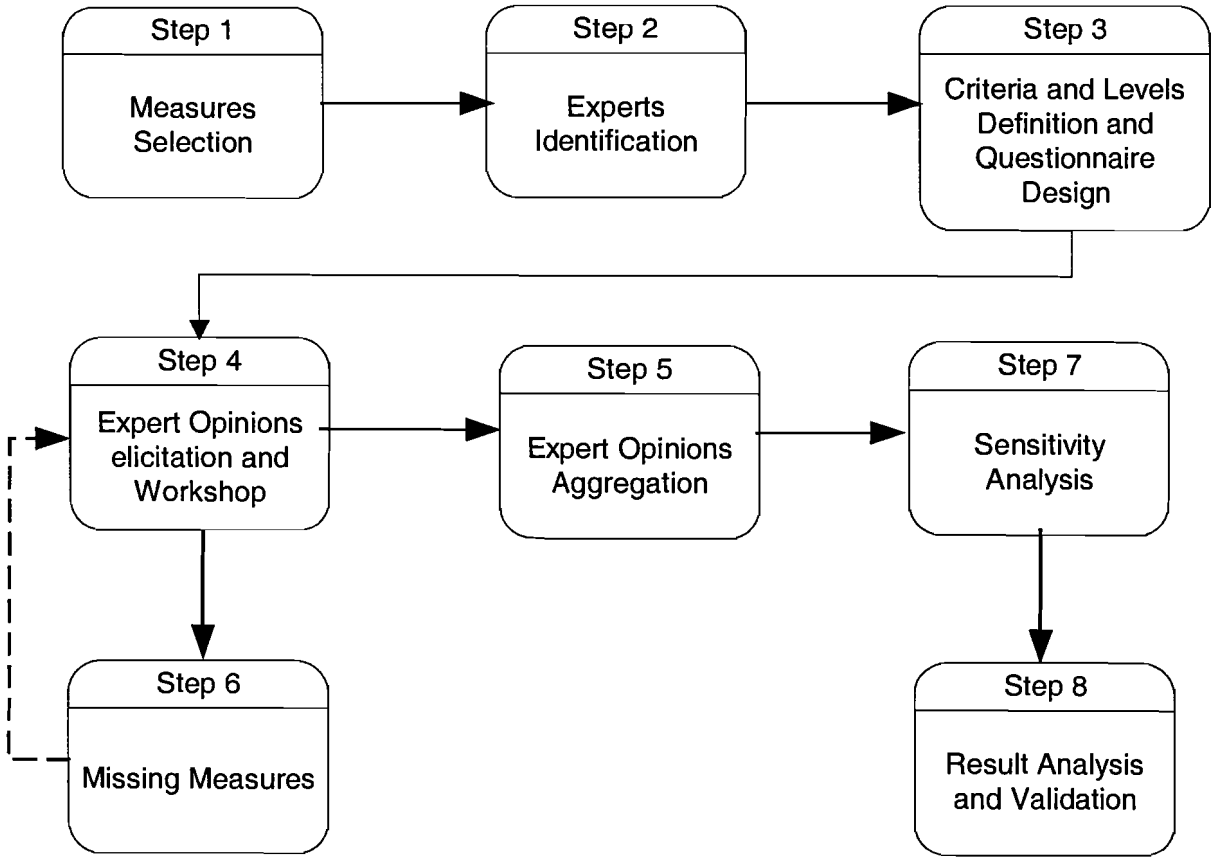
- University of Maryland
  - Development of Software Reliability Prediction Methods
    - How software reliability is determined?
    - Product characteristics
      - Project characteristics
      - Development characteristics
    - Operational environment
  - Software engineering determine software reliability

Digital Failure Assessment Methods and System Models (Cont.)

Reliability Prediction System (RPS)



Digital Failure Assessment Methods and System Models (Cont.)



Digital Failure Assessment Methods and System Models (Cont.)

Pre-selected Measures

Bugs per line of code (Gaffney estimate)
Cause & effect graphing
Code defect density
Cohesion
Completeness
Cumulative failure profile
Cyclomatic complexity
Data flow complexity
Design defect density
Error distribution
Failure rate
Fault density
Fault number days
Feature point analysis
Function point analysis
Functional test coverage
Graph-theoretic static architecture complexity
Man hours per major defect detected
Mean time to failure
Minimal unit test case determination
Modular test coverage
Mutation testing (error seeding)
Number of faults remaining (error seeding)
Requirements compliance
Requirements specification change requests
Requirements traceability
Reviews, inspections and walkthroughs
Software capability maturity model
System design complexity
Test coverage

Digital Failure Assessment Methods and System Models (Cont.)

Validation Results

Measure	Value	The number of Unresolved Defects	p_s	Pe	Original Rankings	Validation Rankings
Mean time to failure	1267.6 seconds	N/A	0.91849	0.029643	1	1
Defect density	11.72 defects/KLOC	9	0.92243	0.076548	2	2
Test coverage	94.6%	5 (4.8)	0.908	0.095238	3	4
Requirements traceability	78.6%	7	0.92243	0.076548	4	3
Function point	75.0	6 (5.6)	0.9980385	0.976649	5	5
Bugs per line of code (Gaffney estimate)	66 (65.6) defects	66 (65.6)	0.999972	0.999667	6	6
p_s(real)	0.916					

Digital Failure Assessment Methods and System Models (Cont.)

- BNL work to develop methods and tools needed to model digital systems in PRA
  - Capture the unique characteristics of digital systems
  - Use FMEA to evaluate digital features and identify the unique dependencies
  - Evaluate existing data bases and determine their suitability in supporting reliability modeling

Digital Reliability Assessment Methods and Integration in PRA's

- FMEA of Digital Features
  - Detailed FMEA
  - Develop description of the systems
  - Develop reliability block diagrams including digital feature and connections
  - Use current NPP systems (Common Q, Tricon, Teleperm, ABWR)
  - Review of unrecognized dependencies, fault tolerant features and level of detail need in modeling

Digital Reliability Assessment Methods and Integration in PRA's (Cont.)

- New program in FY 04 to look at integration issues and develop some technical consensus
- Develop pilot program for digital reliability methods in PRA's
- Assess the feasibility of using current models as "plug-ins" to current generation static PRA's

Digital System Risk Guidance

- Guidance on how to assess risk informed applications in the area of digital systems
  - Review of existing guidance
  - Development of guidance for the methods, data, and quality of analysis
  - Development of guidance for the completeness and scope of the analysis
  - Will used information developed by BNL as starting point

New Reactors

- First project on Lessons Learned from Evolutionary plants
  - Review of technical and regulatory issues encountered in new reactor construction around the world
  - Development of research questions for new reactors using current NRC regulations
  - Results include, new environments, advanced control systems, dependability features

New Reactors (Cont.)

- FY 04 project on development of risk models
- Other projects, in research program but not yet funded include:
  - Review of issues associated with multi-module plants
  - Autonomous control
  - New instruments, and advanced diagnostics

FUTURE PLANS

- Work to Complete the Demonstration Projects
  - University of Virginia, work on RPS
  - University of Maryland, work on RPS
- New Projects On Reliability Assessment Methods and Integration in PRA's and Guidance
- More Active International Cooperation in the Digital Systems Risk Area
  - Database Development
  - Halden Research
  - International Program
- New Reactors

FUTURE PLAN (Cont.)

- PRA Integration
  - Development of test cases and peer reviews
- Guidance Development
  - Review of risk informed I&C submittals
  - Input to other guidance
- New Digital I&C Research Plan

SUMMARY

- Current Research Program Includes Several Project on Digital System Risk
- Research is Focused in Several Areas, Including, Model Development, Data Collection and Guidance Development
- Several Programs being demonstrated with nuclear power plant systems
- Industry and the International Community are also moving forward in this Area

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United States
Nuclear Regulatory Commission

Human Reliability Analysis Program
Overview

Mark Cunningham, Erasmia Lois, and Susan Cooper
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

Presented to
Joint Subcommittee on Reliability Risk Assessment and Human Factors
Advisory Committee on Reactor Safeguards
USNRC Headquarters • Rockville, MD • 9th October 2003

Presentation Overview

- Why HRA research is important
- Accomplishments
- Summary of HRA Program Plan
- Issues currently addressed
  - HRA guidance
  - HRA data
    - NRC
    - Halden
    - CSNI
  - NMSS
- Future activities

HRA research is important because…

- Human performance is more complicated & less understood than most other risk contributors
  - Human error is frequently the cause of serious accidents
  - Human failures are usually significant contributors to risk
- Although on-going research has accomplished a great deal, HRA remains an important contributor to overall uncertainty in risk studies
  - Modeling and data of human performance has not reached the maturity level of some other PRA areas
- "New" issues for PRA (e.g., advanced reactors, HRA for Materials and Waste) require expanded knowledge base for HRA

HRA Research Program--Accomplishments

- Developed improved HRA Technology, e.g., ATHEANA
- Performing HRA applications that lead to more realistic results
  - PTS PRA (completed)
  - SGTR PRA (in progress)
  - Fire re-quantification (in progress)
- Developing lessons learned supporting regulatory activities
  - HRA Good Practices Document
  - Post-fire manual actions rulemaking (Revision To Appendix R)
  - Incorporated in SPAR HRA methodology (SPAR-H)

Summary of HRA Research Program Plan

	Conventional Reactors	Advanced Reactors	Waste & Materials	Security & Safeguards
Rules	✓ Fire Manual Actions			
Licensing	✓ Fire ✓ SGTR	• HRA for Upgraded & Advanced Reactors	✓ Specific applications	Specific applications
Monitoring				
Infra-Structure	*Methods and Tools* ✓ Human performance information repository ✓ Human Actions Under Severe Accidents (SGTR) ✓ Individual and Crew Performance (Halden) • Latent Conditions, Safety Culture • Extended Applications: LPSD, Slowly Evolving Events, Ex-control Actions • Screening Human Actions *Implementation* ✓ Guidance ✓ Standards *Coordination with other programs* ✓ CSNI ✓ Halden ✓ IEEE ✓ ASME ✓ EPRI		*Methods and Tools* ✓ Feasibility study • Methods • Data *Implementation* • Guidance	

✓ ongoing
• planned

Issues Currently Being Addressed

- HRA Practices
  - Consistency: HRA methods are implemented differently
  - Applicability: Some methods may not be suitable to address the issue at hand
  - Data: Lack of data quality is recognized by experts as contributing significantly in the uncertainties of HRA
  - HRA guidance development
  - HRA data development
- New HRA knowledge for emerging needs
  - Materials and Waste

HRA Guidance

- Provide the technical basis for developing an SRP (and a Reg Guide) for reviewing/performing HRA
  - Developed by Sandia
- Recommended by NRR to help address decision-making
  - Licensee requests on plant modifications
  - Options 2 & 3
- Benefits
  - Improve staff's capability to perform more consistent and technically correct evaluation of licensee requests
  - Standardize HRA practices
- Related activities
  - EPRI HRA guidance--method specific
  - IEEE HRA standards
  - ASME PRA standard

Approach for HRA Guidance

- Build in insights from performing/reviewing PRAs/HRAs
- Lessons learned from ATHEANA development and applications will be used to address issues such as
  - Whether and to what degree the non-explicit treatment of error of commission in licensees PRAs may contribute to overlooking potentially significant human failure events?
  - Whether changes in plant design and plant operations create the potential of inducing new human-induced failures?
- 3-step Approach
  - Document 1: describes what are the driving influences on human performance in nuclear safety--set the stage for Document 2
  - Document 2, "HRA Good Practices," Provides technical guidance for performing/reviewing HRA--start with the ASME standard and go to lower level
  - Document 3: Evaluates methods (1st and 2nd generation) for their capability to meet the attributes identified in Document 2

HRA Guidance--Status

- Document 2: HRA Good Practices
  - Draft submitted August 03
  - Public Review and Comment: January 04
  - Final Version: June 04
- Document 1: Drivers of Human Performance
  - Draft to be submitted, Nov 03
  - Public Review and Comment --under consideration
  - Final: June 04
- Document 3: Evaluation of HRA methods
  - Draft June 04
  - Final Sept 04
  - Public Review and Comment: Jan 05
  - Final: June 05

Data Development

- Make an effective use of existing information
  - Hard data (failures/opportunities) are sparse
  - Information/evidence is available
  - Bayesian type methods allow the use of evidence in estimations
- A Human Performance Information Repository (INFORM) is being developed for HRA and HF
  - Developed by INEEL
  - Currently focusing on NPP operational experience
  - Future plans include other sources
- Benefits
  - Improved understanding of human performance
  - More realistic probability estimation
  - Support a variety of NRC activities
- Related activities
  - Halden , CSNI HRA data sharing activity
  - RES/OERB equipment failure database

Approach for INFORM Development

- Characterize the information needed for HRA
  - Identify concepts and terms used in the various HRA methods
  - Identify concept-commonalties
  - Develop glossary
- Identify and evaluate data sources for usefulness
  - Determine what information should be extracted
  - Propose a structure to incorporate the information
- Create-test a repository
- Develop methods to estimate human failure event probabilities

INFORM Development--Status

- CY 03
  - Prototype of repository and limited number of operational events
  - Interaction with users/internal review
  - Letter Report describing INFORM (to become NUREG/CR)
- CY 04 and Beyond
  - Finalize software, add events
  - Develop Bayesian type methods to use information
  - Continue collaborate with Halden, CSNI and other related activities

Halden Simulator Experiments

- Design simulator experiments specifically for HRA
  - Experimental data is the best thing next to "real"
  - Improve understanding of both successes and failures
  - Examine operator and team performance
- NRC support to Halden
  - NRC HRA team meeting at Halden, June 2003
  - INEEL staff at Halden, Sept 03 - March 04
  - Plans for Halden staff visiting to NRC/National Labs, 04
- Benefits
  - Capability to test hypotheses employed in HRA methods
  - Achieve rigorous (systems-type) modeling methods
- Related activities
  - CSNI HRA data sharing
  - INFORM development

CSNI Activities on HRA

- CSNI is "outlining a framework for HRA information exchange"
- HRA WGRisk meeting was held, 9/24-26/03
- Countries expressed strong interest to achieve this goal
- A detailed outline of a report was created
  - Simulator and operational events were considered as useful
  - Need for including data related to design and construction of new reactors was recognized
  - Lead authors of the report are representatives from Germany, Switzerland, USA
- A version of the report for CSNI approval will be ready for next CSNI/WGRisk meeting, Fall 2004.

HRA FOR MATERIALS AND WASTE

- Develop HRA capability specific to Materials and Waste applications
- User Need (NMSS/RTG) asks for
  - Phase 1: Feasibility study to identify important human actions, user needs, & development requirements
  - Phase 2: Development of HRA methods, tools, etc. based on feasibility study
- Benefits
  - Allow NMSS to better risk-inform their activities
  - Support important NRC activities (e.g., Yucca Mountain)
- Related activity
  - Pilot PRA for dry cask storage
- Status
  - Phase 1: To be completed by Dec 03
  - Phase 2: CY 04 and beyond

Future HRA Research Program Activities

- New knowledge for emerging needs
  - Latent conditions (FY 04)
  - Advanced reactors (FY 04)
  - Level 2 (FY 05)
  - External events (FY05)
- Continue activities on data, guidance, and standards as needed
- Continue work on NMSS HRA
- Analyze information collected or generated to test/improve HRA models (FY 05)
- Continue international interactions
  - Leveraging the general knowledge and resources

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SPAR HUMAN RELIABILITY ANALYSIS (HRA) METHODOLOGY (SPAR-H METHOD)

Patrick D. O'Reilly
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Office of Nuclear Regulatory Research
October 9, 2003

SPAR-H METHOD
History

- 1994 – Initial Development of Methodology.
  - Purpose: Improve HRA practices for use in ASP Program.
  - A general, easy-to-use method which handled actuation, recovery, and dependency through a consistent model of human behavior.
  - Use of worksheets simplified application of the methodology.

SPAR-H METHOD
History (Continued)

- 1999 – Modifications Made to Initial Method Based upon a Benchmarking Process.
  - Performance shaping factors (PSFs).
  - Dependency.
  - Human error probabilities (HEPs).

SPAR-H METHOD
History (Continued)

- 2002 – Further Modifications:
  - Refined PSF definitions.
  - Provided uncertainty analysis capability.
  - Evaluated PSFs for low power/shutdown conditions.
  - Increased detail in dependency assignment.
  - Documented in draft NUREG report.

SPAR-H METHOD
Specific Applications

- Incorporated in Level 1, Revision 3 (Full Power) and in Level 1, Low Power/Shutdown SPAR Models.

- Worksheets for Performance Shaping Factor Estimation Used by Regional Office SRAs in Phase 3 Analyses in Significance Determination Process (SDP).

- Used by ASP Program in Uncertainty Analysis of Events in which Operator Performance is an Issue (e.g., August 1999 Loss of Electric Power to a Safety Bus at IP-2; February 2000 SGTR at IP-2).

SPAR-H METHOD
Recent Accomplishments

- One-Day Public Workshop on SPAR-H Method in June.

- Peer Review of Draft NUREG by Internal/External Stakeholders.
  - Internal (NRR, RES, Regional Offices)
  - External (NEI, EPRI, INPO, Owners Groups, Union of Concerned Scientists)

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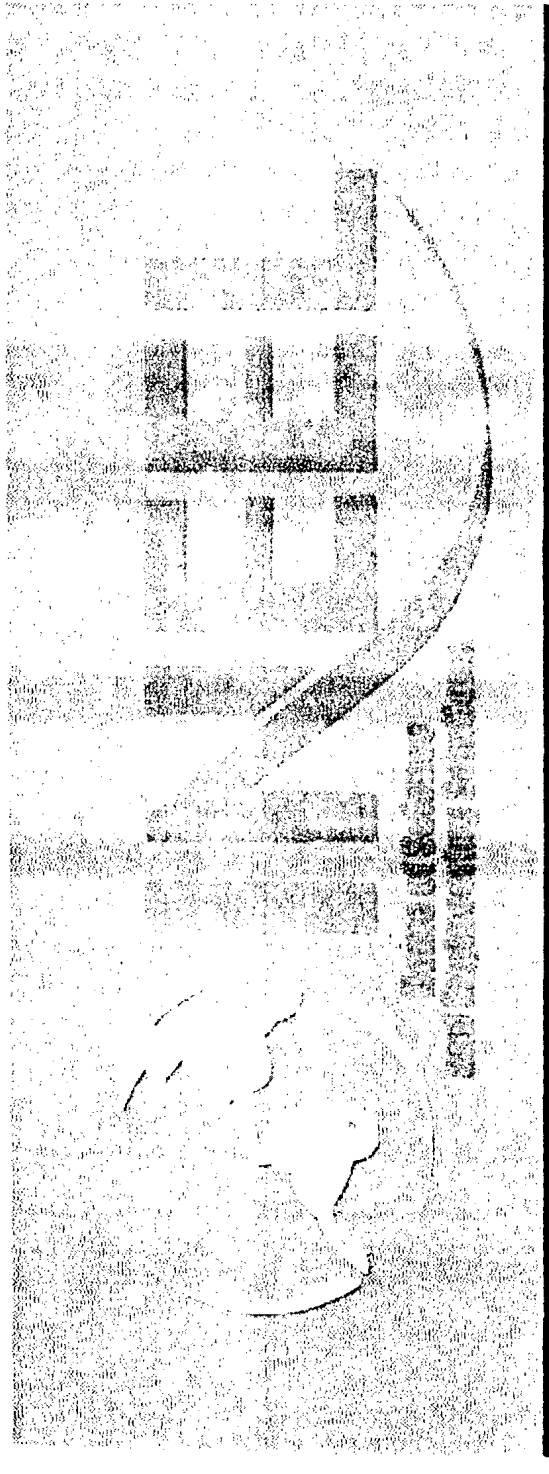

Idaho National Engineering and Environmental Laboratory

SPAR-HRA Methodology

US NRC ACRS Meetings

David I. Gertman and Harold S. Blackman

October 9, 2003

Meet ASP Programmatic Requirements

- ***Based on an Amalgamation of Other Methods***
- ***Easy to use***
- ***Simplified approach***
- ***Analysis can be completed in short time (If a full scope, detailed HRA is needed, other existing methods should be used)***
- ***Ensure relevant factors are addressed/accounted for***
- ***Appropriate for most human behavior***

Assumptions

- ***A simple model of human behavior is adequate***
- ***Model is based on human performance and cognition; <u>not</u> on a specific plant condition***
- ***PSFs can be identified that influence decision making and actions and cover each stage of the human behavior***
- ***Plant conditions, tasks, people, and situations combine to create a context described by PSFs that influence performance***

PSF Approach

- ***Theory and model based***
- ***Reflects PSFs used in many current HRA approaches***
  - ***Influence ranges are calibrated***
- ***Existing literature supporting SPAR-HRA PSFs***

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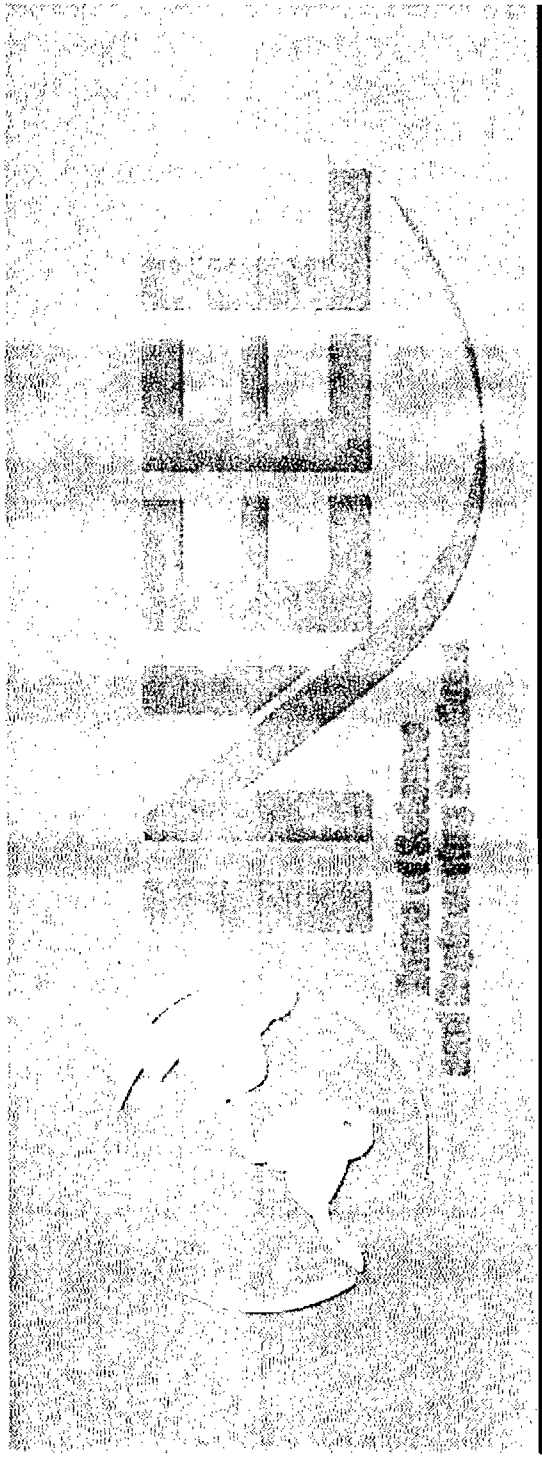

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Highlights for Discussion

- *Why SPAR-HRA?*
- *Justify various PSFs used in SPAR-HRA*
- *Comparisons with other HRA methods, including quantification approach*
- *Comparison with experimental or experiential data*
- *2003 accomplishments*
- *Nature of comments to date on draft NUREG/CR*

Why SPAR HRA?

- *In 1994, the NRC ASP Program was using 4 formal rules and 1 heuristic for HRA (range from 1.0E-3 to 1.0)*

- *NRC requested that INEEL recommend or develop a method to allow for more realistic analysis of human error*
  - *Reviewed HRA methods, - - too detailed, too resource intensive to apply easily*
  - *Informed by 2nd generation and international developmental activities*

Human Behavior Model

Inflow and Perception	*WM/STS*	*Processing/ LTM*	*Response*

Summary Level Influencing Factors

- **Complexity**
- **Stress**
- **Experience/Training**
- **Fitness for duty**

Procedures (job aids)
Ergonomics
Workload
Work Practices

Technical Basis for the PSFs Comes From the Psychological Literature

- *Miller's magic number 7*
- *Fitt's law (reaction time)*
- *Hick's law*
- *Performance under arousal and stress (Yerkes-Dodson's Law)*
- *Work shift effects*
- *Complexity*
- *Experts versus novices*

Comparison with Other HRA Methods

- *Comparison with THERP*
- *Worksheets – unique*
- *Two levels of tasks (diagnosis, action)*
- *Use of nominal rates and PSFs*
- *Multiplicative approach to HEP calculation*
- *Use of Beta distribution in place of error factors*
- *PSFs are fixed, calibrated against methods, and based on theory*

SPAR HRA Results Calibration

- *Experimental data*
  - *Behavioral sciences*
  - *PSF Simulator trials – Oconee work in 1980's*
- *Experiential data*
  - *NRC Users*
  - *Operating experience data*
    - *NUREG/CR-6753 and INFORM HRA data effort*
- *1994 results showed good inter-rater reliability*

Worksheets Ensure Uniform, Consistent Application of Method

- *Unique to SPAR HRA*
- *Major functional areas included:*
  - *Plant information*
  - *Error description*
  - *Task type*
  - *Performance shaping factors*
  - *Dependency condition table*

- *Tractable, HEP calculation on the worksheets*

Draft NUREG Report Contents

- *Update and refine definitions*
- *Provide more examples*
- *Offer better uncertainty approach*
- *Provide more technical basis information on PSFs*
- *Extend applicability to LP/SD*
- *Provide calibration findings*

Peer Review Comments

- *PSF issues*
  - *Fixed versus flexible PSFs*
  - *Orthogonality of PSFs, whether to introduce or not*
- *Practitioner questions (How do I model this?)*
- *Issues for the field of HRA*
  - *(Decomposition, positive dependency, quantification, applicability to extreme events)*
- *Extend checkout beyond USNRC HQ and National Labs*
- *Should worksheets indicate pre- versus post-initiator distinction?*
- *Working with EPRI*

END