

CERTIFIED BY:

George Apostolakis - 6/14/96

CERTIFIED

Date Issued: 4/22/96

ACRS-3001

PDR 10/3/96

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
PROBABILISTIC RISK ASSESSMENT SUBCOMMITTEE
MEETING MINUTES
FEBRUARY 27-28, 1996
ROCKVILLE, MARYLAND

INTRODUCTION

The ACRS Subcommittee on Probabilistic Risk Assessment (PRA) met on February 27-28, 1996, at 11545 Rockville Pike, Rockville, MD, in Room T-2B3. The purpose of this meeting was to discuss topics related to Risk-Based Regulatory Applications (RBRA), including identification of models, analyses and regulatory issues that are currently amenable to risk-based regulatory approach, and the use of PRA in the regulatory decision-making process. The entire meeting was open to public attendance. Mr. Michael T. Markley was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:30 a.m. each day and recessed at 5:00 p.m. on February 27 and adjourned at 5:30 p.m. on February 28.

ATTENDERS

ACRS

G. Apostolakis, Chairman
I. Catton, Member
M. Fontana, Member
T. Kress, Member
W. Lindblad, Member

R. Seale, Member
D. Karydas, Invited Expert
T. Theofanous, Invited Expert
M. Markley, ACRS Staff
R. Sherry, ACRS Senior Fellow

Principal NRC Speakers

M. Cunningham, RES
P. Baranowsky, AEOD
A. El-Bassioni, NRR
E. Butcher, NRR
J. Flack, NRR
M. Cheok, NRR
W. Hodges, RES
G. Holahan, NRR
T. Hsia, NRR
S. Mays, AEOD
A. Ramey-Smith, RES
M. Rubin, NRR

Industry/Public

M. Azarm, BNL
T. Cannon, APS
J. Fulford, NUS
M. Golay, MIT

R. Grantom, HL&P
M. Moddares, UMD
B. Putney, SAIC
N. Siu, BNL
D. True, ERIN

9610070108 960422
PDR ACRS
3001

PDR

DESIGNATED ORIGINAL

Certified By

EMB

O&M-7ACRS
x O&M-6 Meeting

RS01
0/1

A complete list of meeting attenders 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.

Chairman's Opening Remarks

Dr. George Apostolakis, Chairman of the Subcommittee convened the meeting and reviewed the purpose of the meeting. He introduced the ACRS Invited Experts Dr. Dimitrios Karydas and Dr. Theo Theofanous; guest speakers Messrs. Herschel Specter and Mohammed Modarres; and ACRS Senior Fellow Mr. Rick Sherry who also made a presentation. He noted that the Commission had requested ACRS views on the PRA framework document, its relationship to the pilot applications, and the next steps to expand the use of PRA in the regulatory decision-making process. He also mentioned that the ACRS had received some documents from Mr. Bob Christie of Performance Technology regarding programs for performance-based regulation, what performance-based regulation might look like, and what we learn from turbine-driven pump surveillance testing.

NRC Staff Presentation

Mr. Gary M. Holahan, Director, Division of Systems Safety and Analysis (DSSA), NRR, provided an overview of the PRA program, the PRA Policy Statement, framework for regulatory activities, and efforts to accelerate the program in response to the NRC Chairman's memorandum dated November 30, 1995. He discussed the ongoing nature of the pilot applications and their role during Standard Review Plan (SRP) and regulatory guide development. He reviewed the schedule for completing the following pilot applications: motor operated valves (MOVs), inservice testing (IST), inservice inspection (ISI), Technical Specifications (TS), graded quality assurance (GQA), and pilot inspections of the implementation of the Maintenance Rule. Significant points made during the discussion include:

- Elements of the PRA framework include identification and characterization of regulatory activities, deterministic and probabilistic considerations, and the integration of those considerations
- Application groups include screening analysis for prioritization of generic issues and licensing activities; risk ranking analysis for GQA, IST, ISI, and the Maintenance Rule (i.e. establishing goals commensurate with safety); and detailed analysis for TS, backfits, and generic issue resolution

- Key technical issues include:
 - Deterministic considerations: engineering principles based on research test and analysis (sound engineering analysis), quality of design (design bases) and operation (operating experience); defense-in-depth; appropriate codes and standards, and single failure criterion (General Design Criteria)
 - Probabilistic considerations: PRA quality - data, assumptions, and methods; PRA scope - internal and/or external events, at power and/or shutdown, and PRA levels 1, 2, 3; risk metrics - core damage frequency (CDF), importance measures, safety goals, containment performance, and dose; sensitivity and uncertainty analysis; and the process for reviewing quality - industry peer review, staff review, etc.
 - Integration of risk insights: review bases for both deterministic and probabilistic considerations, reconcile differences to achieve acceptable risk and engineering conditions, assure net change in CDF and risk are small, and assure overall risk impact is compatible with other PRA-related guidance
- The process for reviewing quality includes:
 - External peer review and comparison with similar PRAs for applications that depend on relative results (i.e. risk ranking, plant modifications); expert panels are necessary in risk ranking to preclude relying on PRA results alone
 - NRC staff review and national laboratory reviews for applications that depend on absolute risk measures (i.e. TS modifications)
- Additional factors to consider in specific applications include: effects on screening analysis results, effects on PRA assumptions used in analysis, common-cause failures resulting from current applications, human errors of commission and omission, spatial and equipment interactions

The Subcommittee and NRC staff extensively discussed the role of performance criteria. Dr. Apostolakis expressed the view that it should be considered a key technical issue. The staff reviewed the PRA Policy Statement but indicated that the NRC did not have a performance-based policy statement. This led to lengthy discussion regarding the absence of a performance-based approach in the PRA program.

The Subcommittee also discussed the acceptability of models used in PRAs and the level of detail. Dr. Apostolakis expressed the belief that the NRC should make some statement regarding the acceptability or unacceptability of certain models. The staff stated that regulatory guides provide methods acceptable to the NRC in meeting regulatory requirements. Licensees can submit alternate approaches, but regulatory guides do not identify unacceptable methods. The staff expressed the desire for the pilot studies to provide information on the needed data bases and level of detail required to provide meaningful insights. Dr. Kress expressed the view that Level 3 PRA was unavoidable in regulating to limit risk to the public. The staff stated that an understanding of Level 3 effects was necessary; however, they could make an argument where Level 3 would do more harm than good if it results in the NRC departing from assuring defense in depth.

The Subcommittee also discussed issues related to numerical decision criteria: CDF, containment performance, dose, importance measures, and safety goals. The staff expressed the view that total reliance on quantitative results is not appropriate and that non-quantitative considerations should be taken into account. The staff emphasized that they were not trying to define what good PRA is but rather to provide guidelines for getting risk insights into the regulatory decision-making process. Dr. Apostolakis expressed the view that numerical criteria should not be pass/fail. The Subcommittee questioned the staff's view on risk neutrality (i.e., changes that neither increase nor decrease risk). The staff and members of the audience repeatedly stated that changes could not contribute to increases in risk. Drs. Apostolakis and Kress questioned whether safety goals could be or should be extended to plant-specific conditions. The NRC staff stated that the NRC policy on safety goals was not to apply them to individual plants because of potential abuse of the information by external organizations.

ACRS Fellow Presentation

Mr. Rick Sherry, ACRS Fellow, provided a presentation on importance measures. He reviewed the background and objectives, questions associated with risk ranking, calculational methodologies and importance curves, and measures for uncertainty importance. Significant points made during the discussion include:

- Risk measures include core damage frequency (CDF), large early release frequency, offsite consequences or other appropriate measures of risk the model can determine
- Credible changes in a basic model can be defined as a variation within the estimated uncertainty range of an event

probability or a change in the event probability resulting from a variation in the environment of the event

- Importance measures for risk ranking include risk achievement worth (RAW), risk reduction worth (RRW), Fussell-Vesely Importance, Birnbaum Importance, and Criticality Importance
- Difficulties in using importance measures include truncation, multiple basic events representing component failures, and absolute or relative ranking

The NRC staff acknowledged that importance measures are important when considering such things as reduced equipment testing frequency. Guest presenter Herschel Specter questioned the impact of uncertainty on risk rankings. Mr. Sherry emphasized that this study focused on uncertainty for point measures. Dr. Kress noted that evaluating uncertainty helps provide conservatism that helps in the decision-making process.

ACRS Invited Expert Presentation

Dr. Dimitrios Karydas, Invited Expert to the ACRS, presented performance-based standards for fire protection. Dr. Karydas reviewed items related to materials, regulations and codes of practice, elements of fire safety engineering, fire uncertainties, cone calorimeter and related standards, fire standards for buildings, the benefits of fire safety engineering, fire safety design and acceptance criteria, and international activities in fire standards development. Significant points made during the discussion include:

- Models and parameters are based on flame or heat growth rate but uncertainties are not addressed in codes
- Cone calorimetry is not sufficient for a performance-based approach
- There are no standards in the United States for performance-based standards for fire protection and there has been limited progress toward performance-based concepts
- Most performance-based work is being done in international standards development
- The overall approach in fire protection is in prevention (eliminating the primary hazard and initiating events) and in control over the propagation of fires

The NRC staff noted that their approach focuses on results or outputs as opposed to inputs. Guest presenter, Dr. Theofanous

pointed out that the fire protection has benefitted greatly from actual fire experience whereas the nuclear industry has not had a lot of accidents on which to base criteria. Mr. Holahan noted that the NRC has taken a different performance-based approach. He emphasized that the NRC intends to maintain their defense-in-depth philosophy which he believes has served the agency well.

The Subcommittee extensively discussed the issues of probabilistic acceptance criteria for risk. They discussed the difference between the "maximum tolerable" risk to an individual member of the public as opposed to the "generally accepted" risk to members of the public. Key points of discussion were the general acceptance that some fires will occur and that volunteers accept higher risks as part of certain activities. A significant point of difference was noted in the acceptance of quantitatively higher levels of risk for fire than nuclear technology.

ACRS Invited Expert Presentation

Dr. Theofanous, ACRS Invited Expert, reviewed his draft paper, "On the Proper Formulation of Safety Goals and Assessment of Safety Margins for Rare and High-Consequence Hazards." His discussion was focused on technical, policy, and philosophical issues. Significant points made during the presentation include:

- For rare and high consequence events, the collective uncertainty becomes so large that it is counterproductive to quantify it. He suggested that modeling may mask inherent vulnerabilities
- The main need for integration of deterministic and probabilistic considerations is at the goal level
- He suggested that a basic consideration of defense in depth along with practical aspects of communication and synergism are needed for resolution of uncertainties. He defined his approach as Risk Oriented Accident Analysis Methodology (ROAAM)

The NRC staff expressed concern over the difficulty with quantifying uncertainty. The staff agreed with Dr. Theofanous' view that the uncertainties can become so large that they become an impediment to gaining meaningful risk insights. They further stated that the major impediment was poor quality analysis rather than uncertainty. The Subcommittee discussed concepts of uncertainty (epistemic and aleatory uncertainty). Dr. Theofanous stated that uncertainty needs to be managed; otherwise, the complication of so many parameters causes the calculation to explode and lose meaning.

Presentation by Hershel Specter/Mohammad Moddares

Messrs. Specter and Moddares presented their work to develop a functional specifications for a software program for risk-based and performance-based regulation. They reviewed the process to select software for review, the identification of risk-based tasks, matching software with risk-based tasks, identifying tasks without software support, and developing specifications for integrated software. Significant points made during the discussion include:

- The overall concept was to develop something like a risk monitor or risk meter.
- The approach was to set up risk categories (high, medium, and low) and go through analyses to distribute the results into those categories.
- The process entails establishing criteria, identifying what to monitor, setting goals, observing actual performance, trending results, and implementing corrective actions as necessary.
- The goals of the process are to be comprehensive, consistent, dynamic, and synergistic to make informed risk-based decisions.

Dr. Apostolakis questioned how management issues fit into the framework. Mr. Specter stated that the organizational issues were reflected in human reliability assessment (HRA) numbers. Dr. Theofanous stated that he believed the model was more systems and component oriented. The NRC staff stated that many of their programs involve components and equipment not modeled in PRA.

Subcommittee Comments and Concerns

At the close of the meeting, Subcommittee Members provided their observations and concerns. Specific issues of concern were:

- Separation of performance-based from risk-informed concepts and the apparent lack of a performance-based approach
- The need to make judgements on acceptable methods for verifying risk using some criteria
- Confusion over the use of terminology
- Linkage between the PRA framework, pilot applications, and the need for some decision criteria or justification for the pilots

Subcommittee Recommendations

The PRA Subcommittee plans to draft a letter for consideration by the full ACRS regarding the PRA framework document, pilot applications, and the next steps to expand the use of PRA in the regulatory decision-making process. This item is scheduled for the 429th meeting of the Advisory Committee on Reactor Safeguards on March 7-9, 1996. The ACRS needs to respond to the Commission's Staff Requirements Memorandum (SRM), dated December 27, 1995, regarding this matter.

Followup Actions

Representatives of the NRC staff agreed to provide the Subcommittee copies of the NRC Peer Review Guide and a risk study completed at the University of Lund (Sweden).

Background Material Provided to Subcommittee for this Meeting

- Staff requirements memorandum dated December 27, 1995
- Staff requirements memorandum dated June 16, 1995
- Letter dated January 3, 1996, from J. Taylor, EDO, to Chairman Jackson, NRC, Subj: "Improvements Associated With Managing the Utilization of Probabilistic Risk Assessment (PRA) and Digital Instrumentation and Control Technology"
- Letter dated November 30, 1995, from Chairman Jackson, NRC, to J. Taylor, EDO, Subj: "Follow-up Requests in Probabilistic Risk Assessment and Digital Instrumentation and Control"
- SECY-95-280, "Framework for Applying Probabilistic Risk Analysis in Reactor Regulation," dated November 27, 1995
- Letter dated November 14, 1995, from W. Rasin, NEI, to J. Milhoan, DEDRO, Subj: Draft report, "Improving the Regulatory Process Through Risk-Based and Performance-Based Regulation"
- Purpose Statement/List of Issues for PRA Subcommittee on January 10-11, 1996
- *Reliability Engineering and System Safety* 38, 1992, "The Strengths and Limitations of PSA: Where We Stand," D. Bley, S. Kaplan, and D. Johnson

- *Reliability Engineering and System Safety* 35, 1992, "Showing Compliance with Probabilistic Safety Criteria and Objectives," M. Versteeg
- *Reliability Engineering and System Safety* 39, 1993, "Probabilistic Safety Assessment Development in the United States 1972-1990," E. Beckjord, M. Cunningham, J. Murphy
- Fire Safety Science, Proceedings of the Fourth International Symposium 1994, Abstract, "Rational Structural Fire Engineering Design Based on Simulated Real Fire Exposure," O. Peterson
- IAEA-TECDOC-524, Report of a Technical Committee Meeting Organized by the International Atomic Energy Agency, January 27-31, 1986, "Status, Experience and Future Prospects for development of Probabilistic Safety Criteria"
- *Reliability Engineering and System Safety*, Draft paper, "On the Proper Formulation of Safety Goals and Assessment of Safety Margins for Rare and High-Consequence Hazards," T. Theofanous
- Draft paper for International Conference on Probabilistic Safety Assessment and Management, June 24-28, 1996, "Turbine Driven Pump Surveillances, 'What Do We Learn?'" B. Christie
- Draft paper for International Topical Meeting on Probabilistic Safety Assessment, September 29 - October 3, 1996, "Call to Action: Pilot Programs for Performance-Based regulation," B. Christie
- Draft paper for International Topical Meeting on Probabilistic Safety Assessment, September 29 - October 3, 1996, "What Will Performance-Based Regulation Look Like?" B. Christie and E. Ballon

Presentation Slides

The presentation slides and handouts used during this meeting are attached to the office copy of these minutes.

Note: Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, N.W. Washington, D.C. 20006, (202) 634-3274, or can be purchased from Neal R. Gross & Co., Inc. Court reporters and Transcribers, 1323 Rhode Island Avenue, N.W. Washington, D.C. 20005, (202) 234-4433.