

# CERTIFIED

ACRS-3140

CERTIFIED BY:  
George Apostolakis - 3/9/99

Date Issued: 3/2/99

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
MEETING OF THE SUBCOMMITTEE ON  
RELIABILITY AND PROBABILISTIC RISK ASSESSMENT  
MEETING MINUTES - JANUARY 25, 1999  
ROCKVILLE, MARYLAND

## INTRODUCTION

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment met on January 25, 1999, at 11545 Rockville Pike, Rockville, MD, in Room T-2B3. The purpose of this meeting was to discuss the possible use of frequency-consequence curves in risk-informed decisionmaking. The Subcommittee did not review proposed options to make 10 CFR 50.59 (Changes, Tests and Experiments) risk-informed as was previously announced in the *Federal Register*.

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 1:00 p.m. and adjourned at 5:05 p.m.

## ATTENDEES

### ACRS Members

G. Apostolakis, Chairman  
M. Bonaca, Member  
J. Barton, Member  
M. Fontana, Member  
T. Kress, Member  
D. Miller, Member  
D. Powers, Member

R. Seale, Member  
W. Shack, Member  
G. Wallis, Member  
M. Khatib-Rahbar, Invited Expert  
G. Kaiser, Invited Expert  
M. Markley, ACRS Staff

### Principal NRC Speakers

G. Holahan, NRR\*  
J. Murphy, RES\*  
G. Parry, NRR

NRR Office of Nuclear Reactor Regulation  
RES Office of Nuclear Regulatory Research

### Principal Industry Speakers

None

There were approximately 6 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

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

### **OPENING REMARKS BY THE SUBCOMMITTEE CHAIRMAN**

Dr. Apostolakis convened the meeting at 1:00 p.m. He introduced ACRS Members and Invited Experts in attendance. He stated that purpose of this meeting was to discuss the possible use of frequency-consequence curves in risk-informed decisionmaking. He announced that the Subcommittee would not review proposed options to make 10 CFR 50.59 (Changes, Tests and Experiments) risk-informed as was previously announced in the *Federal Register*. Dr. Apostolakis stated Dr. Mohsen Khatib-Rahbar of Energy Research, Inc. would discuss his paper prepared for the Swiss Federal Nuclear Safety Inspectorate regarding the use of frequency-consequence curves in regulatory matters.

Dr. Apostolakis noted that, in the ACRS report dated July 16, 1998, he had offered a proposal for the development of a risk-informed framework for 10 CFR 50.59. He stated that Dr. Kress has pursued this idea further and developed a draft White Paper on the use of frequency-consequence curves.

Dr. Apostolakis stated that the Subcommittee had received no written comments or requests for time to make oral statements from members of the public.

### **DISCUSSION OF AGENDA ITEMS**

#### **Presentations and Panel Discussion**

Dr. Kress, ACRS Member, provided a brief presentation entitled, "Proposed Role of Frequency-Consequence (F-C) Curves in a Risk-Informed Regulatory System." He stated that the points discussed represent his views and not the views of the ACRS. Significant points made during the presentation include:

- The major attribute of a risk-informed regulatory system is that it must have acceptance criteria on risk metrics.
- In NRC Regulatory Guide 1.174, the staff approved acceptance criteria based on core damage frequency (CDF) and large, early release frequency (LERF) for changes to the licensing basis. Dr. Kress stated that he does not object to these criteria; however, he believes that these are not the only regulatory objectives that the NRC should consider.
- Regulatory objectives that could represent a potential definition of safety include:
  - Risk parameters including: individual risk of prompt fatality, individual risk of latent fatality, total fatalities, land interdiction, individual risk of radiation injury to workers and the public.

- Defense-in-depth provisions (recognizing the uncertainties associated with PRA results) including: acceptance criterion on CDF, barrier integrity, redundancy and diversity, and emergency response.
- There is a need for lower-tier surrogate objectives below CDF and LERF because PRA is insensitive for many plant states and operating conditions.
- Regulatory objectives related to the risk parameters depend on: the amount of release of different fission products, timing of release, site-specific atmospheric parameters, population density and distribution, emergency response measures, and health effects.

Dr. Khatib-Rahbar, Invited Expert, discussed his paper entitled, "Risk Analysis and Regulatory Safety Decisions." Dr. Khatib-Rahbar stated that the views expressed in his presentation were his own and do not represent those of Energy Research, Inc. or its customer the Swiss Federal Nuclear Safety Inspectorate. He presented his views on F-C curves including: what relationships could be represented by F-C curves, uncertainties and confidence, PSA-based regulatory decisions, use as a consequence measure, proposed Swiss probabilistic safety criteria, and application for future reactors. Significant points made during the presentation include:

- F-C curves can represent a three-region operations domain (does not currently include shutdown operations risk): 1) risk not acceptable, 2) risk acceptable after optimization, and 3) risk negligible.
- Subjective uncertainties can be quantified using expert judgement, models (albeit incomplete), and test data. However, the uncertainties on releases are enormous.
- A major problem with nuclear accidents is the catastrophic potential for contaminating a large area of land. Prompt fatalities from iodine and noble gases can be mitigated using emergency response protective actions. However, land contamination from Cs-137 can make an area uninhabitable and result in latent fatalities.
- PSA criteria (i.e., Safety Goals) should be viewed as economic and social optimums. Risk reduction below these levels can impose significant economic burdens. Exceeding these criteria could have large economic and social consequences (i.e., accidents).
- Proposed Swiss probabilistic safety criteria are:  $CDF \leq 10^{-5}$  per year and release frequency of greater than 10 kg equivalent Cs-137  $\leq 10^{-6}$  per year. F-C curves can represent a common "risk metric" for all sources of risk and for all modes of operation.
- Existing operating reactors should conform to criteria at the "mean value" level through cost-beneficial backfits. F-C curves should be used as indicators of safety optimization and not as "speed limits."
- Future reactors would conform to 95<sup>th</sup> percentile level of exceedance frequency.

### **SUBCOMMITTEE COMMENTS, CONCERNS, AND RECOMMENDATIONS**

Dr. Powers noted that LERF relates closely with prompt early fatality and land contamination. He questioned the lessons-learned from Chernobyl where injuries were not represented in terms of cost values. Dr. Wallis questioned whether the injuries must be radiation-related. Dr. Wallis also questioned the effectiveness of emergency response measures in mitigating prompt early fatality. He cited the concerns over evacuating densely populated areas around some nuclear plants (e.g., Shoreham). Dr. Wallis stated that there was a lot of uncertainty in the effectiveness of EP actions. Dr. Kress stated that emergency response needs to be considered on a site-specific basis.

The Subcommittee extensively discussed how F-C curves might be used in regulatory decisionmaking. Dr. Khatib-Rahbar, ACRS invited expert, stated that F-C curves are very important for risk management. He reiterated that the Swiss are considering the use of F-C curves for decisions related to "backfitting." Dr. Apostolakis suggested that they may be used in accident management as subsidiary goals. Dr. Kress agreed and suggested that F-C curves be used as surrogates. Dr. Kress stated that the risk objectives should be incorporated into regulatory acceptance criteria. The staff suggested that an alternative might be to develop a new set of design-basis requirements as surrogates. The staff also suggested that the possible use of F-C curves might be considered in April 1999 when the staff offers its proposal for revisions to the Commission's Safety Goal Policy Statement.

Dr. Seale questioned what "benchmarking" had been done to evaluate the use of risk information in other industries. Mr. Geoffrey Kaiser, ACRS invited expert, stated that not much information was available but noted that limited work had been done in the chemical industry in the form of quantitative risk assessments (QRAs). Dr. Powers questioned whether the analyses were expressed in terms of frequency of societal or individual risk. Mr. Kaiser stated that both societal and individual risk are considered.

Dr. Miller expressed the view that F-C curves are too insensitive to changes at the 10 CFR 50.59 level. Dr. Bonaca agreed and suggested that F-C curves might be best used for high-level decisionmaking.

### **STAFF AND INDUSTRY COMMITMENTS**

None.

### **SUBCOMMITTEE DECISIONS**

At the conclusion of the meeting, Dr. Apostolakis stated that the Subcommittee would continue its review of this matter during future meetings. He noted that an individual briefing session was not scheduled for the 459<sup>th</sup> ACRS meeting, February 3-6, 1999, although the Committee may continue its discussion of a the proposed White Paper.

**FOLLOW-UP ACTIONS**

None.

**BACKGROUND MATERIALS PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING**

1. Subcommittee agenda.
2. Subcommittee status report.
3. Draft White Paper prepared by T. Kesss, ACRS, entitled, "On the Relationship Between Frequency-Consequence Curves on Fission Product Release Fraction and the Commission's Safety Goals," **(pre-decisional, for internal ACRS use only)**
4. Article prepared by M. Khatib-Rahbar and E. Cazzioli, Energy Research, Inc., for the Swiss Federal Nuclear Safety Inspectorate, entitled "Risk Analysis and Regulatory Safety Decisions."
5. Table provided by Dr. Apostolakis for Limits on Occurrence of Hazard States, excerpt from report dated October 31, 1980, from M.S. Plesset, Chairman, ACRS, to J.F. Ahearne, Chairman, NRC, Subject: "An Approach to Quantitative Safety Goals for Nuclear Power Plants."
6. Facsimile from Dr. Powers, ACRS, on F-C curves in NUREG-1150, **(pre-decisional, for internal ACRS use only).**
7. Report dated July 16, 1998, from R.L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: "Proposed Revisions to 10 CFR 50.59 (Changes, Tests and Experiments).
8. Report dated December 11, 1998, from R.L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: "Options for Incorporating Risk Insights into the 10 CFR 50.59 Process.

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**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 Ann Riley & Associates, Ltd., (Court Reporters and Transcribers) 1250 I Street, NW, Suite 300, Washington, D.C. Rhode Island Avenue, N.W. Washington, D.C. 20005 (202) 842-0034.