ACRSR-1981

February 14, 2002

The Honorable Richard A. Meserve
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Meserve:

SUBJECT: REVIEW AND EVALUATION OF THE NUCLEAR REGULATORY COMMISSION'S SAFETY RESEARCH PROGRAM

During the 489th meeting of the Advisory Committee on Reactor Safeguards (ACRS), February 7-8, 2002, and during our retreat meeting on January 24-26, 2002, we discussed the Nuclear Regulatory Commission's Safety Research Program. We met on November 8, 2001, with representatives of the NRC's Office of Nuclear Regulatory Research (RES) to discuss this matter. We also had the benefit of the documents referenced.

In April 2001, the ACRS completed a comprehensive and detailed review and evaluation of the NRC's Safety Research Program, as documented in NUREG-1635, Vol. 4. Favorable comments were made concerning most RES programs. We recommended, however, that some RES programs be brought to closure. We also identified potential future research needs in the following areas:

- New Power Plants and a Revised Regulatory Structure
- Risk Implications of License Renewal and Power Uprates
- Decision-Making Methods

Since we issued our report, RES has made a number of adjustments to its programs to address the Committee's recommendations. In addition, RES has increased its attention to safeguards and security in response to the September 11, 2001, events. Beyond those changes, however, the bulk of the RES program has not changed significantly enough to warrant a comprehensive report. Therefore, the Committee has decided not to issue a detailed report in 2002.

In lieu of such a report, we have reviewed and evaluated the RES responses to the Committee's recommendations. We plan to follow RES and industry programs related to future reactor designs, which will be a major focus of our 2003 research report.

RES Responses to ACRS Recommendations for Program Closures

In NUREG-1635, Vol. 4, we recommended termination of research activities in a number of areas: (1) the control room design review guidance; (2) the Organization for Economic Cooperation and Development (OECD) lower head failure research program; (3) the common-cause failure (CCF) program; and (4) the program, "A Technique for Human Event Analysis" (ATHEANA).

RES has agreed with the first two recommendations and has modified its 2002 research budget accordingly.

With respect to the CCF program, RES agrees that there has been a decreasing trend in the occurrence rate of CCF events. Therefore, RES does not plan any further development of the methodology. RES intends, however, to continue participating in the International Common-Cause Failure Data Exchange Program and CCF data collection from operating experience. We view these actions to be appropriate as they are focused on maintaining and updating significant databases.

Regarding ATHEANA, we noted that important elements **(**such as a safety-conscious work environment**)** were missing from the identification of error-forcing contexts, and that ATHEANA did not have a model for the relationship between error-forcing contexts and the probability of unsafe acts. RES plans to continue to implement improvements in ATHEANA throughout Fiscal Year 2002 and to continue to apply ATHEANA to a number of problems such as pressurized thermal shock, steam generator tube rupture, fire, and cable aging. We look forward to reviewing the results. Following these activities, RES plans to sunset the ATHEANA program. RES has also provided us with a research program plan in the area of Human Reliability Analysis. We will review this plan in the near future.

Future Research Initiatives Suggested by the ACRS

In NUREG-1635, Vol. 4, we recommended that research activities be initiated in three areas: (1) to assess the risk implications of license renewal and power uprates**;** (2) to develop a revised regulatory structure for new power plants**;** and (3) to explore the use of formal decision-making methods to support regulatory decisions. RES has since initiated a study to evaluate the risk implications of license renewal and power uprates. The other two areas of recommended research are discussed below.

Research Needs to Support Licensing of Future Plants

The agency may soon receive licensing applications that involve reactor designs radically different from those currently in service. RES will play a critical role in preparing the agency to meet the challenges of licensing such new reactor designs. Consequently, RES needs to develop the technical bases that will facilitate effective and efficient licensing reviews of future plants. RES also needs to develop and adapt the analytical tools that would allow independent analysis of plant safety. On June 4-5, 2001, ACRS sponsored a workshop on regulatory challenges for future reactor designs in order to identify associated regulatory and policy issues. A list of regulatory

challenges developed by the workshop can be found in NUREG/CP-0175, “Proceedings of the Advisory Committee on Reactor Safeguards Workshop on Future Reactors.”

A significant question confronting the agency regarding licensing of new reactor designs is: should the NRC develop a new licensing approach? And, if so, what should be the characteristics of this new approach. As we stated in NUREG-1635, Vol. 4, this question needs to be addressed on an urgent basis because the development of a new design-independent licensing approach will take time. In that document, we also stated the desirability of a new approach for risk-informed, design-independent regulatory framework and identified a number of attributes of this framework. To support such an approach, the staff needs to define the full spectrum of regulatory objectives expressed in terms of risk acceptance criteria. New risk metrics, for example frequency-consequence curves, would have to be developed for designs for which core-damage frequency (CDF) and large early release frequency (LERF) may be inappropriate. Such an approach would place expectations on probabilistic risk assessment (PRA) quality and scope for designs that lack the extensive experience base that exists for “standard” light-water reactors.

Applying the current regulatory process to the extent possible for new reactor designs, with only those essential adjustments required to deal with the differences in technology, may represent a viable option. Even in this case, however, a new design-independent, risk-informed regulatory framework could greatly benefit the required adaptation and the development of design-basis accidents. This approach would benefit from significant interaction with reactor vendors and would resemble the original approach to the licensing of the current generation of water reactors, where regulation did not precede but evolved with the development and implementation of reactor technology.

Regardless of the licensing approach that is selected, the agency needs to revisit existing criteria and guidelines that may not be appropriate for the characteristics of the new reactor concepts being proposed. Some of the more important questions needing to be answered are as follows:

- Do we need alternate risk acceptance criteria for the new designs (e.g., frequency-consequence curves)?
- How will multiple units on a site affect the risk acceptance criteria?
- How are uncertainties to be treated in the licensing process (e.g., confidence level, safety margins, defense-in-depth)?
- How will the adequacy of confinement be assessed?
- How will design-basis accidents be identified?
- What will represent acceptable emergency planning requirements?
- How will the scope, quality, and acceptability of PRAs for radically new designs, and codes for thermal-hydraulic, neutronic, and safety assessment, be evaluated?
- What role can “licensing by test” play in the regulatory process?
- Should the manufacturing process of reactor fuels for Pebble Bed Modular Reactor (PBMR) and Gas Turbine-Modular Helium Reactor (GT-MHR) be part of the licensing basis and subject to NRC regulation?

The most pressing issue related to AP1000 certification is what confirmatory research is needed to evaluate the adequacy of the AP600 separate effects and integral test database for application to AP1000.

Some of the new designs may also challenge current defense-in-depth precepts. For example, the traditional balance between prevention and mitigation may not be offered by new designs that rely heavily on fuel integrity during accidents rather than mitigating systems. Uncertainty criteria to allow setting appropriate limits on defense-in-depth requirements may need to be developed.

Finally, the agency needs to determine what independent capabilities and technical databases it must have to assess the safety implications of new technologies; to conduct selected independent verification, analysis, and testing; and to license the new designs. This will require an assessment of necessary fuel and thermal-hydraulic codes, PRA methods, severe accidents and source term codes, etc. Materials under the operating conditions proposed by new designs could also present new challenges that may require significant study. Early interaction with advanced reactor designers is essential for identifying the need for data, models, and analytical tools.

RES is developing a plan to identify the necessary research activities for new reactor designs. The Committee will review this plan.

Use of Formal Decision-Making Methods to Support Regulatory Decisions

In NUREG-1635, Vol. 4, we observed that the decision-making processes used in the regulatory framework process often appear overly subjective and recommended that the staff initiate a research program to investigate how best to use formal decision-making methods to make regulatory decisions more objective and transparent and, thus, more defensible. In our report on the Revised Reactor Oversight Process, dated October 12, 2001, we observed that formal decision analysis could be helpful in making the action matrix and the selection of thresholds for the performance indicators more objective and scrutable. In informal communications to us, RES has recognized the merit of developing formal approaches to support the agency's decision-making processes but has not initiated any work in this area.

Sincerely

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George E. Apostolakis
Chairman

References:

1. U.S. Nuclear Regulatory Commission, NUREG-1635, Vol. 4, "Review and Evaluation of the Nuclear Regulatory Commission Safety Research Program," A Report to the USNRC by the Advisory Committee on Reactor Safeguards, April 2001.

2. Memorandum dated July 20, 2001, from William D. Travers, Executive Director for Operations, NRC, to NRC Commissioners, Subject: Response to SRM-M010510B Briefing on Office of Nuclear Regulatory Research (RES) Programs and Performance.
3. U. S. Nuclear Regulatory Commission, NRUEG/CP-0175, “Proceedings of the Advisory Committee on Reactor Safeguards Workshop on Future Reactors, June 4-5, 2001, dated December 2001.
4. Letter dated October 12, 2001, from George E. Apostolakis, ACRS Chairman, to Richard A. Meserve, Chairman, NRC, Subject: The Revised Reactor Oversight Process.