June 28, 1996

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: SEVERE ACCIDENT RESEARCH

During the 432nd meeting of the Advisory Committee on Reactor Safeguards, April 11-13, 1996, we completed our review of the status of the NRC severe accident research program and severe accident codes. Our Subcommittee on Severe Accidents held meetings on these matters on March 1 and April 8, 1996. During this review, we had the benefit of discussions with representatives of the NRC staff and of the documents referenced.

Conclusions and Recommendations

1. Severe accident research provides information essential to the development of risk-informed regulation.

2. Severe accident research provides the basis for evaluating severe accident management strategies.

3. The NRC nuclear safety research program budget continues to decline, and various research efforts are being reduced or eliminated. Periodic analysis should be performed to assure that the remaining severe accident research efforts are focused on topics that have the greatest impact on risk and the associated uncertainties. Criteria should be developed for determining when programs have met their objectives.

4. Results of the severe accident research have shown that there is no threat of prompt containment failure posed by direct containment heating (DCH) in Westinghouse large dry containments, alpha-mode steam explosions, and Mark I liner melt-through. Research should continue to:

   . determine the impact of DCH on other containment types,

   . develop codes to better model the hydrogen stratification and detonation,

   . determine the impact of ex-vessel steam explosions on the BWR containments,

- understand the phenomenological aspects associated with molten debris coolability,

- determine the impact of fuel coolant interaction on lower head failure, and

- determine the threats posed to steam generator tubes by the natural circulation induced by the core degradation processes.

5. Quantification of uncertainties is essential to risk-informed regulation. The NUREG-1150 effort contributed significantly to the method for quantification of uncertainties. Additional effort is needed to improve understanding and quantification of phenomenological uncertainties and their impact on Level 2 PRA results. We plan to provide more specific recommendations in this area in the future, as needed.

6. The assurance of the availability of specialized experts to advise the Commission is sometimes a tacit motivation for planning research programs. We believe that such assurance is prudent and should be explicitly recognized as a criterion in the funding of research.

Discussion

We believe it is important that the staff periodically perform top down assessments of research to assure that the work supports top level objectives, to review priorities, and to identify research efforts that have reached maturity and perhaps should be discontinued. In our view, severe accident research should have the following top-level objectives:

- support assessments of severe accident risk from operating plants,

- provide a technical basis for reviewing accident management procedures,

- support the development of risk-informed regulation, and

- provide a technical basis for evaluating advanced plant designs and operational features.

Better Level 2 PRAs are needed to reduce the uncertainties associated with the assessment of the risk to public health and safety. Severe accident research provides the bases for improving Level 2 PRAs, many of which have used unnecessarily simplistic models for severe accident behavior. Severe accident research is needed to reduce the presently large uncertainties in risk assessment results that are inimical to making sound regulatory decisions.

The processes that lead to early failure of containment are of particular importance to risk. Among such processes are DCH, fuel coolant interactions, alpha-mode steam explosions, hydrogen

detonations, direct contact of core debris with containment structures, and steam generator tube ruptures. Additional assessment of DCH is needed for CE, B&W, and ice condenser containments, and for BWRs. Although it appears that large dry containments and containments with igniters can accommodate hydrogen combustion without failing, we believe that stratification and the potential for local detonation needs additional investigation.

The extent to which debris can be cooled can be pivotal in determining the likelihood of containment liner failure and long-term containment basemat melt-through. Viable criteria for coolability of molten debris either in-vessel or ex-vessel have not yet been developed.

A possible disadvantage of successful in-vessel debris cooling is the potential failure of the reactor coolant system or steam generator tubes caused by overheating from the convection of hot gases. Steam generator tube ruptures that might occur as a consequence of, or coincident with, a severe accident would provide a direct path for radionuclide release from the reactor core to the environment. The NRC and industry are addressing this issue, but we believe additional thermal hydraulic and radionuclide transport code development will be required for resolution. The present NRC codes are not capable of assessing this situation.

Currently, significant information in the severe accident area is being developed in international cooperative programs. While we fully support the bilateral agreements and the Cooperative Severe Accident Research Program (CSARP), it is important for NRC that its domestic contractors maintain capability in this area. Staff and contractors who are knowledgeable of the physics and technology of severe accident phenomena will be needed to resolve complex issues in this area, to enhance the regulatory process, and to provide technical support in the event of a real accident.

Dr. Dana A. Powers did not participate in the Committee's deliberation regarding this matter.

Sincerely,

/s/

T. S. Kress
Chairman

References:

1. Report dated August 18, 1992, from David A. Ward, Chairman, ACRS, to Ivan Selin, Chairman, NRC, Subject: Severe Accident Research Program Plan
2. U. S. Nuclear Regulatory Commission, SECY-95-004, dated January 4, 1995, from James M. Taylor, Executive Director for Operations, NRC, for the Commissioners, Subject: Status of Implementation Plan for Closure of Severe Accident Issues, Status of the Individual Plant Examinations and Status of Severe Accident Research

3. U. S. Nuclear Regulatory Commission, NUREG/CR-6109, "The Probability of Containment Failure by Direct Containment Heating in Surry," May 1995
4. Nuclear Energy Institute, NEI 91-04, Revision 1, "Severe Accident Issue Closure Guidelines," December 1994
5. Report (undated) by F. Cheung and K. Haddad, Pennsylvania State University, Subject: Steady-State Observations and Theoretical Modeling of Critical Heat Flux Phenomena on a Downward Facing Hemispherical Surface
6. Sandia National Laboratories Letter Report, "Scaling and Design Report for Lower Head Failure Experiments," May 1995
7. Secretary-General of the OECD Report, Senior Group of Experts on Severe Accident Management (SESAM), "Severe Accident Management Implementation," October 1995
8. Secretary-General of the OECD Draft Report, "Nuclear Safety Research in OECD Countries, Areas of Agreement, Areas For Further Action, Increasing Need For Collaboration," November 1995
9. Proceedings of the Specialist Meeting On Severe Accident Management Implementation, held at Niantic, Connecticut, on June 12-14, 1995, by the Committee on the Safety of Nuclear Installations, OECD Nuclear Energy Agency

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