UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

March 24, 1999

Dr. William D. Travers
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Dr. Travers:

SUBJECT: HIGH BURNUP FUEL PHENOMENA IDENTIFICATION AND RANKING

During the 460th meeting of the Advisory Committee on Reactor Safeguards, March 10-13, 1999, we reviewed the status of the NRC confirmatory research program on high burnup fuel. During this review, we had the benefit of discussions with representatives of the Offices of Nuclear Regulatory Research (RES) and Nuclear Reactor Regulation (NRR), the industry, and of the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

- Conducting an expert opinion elicitation to identify and rank important phenomena that affect high burnup fuel will provide a sound technical basis for refining the NRC's confirmatory research program. It would provide a technical basis for establishing the data and analyses needed to support applications for extending fuel burnup beyond current regulatory limits.

- We urge NRR to participate in the proposed elicitation.

- RES should develop the formalism for conducting and documenting the expert opinion elicitation. Consideration should be given to adapting for the high burnup fuel effort one of the several expert elicitation formalisms developed by NRC in other efforts.

- RES should augment the expert opinion elicitation to include accident source term issues for high burnup fuels.

DISCUSSION

In our report dated June 15, 1998, we discussed the NRC research to confirm the regulatory decision to limit the extent of fuel burnup. In that report, we suggested that the staff develop an understanding of what data and analyses would be required of licensees to support applications for extending fuel burnup beyond the current limit of 62 GWd/t. Development of such an

understanding is a challenge since data on high burnup fuel behavior under accident conditions are sparse and scattered.

The RES staff will undertake an expert opinion elicitation to identify the physical and chemical phenomena that will affect fuel behavior, establish the state-of-knowledge concerning these phenomena, and rank them in terms of their importance to safety. The phenomena identification and ranking elicitation is to be done for accident scenarios found by RES to be risk important. These are loss-of-coolant accidents for both pressurized water reactors (PWRs) and boiling water reactors (BWRs), control rod ejection accidents for PWRs, and anticipated transients without scram (ATWS) for BWRs. RES plans to use this expert opinion elicitation to refine its own confirmatory research program, and is in the process of identifying and soliciting the participation of industry experts so that the phenomena identification and ranking can be extended to fuel burnup beyond current regulatory limits.

We are enthusiastic about the use of a disciplined, scrutable expert opinion elicitation to plan and refine the NRC research. We believe the elicitation to be an essential addition to the planning for extended fuel burnup being done by the Nuclear Energy Institute (NEI) and NRR staff. We encourage that both NEI and NRR participate in the effort being undertaken by RES.

Much remains to be done to complete the planning for the phenomena identification and ranking. RES will need to develop the formalism for conducting and documenting the expert opinion elicitation. RES can adapt one of several formalisms developed by the NRC in other efforts.

RES should expand the original scope of its phenomena identification and ranking elicitation to include the issues of accident source term. The revised accident source term (NUREG-1465) approved by the Commission was developed from analyses of fuel taken to burnups that are moderate in comparison to burnups being achieved in current plants. We are concerned that the accident source term will have to be modified to account for the effects of extended fuel burnup. Chemical forms and volatilities of radionuclides may be affected by burnup because of higher oxygen potentials in the fuel and the fuel-cladding gap. Releases of radionuclides from the fuel may be increased because of higher concentrations of interstitial oxygen, more extensive connection of intergrannular porosity, and smaller grain sizes in the so-called "rim" region.

RES has not established a technically defensible position on modifications of the accident source term to account for fuel burnup. Adequate data have not been marshaled. Analytical tools used to date do not appear to include adequate descriptions of pertinent phenomena and processes. Superior analytical tools may be available in the U.S. and in other countries. Additional data may be available from research done abroad. RES will gain substantial benefit for developing a position on modifying the accident source term by including elicitation of expert opinion on the effects of burnup on radionuclide behavior in fuel.

In October 1998, we met with representatives of France, Germany, and Japan to discuss technical issues of mutual interest and as a result formed a Quadripartite Working Group on High Burnup Fuel. We believe this group could contribute to the planned expert opinion elicitation for phenomena identification and ranking.

Dr. William J. Shack did not participate in the Committee's deliberations regarding this matter.

Sincerely,

Dana A. Powers

Dana A. Powers
Chairman

References:

1. Report dated June 15, 1998, from R. L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: NRC Reactor Fuels Research Program.
2. U. S. Nuclear Regulatory Commission, NUREG-1465, "Accident Source Term for Light-Water Nuclear Power Plant," February 1995.