UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

R-2250

May 16, 2007

The Honorable Dale E. Klein
Chairman
U.S. Nuclear Regulatory Commission
Washington DC 20555-0001

SUBJECT: DEVELOPMENT OF AN INTEGRATED LONG-TERM REGULATORY RESEARCH PLAN

Dear Chairman Klein:

During the 542nd meeting of the Advisory Committee on Reactor Safeguards (ACRS), May 3-5, 2007, we discussed the status of staff's efforts associated with the development of an integrated, long-term regulatory research plan. Our Subcommittee on the Safety Research Program also discussed this matter on May 2, 2007. During these meetings, we had the benefit of discussions with representatives of the NRC staff and of the documents referenced.

In our recent biennial reports on review and evaluation of the NRC safety research program, we have noted the need for long-term research not tied to the near-term issues of the regulatory process. Our focus was on long-term research to modernize the way NRC conducts its regulatory and safety mission. We called attention to critical areas where the NRC will need to maintain long-term technical competencies including neutronics, criticality analysis, reactor fuels, and probabilistic risk assessment (PRA). We also called attention to needs for access to experimental facilities and adequate computational tools for the regulatory process.

As directed by the Commission, the staff has undertaken an examination of the agency's long-term research needs. The focus of the work proposed by the staff differs from that emphasized for long-term research in our biennial reports. What the staff proposes does include some work directed toward the modernization and core expertise stressed in our reports. The staff has searched for emerging technologies and programs that NRC may have to address in regulatory processes sometime in the future. The staff has been careful to distinguish between research addressing current needs that will take a long time to complete and research to meet needs anticipated in the future

The staff has identified four broad areas of long-term research:

- Research to support licensing of nuclear facilities developed for the U.S. Department of Energy's Global Nuclear Energy Partnership (GNEP)
- Research to support reactor license renewal beyond 60 years
- Test facilities
- Long-term research activities for cross-cutting and emergent technologies

The process adopted by the staff has led to the identification of aspects of long-term research that the agency could pursue. The development of this long-term plan is a considerable

departure from the staff's focus in recent years on immediate regulatory needs. We comment below on several of the specific long-term research activities identified by the staff. We understand that in step 2 of the staff's development process, the staff will solicit input from other stakeholders to further develop its long-term research plan. We will comment in a separate forum on the broader scope of long-term research the agency needs to consider.

Research for Licensing GNEP Facilities

The U.S. Department of Energy (DOE), as part of its Global Nuclear Energy Partnership, is exploring the possibility of using a sodium-cooled fast reactor to transmute actinides as a stage in the reprocessing of spent water reactor fuel. Associated with the advanced "burner" reactor (ABR) will be facilities for processing both water reactor fuel and fast reactor fuel. A decision to proceed with the development of these capabilities is not anticipated until June 2008 and there may be delays beyond that date.

NRC has substantial experience dealing with sodium-cooled reactors, including its work on the Fast Flux Test Facility (FFTF), the Clinch River Breeder Reactor (CRBR), and preliminary work on the PRISM reactor. NRC is currently in the process of licensing a Mixed-Oxide (MOX) Fuel Fabrication Facility that will include most of the elements of an aqueous fuel reprocessing system. NRC has no significant experience licensing pyrometallurgical fuel reprocessing systems that might be included in the GNEP projects. We agree with the staff that there is merit in NRC maintaining some cognizance of work under way in GNEP. There would be merit in collection and organization of the documentation of past NRC work with sodium-cooled reactors.

Many involved in this past work on sodium-cooled reactors are nearing retirement age and their experience needs to be preserved at the agency. There is, however, no need to undertake a detailed research program until it is clear the Department of Energy will pursue the development for licensing of an advanced burner reactor and associated fuel reprocessing facilities. The staff will want to monitor the ongoing licensing of the MOX Fuel Fabrication Facility and search for ways to improve review and evaluation of the associated Integrated Safety Assessment.

Research to Support Reactor License Renewal Beyond 60 Years

Extension of reactor operating licenses from 40 years to 60 years is an important NRC regulatory activity today. The staff noted that there have been serious discussions about the possibility of license renewal beyond 60 years. New issues may arise in such further license extensions, especially since many of the plants will have been operating for 10 years to 30 years at power levels higher than originally licensed. We do not find that these new issues are likely to be so different than those encountered in the current license extension process that they merit a separate and distinct long-term research project. It would appear that any issues likely to arise could be identified and addressed in current research efforts, including the Proactive Materials Degradation Assessment project.

Test Facilities

In its long-term research plan, the staff has identified two activities associated with possible development of experimental facilities:

- Integrated Digital Instrumentation and Control and Human Machine Interfaces Test Facility
- Integral Effects Test Facilities for Advanced Non-Light Water Reactors

The staff will explore the feasibility of developing a facility for testing digital instrumentation and control systems and the human/machine interface. This will not be the first time such a feasibility study has been undertaken. In the past, it has been found that such a facility would not be cost effective. As a result, NRC has continued its association with the somewhat less satisfactory capability at the Halden project. If the staff again concludes that a new facility in the U.S. is not cost effective, it should consider collaboration with other nations to better meet the needs foreseen by the agency.

The staff also plans to identify experimental facilities throughout the world that can be used to investigate phenomena associated with advanced reactors that do not rely on water technology, including gas-cooled reactors and liquid metal-cooled reactors. A study with somewhat similar objectives has been conducted by Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA). Again, there may well be international interest in collaboration on this proposed research.

Cross-Cutting and Emergent Technologies

In the fourth category of possible, long term, research projects, staff has identified quite a number of individual topics. We provide synoptic comments on several of these below:

Advanced Fabrication Techniques

The Department of Energy and elements of the industry are aggressively searching for methods to facilitate and improve the construction of nuclear power plants. Some of the methods now being considered could greatly affect the NRC's processes for monitoring nuclear facility construction. The new plant fabrication methods could affect the long-term performance of structures and components. It is appropriate for the staff to develop an understanding of modern construction methods that may be applied to nuclear facilities and how they may affect the regulatory processes.

Advanced Computational Methods

The staff has called attention to advanced computational methods now available. The issue of advances in computer technology is much larger than just improved numerical algorithms. We foresee far greater use of virtual methods for design and evaluation in future applications. The staff is now ill-equipped to evaluate submissions using such advanced design technologies that are becoming ever more widespread within the

engineering community. The evaluation and adaptation of computer technologies that the staff will need to have over the next 20 years could well be a major thrust in NRC's long-term research program.

Extended In Situ and Real-Time Inspection and Monitoring Techniques

Non-destructive inspection and testing are important tools for managing aging degradation at nuclear power plants. Such inspection and testing methods are expensive and can result in significant personnel exposures to radiation. In many cases, non-destructive inspections can only be done when plants are shutdown. There is, then, the possibility that unexpected, rapid degradation would not be detected in time to prevent an accident. In situ, real-time monitoring techniques could lead to more effective and reliable management of aging-related degradation of reactor materials. The staff needs to maintain cognizance of developments of such in situ, real-time methods.

Multiphase Computational Fluid Dynamics Capability

Commercial computer codes are available for computational fluid dynamics but have limited predictive capability for multi-dimensional single phase flows in nuclear systems. Virtually no such capability exists for multi-dimensional, multi-phase flows. However, two phase computational fluid dynamics is an emerging field which may prove useful in many regulatory applications. We are heartened that the staff is looking beyond commercially available computer codes in its search for future computational resources to support regulatory activities.

Offsite Mitigation Strategies

The staff proposes to ascertain if mitigation strategies developed by other industries and agencies are applicable to plants having accidents. We support this effort, but also agree that the staff should not be developing these mitigation strategies.

Nanotechnology for Nuclear Power Applications

Nanotechnology has caught the imagination of the technical community and there may well be future applications to nuclear power including structural materials, sensors, and advanced coolants. In addition, other advanced material technologies may also be useful, for example, surface modifications of reactor material including ion implantation. We encourage the staff to expand this area to include advanced materials in general that may have applications in the nuclear field.

Fire Effects on Fiber Optic Cables

We agree with the staff that it is very likely fiber optic systems may one day be used in nuclear plants and these fiber optic systems may be subject to the effects of fire. It seems, however, a very simple step to add fiber optic qualification as a task in the ongoing research on fire effects on cables. We see no need for a separate long-term research program in this area.

Advanced Quantitative Risk Assessment Methods and Advanced Modeling Techniques for Level 2/3 PRA

NRC's research has developed for the most part the PRA techniques in use today. PRA has become an essential element of the regulatory process. It is essential that NRC not allow development of PRA methods to stagnate. We certainly endorse continued examination of improved methods (including those for Level 1 PRA) to develop these methods and to improve the utility of these risk-assessment methods for the regulatory process.

Advanced Offsite Consequences Code

Consequence analysis computer codes used by NRC both for risk analysis and for accident response have limited capabilities to realistically portray dispersal of radioactive material in the actual environments surrounding nuclear power plants. Staff proposes research to develop codes better able to simulate radioactive material dispersal. The plan for such research should be deferred until completion of the ongoing State-of-the-Art Reactor Consequence Analysis activity to better define agency needs in this area.

Formal Decision Analysis Methods

In the past, ACRS has recommended that the staff should make greater use of formal decision making techniques. The staff should focus on adapting existing methods to support regulatory decisionmaking.

We support the staff's efforts to develop long-range research programs. We understand that the staff plans to prioritize the various research efforts it has identified and to update both the list and the prioritization episodically. We look forward to continued discussions with the staff on these long-term research projects.

Sincerely,

/RA/

William J. Shack
Chairman

References:

1. Memorandum to The Commissioners from Luis A. Reyes, Executive Director for Operations, Subject: SECY-07-0068, "Candidate Agency Long-Term Research Activities for Fiscal Year 2009," April 6, 2007. (Official Use Only Document - Sensitive Internal Information - Limited to NRC Unless the Commission Determines Otherwise)

2. Office of Nuclear Regulatory Research Report, Subject: "U.S. Nuclear Regulatory Commission Long-Term Research: FY 2009 Activities," March 2007. (Official Use Only - Sensitive Internal Information - Draft)

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5. OECD/NEA, “Nuclear Safety Research in OECD Countries, Support Facilities for Existing and Advanced Reactors (SFEAR),” Committee on the Safety of Nuclear Installations (CSNI), Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA), NEA/CSNI/R(2007)6, 2007.

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