

April 4, 2002

MEMORANDUM TO: Farouk Eltawila, Director  
Division of Systems Analysis and Regulatory Effectiveness  
Office of Nuclear Regulatory Research

FROM: James E. Lyons, Director */RA/*  
New Reactor Licensing Project Office  
Office of Nuclear Reactor Regulation

SUBJECT: NRR COMMENTS ON DRAFT ADVANCED REACTOR RESEARCH  
PLAN

The purpose of this memorandum is to provide the Office of Nuclear Reactor Regulation (NRR) initial comments on the draft Advanced Reactor Research Plan to the Office of Nuclear Regulatory Research (RES). On March 13, 2002, RES provided the document to the different program offices for review and comment by March 31, 2002, in order to prepare for a April 12, 2002, briefing of the Advisory Committee on Reactor Safeguards (ACRS). Prior to this memorandum, NRR provided high-level comments to RES via e-mail and telephone conversations on March 27 and 28, 2002.

In response to this request, NRR has performed a cursory review of the plan and is providing these initial comments in the context of preliminary input into either a future NRR request for RES assistance or development of an agency-wide new reactor research plan. NRR would like to acknowledge RES efforts in the preparation of the draft plan, which can serve as the starting point for future interactions. Several high-level comments are summarized below, while more detailed comments are attached to this memorandum. It should be noted that these comments do not constitute NRR's final review of the proposed plan, nor does this memorandum constitute NRR endorsement of any part of this proposed plan.

NRR does not recognize the need for developing a reactor regulatory framework that only applies to advanced reactors. However, NRR does acknowledge resources are budgeted for assessing options related to this activity in the near term. In SECY-01-0188, "Future Licensing and Inspection Readiness Assessment," (FLIRA), the staff articulated that existing regulations are sufficient to address new reactor licensing. Future rulemaking and regulatory infrastructure development identified in the FLIRA is in the context of improving efficiency and effectiveness of licensing reviews, and reducing unnecessary regulatory burden.

NRR does have several rulemaking initiatives underway for operating reactors to better reflect the results of probabilistic risk assessments (PRAs) and the current understanding of reactor safety issues. The first of these initiatives, known as Option 2, would provide an alternative risk-informed approach for special treatment requirements in the current regulations. The second, known as Option 3, identified possible changes to specific technical requirements in Part 50. The staff intends to publish a proposed revision to 10 CFR 50.44 in April 2002 and is developing recommendations for changes to 10 CFR 50.46. In addition, the staff is deriving a

common set of risk-informed objectives that will be used to evaluate the current regulatory structure. It is expected that RES would participate in the development of these risk-informed objectives. The staff feels that these activities may obviate the need for a “new” reactor regulatory framework or at a minimum help define the scope and depth of these activities. It is anticipated that any changes to the existing regulatory structure would be applicable to new reactors.

NRR believes that the plan should be reorganized. At the outset, the plan states that it represents a comprehensive summary of all information gaps. To improve usefulness of the plan, NRR would like some characterization of the research needs, i.e., research to be performed in the context of the new reactor designs and research needed to support specific licensing activities. Furthermore, the latter research to support licensing activities can be further categorized into types of research activities, products and timeframes needed to support these activities. Performance of this type of categorization could lead to either a future NRR request for RES assistance or development of an agency-wide new reactor research plan.

NRR is looking forward to a constructive working relationship to ensure research activities are appropriate and necessary to support the regulatory activities associated with new reactor licensing. One approach for future interactions could build of the technical advisory group (TAG) pilot program. If you have any questions regarding this matter, please contact Stephen Koenick at (301) 415-1239.

Attachment: As stated

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ADAMS ACCESSION NUMBER:

|        |          |             |          |
|--------|----------|-------------|----------|
| OFFICE | PM:NRLPO | (A)DD:NRLPO | D:NRLPO  |
| NAME   | SKoenick | JSebrosky   | JLyons   |
| DATE   | 4/3/2002 | 4/3/2002    | 4/4/2002 |

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**Preliminary NRR staff comments on the  
draft Advanced Reactor Research Plan, March 2002**

On March 13, 2002, RES provided the document to the different program offices for review and comment by March 31, 2002, in order to prepare for a April 12, 2002, briefing of the Advisory Committee on Reactor Safeguards (ACRS). Prior to this memorandum, NRR provided high-level comments to RES via e-mail and telephone conversations on March 27 and 28, 2002.

In response to this request, NRR has performed a cursory review of the plan and is providing these initial comments in the context of preliminary input into either a future NRR request for RES assistance or development of an agency-wide new reactor research plan. Given the expeditious but limited review of the plan, these comments do not constitute NRR's final review of the proposed plan, nor does this memorandum constitute NRR endorsement of any part of this proposed plan.

**1. General Comments**

- a. It is stated in the introduction that "the staff focused on critical research areas and information to technically support an advanced reactor license submittal review." This aspect should have the highest emphasis in this plan. Also these critical areas should be communicated to the applicants to include in, or supplement, their submittals.
- b. It is mentioned in the introduction that the staff needs to define what research would be conducted by the applicants as part of their license applications. This item should have a high priority as a resource saving measure. The staff's main focus should be on confirmatory research as compared to independent research.
- c. Figure 1 is a useful overview illustration of key research areas. To complement this figure, the plan should contain a summary table that lists the particular items that need "research," and describe specifically what that "research" includes. The description should identify whether the "research" requires the construction of experimental or test facilities, whether analytical methods need to be developed, and whether analyses themselves need to be performed. Each "research need" should be linked to a specific regulatory deliverable, such as a Reg. Guide, a revision to an existing regulation, justification for an exemption to a regulation, a new regulation, or a new tool for use in performing regulatory confirmatory analyses. An estimated time to complete each "research need" should be provided.
- d. In cases where the "research" will be conducted in concert with industry, we have concerns about avoiding the appearance of conflict-of-interest. Although the document acknowledges that this aspect will be considered, the actual implementation of the agreements will need to be continuously monitored to assure that the results of the "research" are not tainted and therefore made useless to NRR.
- e. Many of the "research" activities seem to be more regulatory than "research." We believe that a detailed review of the document could separate the "research" from the "regulatory."
- f. There is no discussion in the plan about how knowledge and expertise that is derived from the "research" activities will be transferred to the regulatory decision-makers.

Although written reports are assumed to be one product, the experience of the individuals who perform the "research" is also valuable, and there should be some discussion of whether those individuals will continue to perform supporting tasks during the regulatory review, or whether they will be transferred to the regulatory staff, to participate directly in the review.

2. Topics to be expanded on:

- a. The staff could use review guidance in other generic areas, such as General Design Criteria, Quality Assurance Requirements, and applicability of unresolved safety issues and generic safety issues for gas cooled reactors.
- b. Specific to quality assurance (QA) requirements - This could include the use of International quality standards like the ISO-9000 Quality Management System by the applicant. This issue will be very important with the new reactor designs such as PBMR, including overall QA program oversight and specifically in the areas of design and testing controls. Recently at the NRC Regulatory Information Conference, Commission Merrifield talked about the NRC staff need to assess options for adopting more widely accepted international quality standards like ISO-9000.
- c. Construction Inspection Activities - With the exception of a short discussion regarding ISI and modular construction there does not seem to be any effort dedicated to supporting construction inspection efforts. In the FLIRA report we identified the lack of information regarding the codes and standards that will be referenced in the inspection procedures for gas-cooled reactors. We identified ASME Code Section III, Subsection NH, "Class 1 Components in Elevated Temperature Service," and Section XI, Division 2, "Rules for Inspection and Testing of Components of Gas-Cooled Plants," as Codes that will need to be updated. There are also standards from other organizations that may need to be updated.
- d. Section V.2.3, "Safeguards and Security Arena"

Although Fig. 1, "Key research areas for examination," explicitly identifies "Protection Against Sabotage" as a key research area, the plan seems to be excluding any effort in this area until RES is approached with a specific request "for assessing and limiting the vulnerability of advanced reactor plants and fuel cycle activities to sabotage and outside threats."

In light of the September 11, 2002, the Commission may revisit the requirements in §50.13 to clearly define the extent to which nuclear power plants (including advanced reactors) would need to provide for design features or other measures (physical hardening, spatial separation of redundant/vital systems, computer security, etc.) for the specific purpose of protecting against radiological sabotage. Therefore, NRR's role in licensing advanced reactors may benefit from a more substantial RES effort on design concepts for sabotage protection at nuclear power plants. The following information may be useful:

- i. NUREG/CR-1345, "Nuclear Power Plant Design Concepts for Sabotage Protection," (January 1981)
- ii. NUREG/CR-0463, "Program Plan - Nuclear Power Plant Design Concepts for Sabotage Protection," (December 1978)

- iii. NUREG-0144/SAND76-0637, "Summary Report of Workshop on Sabotage Protection in Nuclear Power Plant Design," (February 1977)
- iv. NEI 01-01/EPRI TR-102348, "Guideline on Licensing Digital Upgrades", (currently in draft form)

In addition, the research plan should include the evaluation/study of emerging vulnerabilities in the area of safeguards and security identified through the presently on-going NRC Homeland Security activities. These should include both physical and cyber vulnerabilities, and should be derived from mitigative actions (e.g., Simple Network Management Protocol), lessons-learned (e.g., output from vulnerability studies) and any training necessary to prevent or mitigate radiological sabotage. Both insider and outsider threats should be considered.

### 3. Specific Comments

#### a. Framework (VI.1.3.3)

It is not clear that a "new regulatory framework" is necessary for licensing advanced designs. This could be considered along with alternative options, such as use of the current licensing guidance with appropriate exemptions or exclusions and additions.

At a minimum, the existing writeup on reactor-neutral licensing framework is ambiguous and needs further clarification since it is central to comprehending the research plan. Safety criteria and regulatory guidelines applicable to advanced reactors, as well as safety related areas identified as important for regulating these reactors, are considered together to develop a set of performance goals. (These goals are claimed to define the level of detail believed to be needed for licensing?). A set of reactor-neutral regulations are then defined based on these goals. The thought process behind this conceptual approach needs clarification. One possible means to achieve that is to apply the process to the area of ALWR, an area in which the staff has fair experience, or even use the licensing guide developed by the South African Government.

One consideration in the development of a new regulatory framework, would be the uncertainty of impacts of technical "research" needs. Developing the regulatory framework in parallel with the technical knowledge to support it is certain to increase costs and delay completion of the staff review. There may be some gain in time, compared to a serial process, but the overall cost is certain to be higher.

#### b. Section III.2.4, "Aging and Inservice Inspection of Structures"

Since NRC has rules related to maintenance and ISI of the containment structure, this effort is not needed for licensing of advanced reactors. However, this research is useful for initiating the development of risk-informed structural inspection criteria.

#### c. Section VI.2.1.2, "Instrumentation and Controls"

The research proposed herein is similar to that which has been agreed to in support of the ongoing digital upgrades of the I&C systems in operating reactors. These activities should be well coordinated to ensure duplication of effort is minimized.

- i. Section VI.2.1.2.3, Objectives and Planned Activities, summarizes nine research efforts that are proposed in support of NRR's needs with regard to I&C. Some of the nine efforts listed here may not be needed, depending upon the directions that the industry chooses to take. While, the staff has not identified any proposed areas or activities where there exists sufficient knowledge that more knowledge would not be helpful, NRR will likely avoid support to research efforts into the viability or preferability of various available technologies. This type of research would be an industry activity. There is the Technical Advisory Group on Instrumentation and Controls Research (TAGI&C), a joint task force within NRR/DE/EEIB and RES that meets regularly and is tasked to appraise each research effort prior to the commencement of the work. The TAGI&C eventually decides whether specific research is or is not indicated.
  - ii. Reliability and security of digital and control systems - This new feature in advanced designs performs sophisticated safety and control functions. Historically malfunctions have been encountered in flight control systems and NASA designs. Applicants should address this issue explicitly in their submittals which should then be followed by confirmatory research.
- d. Section VI.2.4, "Materials Analysis"

The RES plan in the area of materials analysis appears to be written very comprehensively such that it covers the recognized issues needed for the staff to review an ALWR or HTGR licensing application. Given the fundamental nature of the materials issues and the number of issues that need to be significantly better understood, it will be important to explore international agreements, as noted in Section VI.2.4.4, as well as the work to be performed by industry to address the questions surrounding materials performance.

e. Section VI.2.5, "Structural Analysis"

- i. Research needed to support NRR's licensing of advanced reactors

- (1) Seismic Analysis of Reactor Vessel and Core Support Structure

New gas cooled reactor designs involve a core made of pebbles and blocks of graphite with channels for control rod operation. Vibratory response modeling and analysis of such structures are subject to large uncertainties. Consequently, data and validation of models and associated software are important for licensing needs.

- (2) Effect of high temperature on concrete

Whenever a concrete structure is required to function under high temperatures during operation, cooling systems that maintain the average concrete temperatures below 150° F are generally provided. Research effort on changes in concrete properties when subjected to sustained high temperatures is necessary.

- ii. Research effort not needed to support NRR's regulatory mission

- (1) Seismic Hazard Assessment

Research related to implementation of SSHAC methodology is helpful in updating seismic hazard at nuclear plant sites located in the Central and Eastern US (CEUS). However, this is not essential for early site permit reviews, because the existing LLNL results are not likely to change for most of the CEUS sites, as noted from the result of the Trial Implementation Plan (TIP). TIP used two sites in a relatively active seismogenic area of the Southeastern US, and the hazard for one of the sites has increased, while it remained virtually the same for the other site. As stated in RG 1.165, the seismic data base would have to be updated on the basis of local information. If there is any new information to be considered for an ESP, the staff currently has the capability to develop an appropriate hazard curve by taking the new information into account, and examine the applicant's characterization to render its judgement.

## (2) Seismic Soil-Structure Interaction Analysis

A well used and understood computer program, SASSI has capabilities to allow modeling and seismic analysis of buried or partially buried structures by including the soil-structure interaction (SSI) effects. It may be useful to gather down hole recorded data and benchmark SASSI models. This would offer an opportunity to the staff to verify that seismic models proposed by applicants are reasonable. However, the criteria for SSI analysis are well established in the SRP Section 3.7 and these can be used for the licensing of new reactor designs that use a deeply buried reactor building.

## (3) Modular Construction

Modular construction has been used for the design certification of AP 600. The modules for AP 600 were based on finite element models verified by Japanese test data. The staff has direct licensing experience with modular construction. Changes to industry codes and standards are best achieved when they are effected by a consensus process utilizing peer reviewed methods. NRC sponsored research can expedite the process, but in this instance, it is not necessary for licensing of advanced reactors.



f. Use of Probabilistic Risk Assessment

- i. Guidance for advanced design PRA reviews should address:
  - (1) The process used by the applicant to identify vulnerabilities at the design stage.
  - (2) How the balance between preventive and mitigative features was established in the design.
- ii. Uncertainties (VI.2.1.1.3.1.8) - The claim that PRA has a structured approach for identifying uncertainties associated with risk estimates seems to be exaggerated. The issue of completeness is significant in case of advanced designs (especially non-LWRs). We lack experience data, and our knowledge about novel severe accident phenomena that may compromise safety is meager.
- iii. Section (VI.1.2) - This section states that the regulations licensing these advanced reactors will be risk-informed. This is certainly an objective consistent with past Commission guidance, but the balance between risk-informed attributes and more traditional engineering approaches is not yet determined. The statement that "it is expected that future applicants will rely on PRA . . . in their license application," is more than an expectation. Submittal of PRA is a requirement of Part 52.
- iv. Role of PRA - Should the use of SAPHIRE for PRA quantification be limited to only when necessarily needed as a part of licensing review following the examination of each design-specific PRA (for confirmatory purpose) rather than a part of performing an independent PRA.

g. Schedule (VI.1.5):

The plan did not establish any link between the four-year period needed to finalize the framework and any projection of the licensing schedule expected by the staff for advanced designs reviews. This section should address coordination with licensing activities.

h. Purpose (VI.2.1.1.2)

This section addresses the treatment of areas where information and expertise are meager or nonexistent. It recommends the use of expert judgment in areas where no expertise exists. Similarly, sensitivity analyses have an element of subjectivity that is hard to measure. Increasing the safety margin and defense-in-depth still has merits when reasonable conservatism is used.