POLICY ISSUE
INFORMATION

April 18, 2003 SECY-03-0059

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: NRC'S ADVANCED REACTOR RESEARCH PROGRAM

PURPOSE:

To inform the Commission of the NRC's advanced reactor research infrastructure assessment and currently proposed research activities.

BACKGROUND:

In response to "Staff Requirements Memorandum for COMJSM-00-0003," the staff prepared and issued an information paper entitled, "Future Licensing and Inspection Readiness Assessment," (FLIRA), SECY-01-0188, dated October 12, 2001. The FLIRA report assessed the regulatory process and need for enhancements necessary to support future licensing of advanced reactor designs. The FLIRA report also committed the staff to prepare an advanced reactor research plan to guide the development of a research program to support the certification of advanced reactor designs. In developing this plan, the staff performed an infrastructure assessment to identify methods, tools, data, and expertise needed to support the certification of advanced reactor designs. The infrastructure assessment provides the bases for more detailed planning of research activities. The highest priority was given to those activities that support design certification review schedules and provide the technical bases for regulatory decisions. A summary of these activities for each of the key technical areas and reactor designs currently under review is provided in Attachment 1; the supporting infrastructure assessment itself is provided in Attachment 2.

The scope of advanced reactor research plans currently includes six advanced reactor designs: (1) Westinghouse's Advanced Pressurized Water Reactor AP-1000, (2) General Electric's

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ESBWR, (3) Atomic Energy of Canada Limited's Advanced CANDU Reactor ACR-700, (4) General Atomic's Gas Turbine–Modular Helium Reactor (GT-MHR), (5) PBMR Pty of South Africa's Pebble Bed Modular Reactor (PBMR), and (6) Westinghouse's International Reactor Innovative and Secure (IRIS). Framatome's ANP SWR-1000 schedule includes submittal of pre-application material in calendar year (CY) 2004 and design certification application after CY 2005. The SWR-1000 will be added to the plan's scope at that time.

The staff will review the plan annually and will update the plan as needed to accommodate new designs or technical issues. Generation IV designs that are being considered for research and development by the U.S. Department of Energy (DOE) have been excluded because of their early stage of development. The Office of Nuclear Regulatory Research (RES) will, however, remain cognizant of Generation IV activities through coordination with DOE.

DISCUSSION:

While it is the responsibility of applicants and designers to develop the methods, tools, and data sufficient to demonstrate the safety of proposed reactor designs and technologies, the NRC conducts research to independently assess applicants' submittals and to provide the technical bases needed to develop the regulatory requirements that these designs must meet. In this regard, the term "research" encompasses both applying existing knowledge and tools or creating new knowledge and tools. The duration of the research could vary between short-term efforts to respond quickly to emerging issues and long-term research that is forward-looking and focused on developing an infrastructure of tools and data or assessing new technologies. In the past, independent research by the NRC identified important safety issues that brought about a number of design modifications and safety enhancements during design certification review. This often involved exploratory research on margins or beyond-design-basis issues. For example, NRC's extensive program on severe accidents provided the technical bases that allowed designers to incorporate plant-specific features in advanced reactors to enhance margins of safety by preventing or mitigating the consequences of severe accidents. Finally, independent research programs provide a sound technical basis for regulatory decisions and reduce the need for excessive conservatism that normally results from a lack of knowledge.

In general, the staff will determine what information must be provided by the applicant as part of their license application, and what additional NRC research is needed to support the licensing offices. The general principle that will be used for research activities is (a) if research data are needed to support the safety case for a particular reactor design, the applicant will be responsible for providing the data, and (b) if the NRC believes the research is important to independently assess applicants' submittals or to provide the technical bases needed to develop the regulatory requirements that these designs must meet, NRC resources will be used. Within the area of NRC supported research, the research activities generally fall in one of three categories:

(1) Development and maintenance of computer codes and models (fuel behavior, reactor physics, thermal-hydraulics, severe accidents, and consequences) needed to support staff's independent assessment of an applicant's analyses and to explore issues that involve margins or are beyond the design basis.
(2) Development of experimental data to validate codes and models identified above.

(3) Forward-looking activities (e.g., instrumentation and control, human factors, materials, and structures) that relate to new or evolving technologies to identify issues that may become important for regulatory decisions and to provide the technical bases for regulatory requirements.

All proposed research activities have been binned into one of the three categories above. Activities that support pre-application review or design certification are listed by reactor type. It is envisioned that in addition to these activities, NRC's research plan will continue to be updated to accommodate new designs, safety issues, or updated information from applicants. The plan will be kept up-to-date to reflect research needed to develop new or different tools, methods, data, and expertise to respond to the changes. The staff will continue to interact with applicants, vendors, and others as the technologies evolve, so that the NRC will be prepared to respond effectively to industry initiatives.

Experience with previous design certification reviews demonstrates that the scope, schedule, and resource demands for research programs can be extensive (depending on the reactor design) and that the staff could benefit from worldwide research and experience. Consistent with the NRC Strategic Plan, the NRC will continue to seek opportunities to interact with and, where appropriate, initiate cooperative programs with other agencies and organizations. Cooperative agreements have already been initiated or are being pursued with both domestic universities and organizations including DOE, Massachusetts Institute of Technology, and international organizations including the Nuclear Installations Inspectorate, United Kingdom, the Nuclear Energy Agency, and the European Commission (E.C.). In addition, NRC and industry could jointly fund research that benefits both NRC and industry. However, if this is the case, the staff will ensure that NRC's independence will not be compromised in the process, and the quality and integrity of the data used by the NRC will be maintained. The process equally applies to relationships with other government agencies such as DOE, or with industry groups, such as the Electric Power Research Institute. In addition to off-setting costs, significant efficiencies will be gained by sharing research facilities and leveraging resources to minimize duplication.

It should be recognized that similar to other complex technologies, advanced reactor regulation will be a blend of applying technical knowledge within the context of Commission policy and prudent regulatory decisions. There will be a continuous need for defense-in-depth and safety margins to offset limitations in state-of-the-art knowledge and understanding. Priorities set within the program will consider the relative importance of the activity to understanding safety issues and the risk significance of these issues. This will be especially important as new technology is introduced or previously unaddressed safety issues are identified. Priorities will also consider the near term needs, lead time necessary to develop the required data or information, and opportunities to join national or international programs that can result in substantial savings of NRC resources. Routine peer reviews of progress and research products will be conducted to instill confidence in the quality of the research, and these reviews will include frequent interactions with the Advisory Committee on Reactor Safeguards (ACRS) and the Advisory Committee on Nuclear Waste.

Identification and Planning Research Activities

The infrastructure assessment described in Attachment 2 and used to plan advanced reactor research activities addresses the three strategic arenas: Nuclear Reactor Safety, Nuclear

Materials Safety, and Nuclear Waste Safety. Safeguards and security research for advanced reactors will be coordinated with other initiatives that support the Office of Nuclear Security and Incident Response. The Nuclear Reactor Safety Arena includes six key research areas: accident analysis, reactor systems analysis, fuels analysis, materials analysis, structural analysis, and consequence analysis. Each of these areas was examined and plans developed (Attachment 1) for addressing infrastructure gaps. In the arenas of Nuclear Materials Safety and Nuclear Waste Safety, the assessment focused on the fuel cycle and potential differences between current and advanced technologies. Proposed research in these areas is being coordinated with the Office of Nuclear Material Safety and Safeguards (NMSS).

To ensure that research in the Nuclear Reactor Safety Arena supports review activities, a joint RES and the Office of Nuclear Reactor Regulation (NRR) management team has and will continue to review the infrastructure assessment and proposed research activities to identify significant gaps that evolve based on preliminary information. Proposed activities will be incorporated in each offices' operating plan. The management team will identify (1) activities that will be included in the design certification reviews, including research activities in the form of information or data that are the responsibility of the applicant, and (2) NRC funded research activities that are needed to support the licensing office's independent assessment of the application or to provide the technical bases needed to develop the regulatory requirements. Proposed research activities that are undergoing management team review and for which a final decision has not been made are identified in Attachment 1 as TBD. All proposed activities will be prioritized through the Planning, Budget, and Program Management (PBPM) process.

Although the infrastructure assessment stemmed from a technology-neutral perspective, there are two primary domains of research: advanced light-water reactor (ALWR) research and high-temperature gas-cooled reactor research. A discussion of their status is provided below.

Advanced Light-Water Technology

During the AP600 review, and to a limited extent the Simplified Boiling-Water Reactor review, the staff gained valuable experience and insights regarding the performance of passive safety systems through an extensive testing program in the U.S. and overseas. In addition, over the past several years, the NRC consolidated and improved its thermal-hydraulic and severe accident codes. NRC is now confident that it will be ready to support the review of ALWRs of similar designs. Notwithstanding, additional models and assessment will be needed for designs that differ significantly from these previous ALWRs, particularly the IRIS and ACR-700 designs.

High-Temperature Gas-Cooled Technology

The high-temperature gas-cooled reactor (HTGR) research infrastructure development described in Attachment 1 has been scaled back as a result of Exelon's withdrawal from PBMR pre-application review and a reduction in General Atomic's GT-MHR pre-application review scope. Nevertheless, some HTGR research activities will require long-term commitments. Existing NRC computer codes, for example, that were developed for LWR applications will need to be modified to accommodate HTGRs. Materials and fuels used in HTGRs that are subjected to higher temperatures during normal operation and accident conditions than current LWR materials, will also need to be better understood. The NRC will look for opportunities to

collaborate with DOE, the E.C., and Japan on research in these areas, which will allow NRC's research infrastructure to evolve over time and be ready to accommodate a variety of HTGR designs at a later date.

Additionally, the staff recognizes that pre-application reviews of non-light-water reactors could benefit from a technology-neutral licensing framework. Such a framework could enhance consistency and efficiency of NRC's regulatory process across reactors with radically different concepts. Research to develop such a framework has been initiated this fiscal year. In addition to the research needs identified as part of the infrastructure assessment, several policy issues have been identified as a result of the pre-application reviews of the PBMR and the GT-MHR. The staff has prepared a separate Commission paper, SECY-03-0047, "Policy Issues Related to Licensing Non-Light-Water Reactor Designs," on these policy issues for early Commission feedback, consistent with the intent of the Commission's Statement of Policy on the Regulation of Advanced Nuclear Power Plants.

COORDINATION:

The Office of the Chief Financial Officer has reviewed this paper and has no objection. ACRS has reviewed the infrastructure assessment and has forwarded their findings in a separate report to the Commission. Earlier infrastructure assessment drafts had been discussed with the ACRS, and their views were provided in a letter to Dr. William D. Travers dated July 18, 2002. The staff addressed ACRS comments in a letter from Dr. Travers dated August 29, 2002.

RESOURCES:

Implementation activities associated with research infrastructure development are, and will be, prioritized through the PBPM process. Resources budgeted by all the offices will be consistent with their operating plans. Staff and contractor support scheduled for FY 2003 activities have been shifted from HTGR research to support the ESBWR pre-application review and associated infrastructure. The staff's completed FY 2004 budget proposal includes resources for advanced reactor infrastructure for both LWRs and non-light-water reactors. These resources will be applied to accomplish activities in Attachment 1. The strategy reflected in this paper will continue to evolve in response to direction from the Commission, staff insights gained from the pre-application reviews, new information received from industry and stakeholders, and new information provided by applicants for certifications. The staff will use the PBPM process to adjust its resources to any significant changes in the strategy, schedules, and deliverables. Resources will be reprogrammed as needed to satisfy higher priorities, resulting in deferrals of lesser priority work.

/RA/

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Attachments: 1. Proposed Advanced Reactor Activities
2. Advanced Reactor Research Infrastructure Assessment

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2. Advanced Reactor Research Infrastructure Assessment

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