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THE ROLE OF RESEARCH IN NRC REGULATORY PROGRAMS

BY

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TO

THE 23RD WATER REACTOR SAFETY INFORMATION MEETING
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INTRODUCTION

Good morning, ladies and gentlemen. I am pleased to welcome you to the twenty-third Water Reactor Safety Information Meeting. The long history of these meetings suggests that they provide important opportunities for enhancing our common understanding of safety issues related to current and advanced reactor designs. In this regard, I am particularly gratified to see representatives from the U.S. nuclear industry and a large presence from the international community. After reviewing the agenda for this meeting, I am confident that there will again be opportunities for valuable exchanges of information.

I have been Chairman of the NRC for four months, but I have spent most of my career in research and development and understand the role that research plays in the fulfillment of agency and corporate missions. Clearly, valid regulatory decisions must be based on the firm technical understanding that comes from research.

NRC research programs provide a strong independent technical capability for our regulatory programs. Without this strong technical component, our decision making capability would be diminished and public safety could be compromised. It is this independent capability that has made the NRC preeminent in nuclear reactor regulation around the world.

The concept of research to ensure an independent technical capability was defined by Congress in the Energy Reorganization

Act of 1974, and the soundness of that concept is beyond dispute. In practice, our research programs must also anticipate the needs of the regulators and the problems that may occur in the future in the systems that we license. In addition, we must sustain a technical base that allows us to react in the event of abnormal events. Careful planning and priority setting, as well as prudent investments are essential to NRC's research program if we are to maintain technical credibility.

INDUSTRY USE OF NRC RESEARCH

I have studied and have received several briefings on NRC research programs since coming to the agency. I believe the programs have not only provided strong technical support to the NRC, but have also provided valuable information to the industry we regulate. The research programs have provided significant enhancements to data bases of all kinds, and they have produced analytical methods and measurement techniques that have been very useful to the nuclear industry.

Let me take a few minutes to cite some examples.

Behavior of Emergency Core Cooling Systems

In the early 1970s, NRC conducted a major hearing on the behavior of emergency core cooling systems (ECCS) during loss-of-coolant accidents. As a result, NRC undertook a number of research programs to confirm judgments that were made in the hearings. Without the promise of that comprehensive research program, it is quite possible that no construction permits or operating licenses would have been issued in the mid 1970s. In that decade, our research confirmed the conservatism in oxidation kinetics, decay heat levels, embrittlement criteria and other requirements. Arguments over ECCS analyses no longer held up licensing activities.

There are other legacies of our research on loss-of-coolant accidents besides the solution of problems which hindered the licensing process. Much of the data generated in these NRC programs are still used today by reactor manufacturers and utilities as the basis for their analytical models: core reflood data from LOFT, SEMISCALE, and the 2D/3D program; ballooning and rupture data from the Multi Rod Burst Tests; and fuel rod performance data from NRC rigs in the Halden test reactor, among others. And then there are the large thermal-hydraulic computer codes: RELAP, TRAC, and COBRA. All U.S. reactor vendors use NRC-developed computer codes, with some modification, in their technical activities. And almost every major U.S. nuclear utility uses NRC-developed codes in their routine technical studies and core management. In fact, ten of these utilities are full-fledged members of our RELAP users group today.

Heavy Section Steel Research

In another area, where work was started early by our predecessor-the Atomic Energy Commission, the heavy-section steel program provided essential information on materials properties and fracture behavior of steels and weld materials. Virtually all of the early research on the effects of irradiation on the embrittlement of reactor pressure vessels was performed in NRC research programs. This work provided a basis for avoiding plant shutdowns at the time the Pressurized Thermal Shock rule was published, and it continues to provide information to support regulatory decisions on reactor pressure vessel safety. The fracture mechanics tools used today in ASME Section III Appendix G for setting pressure-temperature limits were developed and validated under this program.

Piping Integrity Research

NRC's piping integrity research provided much of the basis for relaxing earlier requirements and allowing leak-before-break to be considered. This resulted in significant relaxation in piping restraints in many plants. NRC's research on nondestructive examinations, containment leakage, valve testing, and seismic issues has also contributed significant benefits to industry activities.

Risk Assessment

One of NRC's most important research accomplishments is in the area of risk assessment. It is fair to say that the NRC's research program has had a major impact on the discipline of probabilistic risk analysis and particularly in its application to nuclear reactor safety. While elements of risk assessment had some earlier use in the aerospace industry, the NRC's Reactor Safety Study (WASH-1400) represented the first integrated assessment of nuclear plant risk ever done. Our later assessment of severe accident risks (NUREG-1150) provided better estimates of plant risk based on a more complete understanding of severe accident phenomena. All U.S. nuclear plants have now performed risk assessments and, because of this work, the increased use of risk insights in regulatory activities holds the potential to improve safety and at the same time reduce costs.

Severe Accident Research

WASH-1400 demonstrated that essentially all of the risk from nuclear plants comes from core-melt accidents. Therefore, right after the accident at Three Mile Island, the NRC initiated an aggressive severe accident research program to examine core-melt sequences and subsequent accident phenomena that might challenge containment integrity. The understanding of severe accident phenomena from this research allowed the risk assessment methodology of WASH-1400 to be revisited to produce the credible

assessments of NUREG-1150. Although, it may not be generally realized, more than 75 percent of all the severe accident research done in the U.S. has been done by the NRC. The Department of Energy work on the examination of Three Mile Island represents about 10 percent of the severe accident research in the U.S., and a little less than 15 percent was done collectively by the industry under EPRI and the Industry Degraded Core Rulemaking program. This large body of severe accident research has been used by all U.S. utilities as the basis for their risk assessments and Individual Plant Examinations.

Source Term Research

An important spin-off of NRC's severe accident research relates to the source term. The current licensing source term dates back to 1962 and gives an unrealistic portrayal of fission product release during accidents. Because of its assumed instantaneous appearance, this source term places emphasis on plant features that may not be optimum, such as fast acting containment isolation valves and rapid spray initiation. Revised source terms, which have come out of our research program, include a more realistic timing and fission product composition and will provide the basis for the design and operation of plant features to mitigate fission product releases more readily.

Current Research Activities

The NRC is also working in newer areas. Let me identify some of these areas, and you will hear more about them in the technical sessions that will start later today.

Most of you are aware of a recent concern about high-burnup fuel and our current program in that area. We issued an Information Notice to the utilities last year on this subject, and it was discussed last year at this Water Reactor Safety Information Meeting. Using data largely from foreign sources and a strong domestic analytical effort, we are hoping to revise fuel damage licensing criteria without creating undue penalties for the operating utilities.

Our progress on the thermal hydraulics of the advanced pressurized water reactor, the AP-600, has been significant, including scaled testing in the ROSA loop in Japan and in a test loop at Oregon State University, and detailed studies utilizing the RELAP computer code are being performed. Several design changes in the AP-600 have been made by Westinghouse that can be attributed, at least in part, to results from these programs.

Our continuing severe accident research is paying off in several ways. In addition to providing the basis for the utilities' accident management plans and Individual Plant Examinations, it has in some cases led to reductions in potential consequences of severe accidents. Hardened vents in Mark-I containments and

provisions for flooding the Mark-I basemat to prevent liner attack are examples of actions taken as a result of our core damage research. Of no less importance, the severe accident research program has provided the basis for not doing anything in other areas. For example, early consideration of the possibility of direct containment heating in PWR containments suggested a high likelihood of early containment failure. More detailed and structured results from this program have indicated that direct containment heating is a very small contributor to public risks at most plants.

Our aging research activities are looking at degradation in pressure vessels, piping, steam generator tubes, reactor internals, valves, cables, and containment structures.

Present work on piping integrity is almost complete for the large baseline programs of the International Piping Integrity Research Group. We are now pursuing more specialized studies. For example, in collaboration with the Nuclear Engineering Power Corporation (NUPEC) of Japan, we are participating in large-scale seismic tests of main steam and feedwater piping systems on the largest shaking table in the world.

Steam generator tube studies are examining inspection-system capabilities to detect flaws, the effects of primary and secondary side environments, and analysis methods used to assess tube integrity. This program will provide an independent assessment of the inspection and analysis methods being used by the U.S. industry in evaluating steam generator tube integrity.

A final example is our review of aging effects on containment structures. Safety margins may be reduced by corrosion of steel containments and steel liners, breakdown of the seal at the concrete floor, concrete contact with grease, corrosion and relaxation of tensioning cables, etc. We are examining these processes to determine what issues should be included in our research programs, as well as looking at in-service inspections and methodologies to perform assessments of current conditions. These activities are particularly important in light of the promulgation of our new performance-based rule on containment leakage rate tests.

International Safety Research Cooperation

International cooperation in safety research has been going on for a long time. NRC's participation in OECD and IAEA, for example, goes back more than 20 years. However, after the accidents at Three Mile Island and at Chernobyl, nuclear safety has been increasingly recognized as a world-wide concern, and our cooperative programs have intensified. This trend has been further enhanced by the general reduction in research budgets at home and abroad, and the resulting need to pool resources in cooperative programs.

Some of our cooperative programs, like the Halden Project's fuel behavior work and the International Piping Integrity Review Group, have continued over many years, and we are still participating in their activities. Others, like the high-burnup fuel tests in the French CABRI reactor and the containment integrity program with NUPEC in Japan, are relatively new cooperative programs. It is important to note that most of these cooperative international programs also have sponsors from the commercial sector.

Well, that is a sample of what we have done in the past and what we are working on now. What about the future?

THE FUTURE OF THE NRC RESEARCH PROGRAM

In general, we have an obligation to stay strong and to maintain our independent technical capability so we can support the regulation of our 100-plus operating reactors. That means we will continue to work in important areas like thermal-hydraulics, materials, severe accidents, and risk assessment; and we will continue to participate in, and to stay abreast of, international nuclear research programs. There always seem to be issues of the day, such as the integrity of radiation embrittled reactor pressure vessels and the behavior of reactor fuel at higher burnups. A wide range of these research programs will be discussed in the following technical sessions, and some of the current issues will be addressed in this plenary session in an effort to make sure our research remains on target.

We are now in a period of change at the NRC. The electric utility industry is under strong competitive pressures and is diligently examining means to reduce its costs. NRC has a role to play in reducing the regulatory burden when the safety benefit is marginal.
However, even without external pressure to reduce costs, a new culture, which I refer to as risk-informed, performance-based regulation, is being adopted by the NRC. NRC is becoming less prescriptive and more performance-oriented in its regulatory posture in order to provide greater flexibility to licensees while maintaining adequate protection for the public. Cost-consciousness and cost-effectiveness pervade all of NRC's operations, including research.

NRC's research programs are being reexamined to ensure proper focus under this new paradigm. Research planning must consider the current and prospective level of plant safety, and there should be a reasonable expectation that research projects and their results will be cost beneficial. Among the criteria to evaluate the merits of a research project are the likelihood that the results will improve the effectiveness of regulations and minimize any undue burdens they impose. Some of the rules that the NRC developed conservatively in the 1960's and 1970's because

of lack of information can now be modified as a result of improved knowledge that has been gained through investments in research over the past 20 years. Future investments in research will be expected to continue this trend.

As nuclear power plants age, we must examine the standards and operating procedures that have been imposed on critical components, such as the primary coolant system boundary, to assure ourselves and the public that an adequate safety margin still exists. Only through research can we derive dependable estimates against which we can make such judgements. One of our top research priorities is improving our understanding of the aging processes in nuclear power plants with particular focus at the present time on reactor vessels, steam generators, and electrical cables.

Many of the performance standards will be established by drawing on knowledge developed in risk assessments performed both by NRC as well as by licensees.

However, we must acknowledge realities. Careful evaluation is needed to determine the future value of additional research in all areas. We are approaching the point where we can, in some areas, go into a program maintenance mode that includes a very limited experimental program and thoughtful fine-tuning of existing analytical models. Our current international cooperative experimental programs are expected to provide additional data to help make this determination. In doing this, however, we have found that adequate resources and careful planning are still required to avoid losing the important technical skills.

However, further emphasis and new work is needed in important areas related to changing focus of our mission, i.e., risk assessment research to develop and strengthen methodologies for dealing with human/organizational factors and degraded equipment. New methodologies from other fields need to be developed and applied to age related effects in reactors, i.e., going beyond fracture mechanics to relate detailed measurements using new experimental probes to microscopic materials properties in order to make stronger predictive statements about behavior, as well as development of possible in situ probes of key plant systems such as the Reactor Pressure Vessel itself.

Since becoming Chairman, I have come to recognize that there are a number of important research areas associated with aging reactors which possess elements common to reactors in all of the countries relying on nuclear power. I know that countries already share the results of their reactor research and that in some specific technical areas, a number of countries have joined together to address issues of common concern and interest. We need to be certain that our collaborative research projects recognize and build upon the unique areas of specialization and

particular expertise each of us has. Through existing institutions, such as the Committee on the Safety of Nuclear Installations of the OECD Nuclear Energy Agency, we must more diligently focus our attention to the planning and integration of our research efforts. At the same time, we should hold these institutions to high performance and efficiency standards so that value is achieved from our investments in them. But, I would like to propose that we go much further. I think that we should consider an international reactor research program focused on aging and risk assessment methodologies in which we seek to integrate the regulatory research activities of various countries within the context of a formal international research program. Each country could specialize in areas of its particular expertise. Thus, we would avoid duplication of effort and meet the common challenges which we are encountering and the common downward pressures on our various regulatory research budgets. In certain areas of mutual interest, a few of which I have already mentioned, this kind of coordinated international research activity has occurred, with excellent outcome. However, this is meant to be a more direct and focused research program than generally exists, internationally. If it can be accomplished with appropriate planning, focus and coordination under the aegis of the existing multilateral structures, then it should happen that way. If not, the task that I propose may be difficult to achieve, but I think that it at least should be carefully considered and explored. Consideration of such an activity will be part of the NRC strategic assessment and rebaselining initiative that I recently announced, and which I will now discuss further.

Strategic Assessment and Rebaselining

Changes in the industries we regulate ultimately affect the regulator, and the NRC is no exception. Although I believe that the NRC has earned its reputation as the foremost nuclear regulatory body in the world, we still need to develop a strategic vision that allows us to adapt to a changing environment and to budgetary constraints, to carry out our regulatory programs more effectively, to take on possible new missions, to conduct effective resource planning, while remaining responsive to the public and the regulated industries. The first phase of the strategic initiative, the "strategic assessment," involves identifying and examining the sources of the mandates that make up our regulatory mission - statutes, executive branch directives, and Commission decisions--so that we can establish a mutual understanding of what the NRC mission is and what is required of us. Also included in this phase is a process of looking at all agency activities to determine whether they are being conducted in response to a specific mandate or whether these activities have some other rationale for their existence, and whether there are areas where we should have ongoing programs to implement a specific mission, but do not. This phase is, as the title implies, essentially a review, categorization, and

assessment. This phase is also meant to begin to surface key strategic issues, questions, and decision making points, which the Commission will address.

The subsequent phases -- rebaselining and strategic planning -- flowing from Commission decisions on the key strategic issues, questions and policy alternatives, will address what our programmatic needs are and should be, and what resource levels should be assigned to them. The first phase will drive and provide input to the following phases and ultimately to budget and human resource planning, which is the final phase. I believe that this review is necessary to position us to meet effectively the challenges we face and to guide intelligently our activities and decision-making in the future.

CONCLUSION

I hope my remarks give you some of my perspectives on the role and value of the NRC research programs. I believe both the nuclear industry and the NRC are facing a series of interrelated challenges that, taken together, could change substantially how the electric power industry continues to develop and how it will be regulated. How we solve today's problems can, and will, affect the role that nuclear energy will play in the nation's energy mix in the future. Our mutual goal should be to view our challenges as opportunities and address them proactively rather than reactively. The NRC's research program can assist us in addressing some of the challenges.

Let me close my remarks by again expressing my appreciation for your interest in our work and to encourage your active participation in this important meeting. Thank you for your attention and I hope you will have an enjoyable and successful meeting.

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