An Overview of the NRC's Office of Nuclear Regulatory Research

by

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Thank you for inviting me to your monthly dinner meeting. Madeline asked me to speak about the origins of the NRC's Office of Nuclear Regulatory Research, as well as provide an overview of how we fit into the NRC's regulatory process and what the future challenges are.

Prior to the Energy reorganization Act of 1975, commercial nuclear power was both promoted and regulated by a single organization, the Atomic Energy Commission, commonly referred to as the AEC. The AEC was created by the Atomic Energy Act of 1954.

Commercial nuclear power plants began to be deployed in earnest in the U.S. beginning in the mid to late 1960's. Within the AEC, the regulation of commercial power plants was done by the Office of Regulation, commonly referred to as REG, whereas the research and development for reactors was done by Office of Reactor Development and Technology, referred to as RDT.

In the late 1960's and early 1970's, there were two major activities underway in both the regulatory and research and development areas. In the late 1960's, some loss-of-coolant accident (or LOCA) tests run at the Idaho National Laboratory, in a scaled test facility called "Semiscale", resulted in safety injection water not being delivered to the simulated reactor core as expected. This was an unexpected consequence, which was later attributed to a scaling distortion of the simulated downcomer. However, this result ultimately led to substantial litigation of plants currently in the licensing process. RDT was charged with conducting the research necessary to address this issue, and in 1972 and 1973, the AEC conducted hearings, referred to as the ECCS hearings, to establish an ECCS rule that would standardize the analysis methods and models for ECCS analyses, and eliminate the time-consuming litigation occurring on individual license application hearings.

At about the same time, estimates of known uranium reserves indicated there was enough uranium to fuel commercial light water reactors for about 25 more years.

To address this, RDT was actively conducting research on liquid metal fast breeder reactors, or LMFBRs. The LMFBR offered the promise of “breeding” fissionable fuel, and greatly extending the utilization of the known uranium reserves.

During this period, the Director of RDT was Milton Shaw, a protégé of Admiral Hyman Rickover. Mr. Shaw was asked to testify at the ECCS hearings, and during the hearings, it was alleged that funding that should have been spent on ECCS research had been diverted and spent on LMFBR research and development.

In the summer of 1973, the AEC Commissioners voted to move the Division of Reactor Safety Research from RDT and put it under REG. At that time, Dr. Herbert Kouts from Brookhaven National Laboratory was named the director of the division, and Saul Levine was his deputy. Milton Shaw was upset with this move, and went to the Commission and said that if this division was moved out of RDT, he would resign. The Commission upheld their decision, and in the summer of 1973, Mr. Shaw resigned as the Director of RDT. The Commission replaced him with Thomas Nemzek, who came from Pacific Northwest Laboratories. In a reorganization of RDT in November of 1973, Mr. Nemzek removed a number of managers that reported to Mr. Shaw.

Within about a year, the Energy Reorganization Act was passed, the AEC was disbanded, and split into the Nuclear Regulatory Commission and the Energy Research and Development Administration, or ERDA. Within a year, ERDA became the Department of Energy.

The Division of Reactor Safety Research became part of the NRC and was renamed the Office of Nuclear Regulatory Research.

In 1976, Dr. Kouts left and in August of 1977, and Saul Levine became the Office Director. In June of 1979, Bob Budnitz was the deputy Director of RES, and became the director for a short period after Saul Levine left in 1980. In 1980, Bob Budnitz left and Tom Murley was the acting Director for a few months until Bob Minogue was appointed the Director. In the Fall of 1981, Denwood Ross became Minogue's deputy. In 1986, Bob Minogue left, and Eric Beckjord was appointed the Director of RES.

Eric Beckjord was director for about 8 years, and in 1994 Dave Morrison became the director. A few years later, Morrison left and Malcolm Knapp took over. In 1998, Ashok Thadani was named the director of RES, and headed the office until Carl Paperiello was appointed. In 2006, Carl announced his retirement, and on May 1, 2006, your truly was appointed the director of RES.

RES is one of three statutory offices within the NRC, which means Congress created them, and only Congress can remove them. The other two are NRR and NMSS.

RES currently is organized into three divisions as well as a management staff. The current staffing is authorized at 243 (full-time equivalents, or FTE, and the FY07 budget was $68M.
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What is the role or RES and what is the scope of our work?

RES is a service organization to the agency. Our primary job is to provide the Agency's regulatory offices with the tools, data, and expertise needed for them to carry out the Agency's regulatory mandate.

The slide showing the current RES organization, and particularly the branch names, should give you a good idea of the breadth of the technical areas we work in.

To talk about each of the technical programs we are working on and providing technical support to out regulatory offices would keep me here days, if not weeks, so I only want to highlight some of our main areas of research.

Systems analysis is, and has always been, a fundamental requirement for assuring operational safety. RES has developed and continues to develop state-of-the-art computer codes for analyzing plant transient and accident behavior, including postulated core-melt accidents with radiological releases, as well as fuel behavior and performance. The fact that approximately 30 foreign regulatory bodies use our codes, such as TRACE and MELCOR, and have cooperative agreements with the NRC through programs such as CAMP and CSARP attest to the quality of our codes.

Since the tragedy on 9/11, RES has been performing aircraft impact analyses to better understand potential vulnerabilities.

With the advent of new reactors, as well as the obsolescence of existing analog controls and protection systems, digital I&C has become a major area of focus in the NRC. RES is actively addressing this challenge through the implementation of our digital I&C research plan, as well working closely with NRR and NRO to develop the necessary standards and guidance needed for the industry to safely deploy digital I&C systems. RES is also actively supporting human factor and human performance research, not only as it relates to new reactors with digital control rooms, but for operating reactors as well.

Material issues have become a fact of life, in particular weld cracking. In addition to supporting NRR in the analysis of operational events that involve material cracking, RES is also engaged in research to better understand the degradation mechanisms at work, and thus better predict when and where degradation might occur, and identify what proactive measures are available to prevent material degradation failures.

In the Energy Policy Act of 2005, the NRC was charged to contract with the National Academies of Science to develop recommendations on alternative radioactive sources that would replace existing sources but would be in less dispersible forms. RES was responsible for

carrying out this mandate, and we have worked closely with not only NAS, but within NRC and with source manufacturers.

Groundwater contamination with Tritium has become an issue recently. RES has been providing technical assistance to our regional offices in not only understanding the behavior and safety significance of the contamination, but also in explaining it to the public.

In the area of seismic design, RES has been active in understanding the impact and lessons-learned from the Niigata Chuetsu Oki earthquake in Japan that damaged the Kashiwazaki plant.

These are a few of the research areas we are actively working on. Obviously there are many more for which time doesn't permit me to describe.

In addition to regulatory research, RES is also charged with carrying several of the Agency's programs. For example, we are in charge of the Generic Issue program, in which potential safety issues that are raised by either the NRC staff, or members of the public, are put into a formal process to assess the safety significance, and determine how best to disposition this assessment. Since the inception of the program over 20 years ago, we have completed assessment of 850 Generic issues, and there are currently 6 active issues being worked on.

RES also conducts the Accident Sequence Precursor (ASP) Program in which operational events are evaluated for their risk significance.

NRC is required to submit a Significant Operational Occurrence report to Congress each year.

RES is charged with the preparation of this report.

In addition to our domestic research, RES leverages its research dollars by actively participating in collaborative international research programs. Through the Organization for Economic Cooperation and Development (OECD), the NRC participates in the activities of the OECD's Nuclear Energy Agency (NEA), and RES participates as the NRC's member on the NEA's Committee for the Safety of Nuclear Installations (CSNI). The CSNI sponsors a wide variety of safety-oriented activities, such as cooperative research projects, international technical workshops, international standard problems for safety code assessment, and development of State-of-the-Art reports. NRC currently participates in over 75 international cooperative research agreements, such as the Halden project in Norway, and the Prisme program in France.

I would now like to spend a little time discussing what I believe the future research challenges will be.

While it is tempting to think that new reactors would pose the greatest research challenge, this is not the case. The new reactors, and I am referring to AP-1000, ESBWR, EPR, and APWR, are relatively similar to the current LWR fleet. As such, there are few new issues associated with these designs that warrant research.

Moreover, it is the NRC's firm position that the safety of the current operating fleet of plants is of paramount importance. As these operating plants age, aging issues have arisen and likely will continue to arise. Continued research on understanding equipment and structure degradation mechanisms will therefore be necessary.

In this same vein, license renewal, which allows current 40 year licenses to be extended for an additional 20 years, has identified a number of areas in which enhanced surveillance and monitoring requirements have been necessary to ensure continued safe operation. Moreover, plants that have applied for and received renewed licenses have invested significant sums of money into replacement components and upgrading equipment. Many plant owners believe that these plants can. In fact, run for an additional 20 years beyond the current renewal period, of for 80 years.

Given the lead times that utilities need to plan for new or replacement power, decisions on whether to apply for a second renewal period could need to be made in less than 10 years. It is therefore important to identify the issues that could potentially affect the ability of a plant to run beyond 60 years, and decide what, if any, research is needed and when it should be started in order to assure that both the industry and the regulator are ready to handle second renewal period applications. To this effect, the NRC and DOE recently sponsored a 3 day workshop on “Life Beyond 60" to help identify what the potential issues are, and what needs to be done to address these issues.

In addition to new light water reactors, commonly referred to as Gen III, there are a number of initiatives to develop and deploy advanced, non-light water reactors. The Energy Policy Act of 2005 specifically charged the NRC and DOE to develop a licensing strategy for the NGNP, or Next Generation Nuclear Plant, which is expected to be a high-temperature gas-cooled reactor.

In addition to NGNP, there is also interest in licensing a pebble bed gas-cooled reactor, and the vendor for this design has indicated an intent to submit a combined license application in late 2009.

Toshiba has developed a small, 30MW modular liquid metal reactor that does not require refueling for 30 years. The city of Galena, Alaska, has expressed a strong interest in licensing and constructing this reactor, and has indicated an intent to submit a license application by the end of 2009.

Finally, we have been approached by a company called Hyperion that is interested in licensing a hydride reactor and wants the NRC to initiate a pre-application review in 2009.
However, in addition to developing a licensing strategy for the NGNP, as well as for these other concepts, NRC must also identify what information and tools are needed to develop the necessary regulatory infrastructure. This includes the need for integral thermal/hydraulic test facilities, fuel performance data, risk assessment information, high temperature material performance data, to name a few.

Finally, each of these designs poses new and significant policy issues that must be addressed, such as the need for containment versus confinement.

In an era of static and possibly shrinking budgets, how to develop this infrastructure poses a significant challenge. While in it’s heyday of the mid and late 1970's, the RES budget was on the order of $200M, largely driven by the cost of code development and the experimental facilities, such as LOFT and Semiscale, needed for the validation of these codes. Around 1988, with the completion of LOFT and Semiscale testing and the shutdown of these facilities, along with the promulgation of the ECCS rule change, the RES budget shrank to around $100M per year. In the past two decades, the budget shrunk further and now seems fairly constant in the $60-$70M range.

Meeting these future challenges with a stagnant budget will not be easy. Much heavier reliance on licensees and applicants to develop the experimental information historically developed by RES will likely become a reality. Foreign regulators will likely be faced with the same demands, and efforts are underway within OECD countries to identify opportunities for collaboration.

I hope my talk has provided you with some insights on the origin of the NRC's Office of Nuclear Regulatory Research, as well as some of the formidable challenges the Office will be facing in the near future. I would be pleased to try and answer any questions at this time.