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NUCLEAR REGULATION AND CAREER EXPERIENCES
BY
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AT
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It is a great honor to be invited back to Bell Labs, now Lucent Technologies, to visit the Semiconductor R&D Manufacturing Facilities and to speak during your Black History Month celebration and on Valentine's Day. I wish to thank Dr. Vincent D. Mattera for extending to me this invitation. It provides me with an opportunity to update my knowledge of the work of Bell Labs, and to consult with former colleagues. I am delighted to be able to share with you some of my career experiences, and to speak to you about nuclear regulation in the United States.

CAREER EXPERIENCES

After graduating from high school in the nation's capitol, I continued my education at the Massachusetts Institute of Technology (MIT). A friend of mine and I were the first African-American women to graduate from MIT, in 1968. She went to medical school and is now a physician; I stayed at MIT as a graduate student and received my Ph.D in theoretical elementary particle physics in 1973. I am happy to say that since that day, a number of African-American women have been awarded doctorates by MIT, but at that time, it was a first.

Later that same year, I had the opportunity to lecture at a NATO Advanced Study Institute in Antwerp, Belgium, on "Polarons and Excitons in Polar Semiconductors and Ionic Crystals." From 1973 to 1974, and again from 1975 to 1976, I was a research associate in the Theoretical Physics Department of the Fermi National Accelerator Laboratory in Batavia, Illinois. The year in between was spent as a visiting scientist in the Theoretical Division of the European Organization for Nuclear Research in Geneva, Switzerland.

In 1976, I joined AT&T Bell Laboratories in Murray Hill, New Jersey, and for the next 15 years, conducted research in theoretical physics, solid state and quantum physics, and optical physics. While at Bell Labs, my research areas included the study of charge density waves in layered transition metal dichalcogenides, the polaronic aspects of electrons on the surface of liquid helium films and the effect on electronic transport, and the electronic and optical properties of semi-magnetic semi-conductor strained-layer superlattices.

In 1991, I joined Rutgers University as a Professor of Physics, while remaining a consultant to AT&T Bell Laboratories in semiconductor theory. Concurrently, in New Jersey, I served on the State's Commission on Science and Technology under two Governors, Thomas Kean and Christine Todd Whitman. I was appointed to the Department of Energy's Advisory Board Task Force on Alternative Futures for the DOE Multipurpose National Laboratories, and served on the Boards of Directors of several corporations. As you can see, I had very rich professional experiences and opportunities while based in New Jersey. I still live in New Jersey, but I work in Washington.

In late 1994, President Clinton nominated me to the U.S. Nuclear Regulatory Commission, and stated his intention to name me as Chairman. After confirmation by the Senate, I took office as a Commissioner in May of 1995, and assumed the Chairmanship two months later, in July 1995.

As some of you may know, the U. S. Nuclear Regulatory Commission (NRC) is the independent regulatory agency that is responsible, among other things, for ensuring the safety of the nation's 110 nuclear power plants. The NRC's charter encompasses many other kinds of nuclear uses as well, including, for example, industrial radiography and nuclear medicine.

Originally, all aspects of nuclear energy, military and civilian, were the responsibility of the Atomic Energy Commission (AEC), which was founded in 1946. The NRC was created in 1975, after Congress decided that the nuclear power industry had reached a point where the same agency should not be promoting the

use of nuclear energy and regulating its use. The AEC was abolished, the promotional and developmental duties were given to what is now the Department of Energy, and the NRC was given an exclusively regulatory mandate.

Having served at the NRC for almost two years, I can say that its duties are extraordinarily interesting and multifaceted. One might imagine that nothing could be more exclusively technical than the task of ensuring the safety of nuclear technology: setting and enforcing standards, inspecting to ensure compliance, and taking corrective action when needed. In reality, however, many disciplines are involved in the NRC's activities. Ours is an agency where science and technology, law, economics, public policy, national security, and sometimes foreign policy considerations intersect.

REGULATORY ISSUES

Economic Deregulation

Let me give you a few real-world examples on how technology, law, economics, and public policy considerations intersect, beginning with the economic regulation of nuclear power plants. For many decades, America's electric utilities have enjoyed monopoly status in their service areas. They have been were regulated by state public utility commissions, which has guaranteed them a fixed rate of return each year on a given asset base, and has allowed them to pass on their business expenses (deemed to be prudent) to the consumers of electricity. As a result, the business performance of these utilities was so predictable and dependable that their stocks and bonds were known as "widows and orphans" securities -- the epitome of safe, conservative investments.

The guarantee of funding meant that if a utility decided to build a nuclear power plant, the NRC did not have to worry, once the plant received its license, about the utility's financial condition. The agency could be confident that there would be adequate finances for the utility to operate the plant safely and then to decommission it properly -- that is, take it out of service and clean up the site -- when its useful life was over.

In 1992, Congress passed the Energy Policy Act of 1992, which gave to the Federal Energy Regulatory Commission (FERC) certain authority to initiate competition in the various parts of the energy business. Recent initiatives at the state and Federal levels have set into motion a process by which we will soon see true competition in the generation of electric power. Just as consumers can now choose their long-

distance telephone service provider, they soon will be able to choose their supplier of electric power.

Let us consider the implications of this. The changes associated with economic deregulation and restructuring of the electric utility industry have operational, economic, and ownership aspects that are important to the NRC. Of course, the NRC is not an economic or rate regulator, but we long have recognized the challenges posed to the nuclear power industry by a changing business environment and by fiscal stringency. They include internal restructuring; ownership changes, including mergers; and a continual effort by utilities to control and reduce costs. These structural changes and economic uncertainties are driven by regulatory and market forces that will determine how, and in what form, nuclear electric generators will survive in an unregulated, or less regulated, world. The role of the NRC is not to dictate what changes should occur or into what form electric utilities restructure. Our focus is on ensuring that, as the business environment changes, economic pressures do not erode nuclear safety. That means that nuclear electric generators must continue to maintain high safety standards, with sufficient attention and resources devoted to nuclear operations, and with decommissioning funding secure.

I should interject at this point that it is not the NRC's task to ensure the economic viability of nuclear power, only to ensure that whenever nuclear power is used, it is used safely, and that, when a nuclear plant is shutdown there is adequate funding to ensure that it can be decommissioned safely. The question now facing the NRC is what deregulation will mean for how we go about meeting these objectives. For example, what level of assurance does the NRC have that a particular utility will spend the money required for adequate maintenance and for necessary safety upgrades? What changes do we have to make in our inspection program and other evaluation process to ensure that we stay ahead of any potential degradation in safety at a plant, so that we can detect adverse trends and correct thembefore, not after, adequate safety is eroded? If a nuclear utility is involved in a merger or acquisition, what will the change in ownership mean for the way the plant is operated?

The NRC traditionally has relied on its inspection and plant assessment programs to identify any adverse trends in safety performance. Based on inspection program results, plant performance reviews, and other evaluative mechanisms, the NRC can take action it deems appropriate to protect public health and safety. In the current economic environment, if new business arrangements, competition, or economic constraints result in any impairment of safety, it is imperative that our assessment mechanisms detect such problems early.

The Commission has asked the staff to examine measures to identify plants where economic stress may be impacting safety. The NRC has approved for public comment a paper entitled, "Establishing and Maintaining a Safety Conscious Work Environment." The paper includes as "evidence of an emerging adverse trend" the following example: "cost-cutting measures at the expense of safety considerations."

As I indicated earlier, as electric utility industry deregulation proceeds, the NRC needs to ensure that adequate decommissioning funding is available, whether nuclear plants operate to the end of their license terms or shut down prematurely. Moreover, since deregulation may change the economic umbrella for some licensees, the NRC may need to monitor their financial qualifications more closely.

In the Fall of 1995, I initiated a reevaluation of NRC policy regarding decommissioning funding. The NRC issued an advance notice of proposed rulemaking (ANPR) in April 1996, seeking additional information on electric utility restructuring. The ANPR also explained that some additional decommissioning funding assurance might be needed for those power reactor licensees no longer subject to rate regulation by FERC or the State regulatory commissions.

We also are examining potential changes in reporting requirements with respect to decommissioning funding.

In short, the NRC is being presented with a host of new challenges, just as a result of utility deregulation, and they involve far more than technological issues. A single change in the law or in the economic regulation of utilities -- that on its face has nothing to do with nuclear regulation -- can have major ramifications for how we go about ensuring the safety of the public.

EXTERNAL REGULATION OF THE DEPARTMENT OF ENERGY (DOE)

One potential change for the NRC is the external regulation of U.S. Department of Energy (DOE) nuclear activities. This issue has been identified in our agency-wide Strategic Assessment and Rebaselining as a direction-setting issue for the agency, because of its potential effect on the future operation of the NRC.

In 1995, the DOE created an Advisory Committee on External Regulation. In its December 1995 report, the Committee recommended that DOE nuclear facilities be regulated externally, and named the NRC and the Defense Nuclear Facilities Safety Board as the two potential safety regulators. Last month, the Secretary of Energy announced that the administration would introduce legislation to give the NRC the

responsibility for the regulation of nearly all DOE nuclear facilities, phased in over a ten-year period.

Many questions remain to be answered and many issues, both legal and technical, must be resolved about NRC oversight of DOE nuclear facilities. In considering this issue as part of the agency-wide Strategic Assessment and Rebaselining, the Commission is factoring in the Energy Secretary's recent announcement and the public comments received on the DOE external regulation direction-setting issue. Those comments overwhelmingly favor NRC oversight of DOE nuclear facilities. This might seem to take us back to the beginning of time, i.e., to the old Atomic Energy Commission. This is not quite so -- this time. We would be the external regulator of DOE, not co-joined in a single agency.

Design Bases

NRC must also anticipate and react to direct changes to the facilities we regulate. In maintaining and improving nuclear reactor facilities, our nuclear power plant licensees make continual changes to their plant systems, structures and components, procedures and other administrative controls. It is important that the as-built plant accurately reflects, and is reflected in, the plant design basis, and that plant changes do not erode or compromise safety margins of risk-significant systems.

Therefore, the NRC is giving increased focus to design basis control, especially as embodied in a nuclear reactor licensee's updated final safety analysis report (UFSAR). The NRC uses the UFSAR as a reference when evaluating license amendment requests and other issues at particular facilities. The accuracy of the UFSAR has a direct impact on the accuracy of recurring reviews and safety analyses performed by the NRC staff.

The NRC staff is putting renewed emphasis on design basis inspections. This is an in-depth review of actual design basis documentation, and comparison of "as-built" and "as-operated" safety systems with the design requirements for each system. These inspections provide a better picture of licensee effectiveness in maintaining licensing and design bases. The verification that licensees know their licensing basis, have appropriate documentation of such, and properly perform the necessary safety assessments when licensing basis changes are made, will continue to be an important part of NRC inspection activities.

Aging

The NRC must also keep abreast of advanced technologies and their relationship to an ever-changing nuclear industry. One of the most obvious manifestations of the maturation of the nuclear power industry is that plants have been in operation long enough for reactor aging to become a major issue both for the NRC and the industry it regulates. Aging affects all plant structures, systems, and components to varying degrees, and it can affect operations and safety, if not appropriately managed. Two specific aging problems of great importance are reactor pressure vessel embrittlement and steam generator tube degradation. Some U.S. reactor pressure vessels could become sufficiently embrittled before the end of their license term that the integrity of the pressure vessel could be challenged during certain accidents. If so, licensees will have to reduce the rate of fluence to the vessel, anneal the reactor vessel, or shut down their reactors. From my perspective, adequate progress has not been made in measuring embrittlement changes in operating reactor vessels and relating those changes to microscopic models which give a stronger predictive capability, and which allow an assessment of the effectiveness of mitigative techniques.

The surveillance programs used by nuclear power plant licensees for determining changes in toughness properties in the vessel materials of operating reactors have a number of shortcomings, especially for older plants. These programs use a simple, but indirect, conservative method that does not utilize improvements in fracture toughness technology. The results tend to have significant variability, making more difficult the assessment of plant-specific reactor vessel integrity.

To address this problem, the use of advanced nondestructive examination techniques for measuring the embrittlement of irradiated reactor vessels should be pursued. Several possible approaches have been proposed for such measurements, including magnetic, ultrasonic, and hardness measurement techniques, although additional research is required to evaluate the viability of these approaches. This is an area with considerable promise, which has the potential for a significant reduction in uncertainties.

To address steam generator tube degradation, the NRC is considering a generic regulatory approach, with a view to reducing plant-specific regulatory decisions, while ensuring defense-in-depth through a balance of preventive and mitigative measures. In the end, however, many plants may have to replace their steam generators because of an inability to accurately characterize and mitigate steam generator tube degradation mechanisms. Indeed, a number have made such replacements already.

If not adequately addressed, both of these aging phenomena could cause plants to be shut down before the end of their 40-year license terms, as corrective actions may significantly impact plant economics.

New Reactors

The future of nuclear power beyond the current generation of plants is also an issue that NRC is actively engaged in. Although in the United States, new nuclear electric generating capacity does not appear likely at this time, the possibility remains that U.S. electric power generators will consider in the future a standard nuclear power plant as a source for new generating capacity. The NRC has issued final design approvals for two standard reactor designs, and the certification of two new designs by rulemaking will be completed very shortly. In particular, the certification of the two standard reactor designs -- the General Electric Advanced Boiling Water Reactor and the Combustion Engineering System 80+ will be completed this year. The NRC also is reviewing the Westinghouse AP-600 standard design application, a light water reactor design which employs passive safety features and greater use of modular construction.

High-Level Radioactive Waste

Finally, the NRC is evaluating and participating in the resolution of issues that have the potential to impact many generations to come, such as the case with the high-level waste program. The continued operation of many nuclear reactors over decades has meant a steadily mounting quantity of spent fuel requiring storage and disposal. The U.S. Department of Energy is the responsible Federal agency for designing, developing, and constructing a geologic high-level waste disposal facility. DOE has the responsibility to accept spent fuel from commercial power reactors, and high-level radioactive waste from the defense program, and dispose of that material in a geologic repository. The Nuclear Regulatory Commission has the responsibility of licensing the geologic disposal facility before spent fuel or high-level waste can be accepted at the repository for disposal.

The high-level radioactive waste program has been marked by calls for change--notably in the 104th Congress and now in the 105th Congress. Just last Wednesday (February 5), the Senate Energy and Natural Resources Committee opened its new legislative session by holding a hearing on proposed new legislation (S.104, the Nuclear Waste Policy Act of 1997) that could alter this country's current high-level waste program. We can expect the high-level waste issue to receive considerable attention by the Congress in the coming months and years.

The need to address and resolve this problem in a timely manner remains critically important. The NRC hopes that the various legislative initiatives in the 105th Congress will lead to a comprehensive High-Level Radioactive Waste Management Program for the nation -- one with clarity and stability. The NRC will continue to support the resolution and implementation of this important program to ensure the safe storage of waste for our children, their children, and grandchildren.

CONCLUSION

Today, I have attempted to describe some of my career experiences and some of the issues associated with nuclear regulation in the U.S. I was educated and began my career in Physics as a particle theorist, and later became a condensed matter theorist. In the space of a few weeks, I went from being a Professor of Physics at Rutgers University to a member of the U.S. Nuclear Regulatory Commission in May 1995, and to the Chairmanship of the agency since July 1995. My rapid transition from the laboratory to the campus to providing policy guidance and management direction for one of the government's major science and technology-based regulatory bodies has demonstrated the value of my education, experience, ambition, hard work and a little good fortune. I only hope that my achievements will help to inspire others to aim high. For, as you can see, one does not always know, when starting a career, where it will take you. But, one does know that the opportunities to be challenged and to excel are many.

Thank you for your attention. I will be happy to respond to your questions.