NRC NEWS

U.S. NUCLEAR REGULATORY COMMISSION

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No. S-06-011

Perspectives on Nuclear Regulation and the Global Interest in Nuclear Energy

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Trombay Colloquium
Mumbai, India
March 27, 2006

I. Introduction and Overview

Good morning. It is a great honor to speak to you here in Mumbai on behalf of the United States Nuclear Regulatory Commission (NRC) and Chairman Diaz. Chairman Diaz regrets that he could not be here in person. I am the most recent member to serve on the five member Commission, having been appointed by President Bush over a year ago. I was sworn in as a commissioner in early 2005, and during my year as a commissioner with the NRC, I have greatly expanded my knowledge of nuclear regulation.

This is the first time I have been to India, and I greatly appreciate the warm hospitality I've experienced here. Last week's discussions with several of your government officials helped me to better understand the goals and challenges in India as you strive for new energy resources. Today, representing the NRC, I am extremely pleased to be able to share perspectives on nuclear regulation in general and our future challenges given the renewed global interest in nuclear energy.

I would like to focus my remarks on several key topics: the mission of the NRC; how the NRC fulfills its mission in its role as an independent regulator; the importance of public involvement in nuclear regulatory oversight; the regulatory challenges of the increase in global interest in nuclear energy; and nuclear safety research, in particular the cooperation between India and the United States. It is clear to me that the regulators in both the United States and India can and want to work together to provide a safe and secure energy future for both our nations.

II. The Mission of the United States Nuclear Regulatory Commission

At the outset, I wish to express my belief that the outlook for the safe and secure utilization of nuclear energy is very positive in light of the improved state of the technology and the expectations of the world for an improved quality of life and for socio-political stability. But I further believe that the positive outlook will continue only insofar as safe operations are demonstrated.

The viability of nuclear power is inextricably linked to its effective regulation. There is no way, presently and in the foreseeable future, to maintain and to advance the use of nuclear power in free societies without a strong, predictable, and credible regulator. At the NRC, we enhance our strengths, which include reactor safety oversight, predictability, and credibility, through technically sound regulation and by enabling public participation. In these areas, it is essential that regulatory infrastructures be strong, sound, and safety-focused, with state-of-the-art technology in every important safety aspect. As regulators, we must listen to, respect, and analyze different views, from public and private stakeholders, while making and enforcing decisions independent of undue influences.

The phrase, "reactor safety," refers to plant design and operational characteristics that provide protection against both design-basis accidents and severe accidents, and to the training and capability of the human beings at the controls. Reactor safety thus embraces systems, structures, and components; programs, practices, and procedures; and knowledge, skills, and abilities. It also includes a factor not always measurable in numbers, but nevertheless crucially important, and that is safety culture: a fundamental commitment to safety. Reactor safety and its regulation are not only about thinking and processes, but also about conservative actions and measurable performance.

At the NRC, our regulatory standard is the assurance of adequate protection of public health and safety and the environment, and the promotion of the common defense and security. The NRC does not regulate to a standard of zero risk. It is not an option. Rather, we are responsible for assuring that the risk is understood, that it is managed, and that it is acceptably low. Today, with risk-informed regulatory tools, we know how to combine deterministic and probabilistic regulation, how to add requirements when necessary, and how to decrease the unnecessary requirements. In other words, we are assessing and quantifying safety and risk.

The NRC's implementation of risk assessment in reactor regulation involves the systematic incorporation of risk insights into the regulatory process, which we now call risk-informed regulation. This regulatory approach takes advantage of the great progress that we have made over the past 30 years in our ability to assess the risks associated with nuclear plant operations. Our knowledge, however, is not perfect; there are still uncertainties and phenomena that are not completely understood. Thus, risk insights are used as one element of regulatory decision-making, but not the only consideration. There is still a need to ensure defense-in-depth and adequate safety margins.

Today, in the United States, reactor safety performance continues to be very sound. Safety measures, including performance indicators and inspection findings, are strong for most plants. But safety measures by themselves are not enough -- it is essential that both the companies we regulate, who are our licensees, and the NRC itself maintain a continuous commitment to safety and the technical competence to achieve it. Commitment to safety must also be reflected in each licensee management's vision and expectations for success and in its willingness to place safety ahead of temporary profit. Commitment to safety also means that each licensee, vendor, consultant, and worker

in the nuclear field understands the safety implications of his or her job and has a sense of dedication to do it well.

In my view, nuclear regulation is for the well-being of the people, for the common good, with full consideration of the national interests and of international law and agreements. Nuclear regulation must be a disciplined national tool for establishing predictable safety and security frameworks. It works by establishing and improving technical and legal structures to define the acceptable safety case that serves the public interest by providing for the beneficial safe utilization of nuclear technologies. Although regulations often restrict, regulations should not deter beneficial activities, but frame them and guide them. Thus, regulations should not be unnecessarily burdensome as they establish adequate margins of safety.

Poor regulation, on the other hand, provides too few or too many controls, focusing more on restricting, limiting, and controlling, losing sight of the common good. This contradicts the fundamentals of a democratic society and the free market. Poor regulation can create the illusion of being "protective" while reducing choices and innovation that may actually benefit safety.

In this regard, I quote the objective stated by the NRC in its current Strategic Plan. Note that this statement begins with the word “enable,” not “promote.” This essential difference guides all our actions. That objective is to:

> **Enable the use and management of radioactive materials and nuclear fuels for beneficial civilian purposes in a manner that protects public health and safety and the environment, promotes the security of our nation, and provides for regulatory actions that are open, effective, efficient, realistic, and timely.**

I wish to close my remarks on the mission of the NRC and its regulatory objective with a word about the importance of an open, public process. Openness is essential to regulatory strength and stability. In the United States, individual members of the public have an opportunity to comment on regulations the Commission proposes to issue, and the NRC addresses their comments in a public process. In addition, our enabling legislation provides for the opportunity for public hearings in connection with the licensing of new reactors and amendments to existing reactor licenses.

The NRC takes its responsibility for public participation very seriously - and strives to communicate all aspects of our regulatory actions to interested members of the public, the regulated community, and government bodies. Of course, not all information should be made public -- in particular, information that could impact the security of nuclear materials and nuclear reactors. In those special cases, we strive to balance openness with security. In general, we recognize and understand that public participation in the regulatory process leads to public understanding of the reasons behind our decisions.

When the public has an opportunity to learn about our decisions and participate in our decision-making process, nuclear safety is enhanced and public confidence in the NRC as a fair, stable and strong nuclear regulator is strengthened. Public confidence in the safety and security of nuclear energy programs is vital to the future of nuclear energy - in India, in the United States, and in the world. For this reason, I urge you to remain committed to public involvement and communication in the Indian nuclear energy program. Well-informed citizens are essential to an understanding of the operations,

risks and benefits involving the nuclear energy option.

III. The Global Interest in Nuclear Energy

The Department of Energy recently estimated that the global demand for energy may increase as much as 50 percent by 2025, with more than half of that growth coming from the world's emerging economies. For electricity, the growth is projected to be particularly steep, increasing more than 75 percent over the next two decades. To begin addressing that challenge today, the President of the United States has stated policy goals that support worldwide expansion of nuclear power.

The reasons for this are clear. Nuclear power is a mature technology with significant potential to provide large amounts of emissions-free baseload power. Benefits from nuclear power include the abatement of greenhouse gas emissions and air pollution, as well as energy diversity. Other nations have reached a similar conclusion. With 24 new nuclear plants under construction worldwide and additional plants planned or under consideration, it is important that nuclear energy expand in a way that supports safety, security, and the environment. I understand that India plans to increase its electrical generation capability from about 3600 MWe to beyond 20,000 MWe by the year 2020.

As we look forward, we also see on the horizon the possibility of new nuclear plants being built in the United States. Of course, this is nothing exceptional from India's perspective, but you may recall that no new plants have been ordered in the United States for approximately 25 years, and the last plant to begin operation did so nearly 10 years ago.

Our two nations and, in fact, the world, are facing expensive and often unreliable energy supplies. Too many times, society has been disrupted and people have suffered when energy was costly, scarce, or not available. The solutions to economic and reliable energy supply are surely important worldwide. The United States, like many other countries, is reviewing the strategic, economic, and environmental considerations of our nation's overall energy supply and considering the contributions of nuclear power to meet its present and future energy needs. In fact, President Bush and the United States Congress have taken positive steps to ensure that America's energy mix includes the reliability of supply, the environmental benefits, and the steady costs that are now achieved with operating nuclear power plants. Maintaining the requisite focus on safety and security, the NRC has the obligation and responsibility to respond to the needs of the U.S.

Although the particular needs of our two nations may differ, you are surely being asked to be ready to respond to the energy, economic, and security demands of the present and the near future as well. I believe that we can agree that every nation of the world would be better served by reducing imbalances in the energy supply and demand and by supporting a safe, economical, and environmentally friendly supply of electricity.

Nuclear regulatory bodies, such as the Atomic Energy Regulatory Board of India (AERB) and the NRC, have a key role to play in resolving the effectiveness and sustainability of regulatory decision making and, therefore, the role that nuclear power could play. Of course we, as regulators, have important duties regarding security and radiological materials safety in addition to reactors. We all need the instruments, mechanisms, resources, and the international multilateral and bilateral cooperation agreements that strengthen our capability to serve our people better with issue resolution based on open and credible regulations.

I want to summarize for you the United States' position in two areas that are important to the viability of nuclear power generation: safety and economics. These two interdependent factors have seen major improvements in the last 15 years with respect to the consideration of nuclear power in the energy mix.

For twenty years, the economics of nuclear power did not fulfill the early expectations of the United States. In the United States, nuclear power deployment took place in the worst possible time for large capital intensive projects. At that time, we licensed plants with a two-step process, which invited delays and raised uncertainties. Our rates of interest and inflation were at historic highs, with both rates above 12%. This, combined with the uncertainty in electricity demand and in regulatory requirements, resulted in increased costs and delayed construction, which further increased costs, and which further delayed construction. The capital costs of nuclear power plants, partly driven by the construction delays, were much higher than ever expected with some plants exceeding $5000/kw in 1999 dollars. At that time, there was still hope that low production costs would make nuclear power competitive; however, constraints of electric rate regulation and requirements in nuclear regulation made it difficult for the anticipated low production costs to provide relief. The accident at Three Mile Island also seriously impacted the public's acceptance of nuclear energy.

The situation has now changed dramatically. The main contributing factor, by far, is the improved generation capability. The plant capacity factor for United States' plants is at an all-time high.

In addition, nuclear production costs have been decreasing. In a Nuclear Energy Institute study, nuclear production costs are now lower than coal with nuclear power at 1.68 cents/kwh, coal at 1.92 cents/kwh, and natural gas at 5.87 cents/kwh. Low inflation and low interest rates have been the norm for the last few years. And finally, many studies suggest that new plants, with new simplified designs, will cost on the order of $2000/kw. Thus, there appears to be a convergence of favorable factors for enhancing present nuclear power generation and for considering new power plants.

Economics is a necessary part of the equation, but it is not sufficient by itself. The socio-political reality is that nuclear power needs to be safer than any other form of power generation. In fact, it needs to be "safe" in both actual and perceived terms.

According to the performance safety indicators used by the NRC, the nuclear industry has achieved better-than-ever performance. Thus, the United States' nuclear power industry is performing with adequate safety margins, and the role of the NRC in providing reasonable assurance for the protection of public health and safety, using established licensing, oversight, and research programs is being fulfilled. This improved industry performance has enabled the NRC to initiate and implement reforms that are progressively more safety-focused.

A look at license renewal is just one example of the profound changes made by the NRC to regulatory effectiveness and efficiency. United States' nuclear plants were initially licensed for 40 years. License renewal authorizes an additional 20 years of operation after safety requirements for passive components and aging are met. The NRC made improvements in the license renewal process, which assured the nation that a fair, equitable, and safety-driven process would be used for utilities applying for extension of their licenses. Today, 39 licenses have been renewed and 12 are being reviewed. Twenty-seven other licensees have announced their intention to apply for renewal of their

licenses. Moreover, the program has resulted in significant capital investments by industry that directly contribute to enhancing operational safety.

One challenge the United States must eventually face is that our current regulatory structure was developed primarily for the light water reactors in operation today. However, we may ultimately receive applications for plants cooled by gas or liquid metals or for an advanced version of the CANDU reactor similar to the heavy water reactors in use in India. We must thus determine how such designs will be reviewed. In the longer term, we are working on a framework for advanced reactor licensing, with the goal of a risk-informed, technology-neutral regulatory approach for such plants. The effort associated with the development of such a framework is significant, and the framework itself is only the beginning.

We continue to take notice of developments not only in the United States, but also around the world, including the work on thorium-based fuels in India. Most of all, perhaps, we must continue to understand that nuclear power is now a global enterprise, and that we in the United States–and you in India–have an abiding interest in seeing that the use of nuclear power is accomplished with a focus, first and foremost, on safety. While nuclear power can be an economic source of energy for many nations, economic considerations can never be allowed to overtake safety as our primary concern.

For nuclear power to occupy a place in the energy portfolio of the world, much work is still needed by both regulators and the industry. Every nuclear operator in every country needs to be committed to safety first and foremost; only through effective safety management can reliability and productivity be achieved. Every nuclear regulator is entrusted with the responsibility of assuring adequate protection of the public and the environment, while enabling the beneficial uses of nuclear energy and radiation.

The NRC is continuing its strong regulatory oversight of the 103 operating reactors in the United States. Our review of applications for license renewal, power up-rate, and other licensing changes is effective and efficient. The NRC is preparing to address the renewed commitment of our Administration and Congress to nuclear energy as a means to address the demand for electric power, and the expressed intentions of the United States' nuclear power industry.

We are using a new licensing process, involving design certifications, early site permits and combined licenses, developed about 15 years ago. The standard design certification process allows a reactor design vendor to submit a reactor design to the NRC for review and certification. The application is independent of a site, and the safety reviews are completed based on an essentially complete reactor design. Certified designs actually become part of our regulations. For that reason, public notice and public comment opportunities apply to the NRC's review of these applications. To date, four designs are certified.

The Early Site Permit process allows early resolution of site-related issues and effectively allows a utility to bank a site for future construction. The NRC holds mandatory public hearings for every Early Site Permit application. In the hearing, the presiding officer determines whether a reactor built at the site can be constructed and operated without undue risk to public health and safety.

A combined license authorizes both construction and conditional operation of a nuclear power reactor. A combined license application may reference an already-approved plant design or early site

permit. This simplifies the review if the site or plant design has been already approved. After the plant is built, the Commission must find that all necessary inspections, tests, and analyses have been performed and associated acceptance criteria have been met before granting authorization to operate.

The nuclear industry has publicly announced that 12 potential Combined License (COL) applications will be submitted to the NRC for a total of 18 new nuclear power plants, distributed among the three major reactor vendors now competing for the United States marketplace.

Many countries in the world are considering expanding their nuclear power capabilities. However, uncertainties remain. The solution to new reactor deployment includes thorough, timely, and safety-focused decisions by nuclear regulatory authorities. Nuclear power plant licensing should be carefully planned, and key issues and interfaces, including regulatory issues, must be resolved at the front end, on budget and on schedule, with all the safety and engineering technology developed and learned over the last 25 years.

IV. Nuclear Safety Research and International Cooperation

The NRC has a strong interest and commitment to utilizing international collaboration to deal with the realities of the increasing "internationalization" of nuclear technology. We recognize that changes in the marketplace, technology, and regulation have taken place around the world, and international partnerships of industry and international partnerships of independent regulators are the optimum path toward success.

As I mentioned, the NRC is responsible for regulating safety in the design, construction, and operation of commercial nuclear facilities and in the other uses of nuclear materials, such as in medicine and industrial activities. As a key component of nuclear safety, the NRC carries out a nuclear regulatory research program to provide independent information and expertise needed to support the NRC's decision-making process and to identify and characterize technical questions that may become important safety issues in the future. NRC's nuclear regulatory research is designed to improve the agency's knowledge and reduce uncertainties in areas underpinning reactor safety. This development of sound technical bases allows proper focus on safety issues and more realistic decisions.

I personally share the agency's interest in international research efforts. I spent 15 of my roughly 30 years at Los Alamos National Laboratory supporting experimental plasma diagnostic measurements. From that work, I acquired an appreciation for the significant challenges associated with the translation of basic research and engineering knowledge into real systems. Those experiences also taught me to have a healthy respect for the limitations of even the best calculations. All too often my measurements differed enough from expectations to provide new insights into the physics or engineering that were missing from computational models.

As one example, I participated in many of the early laser fusion experiments. There was immense optimism then, based on the best calculations available at the time, that modestly sized, fairly inexpensive lasers would provide enough energy to ignite fuel and enable efficient production of fusion energy. In 1972, several researchers wrote "One kilojoule of laser energy may be sufficient to generate an equal thermonuclear energy." Based on such assertions, some assumed that laser fusion would soon be producing power for the grid.

It is now thirty years later and you don't hear much about laser fusion supplying grid power in the near future. The early predictions for success with small lasers are now replaced by construction of multi-megajoule, multibillion dollar facilities, where ignition and energy gain might be demonstrated.

So what went wrong? It seems that careful experiment, some done by my group at Los Alamos, simply did not support the optimism of the early calculations, which were sadly lacking in accurate descriptions of many aspects of the underlying physics. As these new facilities come into operation, we'll see if nature has more new physics surprises to reveal!

Calculations and modeling have a critical role in any technically complex endeavor. But I've learned that computational models are as good, or as bad, as the depth of the physics and engineering underpinning them. Models require careful validation.

Led by the NRC's Office of Nuclear Regulatory Research, the NRC's international cooperative research program covers a wide range of activities and technical disciplines: mixed oxide and high burn-up fuel, plant aging and material degradation, digital instrumentation and control, thermal-hydraulic and severe accident analysis, probabilistic risk assessment, fire risk, radiation protection, human performance, seismic risk, spent fuel, and waste management. Through these interests, we participate in major experimental programs using test facilities that are not available in the United States. Access to these facilities expands our knowledge base, efficiently addresses research on high priority safety issues, and helps strengthen international cooperation that in turn strengthens oversight programs around the world.

Data from these programs are used to develop new analytical models and updates for NRC's analytical codes and to validate existing models. International cooperative research programs also provide access to operating experience from foreign reactors, which augments our own programs in areas such as fire risk, plant aging and materials degradation, and pressurized thermal shock. Analysis of this experience contributes to our knowledge base and improved assessments of plant risk and to the development of risk-informed approaches to regulation.

With respect to the United States' cooperation with India, the NRC has been actively interacting with the AERB on nuclear safety issues from the early 1990s, with NRC Commissioner de Planque visiting India in 1994, and AERB Chairman Gopalakrishnan following with an Indian delegation to the United States that same year. In 1995, during NRC Chairman Selin's visit to India, the two organizations formally agreed to pursue reciprocal nuclear safety technical exchange projects in 1) backfits and design modifications; (2) fire safety; and (3) symptom-based emergency procedures. This was reaffirmed when NRC Chairman Jackson led a delegation to India in April 1998, following AERB Chairman Rao's March 1998 visit to the NRC.

While action by the U.S. Congress halted NRC and AERB engagements for a few years, United States President Bush met with Indian Prime Minister Vajpayee in 2001 which led to a regeneration of bilateral cooperation with India in nuclear safety. This was followed-up by NRC Chairman Meserve, who led a delegation to India in February 2003, for the first formal bilateral information exchange. Dr. Ashok Thadani led the NRC delegation for the bilateral in India in 2004. Most recently, NRC Commissioner Merrifield visited your Center to lead the fifth bilateral exchanges in February 2005. The seventh bilateral exchange begins today and includes a five-person NRC technical team, led by Ashok Thadani and James Lyons.

We at the NRC appreciate the meaningful cooperation between our two countries in pursuit of nuclear safety. Our interactions have progressively expanded from the few earlier topics to include emergency planning, pressurized thermal shock, probabilistic analyses including seismic hazard analysis, license renewal, operating experience feedback, new reactor designs, and severe accident analyses. We are also beginning a dialogue on standard problem exercises to benchmark computer codes used to assess safety of nuclear facilities.

India clearly has an active, innovative nuclear program and is exploring areas that the NRC has yet to encounter, such as thorium-based fuels and heavy water technology. While the United States is not likely to use a thorium cycle in the foreseeable future, India's work in this area has generated expertise in mixed oxide fuel technology. Your work in mixed oxide fuels is of interest to the NRC in its evaluation of MOX fuels. Although the NRC is not currently reviewing CANDU-type reactors, the NRC can benefit greatly from the AERB activities (experimental, analytical and operating experience) in heavy water-moderated reactors if the NRC reviews the ACR-700, or any of its larger derivatives in the future.

On this trip, in addition to visiting the Tarapur site, I am also very much looking forward to visiting the Bhabha Atomic Research Center where, I am informed, you have extensive experimental facilities which can support validation of improved computational models. I see many other benefits in sharing information on our safety programs in areas such as passive systems performance and reliability, materials performance in high temperature environments, and in advanced construction and inspection techniques.

On July 18, 2005, President Bush and Indian Prime Minister Manmohan Singh announced the creation of a "global partnership" which would include full civil nuclear cooperation between the United States and India. Continued India-US cooperation will be of benefit to both countries and I look forward to expanded cooperation in nuclear safety matters.

V. Conclusion

In conclusion, I wish to thank you for the great honor of being able to speak to you today to convey, once again, the interest of the NRC in continuing our nuclear safety information exchanges. Both our countries share in a potential expansion of nuclear energy as a safe, secure means of providing energy. I believe that sound regulation, sufficient independence of nuclear oversight, and public openness play an essential role in the success of any expansion of nuclear power in both of our countries. We have a shared goal of safety of our programs - it is our most important goal - and one that I hope our countries will continue to work toward together. Thank you.