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NUCLEAR POWER INDUSTRY

JOINT HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

AND THE

SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT

OF THE

COMMITTEE ON APPROPRIATIONS UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

TO CONDUCT OVERSIGHT ON THE STATE OF THE NUCLEAR POWER INDUSTRY AND THE FUTURE OF THE INDUSTRY IN A COMPREHENSIVE ENERGY STRATEGY

MAY 3, 2001

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NUCLEAR POWER INDUSTRY

THURSDAY, MAY 3, 2001

U.S. SENATE, COMMITTEE ON ENERGY AND NATURAL RESOURCES, AND THE SUBCOMMITTEE ON ENERGY AND WATER DEVELOPMENT OF THE COMMITTEE ON APPROPRIATIONS, WASHINGTON, DC.

The committee and subcommittee met, pursuant to notice, at 10:04 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Frank H. Murkowski, chairman, Committee on Energy and Natural Resources, and Hon. Pete V. Domenici, chairman, Subcommittee on Energy and Water Development, Committee on Appropriations, presiding.

OPENING STATEMENT OF HON. FRANK H. MURKOWSKI, U.S. SENATOR FROM ALASKA

Chairman MURKOWSKI. Good morning, ladies and gentlemen. I want to welcome you to this joint hearing between the Energy and Natural Resources Committee and the Subcommittee on Energy and Water of the Senate Appropriations Committee.

What we are going to discuss today is a very important matter, and that is the state of the nuclear power industry and the future of the industry in a comprehensive energy strategy. I am very pleased to have two of my colleagues with me, Senator Bingaman, the ranking minority member of this committee, and my good friend Senator Domenici, who is the senior member of the Energy and Natural Resources Committee, I might add, both from New Mexico.

The hearing on the state of our nuclear power industry and the future of that industry in a comprehensive energy strategy, is timely, to say the least. We are seeing more and more interest in utilizing nuclear energy as a consequence of the energy crisis that this country is in. We can reflect on California and we can reflect on increasing gasoline prices, or increasing natural gas prices in our own bills here in Washington, D.C. that clearly indicate we have a significant increase in demand, and our supply sources are not keeping up with that demand.

Thanks to these members and Senator Domenici in particular for his tireless efforts on this subject, we have this opportunity this morning, and I am very pleased that both the Senators from New Mexico are working together on this. I look forward to co-chairing with Senator Domenici.

Now, as you are well aware, I have introduced a bipartisan comprehensive energy bill that addresses both supply and demand issues. We must have a diverse and responsible energy mix if we

are ever to lessen our dependence on imported oil, and I do not say replace it, but I say lessen.

As we reflect on the role of nuclear energy, it is interesting to reflect that it is an industry we have somewhat taken for granted. It produces about 20 percent of the power generation of this country, and leveled off there, and we really have not had any new developments for about 10 years. I had used 20 years, but I was reminded by Earl Nye that it is in reality 10 years. That is Texas Utilities, in case you are wondering.

Now, we must have a diverse and responsible response to meeting our energy demands. Production of electricity from nuclear energy emits no greenhouse gases, no CO_2, no SO_X, no NO_X. It is a base load power, keeps our grid stable, reliable, and it is kind of interesting to note in the California chaos, nuclear still supplies about 16 percent of California's electricity. We wonder where California would be today without the nuclear power industry. High natural gas prices and low uranium prices have helped to make electricity produced from nuclear some of the cheapest in the country. Perhaps some day we might reach the fabled "too cheap to meter" goal, but I am not going to hold my breath for that to happen.

Safe, efficient U.S. nuclear plants are operating at record efficiencies in this country today. U.S. nuclear reactors have achieved close to 90 percent efficiency, a dramatic increase, and those organizations that have achieved that have a great deal to be proud of, because they have done it in a manner that does not compromise safety.

Total efficiency increases during the nineties for existing plants was the equivalent of adding approximately 23 1,000 megawatt power units, and keep in mind, that is all clean, non-emitting generation. And now we have seen nuclear energy on the upswing. 4 or 5 years ago, who would have thought we would hear talk of buying and selling, and yes, even planning to build new plants. Today, this discussion is happening.

I had an opportunity a few weeks ago to discuss how you would approach the conceptual idea of proceeding with a new powerplant. The suggestion was made that you might go to an area where you already have an existing plant where the siting has been approved, so you do not have that problem to go through, maybe get four or five of the major utilities to come together to underwrite the cost and take a proportional equity interest in a new nuclear powerplant, with the provision that the Government, without eliminating any safeguards, would guarantee that once it was built to specifications, it would be allowed to go into production, because that is one of the risks of building a nuclear plant. You could build it, and then you might find you cannot license it, but nevertheless, it was an interesting conversation, and I think it is healthy that the industry is beginning to explore some possible developments in getting back in nuclear construction.

U.S. industry, as I have indicated, is beginning to consider putting dollars into the evaluation of new plants. By the end of 2001 the Chicago-based Exelon Corporation will have invested, I am told, $15 million in a South African venture to build a pebble-bed modular reactor. We have Mr. Corbin McNeill here today to tell us

a little bit more about that, so I will not go into that any further, but given the public's general acceptance that we have got to address this energy crisis, there is more and more awareness and consideration given to the role of the nuclear industry.

This past April, the Associated Press commissioned a poll that suggests half of those polled support using nuclear powerplants to reduce the electricity—I am not sure I believe this figure coming up, but it says 56 percent would not mind a nuclear plant within 10 miles of their home. I think that is contrary to the NIMBY theory of not in my backyard, but anyway, I will just read what it says, because I want to make the staff feel that I have done my job.

[Laughter.]

Chairman MURKOWSKI. Granted, we still have to solve our waste problem, but I believe that has been more of a political problem than a technical problem. Those of us who observed what the French have done, particularly as a consequence of the 1973 Arab oil embargo, where they made a decision they were not going to be held hostage by the Mideast, and went off on a nuclear binge, and now 75 percent of their power is generated by nuclear power, and it evidently does not affect the wine, because as you go through France, you see powerplants out in the vineyards.

The significance of what they have done, though, is the technology to recover the waste. Our industry is strangling on its waste. They have a technique to recover the waste, put the plutonium back into the reactor, burn the plutonium, reduce the proliferation risk, vitrify the waste and put it away, and we are still agonizing about what to do with the waste.

In any event, in conclusion, we perhaps are making progress on Yucca Mountain. I have not checked with the Nevada delegation lately, but I am encouraged by the Department of Energy's IG investigation that found no bias in the science process at Yucca. It seems like if any excuse comes up to delay that process, why Murphy will make sure it comes up.

We now expect the science and engineering report from the Department any day, and I am confident that, as with the December 1999 Viability Assessment, there will be no show-stoppers. I am confident of that. In any event, if we ever hope to achieve energy security and energy independence in this country, we cannot abandon the nuclear option. It is an important and integral part of our energy mix, our economy depends on nuclear energy, our national security depends on nuclear energy, our environment depends on nuclear energy, and our future, to a large degree, in electric generation depends on nuclear energy.

So I look forward to the witnesses, and look for a lively discussion. Senator Domenici, since you and I are co-chairing this, and that puts Senator Bingaman, I guess, since there is only three or four of us here—ordinarily I would call on Senator Bingaman, but you are co-chairing, so in the order of deference between the two of you, you can figure it out.

[Laughter.]

STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

Senator DOMENICI. We had actually figured on starting without you, he and I, and I was going to——

[Laughter.]

Senator DOMENICI [continuing]. Chair it anyway. We had already agreed.

Thank you very much, Mr. Chairman.

Chairman MURKOWSKI. It's a good thing I got here.

Senator DOMENICI. We would have had a disaster. In any event, let me take just a few moments. First I want to join Senator Murkowski in calling this meeting to order. The Subcommittee of Appropriations that is called Energy and Water, which I have been privileged to chair for a long time, has most of the money and the funding from the Federal Government standpoint when it comes to nuclear power and all the other matters nuclear, and not too many years ago, there is no question that we would not have considered such a hearing, because there would have been little or no interest. People would have been wondering what we were doing.

At that point we had a lot of extra energy, so it even made it more of a hearing that people would not consider very relevant. We had a supply of nuclear power, and it was a dying industry, and all I guess we want to leave with today is the theme of how things have changed, and I think they have changed for the better.

Headlines in papers all across the country call out the new interest in nuclear energy. I see a few of them up there on the chart. We will talk to them in just a moment.

Today, it is increasingly recognized that nuclear energy is providing a safe, reliable, and wonderfully clean energy for our electrical needs. It does not matter much what paper you refer to, the *Washington Post*, *Washington Times*, *New York Times*, *Wall Street Journal*, *USA Today*, the picture is the same. Nuclear energy is poised for a dramatic rebirth. I believe that if we will just get leadership in the Congress and the White House, it will happen. One headline says, It is Time for Greens to go Nuclear. *Wall Street Journal*, and Nuclear Power Can Halt Shortages, *Los Angeles Times.*

Less than 4 years ago, October 1997, at Harvard University, the stage was pretty lonely when I started participating in a series of lectures and speeches. I called for a new dialogue in nuclear technologies. The progress since then has been spectacular. The energy crisis finally being obvious—it was there all along, the shortage—has pushed this premise along very, very rapidly.

Our witnesses today, and many of you in this room, have worked to provide accurate information to the public about nuclear power, its current impact and its future promise. I am very proud to realize now that if we repeated the Harvard speech today, the stage would be crowded, so let me cite three of the spectacular events, achievements of nuclear energy.

First, it is producing 22 percent of our electricity at costs that are now even lower than coal, and the availability of the 103 plants has increased so dramatically that we have effectively gained output of more than 20 plants, without building any. That is, the efficiency of the plants has done that.

Second, its safety record is absolutely superb. New safety records are being set by our commercial plants every day, and our nuclear Navy powerplants, which have more than twice the operational experience of commercial plants, have never had a significant accident.

At the same time, I like to emphasize that 90 nuclear ships of the Navy, powered by over 100 reactors, are welcomed into just about every port in the world, with just one exception, New Zealand, and they carry in their bowels one or two nuclear powerplants with spent fuel rods on board, and they boat into ports, and are welcome. I think that means there is very little risk. That is how I see it.

Third, it has avoided air emissions, more than 2 billion tons of carbon. I just received life cycle data from a new Japanese study. It confirms the tremendous advantage of nuclear energy over fossil fuel plants, and shows that solar and wind are larger pollutant emitters than nuclear.

In some of my recent discussion about nuclear energy, I have discussed the increasing trend toward globalization, through globalization the world becomes more integrated, and clearly it is one way to provide more economic prosperity for the world. Our high technology products find themselves in the markets of these countries, and it is pretty obvious these countries are going to need energy. What will they choose?

At this point in history, I am sure one of the witnesses can tell us who has orders for nuclear powerplants now, what countries around the world are ordering them. What is the backlog, what is the long term as of now, what do orders look like in the Koreas and Japans and others?

So from my standpoint, there is going to be prosperity in the world, and American leadership is going to have to insist on prosperity in America, and when we look at our energy needs, subtract all the conservation we can do, there is still a huge supply vacuum. I think we are going to be able to honestly assess the role of nuclear in that, and I believe it will be significant, and I believe it will occur. It will not be sometime 100 years from now like people thought. It will be in a reasonable time frame.

With that, I want to just quickly—unless you want to introduce the witnesses.

Chairman MURKOWSKI. No, I will be happy, you can introduce them. Maybe Senator Bingaman would like to—

Senator DOMENICI. Fine. Senator Bingaman, I yield.

STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Senator BINGAMAN. Well, thank both of you for scheduling this hearing, both chairmen. I believe there is strong bipartisan support, at least on the Energy Committee, for nuclear power. Nuclear power does play a very essential role, an indispensable role in providing the power that we use today. By extending the operating lives of the current generation of nuclear plants, the expectation is, I think, realistic that it will continue to play a very central role.

The more difficult question, which I am sure we will hear a lot of testimony about, is whether new nuclear powerplants will be

built in the foreseeable future in this country. Plainly, they would not have been built under the cumbersome and uncertain licensing and regulatory process of the past, but 9 years ago Congress streamlined that licensing system. The system that we enacted in 1992 remains untested and unused, but it does offer the next generation of reactors more timely and predictable licensing decisions than the old system did.

The reasons the utility industry has been unwilling to order new powerplants, as far as I understand it, is primarily an economic reason, and also relates to the changing structure of the electricity market, and that has been more important than the nuclear safety regulation issue.

There are things that Congress needs to be doing. We need to get on with the nuclear waste repository. We need to renew the Price-Anderson Act, we need to restore funds for nuclear research, and encourage bright students like Ms. MacLean to choose nuclear engineering as a career, and most of all, perhaps, we need to ensure that the Nuclear Regulatory Commission remains a credible and effective and vigilant regulator so that the public can have confidence in the safety of nuclear powerplants.

In the final analysis, I believe it will be up to the industry to decide whether to build plants or not. For over 20 years the decision has been not to go ahead with any new plants. There is evidence that that is changing, and I hope we can hear some good testimony on that from our witnesses today.

Thank you again for holding the hearing.

Senator DOMENICI. Thank you, Senator.

Chairman MURKOWSKI. Senator Hagel I believe just stepped out for a phone call. Senator Landrieu, we have had opening statements, and we are ready for the witnesses.

STATEMENT OF HON. MARY L. LANDRIEU, U.S. SENATOR FROM LOUISIANA

Senator LANDRIEU. Thank you, Mr. Chairman. I will just be brief, but I would like to say that I am glad we are having this hearing, and I want to commend Senator Domenici particularly for his leadership and, of course, the chairman and the ranking member. Senator Domenici has spent a tremendous amount of time, energy and great passion on this issue. I think he has taken the right approach to this particular aspect of energy policy, and I am proud to join him as original cosponsor of his bill.

I do believe that one of the cornerstones of energy policy in this Nation must include an increase of domestic supply. Nuclear serves as one important component of our supply. We also obviously need to reduce demand, but I think it should be apparent to everyone that the domestic supply issue as well as the supply necessary to fuel our electric grid, are crucial. Senator Domenici, I want to commend you for your good work.

Senator DOMENICI. Thank you.

Senator LANDRIEU. I am proud to be a cosponsor of his bill, and look forward to working with you all. Thank you.

Chairman MURKOWSKI. Senator Domenici.

Senator DOMENICI. Might I just name the witnesses and give a little tiny background and then we can proceed, Mr. Chairman.

First, Richard Meserve serves as Chairman of the U.S. Nuclear Regulatory Commission, previously served as legal counsel for the President's Science and Technology Advisor. I want to compliment you right now on the work of the Nuclear Regulatory Commission, the last 3 years or so with the revamping that is taking place, and putting the assets more in the area of where they were needed. You have done an excellent job, and I think you should be very proud of the safety that has ensued, and the increased production that has come along as a causal relationship to that, so thanks for your work.

Second, Mr. Richard Rhodes, Pulitzer prize-winning author of a wide range of books. His articles have appeared everywhere, from *Reader's Digest* to *Atlantic Playboy.* His book, *Nuclear Renewal*, is one of the clearest and best calls for a strong role for nuclear energy. We thank you very much for being here and for what you have contributed to the dialogue, Mr. Rhodes. It is must-reading for those who are trying to understand where we are going.

Third, Corbin McNeill, Jr., chairman and CEO of Exelon Corporation. You are going to address the panel, and your company operates the country's largest fleet of nuclear plants.

Fourth is Heather MacLean, currently a graduate student of nuclear engineering at MIT. Senator Bingaman just alluded to our hope that we will have more like you. We look forward to listening to you.

Fifth is James Asselstine, managing director of Lehman Brothers in New York, who served as a commissioner of the U.S. Regulatory Commission from 1982 to 1987.

Sixth is Dr. John Ahearne, professor of Duke University, served as chairman and commissioner of the U.S. Nuclear Regulatory Commission from 1978 to 1983, and has had many other national positions.

So shall we start at that side of table with Richard Meserve.

STATEMENT OF RICHARD MESERVE, CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION

Mr. MESERVE. Chairman Murkowski, Chairman Domenici, members of the committee, I am very pleased to testify on behalf of the U.S. Nuclear Regulatory Commission on how nuclear energy fits into a comprehensive energy strategy. I have submitted a statement for the record, but would like to make a brief summary.

Chairman MURKOWSKI. Your statement will be entered into the record.

Mr. MESERVE. At the outset, I would like to acknowledge the presence in the audience of two of my fellow Commissioners, Edward McGaffigan and Jeffrey Merrifield. I very much appreciated Senator Domenici's kind word, but I must say that I have had the benefit as Chairman of very capable colleagues on the Commission, and of very talented staff.

As you know, the Commission does not have a promotional role for nuclear power. Rather, the agency seeks to ensure the safe application of nuclear technology, if society elects to pursue the nuclear energy option.

Many of the commission's initiatives over the past several years have sought to maintain or enhance safety while simultaneously

improving the efficiency and effectiveness of our regulatory system. We believe that the Commission's most recent legislative proposal, which is described in my statement, would enhance safety and improve our regulatory system even more.

I am pleased to see that many of our proposals have been incorporated into proposals now pending before Congress. The Commission also recognizes that its decisions and actions as a regulator influences the public's perception of the NRC and ultimately the public's perception of the safety of nuclear technology. For this reason, the Commission's primary goals also include increasing public confidence.

Currently, there are 104 nuclear powerplants licensed by the Commission to operate in the United States in 31 different States. As a group, they are operating at high levels of safety and reliability. These plants have produced approximately 20 percent of our Nation's electricity for the past several years. In 2000, these nuclear powerplants produced a record 755,000 gigawatt hours of electricity.

The Nation's nuclear electricity generators have worked over the past 10 years to improve nuclear powerplant performance, reliability, and efficiency. The improved performance of U.S. nuclear powerplants since 1990 is equivalent to placing 23 new 1,000 megawatt powerplants on line. The Commission has focused on ensuring that safety is not compromised as a result of these industry efforts.

The nuclear industry is undergoing a period of remarkable change, as several of the opening statements indicated. One of the more immediate results of the economic deregulation of the electric power industry has been the development of a market for nuclear powerplants as capital assets. As a result, the Commission has seen a significant increase in the number of requests for approval of license transfers. These requests have increased from an historical average of about two or three per year to 20 to 25 in the past 2 years.

Another result of the new economic conditions is an increasing interest in license renewal that would allow plants to operate beyond the original 40-year term. The Commission has renewed the licenses of five units at two sites, for an additional 20 years. The thorough reviews of these applications were completed ahead of schedule. Applications for an additional five units at three sites are currently under review.

As indicated by our licensees, many more applications for renewal are anticipated in the coming years. The Commission recognizes the importance of license renewal and is committed to providing high priority attention to this effort.

In recent years, the Commission has approved numerous license amendments to permit licensees to make power increases or up-rates. Typically, these increases have been approximately 2 to 7 percent. These up-rates in the aggregate have resulted in adding approximately 2,000 megawatts to the grid.

The NRC is now reviewing five license amendment requests for larger power up-rates. These requests are for boiling water reactors and are up-rates of 15 to 20 percent. While the staff has not received requests for additional up-rates beyond these five, some estimates indicate that as many as 22 boiling water reactors may re-

quest such up-rates. These up-rates, if allowed, could add approximately 3,000 to 4,500 megawatts.

In addition to the three already-certified advanced reactor designs, there are new nuclear powerplant technologies, such as the pebble bed modular reactor, which some believe can provide enhanced safety, improved efficiency, lower cost, as well as other benefits. To ensure that the Commission staff is prepared to evaluate any applications to introduce these advanced reactors, the Commission recently directed the staff to assess the capabilities that would be necessary to review an application for new construction. An examination of possible changes in our rules is also underway.

In order to confirm the safety of new reactor designs and technology, the Commission believes that a strong nuclear research program should be maintained. Additionally, the Commission is reviewing its human capital to assure that the appropriate professional staff is available for the Commission to fulfill its safety mission, as well as any new regulatory responsibilities in the area of licensing new reactor designs.

The Commission has long been and will continue to be active in concentrating its staff's efforts to achieve our statutory mandate. We are also mindful of the need to reduce unnecessary burdens, to maintain open communications with all our stakeholders, to continue to encourage our staff to strive for increased efficiency and effectiveness.

I look forward to working with the committees, and I welcome your comments and questions. Thank you.

[The prepared statement of Mr. Meserve follows:]

PREPARED STATEMENT OF RICHARD MESERVE, CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION

INTRODUCTION

Mr. Chairman, members of the Committees, I am pleased to submit this testimony on behalf of the U.S. Nuclear Regulatory Commission (NRC) on how nuclear energy fits into a comprehensive energy strategy. As you know, the Commission's mission is to ensure the adequate protection of public health and safety, the common defense and security, and the environment in the application of nuclear technology for civilian use. The Commission does not have a promotional role—rather, the Agency seeks to ensure the safe application of nuclear technology if society elects to pursue the nuclear energy option.

The Commission recognizes, however, that its regulatory system should not establish inappropriate impediments to the application of nuclear technology. Many of the Commission's initiatives over the past several years have sought to maintain or enhance safety while simultaneously improving the efficiency and effectiveness of our regulatory system. We believe the Commission's most recent legislative proposals would enhance safety and improve our regulatory system even further and are pleased to see that many of our proposals have been incorporated into the bills before this Committee. The Commission also recognizes that its decisions and actions as a regulator influence the public's perception of the NRC and ultimately the public's perception of the safety of nuclear technology. For this reason, the Commission's primary performance goals also include increasing public confidence.

BACKGROUND

Currently, there are 104 nuclear power plants licensed by the Commission to operate in the United States in 31 different states. As a group, they are operating at high levels of safety and reliability. (See Charts on Attachments 1 and 2.)[1]

These plants have produced approximately 20% of our nation's electricity for the past several years and are operated by about 40 different companies. In 2000, these

[1] Attachments 1–3 have been retained in committee files.

nuclear power plants produced a record 755 thousand gigawatt-hours of electricity. (See Graph on Attachment 3.)

Improved Licensee Efficiencies (Increased Capacity Factors)

The Nation's nuclear electricity generators have worked over the past 10 years to improve nuclear power plant performance, reliability, and efficiency. According to the Nuclear Energy Institute, the improved performance of the U.S. nuclear power plants since 1990 is equivalent to placing 23 new 1000 MWe power plants on line. The average capacity factor for U.S. light water reactors was 88 percent in 2000, up from 63 percent in 1989.[2] (See Table on Attachment 3.) The Commission has focused on ensuring that safety is not compromised as a result of these industry efforts. The Commission seeks to carry out its regulatory responsibilities in an effective and efficient manner so as not to impede industry initiatives inappropriately.

Electric Industry Restructuring

As you are aware, the nuclear industry is undergoing a period of remarkable change. The industry is in a period of transition in several dimensions, probably experiencing more rapid change than in any other period in the history of civilian nuclear power. As deregulation of electricity generation proceeds, the Commission is seeing significant restructuring among the licensees and the start of the consolidation of nuclear generating capacity among a smaller group of operating companies. This change is due, in part, to an industry that has achieved gains in both economic and safety performance over the past decade and thus is able to take advantage of the opportunities presented by industry restructuring.

INITIATIVES IN THE AREA OF CURRENT REACTOR REGULATION

License Transfers

One of the more immediate results of the economic deregulation of the electric power industry has been the development of a market for nuclear power plants as capital assets. As a result, the Commission has seen a significant increase in the number of requests for approval of license transfers. These requests have increased from an historical average of about two or three per year, to 20-25 in the past two years.

The Commission seeks to ensure that our reviews of license transfer applications, which focus on adequate protection of public health and safety, are conducted efficiently. These reviews sometimes require a significant expenditure of staff resources to ensure a high quality and timely result. Our legislative proposal to eliminate foreign ownership review could help to further streamline the process. To date, the Commission believes that it has been timely in these transfers. For example, in CY 2000, the staff reviewed and approved transfers in periods ranging from four to eight months, depending on the complexity of the applications. The Commission will strive to continue to perform at this level of proficiency even in the face of continued demand.

License Renewals

Another result of the new economic conditions is an increasing interest in license renewal that would allow plants to operate beyond the original 40-year term. That term, which was established in the Atomic Energy Act (AEA), did not reflect a limitation that was determined by engineering or scientific considerations, but rather was based on financial and antitrust concerns. The Commission now has the technical bases and experience on which to make judgments about the potential useful life and safe operation of facilities and is addressing the question of extensions beyond the original 40-year term.

The focus of the Commission's review of applications is on maintaining plant safety, with the primary concern directed at the effects of aging on important systems, structures, and components. Applicants must demonstrate that they have identified and can manage the effects of aging so as to maintain an acceptable level of safety during the period of extended operation.

The Commission has now renewed the licenses of plants at two sites for an additional 20 years: Calvert Cliffs in Maryland, and Oconee in South Carolina, comprising a total of five units. The thorough reviews of these applications were completed ahead of schedule, which is indicative of the care exercised by licensees in the preparation of the applications and the planning and dedication of the Commission staff. Applications for units from three additional sites—Hatch in Georgia, ANO-1 in Ar-

[2] Capacity factor is the ratio of electricity generated, for the period of time considered, to the amount of energy that could have been generated at continuous full-power operation during the same period.

kansas, and Turkey Point in Florida—are currently under review. As indicated by our licensees, many more applications for renewal are anticipated in the coming years.

Although the Commission has met or exceeded the projected schedules for the first reviews, it would like the renewal process to become as effective and efficient as possible. The extent to which the Commission is able to sustain or improve on our performance depends on the rate at which applications are actually received, the quality of the applications, and the ability to staff the review effort. The Commission recognizes the importance of license renewal and is committed to providing high-priority attention to this effort. As you know, the Commission encourages early notification by licensees, in advance of their applications to seek renewals, in order to allow adequate planning of demands on staff resources. The Commission is committed to maintaining the quality of its safety reviews.

Reactor Plant Power Uprates

In recent years, the Commission has approved numerous license amendments that permit licensees to make relatively small power increases or uprates. Typically, these increases have been approximately 2% to 7%. These uprates, in the aggregate, resulted in adding approximately 2000 MWe or two new 1000 MWe power plants.

The NRC is now reviewing five license amendment requests for larger power uprates. These requests are for Boiling Water Reactors (BWR's) and are for uprates of 15% to 20%. (There are two primary designs for operating light water reactors: Boiling Water Reactors and Pressurized Water Reactors.) While the staff has not received requests for additional uprates beyond these five, some estimates indicate that as many as 22 BWR'S may request uprates in the 15% to 20% range. These uprates, if allowed, could add approximately 3,000 to 4,500 MWe to the grid.

Approvals for uprates are granted only after a thorough evaluation by NRC staff to ensure safe operation of the plants at the higher power. Plant changes and modifications are necessary to support a large power uprate, and thus require significant financial investment by the licensee. While the NRC does not know the number of uprate requests that will be received, the staff is evaluating ways to streamline the review and approval process. As with license renewals, the Commission encourages early notification by licensees, in advance of their applications for uprates, in order to allow adequate planning of demands on staff resources.

High Level Waste Storage/Disposal (Spent Fuel Storage)

In the past several years, the Commission has responded to numerous requests to approve spent fuel cask designs and independent spent fuel storage installations for onsite dry storage of spent fuel. These actions have provided an interim approach pending implementation of a program for the long-term disposition of spent fuel. The ability of the Commission to review and approve these requests has provided the needed additional onsite storage of spent nuclear fuel, thereby avoiding plant shutdowns as spent fuel pools reach their capacity. The Commission anticipates that the current lack of a final disposal site will result in a large increase in on-site dry storage capacity during this decade.

The Commission is currently reviewing an application for an Independent Spent Fuel Storage Installation on the reservation of the Skull Valley Band of Goshute Indians in Utah.

Certain matters also need to be resolved in order to make progress on a deep geologic repository for disposal of spent nuclear fuel. The Energy Policy Act of 1992 requires the Environmental Protection Agency (EPA) to promulgate general standards to govern the site, while the Commission has the obligation to implement those standards through its licensing and regulatory process. The Commission has concerns about certain aspects of EPA's proposed approach and is working with EPA to resolve these issues. Some of our legislative proposals would eliminate these issues.

Risk-Informing the Commission's Regulatory Framework

The Commission also is in a period of dynamic change as the Agency moves from a prescriptive, deterministic approach toward a more risk-informed and performance-based regulatory paradigm. Improved probabilistic risk assessment techniques combined with more than four decades of accumulated experience with operating nuclear power reactors has led the Commission to recognize that some regulations may not serve their intended safety purpose and may not be necessary to provide adequate protection of public health and safety. Where that is the case, the Commission has determined it should revise or eliminate the requirements. On the other hand, the Commission is prepared to strengthen our regulatory system where risk considerations reveal the need.

Perhaps the most visible aspect of the Commission's efforts to risk-inform its regulatory framework is the new reactor oversight process. The process was initiated on a pilot basis in 1999 and fully implemented in April 2000. The new process was developed to focus inspection effort on those areas involving greater risk to the plant and thus to workers and the public, while simultaneously providing a more objective and transparent process. Although the Commission continues to work with its stakeholders to assess the effectiveness of the revised oversight process, the feedback received from industry and the public is favorable.

FUTURE ACTIVITIES

Scheduling and Organizational Assumptions Associated With New Reactor Designs

While improved performance of operating nuclear power plants has resulted in significant increases in electrical output, significant increased demands for electricity will need to be addressed by construction of new generating capacity of some type. Serious industry interest in new construction of nuclear power plants in the U.S. has only recently emerged. As you know, the Commission has already certified three new reactor designs pursuant to 10 CFR Part 52. These designs include General Electric's advanced boiling water reactor, Westinghouse's AP-600 and Combustion Engineering's System 80+. Because the Commission has certified these designs, a new plant order may include one of these approved designs. However, the staff is also conducting a preliminary review associated with other new designs. Licensees have also indicated to the NRC that applications for early site permits could be submitted in the near future. These permits would allow pre-certification of sites for possible construction of nuclear power plants.

In addition to the three already certified advanced reactor designs, there are new nuclear power plant technologies, such as the Pebble Bed Modular Reactor, which some believe can provide enhanced safety, improved efficiency, and lower costs, as well as other benefits. To ensure that the Commission staff is prepared to evaluate any applications to introduce these advanced nuclear reactors, the Commission recently directed the staff to assess the technical, licensing, and inspection capabilities that would be necessary to review an application for an early site permit, a license application, or construction permit for a new reactor unit. This will include the capability to review the designs for Generation III+ or Generation IV light water reactors, including the Westinghouse AP-1000, the Pebble Bed Modular Reactor, General Atomics' Gas Turbine Modular Helium Reactor, and the International Reactor Innovative and Secure (IRIS) designs. In addition to assessing its capability to review the new designs, the Commission will also examine its regulations relating to license applications, such as 10 CFR Parts 50 and 52, in order to identify whether any enhancements are necessary. We also recently established the Future Licensing Project Organization in order to prepare for and manage future reactor and site licensing applications.

In order to confirm the safety of new reactor designs and technology, the Commission believes that a strong nuclear research program should be maintained. A comprehensive evaluation of the Commission's research program is underway with assistance from a group of outside experts and from the Advisory Committee on Reactor Safeguards. With the benefit of these insights, the Commission expects to undertake measures to strengthen our research program over the coming months.

Human Capital

Linked to these technical and regulatory assessments, the Commission is reviewing its human capital to assure that the appropriate professional staff is available for the Commission to fulfill its traditional safety mission, as well as any new regulatory responsibilities in the area of licensing new reactor designs.

In some mission critical offices within the Commission, nearly 25 percent of the staff are eligible to retire today. In fact, the Commission has six times as many staff over the age of 60 as it has staff under 30.

And, as with many Federal agencies, it is becoming increasingly difficult for the Commission to hire personnel with the knowledge, skills, and abilities to conduct the safety reviews, licensing, research, and oversight actions that are essential to our safety mission. Moreover, the number of individuals with the technical skills critical to the achievement of the Commission's safety mission is rapidly declining in the Nation, and the educational system is not replacing them. The Commission's staff has taken initial steps to address this situation, and as a result, is now seeking systematically to identify future staffing needs and to develop strategies to address the gaps. It is apparent, however, that the maintenance of a technically competent staff will require substantial effort for an extended time. The various Senate energy

bills properly give attention to such matters. The Commission would be pleased to offer some further suggestions in the same vein.

The Commission is currently challenged to meet its existing workload with available resources; nevertheless, the NRC, with its current budget, can continue to carry out its mission to protect health and safety, to promote the common defense and security, and to protect the environment. However, additional resources will be necessary to respond to increased workloads which could result from some of the initiatives discussed in this testimony or proposed in pending legislation.

LEGISLATIVE PROPOSALS

The Commission has identified in its legislative proposals areas where new legislation would be helpful to eliminate artificial restrictions and to reduce the uncertainty in the licensing process. These changes would maintain safety while increasing flexibility in decision-making. Although those changes would have little or no immediate impact on electrical supply, they would help establish the context for consideration of nuclear power by the private sector without any compromise of public health and safety or protection of the environment.

Legislation will be needed to extend the Price-Anderson Act. The Act, which expires on August 1, 2002, establishes a framework that provides assurance that adequate funds are available in the event of a nuclear accident and sets out the process for consideration of nuclear claims. Without the framework provided by the Act, private-sector participation in nuclear power would be discouraged by the risk of large liabilities.

Reorganization Plan No. 3 of 1970 could be revised to provide the Commission with the sole responsibility to establish all generally applicable standards related to Atomic Energy Act (AEA) materials, thereby avoiding dual regulation of such matters by other agencies. Along these same lines, the Nuclear Waste Policy Act of 1982 could be amended to provide the Commission with the sole authority to establish standards for high-level radioactive waste disposal. These changes would serve to provide full protection of public health and safety, provide consistency, and avoid needless and duplicative regulatory burden.

Commission antitrust reviews of new reactor licenses could also be eliminated. As a result of the growth of Federal antitrust law since the passage of the AEA, the Commission's antitrust reviews are redundant of the reviews of other agencies. The requirement for Commission review of such matters, which are distant from the Commission's central expertise, should be eliminated.

Elimination of the ban on foreign ownership of U.S. nuclear plants would be an enhancement since many of the entities that are involved in electrical generation have foreign participants, thereby making the ban on foreign ownership increasingly problematic. The Commission has authority to deny a license that would be inimical to the common defense and security, and thus an outright ban on all foreign ownership is unnecessary.

With the strong Congressional interest in examining energy policy, the Commission is optimistic that there will be a legislative vehicle for making these changes and thereby for updating the AEA. Indeed, we note that certain of these matters are included in bills now before this Committee.

SUMMARY

The Commission has long been, and will continue to be, active in concentrating its staffs' efforts on ensuring the adequate protection of public health and safety, the common defense and security, and the environment in the application of nuclear technology for civilian use. Those statutory mandates notwithstanding, the Commission is mindful of the need to: (1) reduce unnecessary burdens, so as not to inappropriately inhibit any renewed interest in nuclear power; (2) maintain open communications with all of its stakeholders, in order to seek to ensure the full, fair, and timely consideration of issues that are brought to our attention; and (3) continue to encourage its highly qualified staff to strive for increased efficiency and effectiveness, both internally and in our dealings with all of the Commission's stakeholders.

I look forward to working with the Committees, and I welcome your comments and questions.

Senator DOMENICI. Mr. Corbin McNeill.

STATEMENT OF CORBIN A. McNEILL, JR., CHAIRMAN & CO-CEO, EXELON CORPORATION, CHICAGO, IL

Mr. MCNEILL. Thank you very much, Senator. I am Corbin A. McNeill, Jr., and I am chairman and co-chief executive officer of Exelon Corporation, and president of our subsidiary, Exelon Generation Company.

There are five key messages that I would like to leave with you today. First and foremost is that the state of the industry today is very sound and, as Chairman Meserve has noted, today's reactors are operating at record levels of safety, output, competitive cost, and reliability.

Second, the outlook for the existing fleet of nuclear plants is excellent, and current plants can be expected to produce more electricity through increased efficiency and capacity increases.

Third, there is a critical shortage of generating capacity in the United States. The new nuclear plants can play a role in meeting our Nation's growing demand for environmentally clean electricity.

Fourth, there are a number of new advanced nuclear technologies that have been approved by the Nuclear Regulatory Commission, and other new designs are on the horizon, including the new pebble bed modular reactor, which Exelon believes can provide future generation safely, economically and cleanly.

And lastly, that there are several outdated legislative and regulatory requirements that should be modernized to reflect the new deregulated marketplace in which future nuclear plants will be built.

Rather than spending time reviewing the state of the industry at this point, and I have done that in my written statement, let me jump right to a discussion of the future of nuclear energy. For the current fleet of reactors, I see three trends that are continuing into the near future. First, increased output from existing plants, a gradual consolidation of plant ownership and operation, and the application for renewal of existing operating licenses.

Electric generation from the current fleet of nuclear reactors is likely to increase as a result of higher capacity factors and plant up-rates, which Commissioner Meserve highlighted. Exelon Nuclear alone plans to add approximately 1,000 megawatts, or nearly one new plant of new capacity over the next 3 years through up-rates, and NEI, the Nuclear Energy Institute predicts that the industry will add 8,000 to 12,000 megawatts of new capacity over the next several years.

The consolidation trend of the industry has seen in recent years is also likely to continue, though at a slower pace than we have seen in the recent past. While two utilities have announced their intention to auction plants later this year, most of the consolidation that will occur in the future will be likely through mergers and acquisitions of entire utilities.

Finally, despite earlier predictions by the NRC, the Energy Information Administration, and others, most industry observers predict that the vast majority of the Nation's 103 operating plants will apply for license extensions rather than be shut down, as predicted.

As for new plants, I would note that the DOE estimates that the United States will need to construct more than 1,300 new powerplants over the next 20 years to meet future demand for electricity

and, as these new plants are built, it is critically important that there be a diversity of energy sources to include nuclear.

Senator DOMENICI. What are the size of those plants?

Mr. MCNEILL. I do not know exactly what the size is. I would say that it is probably in the 600 to 800 megawatt range, because that is the typical range size that is being constructed today.

New nuclear plants will have to possess three characteristics to be acceptable. They must be safe, economic, and clean. The pebble bed modular reactor, a design under development in South Africa, possesses these characteristics and, I believe, answers every criticism of the technology, with the exception of nuclear waste storage, which is an issue that I even have more confidence that Senator Murkowski will see a major jump by this time next year in acceleration and its movement toward identifying Yucca Mountain.

The PBMR technology uses a ceramic fuel design that cannot suffer meltdown. In the PBMR, through physical characteristics of the design, the reactor temperature never rises above 1,600 degrees Centigrade, even under the worst case loss of coolant accident, and the PBMR fuel, however, does not even begin to degrade until temperatures reach about 2,000 degrees Centigrade.

As a small modular reactor, in the 110 to 125 megawatt range, the PBMR is well-suited for use in deregulated power markets. Capital costs of each PBMR module are expected to be a fraction of the costs of the current larger reactors, roughly $125 to $150 million for 125-megawatt plant, which significantly reduces the investment risk for the builder of the plant.

PBMR's can be built in 18 to 24 months, and the speed of the market is essential if the PBMR is to compete effectively with coal and natural gas plants in a deregulated environment. Timely licensing action will be necessary to take advantage of the shorter construction time.

Adding small increments of capacity which better match new supply with demand growth prevents an oversupply situation, volatility of electricity pricing in the marketplace, and allows quicker recovery of the capital cost and, like our current nuclear reactors, the PBMR will emit no air pollutants or greenhouse gases.

We are developing the PBMR on the following time line. This summer, we will complete the detailed feasibility study. By November, we will, in conjunction with the rest of the investors, make a decision whether to build a demonstration plant in South Africa. In early 2002, we would contemplate early site licensing in the United States, and by late 2002 or early 2003, application for a combined construction and operating license.

Many legal and regulatory requirements that we run into are really outdated. Two categories of these that should be addressed as a result of that fact are, first, that new nuclear plants will be merchant plants operating in a deregulated environment, and the PBMR is a small, modular reactor that produces roughly one-tenth of the power of a conventional 1,100 megawatt light water reactor, and two important issues must be resolved in conjunction with first, the Price-Anderson Act, which will expire in 2002 must be renewed, and the Federal Government must assure the existence of a competitive nuclear fuel market.

The smaller size of these plants also requires that consideration be given in the relicensing of the Price-Anderson Act, consideration so that they do not bear the same burden, but they have a proportionate burden for other reactors of larger size in the payments under Price-Anderson if it was ever implemented.

Also, while the development of the design of the PBMR is being done on a commercial basis buy the partners, it would be appropriate for some level of Government funding to be provided for first of a kind costs incurred by the NRC in developing the staff necessary for this new technology, and as a result of the unproven nature of the 10 CFR part 52 licensing process and the need to create a new process for the gas reactor.

Thank you again for the opportunity to discuss this issue, and I look forward to questions.

[The prepared statement of Mr. McNeill follows:]

PREPARED STATEMENT OF CORBIN A. MCNEILL, JR., CHAIRMAN & CO-CEO, EXELON CORPORATION, CHICAGO, IL

Chairman Murkowski, Chairman Domenici, and Members of the Committee and Subcommittee:

I am Corbin A. McNeill, Jr., and I am Chairman and Co-Chief Executive Officer of Exelon Corporation and President of Exelon Generation Company. I appreciate the opportunity to appear before you today to discuss the state of the nuclear energy industry and the role that nuclear power can play in meeting America's future energy needs.

Exelon Corporation was formed last year by the merger of Unicom Corporation of Chicago and PECO Energy Company of Philadelphia. Exelon is the holding company for three wholly-owned subsidiaries: Exelon Energy Delivery, which includes Commonwealth Edison and PECO Energy, two distribution companies providing electric service in Northern Illinois and electric and natural gas service in Southeastern Pennsylvania, respectively; Exelon Enterprises, which owns a host of unregulated businesses involved in energy and infrastructure services, broadband and telecommunications services, and other ventures; and Exelon Generation Company.

Exelon Generation currently owns and operates approximately 37,000 megawatts of diversified electrical generation, including 17 nuclear reactors which generate 16,970 megawatts of electricity. We have another 8,500 megawatts of non-nuclear generation under construction or development. Exelon is the largest nuclear operator in the country, with approximately 20% of the nation's nuclear generation capacity, and the third largest private nuclear operator in the world. AmerGen Energy is a partnership between Exelon Generation and British Energy of Edinburgh, Scotland that was created to purchase nuclear power plants in the United States. AmerGen currently owns and operates nuclear plants in Illinois, New Jersey, and Pennsylvania.

In my testimony today, I want to provide you with five key messages:

- The state of the nuclear industry is sound. Reactors are operating at record levels of safety, output, and reliability.
- The outlook for the existing fleet of nuclear plants is excellent, and current plants can be expected to produce more electricity through increased efficiency and capacity uprates.
- There is a critical shortage of generating capacity in the United States, and new nuclear plants can play a role in narrowing the gap between supply and demand.
- There are a number of new nuclear technologies that have been approved by the NRC and others that are on the horizon, including the Pebble Bed Modular Reactor, which Exelon believes can provide future generation safely, economically, and cleanly.
- There are several outdated legislative and regulatory requirements that must be modernized to reflect the new deregulated marketplace in which future nuclear plants will be built.

STATE OF THE INDUSTRY

In assessing the state of the commercial nuclear industry today, I am pleased to report that the industry is operating at extraordinarily high levels by any measure of performance.

No other source of energy receives the scrutiny that nuclear power does. The nuclear industry is held to the highest standards of operation by regulators, legislators, investors, the media, and the general public. The industry has been required to produce power safer, cheaper, and cleaner than any other source of baseload electric generation in order to gain public acceptance. This has presented the industry with enormous challenges, but the industry has successfully embraced and met these challenges.

In fact, the industry has held itself to the highest standards of operation. In 1980, the industry established the Institute of Nuclear Power Operations (INPO) to allow the industry to provide internal assessments of power plant performance and to share operational best practices industry-wide.

I have included as an attachment to my written testimony the most recent report by INPO that outlines the industry's achievement as judged against 10 separate goals for industry performance. For each of the 10 performance indicator goals set by INPO in 1995, the industry has met or exceeded the performance goals for the year 2000.*

Let me provide a brief overview of the industry's performance in five major areas.

Safety. The nuclear industry remains deeply committed to operating our reactors in a manner that protects the health and safety of both the public and our workers. The industry today is operating at an extraordinarily high level of safety, having exceeded the INPO performance targets by over 10 percent for safety system readiness, collective radiation exposure of employees, and industrial safety accident rate. At one time, critics of nuclear power argued that reactor operators in a deregulated marketplace would be pressured to cut corners on safety in pursuit of greater economic return. The industry's record, however, has proven that safety and operational excellence go hand-in-hand.

Economics. In economics, too, the industry is performing at unprecedented levels. For the first time in a decade, production costs for nuclear power are lower than those for coal. Nuclear production costs in 1999 were 1.83 cents/kWh; production costs for coal were 2.07 cents/kWh; for gas, 3.52 cents/kWh (even prior to gas price spikes); for oil, 3.18 cents/kWh. An existing well-managed nuclear power plant can produce electricity at an all-in cost of less than 2.5 cents/kWh. This cost compares to combined cycle gas plants at 3.5–4.5 cents/kWh, assuming a gas price of $3 to $4 per million BTUs.

Reliability and Operational Excellence. Closely related to economics is the area of reliability and operational excellence. The industry is operating plants at record high capacity factors, achieving an industry-wide average of over 91 percent capacity during 2000. As a result, the nuclear industry is generating more electricity than at any time in the past, even though there are fewer operating reactors today than there were just a few years ago. In the last decade, the nuclear industry has added the equivalent of 23 new 1,000 megawatt plants through increased output from the current reactor fleet. These gains have come not only from increased capacity factors, but also from capacity additions at existing plants through power uprates. According to INPO's 2000 Performance Indicator report, unplanned capability loss factors, unplanned automatic scrams, thermal performance, and fuel reliability indicators all show record performance as well.

Environmental Performance. No other baseload energy source is as efficient at limiting and containing the amount of pollution it generates. Nuclear plants emit no pollutants or greenhouse gases into the air. Nuclear plants are playing a key role in allowing many areas of the country to meet clean air requirements mandated by the Environmental Protection Agency, and Vice President, Richard Cheney is among the policymakers worldwide who have publicly recognized the importance of nuclear energy in reducing emissions of carbon dioxide and greenhouse gases. In a major energy policy speech earlier this week, in fact, Vice President Cheney referred to nuclear power as "the cleanest method of power generation that we know."

Nuclear reactors also emit no pollutants into the water beyond thermal discharge. And while some solid wastes from nuclear plants contain long-lived radioactive elements, these wastes are stored, transported, and disposed of safely in a manner that isolates the waste from the public and the environment. Since 1980, the volume of solid low-level radioactive waste generated by nuclear reactors has decreased an astounding 94% at boiling water reactors and 96% at pressurized water reactors. As

*The report has been retained in committee files.

for spent fuel, the industry continues to store this material safely onsite, either in spent fuel pools or in dry cask storage. The federal government has failed in its obligation to begin removing spent fuel from reactor sites by 1998. While the Department of Energy (DOE) appears to be making progress in their investigation of Yucca Mountain as a permanent repository for spent fuel, the federal government must work to meet its obligation in a more timely manner.

Public Acceptance. A natural result of the industry's strong performance is an increase in the level of public acceptance of nuclear energy. Recent surveys by the Nuclear Energy Institute (NEI) and the Associated Press indicate that the public is increasingly supportive of nuclear power. Interestingly, last month's Associated Press poll found that 55 percent of those who support nuclear power would support a new plant within 10 miles of their home. Recent NEI surveys also show that acceptance of new nuclear plants is increasing, particularly in the West.

Policymakers, the media, and the public itself often fail to give people enough credit for being able to make an informed decision about nuclear power. When surveyed, many people who support nuclear power believe that their neighbors do not. Yet, surveys consistently show that a majority of the public has a favorable opinion of nuclear power. Public acceptance presents perhaps the biggest challenge for the nuclear industry in that we can only indirectly influence how the public perceives the industry. Countering inaccurate and reckless statements from the anti-nuclear community takes an enormous amount of public education.

FUTURE OF THE INDUSTRY—CURRENT REACTORS

It will come as no surprise that I believe that the nuclear energy industry has an exceptionally bright future. For the current fleet of reactors, I see three trends continuing in the near future: increased output of electricity from existing nuclear reactors, a gradual consolidation of plant ownership and operations, and applications for the renewal of existing operating licenses.

Electric generation from the current fleet of nuclear reactors is likely to increase as a result of higher capacity factors and plant uprates. As strong as the performance of the current fleet of nuclear plants is today, capacity factors can increase further as the industry continues to share best practices among plants. In fact, I think that this is a trend that we will see not just in the United States, but worldwide as well. While plants are nearing their maximum capacity factors, plants can produce additional electricity by uprating units to increase their maximum capacity. The Chairman of the House Energy and Commerce Committee recently noted in a letter to NRC Chairman Meserve that there are 14 license applications pending at the NRC for power uprates which would add over 1,000 megawatts of new capacity. Exelon Nuclear plans to add approximately 1,000 megawatts of new capacity over the next three years through uprates at our existing plants. Some industry analysts believe that a total of 8,000 to 12,000 megawatts of additional generation can be gained if uprates were sought by the current fleet of reactors.

The consolidation trend that the industry has seen in recent years is also likely to continue, though at a slower pace than we have seen in the past. Since 1998, nearly two dozen reactors have changed hands through utility mergers and acquisitions, the sale or auction of individual plants, and the formation of nuclear operating companies. While two utilities have announced their intention to auction plants later this year, most of the consolidation that will occur in the future is likely to be through mergers and acquisitions.

A final trend affecting the current fleet of reactors deals with plant life extension through license renewals. As recently as 1997, the Nuclear Regulatory Commission (NRC) estimated that only a fraction of currently operating reactors would seek to extend their operating licenses. Predictions by the Energy Information Administration (EIA) were even more dire, with EIA estimating that 58 reactors would cease operation between 1996 and 2015. The improved economic performance of plants, combined with a recognition of the clean air compliance value of emissions-free generation, have led the NRC and EIA to reexamine those estimates. Today, most observers, including NRC Chairman Richard Meserve, predict that the vast majority of the nation's current 103 operating plants will apply for 20-year license extensions.

FUTURE OF THE INDUSTRY—NEW PLANTS

The demand for electricity in the United States is growing rapidly. The DOE estimates that electricity demand will grow by 45 percent over the next 20 years. Based on that estimate, the U.S. will need more than 1,300 new power plants—65 a year—to meet that demand. It is significant to note that it was over 15 years ago when 65 plants were last built in a single year in the United States.

As these new plants are built, it is critically important that there is a diversity of energy sources. One of the reasons California is having such difficulty is that they depend too much on natural gas as the fuel for electric generation. New plants cannot just operate on natural gas, but must also include coal hydro, solar, wind, and yes, nuclear.

New nuclear plants will have to be safe, economic, and clean to be acceptable to legislators, regulators, investors, and the public.

Safe. Any new nuclear technology must be passively or inherently safe. Given the importance of public opinion in the siting of any new industrial facility, any new nuclear plant should exhibit such safety features, and the new reactor technologies certified by the NRC incorporate many passive design features.

Economics. Of course, any new reactor technology must be economically competitive with other generation sources. In the newly deregulated marketplace, however, it is also important for any new technology to have a low capital cost, to have short construction lead times, and to be of relatively small size so as not to disrupt the economics of the regional market the plant is built to serve.

Clean. New reactor technologies must also have a minimal impact on the environment.

The industry is working together to lay the groundwork for new nuclear plants. The NRC has certified three new advanced reactor designs after conducting extensive, multi-year safety reviews. Of the three new certified designs, two have been built and are setting world-class performance records in Japan, and additional reactors are being built in Korea and Taiwan. Two additional advanced designs are expected to be submitted to the NRC in the near future for approval.

THE PEBBLE BED MODULAR REACTOR

Exelon Corporation believes that we have found a technology that possesses the characteristics necessary to successfully compete in a deregulated environment in the Pebble Bed Modular Reactor (PBMR), a design under development in South Africa. Exelon is a partner in the PBMR project with Eskom, the state-owned utility in South Africa; the Industrial Development Corporation of South Africa, a state-owned investment firm; and BNFL, the former British Nuclear Fuels Limited. The PBMR technology is an evolutionary improvement of a proven design previously utilized in Germany. Let me explain.

Safe. The Pebble Bed technology relies on a ceramic fuel design that cannot suffer meltdown. Fuel melting is the primary safety concern related to current light water reactor technology. In the PBMR, the reactor temperature never rises above 1600 degrees Celsius, even under a worst-case loss of coolant accident. PBMR fuel, however, does not begin to degrade until temperatures reach 2000 degrees Celsius.

Economic. As a small (110–125 megawatt) modular reactor, the PBMR is well-suited for use in a deregulated power market.

- Low Capital Cost: Capital costs for each PBMR module are expected to be a fraction of the cost of current reactors—roughly $125 to $150 million for a 125 MW plant—thus decreasing investment risk. At $1,100 per kilowatt to construct, the PBMR can be competitive with other energy sources.
- Speed to Market: We estimate that the PBMR can be built in 18 to 24 months, as opposed to 48 to 72 months or more for large reactors. Speed to market is essential if the PBMR is to compete effectively with coal and natural gas-fired plants in a deregulated market. Of course, the construction timeframe does not include the time necessary to receive regulatory approvals for building the plant. Timely licensing action will be necessary to take advantage of the quick construction time.
- Small Size: Adding small increments of new capacity to electric markets will better match new electric supply with demand growth, thus preventing an oversupply of electricity and allowing a quicker recovery of the capital costs.

Clean. Like current nuclear reactors, PBMR reactors will emit no air pollutants or greenhouse gases, and since the PBMR is a more efficient reactor, the plant uses a fraction of the water used by conventional light water reactors. This lack of reliance on water may also enable the PBMR to be sited in locations that are not suitable for light water reactors.

The PBMR project is currently in its preliminary stage, with a detailed study of the design being conducted by an international team of experts. The study is due to be completed this summer. If the technology is deemed ready for commercialization, and if the economics prove to be competitive against other forms of generation, the partners will proceed to build a demonstration plant in South Africa near Cape Town. We estimate that construction of the plant will take 36 months, with a 12-month testing period following the completion of construction.

If Exelon's review of the feasibility study is favorable, we intend to begin the licensing process to build a number of PBMRs in the U.S. as soon as next year. Our current business plan calls for the submission of a license application for early site permitting in 2002, followed by an application for a combined construction and operating license in 2003, after the detailed design is completed in South Africa.

Of course, a number of legal and regulatory issues must be addressed before a pebble bed reactor can be built in the United States. Most of these issues fall into one of two categories: the first category results from the fact that new nuclear plants would be merchant plants operating in a deregulated environment; the second category results from the fact that the PBMR is a small, modular reactor that produces roughly one-tenth of the power of a conventional 1,100 megawatt light water reactor.

The current NRC regulations were promulgated when it was anticipated that only regulated electric utilities would build nuclear plants. These regulations did not foresee the dawn of a deregulated power generation market and are now obsolete. If Exelon builds a PBMR, it will be a merchant nuclear power plant that will not be in a regulated utility rate structure. The financial risk of the plant will rest on the shareholder, not the ratepayer. If these outdated regulations are not changed, the financial burden imposed on merchant plants clearly has the potential to make the economics untenable. Some of the key regulations that need to be addressed include the financial protection requirements of 10 CFR Part 140, the decommissioning funding requirements of 10 CFR Part 50.75, and the antitrust review requirements of 10 CFR Part 50.33a.

The PBMR would similarly be disadvantaged by current regulations because of its small size. For example, the Price-Anderson Act should be amended to treat Pebble Bed Modular Reactors in a manner that recognizes the inequity of treating individual PBMR modules as separate facilities. Under the current NRC interpretation of Price-Anderson, a 10-module, 1,100 megawatt PBMR site would have 10 times the potential retroactive liability of a single 1,100 megawatt light water reactor. Similarly, the annual fees assessed on a per reactor basis under 10 CFR Part 171 should be revised to recognize the disparity between a 110 125 megawatt PBMR and a much larger light water reactor. The large emergency planning zone requirements in 10 CFR Part 50.47 should also be revisited given the fundamental safety differences between a PBMR and current reactors.

In addition to the above regulations, the licensing process which we would follow under 10 CFR Part 52 to obtain a combined construction and operating license for these plants has never been utilized. As a result, we expect that there will be a steep learning curve for both the NRC staff and ourselves on how to execute this process with resultant high costs and delays. We will also need to work with the NRC staff to develop the technical licensing framework for the PBMR as the existing regulations are written for light water reactors. Regulations will need to be developed for gas reactors, also at additional costs and potential delay.

Exelon believes strongly that the development of the design and the cost to commercialize and build the PBMR should be borne by the PBMR partners. We anticipate that the partners will invest upwards of $600 million of their own money to make the PBMR commercially viable with Exelon investing a significant additional amount to license and build the first PBMRs. There are, however, a number of first of a kind costs that Exelon will bear as the first licensee for this new technology that will flow directly to government agencies such as the NRC in the form of licensing fees and the national laboratories as consultants to the NRC. As stated earlier, we expect that the costs of licensing this technology will be higher than normal because of the unproven nature of the 10 CFR Part 52 licensing process and the need to create a gas reactor licensing framework. The technical expertise needed to review the PBMR application does not currently exist either in the NRC or in the national labs and will need to be developed. We believe it is appropriate for some level of government funding to be provided to fund the work of government agencies in these areas.

Finally, the federal government must take additional action if new plants using any nuclear technology are to be built. First, Congress must renew the Price-Anderson Act, which will expire in August 2002. Second, Congress and the Administration must take steps to assure the existence of a competitive nuclear fuel market.

Thank you again for the opportunity to discuss this important issue with you today.

Senator DOMENICI. Thank you. James Asselstine, Lehman Brothers. We welcome your testimony.

STATEMENT OF JAMES K. ASSELSTINE, MANAGING DIRECTOR, LEHMAN BROTHERS, INC., NEW YORK, NY

Mr. ASSELSTINE. Thank you, Mr. Chairman. I submitted a written statement, so what I will do is really just summarize some of the testimony.

Senator DOMENICI. It will be made a part of the record.

Mr. ASSELSTINE. My perspective here is really as a financial analyst, and I and most of my counterparts and colleagues spend a fair amount of our time looking at and evaluating the economic value of generating assets in this country as we move to a competitive marketplace. My conclusion, and I think it is shared by many, if not most of my colleagues, is that nuclear assets are looking to have very significant value in a competitive marketplace, and we really look to five elements or factors in reaching that conclusion.

One is the satisfactory progress in terms of restructuring within the industry, and generally a fairly good track record in terms of how nuclear issues are being addressed in individual State restructuring plans. Second is nuclear economics, third, the improved operating performance that we have seen from the plants, particularly over the past decade or so, fourth, some of the positive regulatory changes that we have seen at the NRC, and finally some of the steps that have been taken in terms of industry consolidation and changing operating arrangements for the companies and the plants, and I will touch a little bit more on each of those.

In terms of industry restructuring, about half of the country now has adopted formal restructuring plans to move to a competitive marketplace. Those plans cover about 60 of the nuclear units in the country, so we have enough of a track record at this point I think to assess how nuclear issues are being addressed in industry restructuring.

There are really two cost considerations. The first is the utilities' ability to recover their stranded costs, the second is the ability to recover decommissioning costs. Those both relate fairly directly to nuclear.

In terms of stranded cost recovery, although no company is being given an absolute guarantee, in general the State restructuring plans provide a reasonable opportunity for stranded cost recovery. Similarly, for decommissioning expenses, those expenses have been recognized to be a health and safety expense largely incurred during the regulated operation of the plants, and those costs have been allowed to be recovered as well, so by and large, industry restructuring so far has treated nuclear fairly and evenhandedly, and restructuring has been relatively benign for the nuclear fleet in this country.

In terms of nuclear economics, nuclear enjoys several advantages, and I think a number of the members of the committee have already touched upon those in terms of the low and stable fuel costs that nuclear units have. They are low on environmental impacts. These are relatively large base load plants, which enjoy economies of scale, and in many instances these plants are must-run units that are necessary for system reliability.

If you compare nuclear costs to those of coal and gas-fired generation, nuclear compares very favorably today. A well-run large base-load coal plant can generate power at 2 cents or slightly below

per kilowatt hour. Combined cycle gas-fired units with the increase in natural gas prices are beginning to push 4 to 5 cents per kilowatt hour Most all nuclear fleet in this country has operating costs that compare very favorably with coal, and well under where current gas-fired generation is today, so it appears to us that the nuclear fleet today is very competitive compared with other alternatives.

Senator DOMENICI. Would you put your mike up a little closer?

Mr. ASSELSTINE. We have also seen fairly significant improvement in the operating performance of the units. If you look at operating costs, fuel and maintenance costs, if you look at the capacity factors of the units themselves, the length of refueling outages, the reporting of unusual events to the NRC, all of those indicators have shown very significant, dramatic improvement over the past decade, and that has been something to those of us in the financial community that have provided the assurance of the value of these units.

In terms of regulatory changes, I thing that Chairman Meserve and his colleagues have done an excellent job in carrying out their health and safety responsibilities, but also doing that in a way that adapted to the changing requirements of a competitive industry for nuclear units, and I would point to three elements in particular where we have seen positive contributions from the NRC.

One is in the new plant oversight and assessment process, a second is in processing license transfers, ownership changes for nuclear units as we move to competition has required significant activity on NRC's part in terms of approving license transfers, license amendments, and finally, in the license renewal process, and as Chairman Meserve pointed out, the commission in relatively quick time approved license extensions for five units. If you add up all of the units that have indicated a desire to move to plant life extension, they total almost 40 percent of the plants in the country.

Finally, in terms of industry consolidation, we have seen different changes in terms of ownership arrangement for the plants. I tend to believe those will also enhance the efficiency and lower the cost profile of those plants going forward.

Turning to future commitments for plants, I would cite five requirements as being important. First, new nuclear units will have to be cost-competitive on a stand-alone basis. One of the challenges here is the initial capital investment for nuclear units. As with coal units, it is somewhat higher than gas-fired plants. That issue will probably need to be addressed in terms of the utility's ability, or the generating company's ability to recover those costs going forward.

Second, it is necessary, given the past experience that we have had in this country, to provide both the generating companies and investors with assurance that plants can be built on a predictable schedule and at a predictable cost.

Third, appropriate financing arrangements will have to be provided if you will see future nuclear commitments in this country.

Fourth, we will need continued assurance of a reliable low coast supply of fuel and enrichment services for the plants to maintain one of nuclear's key cost advantages, and finally, on the public acceptance side, I think the one issue where we could see some addi-

tional progress would be in developing a solution to the spent fuels disposal problem.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Asselstine follows:]

PREPARED STATEMENT OF JAMES K. ASSELSTINE, MANAGING DIRECTOR, LEHMAN BROTHERS, INC., NEW YORK, NY

Mr. Chairman, and members of the Committee and Subcommittee, I want to thank you for your invitation to testify at this joint hearing on the state of the nuclear power industry and the future of the industry in a comprehensive energy strategy. I head the High Grade Credit Research Department at Lehman Brothers, and I am the senior credit analyst on Lehman's fixed income research team following the electric utility industry. I am pleased to offer my perspective as a financial analyst on the state of the nuclear power industry and the future of the industry in a comprehensive energy strategy. My testimony will consist of two parts. The first part will address the current state of the industry, focusing on the 103 nuclear units now in operation in this country. The second part will consider the conditions under which we might see future commitments to new nuclear units in the United States.

Turning to my first topic, I believe that there is a growing recognition within the financial community that the existing nuclear units in this country can be attractive and valuable assets as the industry makes the transition to competitive power markets. This view is based upon five factors: the generally beneficial treatment of nuclear assets in the various state restructuring plans that have been adopted to date; the favorable economics for nuclear units, which make most, if not all, of the nuclear units in operation in the U.S. today competitive on a cost basis with other available forms of generation; the significant improvement in operating performance at the plants over the past decade; positive regulatory developments at the Nuclear Regulatory Commission, which allow the NRC to discharge its health and safety responsibilities while at the same time permitting the units to retain their low cost advantage in a competitive power market; and finally, consolidation within the industry and new operating arrangements for the plants, which should further enhance the low cost position of our nuclear units.

Turning first to industry restructuring, to date, 24 states and the District of Columbia have adopted comprehensive industry restructuring plans for the electric utility industry, either through legislation or by administrative action. About 60 operating nuclear units are included within these states, giving us a reasonable basis for assessing how nuclear issues will be addressed in the transition to competitive power markets. These state restructuring plans have addressed two important cost components for nuclear units. For a utility's stranded costs—that is, the difference between the current capital investment in a plant and the estimated value of that plant based upon estimated power prices in a competitive market—state restructuring plans have generally provided the utilities a reasonable opportunity to recover their stranded costs. Stranded costs have generally been recoverable through a combination of established rates during the transition period to competition, the benefits of securitized financings, often known as rate reduction bonds, cost reductions, and the proceeds of asset sales. Although we are still in the transition period in most jurisdictions, the evidence suggests that in most instances, the utilities will likely recover most or all of their stranded costs. Decommissioning expenses represent the second nuclear-related cost component being addressed in industry restructuring plans. Recent decommissioning cost estimates tend to fall in the range of $400-$450 million per reactor, or about $40–$45 billion in total for the industry. Of this amount, more than one-third of the expected costs has been collected to date. State restructuring plans have generally recognized that nuclear plant decommissioning is a health and safety requirement, and that decommissioning costs largely represent a pre-existing obligation that was incurred during the operation of the plants under the regulated regime. Accordingly, restructuring plans have typically allowed the recovery of decommissioning costs through a wires charge to be paid by utility distribution customers.

This brings me to my second factor, nuclear economics. With provisions for the recovery of most or all stranded costs and of decommissioning costs, the ongoing operating costs of the units becomes the key variable in assessing the economics of nuclear power in a competitive power market. Nuclear units enjoy several important advantages, including their low and stable fuel costs, and their low environmental emissions when compared with fossil-fueled generation. Further, most nuclear units are large, baseload generators which enjoy significant economies of scale, and many

are "must-run" units that are needed to maintain system reliability. Nevertheless, nuclear units must compete on a cost basis in what is likely to be a highly competitive generation market. Several factors affect expected wholesale power prices. Wholesale prices in many regions of the country are increasing, driven in part by increases in natural gas prices. Marginal pricing in the market is typically set by coal-fired generation and combined cycle gas. Environmental requirements are increasing for coal-fired generation. Today, efficient, baseload coal-fired plants can produce power at two cents/kWh or less, and new combined cycle gas-fired plants can produce power at four to five cents/kWh. By comparison, a well-run single nuclear unit can produce power at or slightly above two cents/kWh, and large, multi-unit nuclear plants can do somewhat better. These cost numbers reflect the cost of fuel, operating and maintenance costs, new capital costs, taxes, and general and administrative expenses.

My third factor is the improving operating performance of the plants. Production costs—fuel, and operating and maintenance costs—have been steadily declining, with an average of 1.83 cents/kWh in 1999. On a three-year rolling average for 1997–1999, the plants in the top quarter of the industry had production costs of 1.33 cents/kWh; plants in the bottom quarter had production costs of 2.8 cents/kWh. Nuclear plants in the top three quarters are fully cost-competitive with coal-fired units, and all nuclear units are cost-competitive with new combined cycle gas. Substantial performance improvement is also evident in the increased plant capacity factors over the past decade. In 1990, only about half of the operating nuclear units in the country had capacity factors above 70%, and less than one-third of the units had capacity factors above 80%. In contrast, in 1999, 98 units, or all but five, had capacity factors above 70%, and 90 units had capacity factors above 80%. This trend is also reflected in the length of plant refueling outages. In 1990, the average duration for refueling outages was 101 days; in 1999, the average duration was 41.5 days, and the top performers within the industry conducted refueling outages of 25 days or less. Another measure of improved performance is the number of unusual events reported to the NRC. In 1990, the number of unusual events reported was 151; in contrast, in 2000, the number was 18. These figures portray a clear trend in improved economic and operational performance within the industry.

My fourth factor is the adoption of positive regulatory changes by the NRC in the areas of plant oversight and assessment, the review of license transfer requests, and the consideration of license renewal applications. The NRC has adopted a new plant oversight and assessment process, which replaces the agency's earlier Systematic Assessment of Licensee Performance (SALP) and Watch List process. The new oversight and assessment process uses more objective criteria to monitor and evaluate plant performance, and provides a greater focus on the safety significance of operating events. These changes, which make the regulatory process more predictable and objective, are consistent with the improving trend in plant performance. In the area of license transfers, industry restructuring is leading to the need for a number of plant ownership changes, which require NRC license transfer approval. The NRC established an expedited hearing process in 1998, which allows the agency to discharge its health and safety responsibilities in a predictable and timely manner. Finally, the NRC has demonstrated a successful plant license renewal process, which led to plant license renewal decisions for the five Calvert Cliffs and Oconee units in less than 23 months. License renewal applications were filed for five additional units in 2000, and applications are expected to be submitted for a further 28 units in the 2001–2004 time period. Taken together, these units represent almost 40% of the operating units in the country.

My final factor is industry consolidation and the adoption of new operating arrangements within the industry. Consolidation carries with it several benefits, including greater economies of scale, broader career development opportunities leading to improved employee retention, and the ability to capture the operating strengths and experience of the stronger performers. In addition, these larger nuclear operating organizations may be better equipped to cope with individual plant challenges. Consolidation takes several forms. One form is the creation of fewer, larger companies through mergers and acquisitions, which have resulted in greater nuclear management concentration. One example is the merger of PECO Energy and Unicom to form Exelon, which created the largest nuclear operating organization in the country with 17 operating units. A second example is the merger of Carolina Power & Light and Florida Power Corporation to form Progress Energy, which operates five nuclear units. Another form of new operating arrangements is the use of corporate restructuring within the industry. As the electric utilities transition to a competitive market, an increasing number of companies that wish to retain their generating plants are moving to a holding company structure with separate subsidiaries for the regulated transmission and distribution business, and for the unregu-

lated generation business. In many instances, these new, unregulated generation subsidiaries will have a significant nuclear component. A third form of consolidation is through nuclear plant sales. In 1999, Entergy completed its purchase of the Pilgrim plant and AmerGen Energy completed its purchases of the Three Mile Island and Clinton units. In 2000, AmerGen Energy completed its purchase of Oyster Creek, and Entergy completed its purchases of the Indian Point 3 and Fitzpatrick units. Last month, Dominion Resources completed its purchase of the three Millstone units. Sales of minority interests in the Salem and Hope Creek units to Exelon and PSEG Power, and the sale of the Nine Mile Point units to Constellation Nuclear are pending, and other plants including Vermont Yankee and Seabrook will likely be auctioned in the future. Finally, still other electric utilities are forming strategic alliances for certain aspects of the operation of their nuclear units. Examples include the Nuclear Management Company, which now serves as the licensee for eight units in the Midwest, the STARS alliance, which provides cooperative efforts for outage management, procurement, and regulatory affairs for eight similar nuclear units, and ongoing studies by the Omaha and Nebraska Public Power Districts of the feasibility of a joint operating company for their two nuclear units.

Taken together, the generally positive treatment of nuclear issues in state restructuring plans, the strong economic competitiveness of nuclear units compared with other alternatives, the improving trend in nuclear operating performance, positive NRC regulatory developments, and the benefits of consolidation in nuclear plant operations are leading many of us in the financial community to conclude that our existing nuclear units can be attractive and valuable assets in a competitive power market. As a final matter, it is worth noting that the most rapid and cost-effective means of increasing nuclear generation in this country is through pursuing incremental gains in operating performance, as well as license renewal, for the existing plants.

In the second part of my testimony, I want to consider the conditions under which we might see future commitments for new nuclear units in this country. I see five requirements that must be met if new nuclear units are to be ordered and built. First, a new nuclear unit must be cost competitive on a stand-alone basis with other alternatives, such a clean coal technology and gas-fired generation. One challenge for new nuclear and coal-fired generation is the relatively higher initial capital investment required as compared with a new combined cycle gas-fired plant. This disadvantage could be overcome by a combination of lowering the initial cost differential and perhaps by permitting the accelerated depreciation of the plant investment.

Second, given the past experience with the construction and cost of the current generation of nuclear plants, the generating companies and their investors will require assurance that the plant can be built at a predictable cost and on a predictable schedule. There are two aspects to this requirement. The first aspect requires validating the expected performance of the NRC's new licensing and regulatory process for the approval of standardized designs and sites. The intent of this process is to permit the advance approval of new plant designs and sites in order to minimize the time and uncertainty related to the regulatory approval for the start of plant construction, and especially, for the start of plant operation. Although the NRC has approved several advanced designs, the effectiveness of the entire process remains to be tested. The second aspect requires measures to mitigate construction completion and plant performance risk. Such risk sharing measures as turnkey construction contracts, required plant performance specifications, and liquidated damages provisions for nonperformance or delays, which are commonly used in other power plant construction projects, or other alternative risk sharing arrangements among the project participants, may be needed.

Third, a new nuclear plant project must have appropriate financing arrangements. One complicating factor here is that unlike previous plants, which were built under a regulated regime that generally provided for recovery of prudent costs from ratepayers, future plants must be built, financed, and operated in a competitive power market. At least for the initial plants, stand-alone financing for a nuclear project would likely require substantial equity investments from a number of project participants to minimize the adverse financial impact on any single participant. Alternatively, a new nuclear unit could be financed as part of a much larger operating generation company, thereby diluting the new nuclear construction risk exposure sufficiently. Over the past year, we have seen strong receptivity in the equity and debt markets to financings for the new competitive generation companies within the industry, including a recent debt financing for PSEG Power, a company with several operating nuclear units. A successful competitive generation company with a substantial portfolio of nuclear and non-nuclear generating assets might well be able to "shelter" the higher risk of a new nuclear unit.

Fourth, commitments to new nuclear units will require continued assurance of a reliable, low cost supply of fuel and enrichment services to preserve one of nuclear's key cost advantages. Finally, new nuclear commitments will also require public acceptance. On the safety side, continued strong performance of the existing plants together with a continued effective NRC regulatory and oversight process should lead to public acceptance of new plant commitments. The one area requiring further attention is the need to demonstrate progress in developing a solution for the disposal of spent fuel.

Senator DOMENICI. Thank you very much.

Mr. John Ahearne, professor, Duke University.

STATEMENT OF JOHN AHEARNE, ADJUNCT PROFESSOR, DUKE UNIVERSITY, DURHAM, NC

Dr. AHEARNE. Thank you, Mr. Chairman and Senators. I am here representing myself. In 5 minutes I would like to briefly cover five topics, NERAC research, education system, infrastructure, and nuclear waste.

A few words on NERAC. That is the Nuclear Energy Research Advisory Committee. It was set up several years ago to advise the nuclear energy part of the Department of Energy on things nuclear. We have generated several reports, and I would like to submit for the record the summaries of those reports. One is on the blue ribbon panel to look at education issues, another on isotope research and production planning, another on proliferation-resistant nuclear power systems, and the fourth on the long-term R&D plan, and I would like to submit those for the record.

Senator DOMENICI. That is done.

Dr. AHEARNE. I would also submit the statement which is called, Goals for Nuclear Energy.* This was just passed. It is a 2-page summary passed by NERAC on Monday, and I submit that also for the record.

On research, research is the fundamental support for an advanced technology. The United States is a country that depends on advanced technology. Let me quote from the Scientific Allocation of Scientific Resources. This is a National Science Board, March 28 of this year discussion draft. It says, the Federal role today is especially critical for research that is high risk, requires long-term investment in the expectation of high pay-offs to society, or that is unlikely to be funded by the private sector, for unique, costly, cutting-edge research facilities and instrumentation, and for academic research that is a primary purpose, supports the education of the future science and engineering workforce. That directly applies to nuclear energy enterprise.

The past administration, until the closing years, did not support nuclear energy research. In 1997, PCAST, the President's Council to the Advisor on Science and Technology, did put out on Federal energy R&D, and it recommended something that we call NERI, the nuclear energy research initiative, and it began in 1998. It was a program to bring water to a parched discipline. The program began and was supported, not at the PCAST recommended level, but was supported, and I was delighted to read in the several Senate bills—S. 388, S. 472, S. 597—strong support for NERI.

*Retained in committee files.

Many in the nuclear community have welcomed the positive words on nuclear by the administration, but the DOE budget cripples the NERI program. From $28 million in 2001, the program is cut to $11 million in 2002, and there are two invisible aspects of that cut. First, this will not allow any new starts. It will only carry on to completion the grants that were made in the last 2 years.

Then, second, the grants that were awarded 3 years ago for the first time come to completion. Some of those would deserve being funded for a continuing basis. There is no money to do that.

The message to the research community that DOE has given by what they have done to NERI is that DOE is not interested in nuclear energy research, and hopefully the Congress can redress that.

Nuclear energy is more than electricity generation. Medical isotopes are widely used, more than 12 million procedures a year, industrial use, for example, for nondestructive testing, and space power. The Rover, the little device that captured the American public's interest as it moved around on Mars, was powered by nuclear power.

Education. Nuclear energy is disappearing on campuses, for many reasons, a hostile administration, an apparent demise of nuclear powerplants, and no money for students and faculty. Also, university research reactors are disappearing. This year, at the moment, research reactors are—what are generally regarded as the best undergraduate and graduate nuclear engineering departments, Michigan and MIT, their research reactors are slated to close. Why? The lack of Energy Department support.

Infrastructures in university and national labs, both of them are decaying. It is hard to convince young students that a field is viable if physical signs indicate it is not. In these Goals for Nuclear Energy, we say, it is hard to imagine a revitalization powered by utilization of 40- to 50-year-old infrastructure.

And then finally, on waste, waste is long seen as the Achilles heel, the total flaw of nuclear power. The lack of the Energy Department taking spent fuel may close down some reactors, something that opponents have not been able to do, but there are several States that are now saying they will not allow any more dry casks to be built, because those States are viewing themselves as becoming the national repository.

The permanent disposal of high-level waste has been accomplished nowhere in the world. Finland is the country that is closest to actually getting somewhere. The scientific and technical community believes that deep geological repositories are acceptable, but as Congress well knows, there is much more to getting a site built than having the technical community agree that it is a good idea.

This summer, a report will come out from the National Research Council on geological disposal of high-level waste, and I think that will have some light to shed on this issue, and I will be glad later to answer any questions, and I look forward particularly to hearing from the graduate student, who can probably speak much more eloquently on the need for funding of students.

Senator DOMENICI. Thank you very much, doctor.

Mr. Rhodes, would you proceed?

STATEMENT OF RICHARD RHODES, AUTHOR, MADISON, CT

Mr. RHODES. Thank you, Mr. Chairman, members of the committee. I have provided a statement for the record. I would like to just comment a little bit.

I am an independent journalist and historian. I have written about nuclear issues for the last 30 years. I am not a scientist or an engineer, but simply an informed citizen. To quote Secretary of State James Baker, "I got no dog in this fight," but I do have three young grandchildren, and I care about their future.

I just returned from the annual Japan Atomic Industrial Forum Conference. It was held this year in Northern Japan. We toured the new reprocessing facility that is under construction at Rokashomora, and I must say, it was a wistful experience to realize there was no American technology there, no American participation there. I know the word reprocessing has been taboo in these halls. Sooner or later, I think it is an issue we are going to have to confront.

My book, *Nuclear Renewal*, which was published in 1994, gave me a chance to talk to some of the pioneers in the industry. I remember vividly speaking with Philip Fleger, who was the chairman of Duquesne Light, the company that built the first commercial nuclear power reactor in the United States, at Shippingport.

Fleger said the reason they went nuclear was for pollution control. They were facing an increasing demand in Pittsburgh, the smoky city in those days. Objectors were objecting to building a coal plant, and the answer, and the solution, the green solution in those days was to go nuclear. Nuclear power is still the greenest form of energy that we have.

I think that we must deal with, or at least discuss, what is clearly a strong anti-nuclear bias in many of the media. I say that as a practicing journalist. I started out writing about nuclear power from an anti-nuclear perspective simply because I did not know any better, and as I got to know the people who worked in the field, and as I got to understand the technology, my position changed to being essentially pro-nuclear.

To read the newspaper or watch television, you would never know that coal-burning, besides killing at least 15,000 Americans every year from lung diseases, also releases 100 times as much radioactivity into the environment, megawatt for megawatt, as nuclear power does.

Polling indicates that ordinary Americans have a generally favorable view of nuclear power, but believe other people, believe their neighbors disapprove of it.

I think that obviously the media's bias is not something that this Congress can address, but surely the responsible parties in the media might want to think about their position, which seems to me to run counter to the interests of public health in the United States, much less energy policy.

Let me close by mentioning a conversation I had some years ago with Marcel Boiteux, who was the director of Electricité de France at the time that France began to go commercially to nuclear power. When I interviewed Dr. Boiteux, I made the mistake of suggesting that the French Government and the industry had encountered little resistance when they made their decision to move to what is

now about 80 percent dependence on nuclear electricity. He was indignant. He said, to the contrary, they had enormous problems. He said, our employees received death threats. Coffins were delivered to plant sites. My apartment, he told me, was bombed with plastique. He said, the stairs collapsed through eight floors. It was a very difficult time.

But then, he said, something important happened. At the end of July 1977, he told me, the president of the republic, Giscard d'Estainge, courageously announced that the nuclear policy was not an EDF policy, it was a French policy, and that, he concluded, changed the climate completely, because once the whole of the political scene had taken a positive position in relation to nuclear power, there was little protest.

That, I think, is what Senator Domenici and others in this organization have, in fact, been doing these recent years, and I commend you for it. Robert Oppenheimer, who, of course, was the physicist who led the Los Alamos Laboratory in the development of the first nuclear weapons, said something similar once at a dark time in American history. He said, the answer to fear does not always lie in dissipating the causes of fear. Sometimes the answer lies in courage.

Thank you.

[The prepared statement of Mr. Rhodes follows:]

PREPARED STATEMENT OF RICHARD RHODES, AUTHOR, MADISON, CT

My name is Richard Rhodes. I'm an independent journalist and historian, the author of eighteen books and numerous articles for national magazines. One of my books, *The Making of the Atomic Bomb*, won the 1988 Pulitzer Prize in Nonfiction. Since 1970 I've written extensively about nuclear power, most recently in the journal *Foreign Affairs*. I'm not a scientist or an engineer but simply an informed citizen. I have no financial or professional connection with the nuclear power industry. I do have three young grandchildren, and I care about their future.

I've been writing about nuclear power issues since the early 1970s, when the Energy Crisis moved them to the foreground. I vividly remember interviewing Philip Fleger, chairman of Duquesne Light, which started up the first American demonstration nuclear power plant at Shippingport, Pennsylvania, in 1954. The basic reason Duquesne went nuclear, Fleger recalled, was pollution control. Pittsburgh was still very much the Smoky City in the early 1950s. It had begun urban redevelopment in the late 1940s, instituting strict smoke control. By the time the AEC solicited bids for the demonstration project, sulfur oxide controls were under discussion in the Pittsburgh area, well ahead of the rest of the nation. Duquesne at that time was petitioning to build a coal-fired power plant on the Allegheny River, and citizens were resisting. "We encountered a great deal of harassment and delay from objectors," Fleger told me—objectors objecting to coal, that is, not to nuclear power. Fleger added, "It began to look as if we wouldn't be able to complete the plant on time to meet the power demands we were facing." Doesn't that sound familiar? From Fleger's and the Pittsburgh community's point of view, Shippingport was a godsend.

In 1954, nuclear power was generally perceived to be the green form of energy for electrical generation. Nothing whatsoever has changed, factually speaking, in the forty-seven years since then. Nuclear power is still the greenest form of energy for electrical generation, greener even than hydropower, solar or wind if damage to the environment is the measure. France, by generating 80 percent of its electricity with nuclear power, has reduced its air pollution by a factor of five. The U.S. nuclear power industry has already made the largest contribution of any U.S. industry to meeting the U.S. Kyoto commitment.

Why then is nuclear considered so problematic in the United States? I think we should distinguish between public opinion as measured by media coverage and public opinion as measured by scientific polling. As a professional writer with more than eighty articles published in national magazines across the past thirty years, it's my judgment that the media has developed an antinuclear bias. There's ample

evidence of that bias in media coverage of accidents and breakdowns, which is far more sensational and punitive for nuclear power than for other kinds of energy generation.

To read the newspaper or watch television, you would never know that coal burning, besides killing at least 15,000 Americans every year from lung diseases, also releases one hundred times as much radioactivity into the environment, megawatt for megawatt, as nuclear power. Polling indicates that ordinary Americans have a generally favorable view of nuclear power but believe other people disapprove of it. With more than 100 power reactors operating nationwide, supplying 20 percent of U.S. electricity, millions of Americans live comfortably near nuclear power plants. If they are reluctant to see new nuclear power plants constructed in their communities, they are equally reluctant to see coal or even gas-fired power plants constructed. NIMBY is a fact of life in America today, and a serious problem as energy shortages loom. Certainly it has been part of California's problem.

Let me close by mentioning a conversation I had some years ago with Marcel Boiteux, the director of Electricité de France who pioneered French commercial nuclear power. When I interviewed Dr. Boiteux I made the mistake of suggesting they had encountered little public resistance. To the contrary, he told me indignantly, there were enormous problems. "Our employees received death threats," he said. "Coffins were delivered to the plant sites. My apartment was bombed with plastique—the stairs collapsed through eight floors. It was a very difficult time." But then, he said, something important happened. "At the end of July 1977," he told me, "the president of the republic, Giscard d'Estaing, courageously announced that the nuclear policy was not an EDF policy: it was a French policy. And that," Boiteux concluded, "changed the climate completely, because once the whole of the political scene had taken a positive position in relation to nuclear power, there was little protest."

Robert Oppenheimer said something similar once, at a dark time in American history. "The answer to fear," he said, "does not always lie in dissipating the causes of fear; sometimes the answer lies in courage."

Senator DOMENICI. Thank you very much.

Heather, we are glad to have you.

STATEMENT OF HEATHER J. MacLEAN, GRADUATE STUDENT, NUCLEAR ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MA

Ms. MACLEAN. Thank you very much. It is an honor to present testimony at this joint committee hearing today. I would like to thank Senators Murkowski and Domenici for inviting me here.

There have been many positive discussions recently about the role of nuclear power in our Nation's energy supply, both within the industry and in the general public and press. I have dedicated my education and career to creating safer, more efficient nuclear energy, often struggling against poor public perception and a lack of awareness of the benefits of nuclear technologies.

As I near the end of my graduate work, and contemplate my future career, it has been especially encouraging to hear government leaders in both Congress and the executive branch discussing the importance of nuclear energy. Words alone, however, are not enough. We must take action now to reverse the decline in our nuclear human resources.

In my 9 years of studying nuclear engineering, I have conducted experiments at three university research reactors, earned by NRC operator's license at the University of Wisconsin, worked three summers at a commercial nuclear powerplant, and am now working closely with the Knolls Atomic Power Laboratory on my Ph.D. research.

I have always worked with students, professors, and professionals who are committed to the challenges of making advances in nuclear science and technology. It is through these experiences that

I have developed my belief in the importance of nuclear energy to our Nation's development and security, and have become dedicated to rebuilding our future in nuclear energy.

To continue our past successes and make future advances in nuclear engineering, we must start now to rebuild our strongest resource, our students. To do this requires three commitments. First, we must attract new students to nuclear engineering programs, or we will not be able to run our current reactors or design new ones.

Second, we must also encourage young Ph.D. graduates to teach the next generation of students. Without new professors, who will develop the future nuclear engineers and scientists we so desperately need, and third, equally as important, we must also support the nuclear industry and encourage a business climate where utilities can make decisions to build new plants without undue uncertainty. We need a business environment in which the nuclear industry can thrive, seeking innovative and progressive solutions so that students will want to participate.

Unfortunately, the group of nuclear engineers with whom I have worked is shrinking, as talented and skilled nuclear graduates are leaving the field. The nuclear power industry is still often seen as a dying one, and many of my classmates are pursuing other careers with higher perceived opportunity and longer term, more certain futures. For those same reasons, few new students are willing to join nuclear engineering programs, and many departments have closed or merged with others.

During the past decade, the number of nuclear engineering programs has declined by 50 percent, with only approximately 25 4-year degree programs remaining. Equally alarming, in just the past 10 years, enrollments in nuclear engineering Nation-wide have dropped by almost 60 percent. This year, the demand for nuclear engineers exceeded supply by 350. Companies actually want to hire nuclear engineers now, but there are not enough.

This trend will only continue to worsen, as 76 percent of our nuclear professionals will be eligible to retire in 5 years. At the same time, more and more plants are renewing their licenses and are in need of qualified nuclear engineers. We must take action now to stop the decline in the nuclear workforce and rebuild our human resources for the future.

When I was first offered a summer job at a commercial nuclear powerplant 7 years ago, I was sure it was not the career path for me. 3 months later, I realized I could not have been more wrong. As a nuclear engineering student, working at a powerplant was an amazing experience, an incredible opportunity to see, in operation, the ideas I had read about in textbooks.

In my graduate studies, I am working with a team designing an advanced gas-cooled pebble-bed reactor, a concept that has received much positive attention in the press recently. We are developing a safe, reliable reactor technology that is also easy to build and operate, and is competitive with natural gas plants. I have decided to stay in nuclear engineering, and continue to work on advance designs, often despite the advice of engineering colleagues, because these technologies offer improved safety, higher efficiency, clean air, and integrated waste management.

However, I do not think I would have stayed at MIT had I not been a recipient of DOE nuclear engineering fellowship. The fellowship program awarded me the opportunity to stay in school and research a topic I found important and vital to nuclear engineering. It is clear that our educational institutions are world-class, and have been at the forefront of new nuclear technology development, but we are in danger of losing our edge and our expertise, immediately to be followed by global leadership.

The industry cannot survive without new students. The best way to attract new students is with an active, viable industry with long-term careers. The Government needs to help by sending the message that nuclear energy is an important national resource, vital to our economic development and environmental health, by helping ensure opportunities for the future.

As an optimistic nuclear engineering student, I would like to encourage the members of these committees to support nuclear energy and its students by supporting bills such as S. 242, sponsored by Senator Bingaman, and S. 472, sponsored by Senator Domenici.

Thank you very much for your interest in the future of nuclear energy.

[The prepared statement of Ms. MacLean follows:]

PREPARED STATEMENT OF HEATHER J. MACLEAN, GRADUATE STUDENT, NUCLEAR ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MA

ATTRACTING STUDENTS FOR THE NUCLEAR FUTURE

Supporting Our Best Nuclear Resource—Our Students

It is an honor to present testimony at this joint committee hearing on the current state and future of nuclear power. I would like to thank Senators Murkowski and Domenici for inviting me here today. I am also honored to be the second student from MIT to be invited to speak on the future of nuclear energy, following Alan Smith's testimony before the Senate Appropriations Subcommittee on Energy and Water Development in 1998.

There have been many positive discussions recently about the role of nuclear power in our nation's energy supply, both within the nuclear industry and in the general public and press. These discussions and increasing acknowledgement of the benefits of nuclear power and a more open discussion about the possibility of nuclear power becoming a more active participant in our energy mix have been extremely encouraging to me as I near the end of my graduate work and contemplate my future career. I have dedicated my education and career, my life's work, to creating safer, more efficient nuclear energy, often struggling against poor public perception and a lack of awareness of the benefits of nuclear technologies. Therefore, it has been especially encouraging to hear government leaders in Congress and the Executive branch discussing the importance of nuclear energy. Vice President Cheney has publicly emphasized the need for new nuclear power plants to meet increasing power demands and environmental concerns. Words alone, however, are not enough; we must take action to reverse the decline in our nuclear human resources.

In my nine years of studying nuclear engineering, I have had many exciting and rewarding opportunities to experience the hands-on effects of the theory I have learned. I have been fortunate to have conducted experiments at three university research reactors (at the University of Michigan Ford Nuclear Reactor, the University of Wisconsin Nuclear Reactor, and the Massachusetts Institute of Technology Reactor); earn my NRC operator's license at the University of Wisconsin Nuclear Reactor; work three summers at a commercial nuclear power plant, including sitting above the core during a refueling outage; tour seven commercial nuclear power plants; and work closely with Knolls Atomic Power Laboratory and the Idaho National Engineering and Environmental Laboratory on my Ph.D. research. I have also served as the president of both the University of Wisconsin and MIT Student Sections of the American Nuclear Society and have helped organize student programs at national meetings. I have always worked with students, professors, and professionals who are committed to the challenges of making advances in nuclear science and technology. It is through these experiences that I have developed my belief in

the importance of nuclear energy to our nation's development and security and have become dedicated to rebuilding our future in nuclear energy.

To continue our past successes and make future advances in nuclear engineering we must start now to rebuild our strongest resource—our students. To do this, we must attract new students to nuclear engineering programs, or we will not be able to run our current reactors or design new ones. We must also encourage young Ph.D. graduates to teach the next generation of students; without new professors, who will develop the future nuclear engineers and scientists we so desperately need? Equally as important, we must also support the nuclear industry and encourage a business climate where utilities can make decisions to build new nuclear plants without undue uncertainty. We need a business environment in which the nuclear industry can thrive, seeking innovative and progressive solutions, so that students will want to participate.

In my graduate studies, I am working with a team designing an advanced gas-cooled pebble bed reactor, a concept that has received much positive attention in the public press recently. Working closely with other universities, national laboratories, and the international industry, we are developing a safe, reliable reactor technology that is also easy to build and operate and is competitive with natural gas plants. The safety and viability of this and other advanced designs needs the type of attention and research that previous research reactors provided for the current technology. I chose to work on this design because it offers the possibility of reintroducing nuclear energy technologies to the American market and seeks to improve on plant design, incorporating many of the lessons learned over the past 50 years. Even more importantly, I've decided to stay in nuclear and continue to work on advanced designs, often despite the advice of engineering colleagues, because these technologies offer improved safety, cleaner air, and solutions that address the waste issue.

I don't think I would have stayed at MIT past a master's degree had I not been a recipient of a DOE Nuclear Engineering Fellowship. The Fellowship program awarded me the opportunity to stay in school and research a topic I found important and vital to nuclear engineering. Not only has the fellowship program supported me financially; the opportunity to conduct part of my research at the Knolls Atomic Power Laboratory has been invaluable.

Created in 1948, the Atomic Energy Commission Special Fellows program, predecessor to the DOE Fellowship program, trained bright, young students in nuclear science and related fields. Between 1948 and 1970 this program supported 75 to 100 students per year at 60 national education institutions. Former AEC Fellows authored many of the leading textbooks used in nuclear engineering today. AEC Special Fellows graduates include four Nobel Laureates, several DOE Laboratory Directors, and University Presidents. AEC Fellow graduate James Duderstadt is the author of my first nuclear engineering textbook and the President Emeritus of the University of Michigan.

Many of the AEC Special Fellows program graduates went on to teach in nuclear engineering programs, developing advances in nuclear technology while training the next generation of nuclear engineers. Today, there are only about 25 university programs offering nuclear engineering degrees and the DOE Nuclear Engineering Fellowship program supports only 22 students. Equally alarming, in just the past ten years, enrollments in nuclear engineering nationwide have dropped by almost 60 percent (from 3,440 to 1,520) according to written testimony submitted by James Duderstadt, Chairman of the Nuclear Energy Research Advisory Committee. This year, the demand for nuclear engineers exceeded supply by 350; by 2003 it will be more than 400. This trend will only continue to worsen as more nuclear professionals are eligible to retire and more and more plants are renewing their licenses and are in need of qualified nuclear engineers. We must take action now to stop the decline in the nuclear workforce and rebuild our human resources for the future.

When I was first offered a summer job at a commercial nuclear power plant seven years ago, I was sure it wasn't the career path for me. With my limited knowledge at the time, I thought the future of nuclear power was dim; no new plants had been ordered in 25 years and the oldest plants were just beginning the decommissioning process, with more to follow. I was attracted by the future prospects of creating energy through fusion, but saw little hope in the fission industry. Three months later, I realized I couldn't have been more wrong! The atmosphere at the plant was electric; the plant I was at had been through some hard times, but everyone on site was dedicated to getting the plant up and running and operating well. As a nuclear engineering student, working at a power plant was an amazing experience, an incredible opportunity to see, in operation, the ideas I had read about in textbooks. Two-inch square black and white diagrams of nuclear reactor cores in a textbook simply don't compare to seeing the real thing, in full size and color, while sitting

above 30 feet of water. Few things have been as memorable as sitting above the core supporting the operators as old fuel was moved out and new fuel brought in. I returned for two more summers, always comparing what I learned in class to what I saw at the plant.

Unfortunately, the group of nuclear engineers with whom I have worked is shrinking as talented and skilled nuclear graduates are leaving the field. The nuclear power industry is often seen as a dying one and many of my classmates are pursuing other careers with higher perceived opportunity and longer-term, more certain, and exciting futures. For these same reasons, few new students are entering nuclear engineering programs. Many nuclear engineering departments have closed or merged with other, larger departments. During the past decade, the number of nuclear engineering programs has declined by 50 percent, with only approximately 25 four-year degree programs currently existing nationwide.

It is important that we attract students to our nuclear education programs to develop the future workforce. To do that, students (and their parents) need to understand the importance of nuclear energy to our nation's future. However, our nuclear programs are disappearing and those remaining are growing older. Over two-thirds of the faculty in these programs are 45 years or older. The statistics are even more severe in the overall nuclear picture: according to the Department of Energy University Nuclear Science and Engineering Act, Senate Bill S. 242, 76 percent of the nation's professional nuclear workforce will be eligible to retire in five years. If we don't bring new students into the universities and into nuclear jobs now, we will lose the opportunity to transfer that hard-earned knowledge to the next generation. We've invested over 50 years of dedicated research to develop our nuclear programs, both for civilian and defense purposes, if we don't save it now, we will have to start over.

The continued survival and success of our nuclear energy industry requires government leadership fostering attitudes that value the contribution energy makes to our standard of living and the benefits achieved from nuclear science and technology. Energy is a commodity different from most other consumer goods and is usually taken for granted by those who use it. When asked where electricity comes from, the most common answer in the United States is "from the outlet" or "from the switch". Energy is absolutely vital to our economic prosperity, technological advances in all fields, and our standard of living. Recognizing and promoting the value of energy as a national good, as a solution to problems, not a detriment, is crucial to maintaining a vibrant, innovative, and reliable energy industry.

I am sure that most members of these committees here today would agree that nuclear energy is vital to our nation's economic and environmental health. Nuclear energy provides reliable electricity generation, supplying 20 percent of the electricity we consume, and is free of greenhouse gas emissions and pollutants. To ensure the availability of nuclear power in our overall energy strategy, we must continue to attract students to nuclear engineering education programs to provide a qualified workforce for the future.

At many of our universities, we are training as many foreign students as domestic. It is clear that our educational institutions are world-class and have been at the forefront of new nuclear technology development, but we are in danger of losing our edge and our expertise immediately to be followed by our global leadership. If we cannot attract our own students into these programs and into industry, we will be forced to buy nuclear technology back from the other countries that have supported nuclear power as a part of their own energy strategies when we decide it's necessary here.

Since I've entered this field I've always known that there would be jobs available for me, though I have been afraid that my career would consist of decommissioning the current reactors. Given the current discussions and renewed interest in nuclear power, I am once again excited about the opportunities that will be available to me when I graduate. The prospect of being a member of a team working to develop a new reactor technology and bringing new nuclear reactors to the American market would be a dream job for me! I believe that nuclear energy is important to our energy mix, our energy independence and stability, our economic prosperity, and our environmental health. Nuclear technology provides wide-reaching benefits to our society not only through energy stability, but also through medical diagnoses and treatments, and food safety, just to name a few. I want to make a contribution to this technology that is not just a future job for me, but also a core belief.

To revitalize our nuclear industry and to continue to support the tremendous achievements made during the past 50 years requires, in my opinion, three commitments. We must attract students to nuclear engineering programs; we must attract new, young professors to those programs to teach the next generation of nuclear professionals; and we must enhance the business climate for the introduction of new

technologies. Students will only be attracted to nuclear engineering if they can see active, exciting, and long-term careers. I have found out, contrary to my initial opinions, that the nuclear industry is indeed exciting, challenging, and rewarding. Unfortunately, it seems to be a secret we try to keep from everyone else. The government needs to help by sending the message that nuclear energy is an important national resource, vital to our economic development and environmental health, and by helping ensure opportunities for the future.

As an optimistic nuclear engineering student, I would like to encourage the members of these committees to support nuclear energy and its students by supporting bills such as Senate Bills S. 242, the Department of Energy University Nuclear Science and Engineering Act, sponsored by Senator Bingaman, and S. 472, the Nuclear Energy Electricity Supply Assurance Act, sponsored by Senator Domenici.

Thank you for your interest in the future of nuclear energy!

Senator DOMENICI. Thank you very much, ma'am. Mr. Chairman, we are finished with our witnesses.

Chairman MURKOWSKI. Thank you very much. I apologize for running in and out of here like this, but I had the Ambassador from South Korea in, and that is one of the problems we have.

I just have one question that I would like to pose to Mr. McNeill relative to the pebble bed reactor, and it involves your comment that this appears to be the safest technology that we have been able to theoretically develop. That kind of leads me into my question.

If you were going to evaluate the next step for the nuclear industry in the United States, would you not think that it would be somewhat of a risk to start on an unproven technology such as the pebble bed, even though it seems to have a great deal of promise, particularly from the standpoint of the unlikely possibility for meltdowns and so forth, or would we be better off, if we are going to initiate a new program, to go back to a more conventional light water reactor that has proven technology, and we know what the costs are, and we know through experience the operational procedure and so forth?

It would seem to me that there is some risk in initiating a new technology that has yet to be proven in the sense of operational functions that if the costs went up, or we had some problems, it could again set back the industry from the standpoint of the criticism from public and Government over delays, cost increases and so forth, so if you could just comment on that very briefly, and I will yield to my colleagues.

Mr. MCNEILL. I would be happy to. First of all, the reactor technology in the pebble bed is evolutionary, it is not revolutionary. It is not new. This is a design that has been used in Europe, in Germany for about 20 years. The problems associated with that design have been identified, and we are incorporating the solutions to those modest problems in our design, so what is different in the pebble bed is the coupling of the reactor with a direct cycle turbine. We do not think that is—while it is new, we do not think it is of high risk, because turbine technology is fairly well understood in itself.

So on a personal basis, representing my company, I think it is a risk for our investment purposes that is worth taking, given the other advantages that come with the design and the safety features and the small modularity that come with that particular design.

Chairman MURKOWSKI. Well, let me ask you one more question. Do you intend, then, since you are one of the larger operators of

nuclear plants, to proceed with an application at a given time, to develop the pebble bed reactor?

Mr. MCNEILL. As I highlighted in my written testimony, based upon our evaluation of the design feasibility study, which will be done this summer, in conjunction with the other investors, we would make a decision in the fall to move ahead with a demonstration plant in South Africa, follow that up with an early site permitting process in the United States sometime early to mid next year, more likely mid next year, and then a design for an application for a construction and operating license under Part 52 late next year or early in 2003.

Chairman MURKOWSKI. Is that process going to require any role for the Federal Government, other than the review, obviously of permits and application and so forth? Is there going to be a request for an expedited procedure, or is there going to be some kind of a request that will ensure that if it is built it is going to receive operational approval?

Mr. MCNEILL. We would do this under the new Part 52 permitting process, in which we would expect to exercise the new requirements that were put in place in the late 1980's. It would be the first, I think, the first application for construction, unless somebody gets there with a light water application prior to that, and one of the benefits of this design is, is that we would only be risking $150 million.

Not that that is a small amount of money, but it is not the $2 to $3 billion that have been at risk in prior constructions, and this is one of the fundamental benefits of this design, that I do not think people fully comprehend yet, is that the investment risk is much smaller than it was in prior designs.

Chairman MURKOWSKI. Well, that is very encouraging, and we are certainly pleased to hear that, and I trust that as you proceed, that if you are going to need anything other than the normal reviews of the permits and so forth from the Federal Government, that you advise us.

Mr. MCNEILL. I think in my written testimony we have highlighted a few items that would be beneficial in terms of providing funding to the NRC for development of expertise in this technology, and some other things.

Chairman MURKOWSKI. Thank you very much.

Senator Domenici.

Senator DOMENICI. Senator Bingaman, do you want to proceed?

Does anyone know how many nuclear powerplants are in some phase of construction or on a permanent order status anywhere, a combination of those in the world, Japan or elsewhere? Anybody at the table know how many that is?

Mr. MESERVE. Senator, we would be prepared to submit more complete information for the record. I do know that the Japanese have an aggressive program for construction of reactors. Similarly, the Koreans, who have 16 nuclear reactors now, have aspirations of building about another 10 or so over the next 15 years.

[The information referred to follows:]

According to the *Nuclear News*, as of December 31, 2000, 40 nuclear power reactors were either under construction or on order outside the United States (1 in Argentina, 4 in Armenia, 1 in Brazil, 8 in China, 1 in Czech Republic, 4 in India, 1

in Iran, 4 in Japan, 2 in Russia, 2 in Slovakia, 2 in North Korea, 4 in South Korea, 4 in Ukraine, and 2 in Taiwan).

Senator DOMENICI. So Japan is planning on 15 for their energy needs in the future? What about China?

Mr. MESERVE. I do not know the precise number that the Japanese are planning on, but they do have aspirations for construction. There is a reactor that is under construction in Taiwan right now. The Russians have an interest in new reactors. It is clear the Chinese have aggressive interest in nuclear reactors. There recently, as I understand it, was an application for new construction in Finland. There are a variety of countries in the world that have an interest in and plans for construction.

Senator DOMENICI. Anybody else?

Mr. RHODES. The vice chairman of the Chinese Atomic Energy Authority spoke at the conference I attended in Japan. He said that eight units with total capacity of 6,600 megawatts will be completed and put into operation between 2003 and 2005.

Taiwan, of course, has one new plant, North Korea has two plants under construction, with U.S. support, which we may all be grateful, and then Finland is pursuing developing one more plant. That was the information from the conference.

Senator DOMENICI. Anybody else know of any more?

Mr. MCNEILL. Senator, let me clarify up one thing. I have been informed that the 1,300 plant construction requirement the DOE predicts is 300 megawatts each, so that is a more accurate number than the one I gave you.

Senator DOMENICI. So the current DOE assessment of how many new powerplants we need online for electricity is 1,300.

Mr. MCNEILL. 1,300, and they would be of the 300-megawatt size.

Senator DOMENICI. Which are much smaller than we have been building.

Mr. MCNEILL. Yes, they would be.

Senator DOMENICI. Anybody else, do you know anything about any other powerplants being ordered?

Dr. AHEARNE. Well, Russia, of course, is quite interested in getting back to completing some of the plants that they had halted, and if they can find money somewhere, they would like to build some more, but money is being a real problem for them.

Senator DOMENICI. Well, let me move ahead rather quickly and just lay before the record, with reference to the activities that are going on in the Department of Energy that affect nuclear research and the like, and what is happening to them.

The budget of the executive branch for the Department of Energy, Senator, looks kind of like they put it together not anticipating that they were going to do anything in the nuclear field. Now, maybe they are coming around saying they are, but that is kind of what it looks like. Nuclear energy research, an area which you have referred to, we have been funding that without executive requests for a number of years. It is $35 million. It has been halved, been cut in half.

Dr. AHEARNE. More than that, cut more than that.

Senator DOMENICI. Okay. We are putting it down as a half. Maybe it is more. There is a very serious research effort on low-

dose radiation effect which I think all of you would concur is a national necessity.

We have been using this linear automatic relationship on a linear basis for years, and that makes people much more fearful of low-level radiation than we think they are going to have to be, and this is cut back from 20 to 10 or lower, and university research which you were referring to, Heather, we had at $12 million, not a lot, but we have got started, right out of that little budget. I think that has been cut in half, or more, so I believe we have to go back—in fact, the American effort is going to be to get back into doing something in this area.

Then we have to have a Department of Energy that has some nuclear science somewhere in the building. It cannot go somewhere else for nuclear energy. It has got to be in the building. Some of these things have to be happening.

I have a lot more, but I am going to let Senator Bingaman, my friend from Nebraska, and then I will try to wrap up. Senator.

Senator BINGAMAN. Thank you very much. One other aspect of this projection about how many new plants we are going to need in the future, I think that comes from the Energy Information Administration's Annual Energy Outlook for 2001. They say in there that they anticipate we will need 393 gigawatts of new generating capacity, 16 percent of which will replace retired nuclear capacity, so 16 percent of the additional capacity they anticipate we will need between now and 2020, will be needed to make up for retired nuclear capacity.

Chairman Meserve, you said something that led me to believe that a lot of that anticipated retiring of nuclear capacity is not likely to happen. Am I right about that?

Mr. MESERVE. You are right, Senator.

Senator BINGAMAN. Do we have an idea as to whether there will be retiring of any of our existing nuclear capacity?

Mr. MESERVE. About 40 percent of the fleet have come in and told us already that they intend to seek license renewal. Informally, we have been told that 85 to as much as 100 percent of the fleet will, in fact, seek license renewal.

This reflects that these plants are the low-cost producers, and it is in the interest, then, of the generating companies to keep them online if they can.

Senator BINGAMAN. So it is very possible that the retiring nuclear plants that 16 percent of the new generating capacity that EIA says we need to replace, will not, in fact, be retired?

Mr. MESERVE. That is correct.

Senator BINGAMAN. Let me ask also, Chairman Meserve, you cited a whole bunch of new responsibilities which were not necessarily expected 6 months ago when the administration started putting its budget together.

I know this is a long process each year when the administration starts putting budgets together, but all of these applications for renewal, all the applications for expanding capability that you talked about, Mr. McNeill's reference to perhaps this new technology that they are coming on with, which will require additional—I am just wondering whether the Nuclear Regulatory Commission budget, the way it has been presented to us, is going to reflect any of that,

or if you could give us an estimate as to how much additional funding the NRC is going to need in order to carry out these new responsibilities.

Mr. MESERVE. Yes, Senator, you are quite correct that the budget process does involve us starting to engage with OMB around this time of the year, and a lot of the changed environment that we have been discussing today has been something that has just emerged in the last few months.

We are in the process of evaluating the implications that that will have for us for the fiscal year 2002 budget, which is the one that is before you now. I would be very happy to submit information for the record as to what increased demands that places on us.

[The following information was provided:]

Serious industry interest in new construction of nuclear power plants has only recently emerged. As a result, after a mid-year budget review, the NRC reprogrammed approximately 12 full-time-equivalent (FTE) staff in FY 2001 to evaluate and assess the agency's technical, licensing, and inspection capabilities. These resources have been made available through efficiencies and postponing work that in the short-term should have no impact on our ability to meet our Strategic Plan goals, metrics and program requirements. This evaluation and assessment of our capabilities will help identify any enhancements that are necessary to ensure that the agency can effectively carry out its responsibilities associated with an early site permit application, pre-application and license reviews, and the construction of a new nuclear power plant. The new initiative will not affect our ability to continue to ensure the adequate protection of public health and safety at existing operating facilities in FY 2001.

The preliminary estimate of resources needed in FY 2002 to review early site permit applications, conduct pre-application and license review activities, and begin to assess the advanced technologies being considered by industry, is approximately $15–$18 million. Since there was no indication of serious industry interest in future licensing activities at the time our FY 2002 budget was developed, the budget now before the Congress does not include resources which may be needed for these activities. We note that there are significant demands on NRC budget resources to ensure safety of existing operating facilities and continue important ongoing initiatives, such as renewal of existing reactor licenses, and moving forward a more risk-informed regulatory environment. To the extent additional resources are needed and approved, NRC would need appropriate lead time to hire and train personnel to perform activities associated with these new initiatives.

Senator BINGAMAN. I think that would be very useful for us.

Mr. Asselstine, you cited about five requirements you believe need to be met if new nuclear plants are to be built in the country. Do you see any legislation that is required in order to achieve any of those requirements? I mean, did you identify in your analysis things that we need to change in the law in order for this to become a reality?

Mr. ASSELSTINE. I am not sure that there are a lot of legislative changes that are really necessary here. As a result of the Congress' past action, we now do have a new regulatory process, a streamlined process, as you pointed out, for site approval, for standardized design approval. What we really need to do, I think, now, is come in with a couple of applications and test that process out, and validate it, to demonstrate that, in fact, it will work as intended.

One area that might help, and I mentioned this briefly in my comments, one of the challenges in terms of building either new coal plants or new nuclear plants is the relatively larger initial capital investment for those plants, and one thing that the Congress might look at is accelerating depreciation for those investments. That would certainly make making the larger up-front capital in-

vestment for a nuclear unit or for a coal-fired plant more attractive to a generating company going forward.

A generating company will look at, what investment do I have to make today, how quickly will I be able to recover that investment, and right now the balance has clearly been skewed in favor of new gas-fired generating capacity. The plants are cheaper to build initially, operating costs may be higher over the remaining life, but the risk profile of the initial investment is quite low, and that has driven most generating companies to make commitments to gas-fired capacity, and that has been the name of the game, literally for the past several of years.

Senator BINGAMAN. Let me ask Chairman Meserve one other question here. How long a period are we looking at for the NRC to issue a license to construct and operate a plant? One of the other factors, I assume, that causes investors to look more favorably upon gas-generating plants instead of nuclear is the delay that they anticipate in getting a license issued, so I guess there are two different kinds that we talked about here.

You have certified designs that the Nuclear Regulatory Commission has already approved. If a utility board comes in and requests a license to go ahead with one of those, could you give us a time frame, and then if they request a new design—I gather this pebble bed reactor would qualify as different from those—how long would that take?

Mr. MESERVE. What we have tried to do is to put in place a process that gets as many of the regulatory decisions as possible made early so that an investor has some predictability in the process before a lot of money is sunk into a project that may go nowhere.

We have not exercised, yet, the regulatory system that we have in place that is intended to provide that predictability, other than certifying designs. We have three advanced reactor designs that have been certified. None of them have been built in the United States, but there have been three designs on the shelf, as you indicated.

We also have a process that allows issuance of an early site permit. Before you have announced an intention to actually use the site, you can come in and have the issues as to the site addressed and resolved early.

We also have the prospect of a combined license, which means early in the process you can have all of the issues resolved. Such an application might include a reference to an early site permit and a certified design. That would be faster, obviously, if you did that.

Since we have not tested these processes, I would be very reluctant to give you an estimate on which you could rely as to the time for their completion. It is clearly something that would likely take several years. You have to go through a NEPA process, for example, which means that there is preparation of an environmental impact statement. There might be hearings, which of course would be a wild card that could affect the timing of events.

We think we have in place a system that does enable us to avoid some of the pitfalls that have existed in the past as to late decisionmaking from an economic point of view, and delayed decisionmaking.

Senator BINGAMAN. Mr. McNeill, did you want to supplement that answer?

Mr. MCNEILL. Our estimate, Senator, is that that is roughly a 27-month process.

Senator BINGAMAN. 27 months from the time you filed the application to the time that it is granted?

Mr. MCNEILL. Yes. We think that that is sort of a favorable time line because of the requirements. Some of them are requirements that have been longstanding in place, NEPA and things of that nature. We would encourage creating the ability to move through that in a faster manner, just to make sure that time lines are kept as reasonable, but shortened as much as is feasible, and I do not know what that is right now, but from a business standpoint, without relation to anything, if we could do that in 18 months I would feel a lot better on things.

Senator BINGAMAN. Thank you very much, Mr. Chairman.

Senator DOMENICI. Were you finished, then?

Senator BINGAMAN. Yes.

Senator DOMENICI. Thank you for the questions, Senator. Good questions.

I would like to talk a little bit with all of you about the way things are changing. First, let us talk with the financial man. What you are saying, coupled with what Corbin McNeill is saying regarding the kind of powerplant that we will be building in the future, his expectation is they will not be 1,000 kilowatt, big ones that the finance people have to look at and wonder if they can finance because it is going to take 10 to 12, 14 years to get finished.

We are talking about the marketplace having a bigger impact here because it is assumed we can get these done quicker, and that they will probably be modular, upon which you can add later on whatever models are desired.

Between the two of you, could you tell us, other than size, what makes this doable now, and we could not do anything 10 years ago? Is it new design, is it the new statute that we have where you can now apply under—could you just share with the committee what is making it possible? Go ahead.

Mr. ASSELSTINE. I think several factors. One, 10 years ago, all of the experience of working through recovering the initial investment and the cost of the current generation of plants was pretty fresh on our minds, and it certainly had an impact on the credit quality and the financial position of the utilities, and also it had an impact on investors as well.

Second, that was at a time when we then had a substantial amount of base load generating capacity. There really was not much need at that point in many parts of the country for new, large base load generating plants so the need really was not there, either.

Third, we did not have the new NRC regulatory process. At the time, under the old regime, you had to come in with an application to build a new plant, and you also had to face the risk of a licensing process prior to the time that the plant would go into operation, and if you are trying to build a plant and really needed that plant at a particular period of time, there was a fair degree of regulatory uncertainty.

We all hope and expect that the changes were made, both by the Congress and by the NRC, have now created a process where you can really move a substantial part of that key decisionmaking early on, fully ventilate the issues, but approve the design, approve the site before you really need to move ahead with building a plant so that once you make the decision to build a plant you can get through the regulatory process quickly and, most importantly, you will not face significant uncertainty once the plant is largely completed, and you have made the investment in the plant.

At that point, those of us on the financial side, those of us on the company side want one thing, want the plant to go into operation and run well on a predictable and timely basis.

The pebble bed design that Corbin described clearly does have a number of attractive elements to it. You can build the plants with smaller modules, so you are adding a smaller increment of generating capacity, rather than 1,200 megawatts at a time. The initial capital investment in the plant is considerably smaller, and it enables the generating company to say precisely what Corbin said earlier, my total commitment and my total investment is $150 million. If things do not work out as we expect they will, that is the limit of my risk and my exposure.

I think you could do the same thing with larger plants or the evolutionary light water reactor designs, either the 600 megawatt plants, or conceivably either—or the larger ones, but you probably need to bring in more project participants to limit their individual exposure so that they can make that same statement.

Mr. MCNEILL. I agree, and I think that is a very good analysis. I think you need to put this in a context, however. In many parts of the country today, the utility marketplace is deregulated, and the large—my view is that the large reactors fit very well in either regulated or controlled economies, and that is why you see them being built in Japan, in Taiwan, in China, because you are putting large increments of capacity online at one time.

Much of that is excess capacity, and you are able to recover your investment only because of the regulated stream of revenue that comes with the rate regulation, so in a deregulated environment, you need to bring in smaller increments of capacity, such that you do not disturb market prices drastically, because if you brought a big unit in the line prices would drop to marginal cost pricing instead of full recovery pricing, and you see a much better adaptation of a deregulated marketplace in small modular reactors.

The shorter lead time, the 18- to 24-month construction period, is facilitated by the fact that in this small modular design much of the construction is done in factory construction, which is much more quality controllable, much more efficient in its manufacturing processes, and therefore does not lead to as much inefficient, lost productivity that you have seen in the construction of the large plants.

Senator DOMENICI. Mr. Rhodes, you mentioned in your remarks, if I got it right, that maybe we needed some courage. Perhaps that is what would put this into focus and perhaps get us to proceed in the proper manner. Aside from that, which wholeheartedly agree with, I do not have any problem in terms of, if that means talk about something that is needed even if people are going to dis-

agree, and wholeheartedly, and stay with it, we have some people prepared to do that.

But you must have, in your long involvement in this, seen some other things that ought to be changed, as you see it, which would bring on new powerplants for our future needs, here and in the world.

Mr. RHODES. One aspect of nuclear power that I think has never been much discussed, but is a very crucial part of its contribution, is its public health advantages. I suspect that is because utilities that run nuclear powerplants frequently also run coal plants, but when you look at the relative benefits and risks in terms of health of a system that puts no pollutants into the environment at all until the waste is eventually retired, compared to one that processes so much material that it necessarily pollutes.

In the case of coal, but also but in the case of natural gas, and, indeed, even in the case of wind and solar systems, when you count the necessary construction materials, the advantages in terms of saving American lives simply has not been discussed. Nuclear power has been perceived to be something that is dangerous when, to the contrary, one can look at the numbers and say, even if there were leakage from a waste repository in 10,000 years, how do you balance that risk against the fact that—this is a World Health Organization number—that 3 million people die in the world every year from indoor and outdoor air pollution.

So if that perspective were something that we might consider a little bit. One of the participants in the conference in Japan, who is the head of Cogema, the reprocessing operation, suggested that what we need is an authoritative world data base that looks at all the different kinds of energy generation systems in terms of their economics, their health, and all these other questions that we are concerned with. Everyone, through, presumably, the Internet, might have a place to go to, say, what is the advantage, what is the disadvantage.

Senator DOMENICI. I am going to take a minute, and he is going to take the chair, and I will be right back.

Chairman MURKOWSKI. Thank you, Senator Domenici. I would like to pose a question to Mr. Meserve and Mr. O'Neill relative to Price-Anderson. We have got Price-Anderson in the comprehensive energy bill, and that is going to be taken up probably sometime—I am guessing prior to 4 July recess, but again, I am guessing. The Energy Task Force report is going to come out mid-month, this month. Do you have any views on whether or not we should try and move legislation out separately, or as part of the comprehensive bill? We all agree it is necessary to the industry.

Mr. MESERVE. The Nuclear Regulatory Commission has endorsed the notion of the renewal of the Price-Anderson Act. It is my understanding that this is of great importance and interest to the industry as well, that the Price-Anderson Act be renewed early, and so I think perhaps moving it as a separate bill is wise.

Let me add, if I may, Senator——

Chairman MURKOWSKI. You see, the problem with moving it as a separate bill around here is what you get with the bill, particularly in this tied Senate.

Mr. MESERVE. Yes. Well, I will not purport to be able to second-guess your judgment on those matters, Senator.

[Laughter.]

Chairman MURKOWSKI. If we try and move it, you folks are going to have to be pretty active in trying to keep it clean, otherwise you can drag it down in the process. That is what worries me, but I agree with the importance.

Mr. McNeill.

Mr. MCNEILL. I know the industry would like to move it along, whatever way I think you feel that it could move along fastest.

On a specific basis, for looking at new modular reactor design, we need to find a way, whether it is legislatively or an interpretation of the legislation, to make sure that small modular designs are proportionately covered by the Price-Anderson requirements, so that the fees that would be paid by a modular individual plant would be proportionate to those paid by a larger plant.

Mr. MESERVE. Senator, if I may, there is one aspect of the Price-Anderson Act that I would like to mention to you. I know that several of the bills that are pending before the Senate now include an NRC recommendation having to do with the retrospective premium, a recommendation that it be increased from $10 to $20 million.

That recommendation was made at a time when everybody anticipated that the number of nuclear powerplants in the United States would be drastically reduced over time, and that therefore there was a need for that increase. That seems unlikely to be necessary now. The Commission is reevaluating that recommendation, and we will be submitting something to you as to that recommendation shortly.

Chairman MURKOWSKI. I appreciate that. I have one other question, and that is for the Lehman Brothers gentleman, Mr. James Asselstine, and it is relative to this hyperconsideration on wholesale price caps, and my question to you is, do you think the financial community would finance a nuclear plant if wholesale price caps did not give you the flexibility to let the market determine the rate structure, because we are seeing a situation in California now where we have got some real problems.

We have had retail caps, and clearly the result of that is that Californians are subjected to an obligation as taxpayers that ordinarily they would be subject to as ratepayers. They are the same people. I hope they can figure out the difference, or somebody can explain it to them, maybe the media in California will take that obligation. They have not done a very good job so far.

But my point is, specifically, what do wholesale price caps do to you and your industry's willingness to finance rejuvenation of the nuclear industry?

Mr. ASSELSTINE. I think that whether it is nuclear or nonnuclear generating asset probably does not matter that much. Investors are going to want to have confidence, if they look at financing a competitive generation asset, that that asset is going to be able to earn a reasonable return in the market in which they have to operate in.

We have seen a number of financings over the past couple of years for competitive generation assets. They could be single powerplants, or they can be generation companies.

Chairman MURKOWSKI. Get specific, now, because I am going to pin you down if you do not. Where do you get this level of comfort, if you have wholesale price caps on?

Mr. ASSELSTINE. It is very difficult if you have caps on, particularly caps that would be there for an extended period of time. We evaluate what the market looks like, and what we look for is the ability to price power at a level that will allow a fair return.

Chairman MURKOWSKI. So you are telling me it is where the price cap is.

Mr. ASSELSTINE. Or not having a cap at all, that is right, and investors have been most comfortable with the competitive generation markets that have operated as free markets, without artificial restrictions, where you have price transparency, and where we, as outsiders, can look at that market and gain comfort in the way the market is running, and the best example I can give you is the PJM pool. I personally believe that is the best-functioning competitive market in the country today.

Chairman MURKOWSKI. Why?

Mr. ASSELSTINE. It is the largest market, it is very liquid, you have a large number of participants in the market——

Chairman MURKOWSKI. It has no price caps.

Mr. ASSELSTINE. No price caps. You have a substantial amount of base load generation in that pool that provides very stable and steady pricing, and you have market mechanisms in terms of allowing the participants to buy power directly from generators.

Chairman MURKOWSKI. So you have got competition, and you have got overcapacity.

Mr. ASSELSTINE. And a fair amount of capacity, that is exactly right.

Chairman MURKOWSKI. Yes, but when you do not have that, which is what we are faced with in California, how do you create it if you have wholesale price caps?

Mr. ASSELSTINE. California is a particularly difficult situation right now. You clearly need more generation built, and you do not want to discourage it.

Chairman MURKOWSKI. Well, what I want to try to do is get the investment community to help us out one way or another here, because we can beat our gums around and say, well, you need this or that, but if you folks are not going to finance, the State of California can put all the permits out in the world and nobody is going to finance a plant if those price caps are too tight in your evaluation to make a return on investment. You folks need to tell us that.

Mr. MCNEILL. I think there is an important feature here. What is being proposed at the State level in California is basically rate-of-return regulation. They want to go back to price caps for individual operators that represent their cost, and if you really look at that, what that does is, it discourages lower cost generation coming into the market, because it will be treated just the same as other generation, and what you really want to do, if you are going to set a price cap, it is a uniform price cap, and it allows cheaper genera-

tion to come in and get rewarded by getting a higher return than it would have, which is the way normal markets function.

So I think the real issue is that—I know there is this debate on whether price caps ought to be applied at all. If they are applied, and I know there is a lot of political pressure to do that, they should not be cost of—rate-of-return or cost-of-generation based. They ought to be uniform price caps across the whole spectrum.

Chairman MURKOWSKI. And you have got to have them high enough.

Mr. MCNEILL. That is correct.

Chairman MURKOWSKI. What is high enough? We don't know.

Mr. MCNEILL. I will tell you. If my PBMR comes in at the cost structure that we think, I will sign contracts that are 10 percent below what is existing in the marketplace today at least, is what is being——

Chairman MURKOWSKI. So you want a price cap that is 10 percent above, is that right? I mean, somebody tell us, for heaven's sake. Do you expect us to know?

Senator DOMENICI. Well, they did not come here for that.

Chairman MURKOWSKI. Just a minute, the gentleman from Lehman Brothers——

Mr. ASSELSTINE. I would like nothing better than to see a solution to the problem.

Chairman MURKOWSKI. Well, you have got to be part of the solution by telling us what you are going to finance and what you are not, because we sit around here and discuss the merits of price caps, and California says, we have got all these permits out there, and if you are not going to finance them, we are both wasting our time.

Mr. ASSELSTINE. If we are looking at financing a generating investment, what we need to know is, where is the money going to come from to pay us back, and is it going to be adequate, and you can do that one of a couple of ways. You could sign a contract with the State of California to sell the power to the State at a fixed price, and you know what recovery you will get from that. That is one alternative.

If you are not going to go that route and you are going to sell power into the competitive marketplace, we will need assurance that over time that marketplace will operate efficiently and competitively, which means no caps, or caps that clearly are not going to constrain the expected economic performance of that plant.

Right now you have got a problem in California because it is going to take 2 or 3 years to build the supply that is really necessary to meet demand because of the failure to build plants over the last several years. You need to figure out how to bridge that gap without destroying that new plant investment that is critical to solving the problem on a long-term basis.

Chairman MURKOWSKI. Well, are we going to bridge that gap if we put on wholesale price caps in California?

Mr. MCNEILL. If they are set high enough, I think you will.

Mr. ASSELSTINE. If you set them too low, you will not.

Chairman MURKOWSKI. Well, okay, but you know, we asked the question of how high is high, and it is basically a return on investment.

Mr. MCNEILL. On the most expensive plant.

Chairman MURKOWSKI. Probably. Well, for example—and I am going to conclude—Pennsylvania has 1,000, Texas has 1,000, but they also have significant capacity and efficient plants. Would that work in California today?

Mr. MCNEILL. Senator, if I could just make—Pennsylvania, when power can be met inside of PJM the cap is 1,000. If they have to go outside and import power, then the price is uncapped.

Chairman MURKOWSKI. Is that right?

Mr. MCNEILL. And that 1,000 is an artificial number, because the computer will not accept a number greater than $999.99. That is why that cap is there.

Chairman MURKOWSKI. Thank you, Senator Domenici. As they look to a solution from us——

[Laughter.]

Mr. MCNEILL. Well, you might use that solution, find something that simple, that the computer will not take the number higher.

Senator DOMENICI. Thank you, Chairman. I am glad that such an expert group was asked some of the most profound questions of our day, and I thank you for the questions. I want to get back to the nuclear, if I could, for just a minute. Let me talk a minute with the chairman. First of all, we still have a big issue with reference to America's effort to go on with a permanent depository for spent fuel.

Whether one thinks it is right or wrong, whether we should do it or not, the EPA Administrator, many people have communicated with her in writing and otherwise about this problem. I wrote to her in March, at the end of March, noting that the draft EPA regulations for Yucca Mountain were severely criticized by the National Academy for Sciences. No such criticism, to my knowledge, was leveled by the academy against the proposed NRC standards.

I suggested in my letter that the EPA and the NRC should be working to harmonize these differences in standards, in approaches to the standards. On April 26, the Administrator reported that the EPA and the NRC, and I quote, "are working through an interagency process to determine the most appropriate public health standard for Yucca Mountain."

What is your view of the current interagency effort?

Mr. MESERVE. Senator Domenici, there is an interagency effort that is underway. The context for this was that, as Secretary Browner was leaving the EPA, she had a proposed final rule for Yucca Mountain that was submitted to OMB. With the new administration coming in there has been discussion between EPA and the Department of Energy and EPA and the NRC about issues associated with that proposal, and those discussions are still underway.

At this juncture, I personally do not have a sense as to exactly how it is going to turn out. We have articulated views, which I know you are familiar with, about the need for a groundwater standard, and about the appropriate all-pathways limit. The process of evaluating this matter is now underway in the executive branch.

Senator DOMENICI. Well, I wanted some kind of notion whether they were proceeding in a manner that might yield a conclusion,

or are we just standing at opposite sides of the room yelling at each other?

Mr. MESERVE. I would say that we certainly are not standing on opposite sides of the room yelling at each other. I don't want to suggest that there are no differences of views that are expressed in this context, but I think that there is an effort that is underway to try to find a satisfactory resolution. Whether that will be achieved or not, I think it is too early to say.

Senator DOMENICI. Okay. I want to make an observation regarding your funding and new regulatory aspects of your commission. You have the requests in to the appropriators through the budget, and you will be called upon for your needs as to dollars. We will try to take care of that in the appropriation bill. I think you know that.

Mr. MESERVE. Good. Thank you very much, Senator. We appreciate that.

Senator DOMENICI. My last question has to do with—first, before I do that, Ms. MacLean, you have been listening here, and you obviously are in the middle of nuclear energy and know a lot about it. Do you want to contribute here? I will give you a general question. From your knowledge and experience, what would you like to tell the Senate we ought to do about nuclear power to make it become a more realistic part of our energy future?

Ms. MACLEAN. I have been very encouraged over the past couple of years at the progress we have made in talking about nuclear. It has been an idea and a word that 6 years ago I would not have even considered the possibility of bringing new reactors to the market.

From my personal standpoint it would be an absolutely thrilling job to be a part of a team that brings new reactor technologies and new reactors of any kind to the market, and part of what is necessary is making it possible for companies that want to do that to be able to do it. At the same time, I think we are facing a serious shortage of students. I know that I have always been part of incredibly small departments, which is nice as a student, you get that personal feel, but being a graduating class of, I think, about eight people is not going to sustain industry, and part of what we need is research funding to get students into school and keep them in school. I know that the fellowship program I have been a recipient of, the DOE nuclear engineering fellowship, kept me in school. I am not sure I would have been here, had it not been for that fellowship.

But all of those things fit together, and funding fellowships without funding research does not get us anywhere. Funding research without supporting the industry will never attract students, so being able to support both verbally, by sending the message that we value the resource, and being able to shore up our funds again I think are both very important.

Senator DOMENICI. Thank you very much.

My last question, then I will yield to my friend from Idaho. For you, Mr. Rhodes, I, in introducing you, stated that you have written a lot of books that people have read, and that probably you have influenced them. In your travels you do sense a growing opti-

mism, I believe, for the re-birth of nuclear energy. I think you have told us that.

Could I say, some of the critics argue that we have other options as a Nation. They say that we can further improve energy conservation, and that renewables are poised to take over large-scale production of electricity. Based on your studies—I do not want to say are those accurate statements, but I do want to say, do you think that statement is realistic with reference to solving the energy future for Americans?

Mr. RHODES. Senator, I debated Amory Lovins recently in a conference in Washington about nuclear proliferation, so I have had recent experience with these arguments. Obviously, efficiency and conservation are important. Obviously, they are going to be more important as energy demand grows.

But we are adding a new California in terms of population to the United States every 10 years, and I seriously doubt if efficiency, as long as we want to live the way we live as Americans, is going to get us there. It seems clear to me that we have to move toward more capacity, more base load capacity in particular.

If you look at the numbers on the renewable systems that are already in place, they are really pretty discouraging in terms of capacity. The wind farm in Wisconsin that was built as a result of the desire by the nuclear power industry to build some dry cask storage had, I think, in one typical month about 13 percent capacity. These things are inherent in the problem of collecting energy from diverse sources, obviously, not to mention the hidden costs in developing the materials for those dispersed collection systems in terms of air pollution in the manufacturing of those materials.

So I think the answer to your question from my personal perspective is, clearly we need more base load capacity, and the only form of base load capacity that is really free of both pollutants and of greenhouse gases is nuclear power.

Let me just add to that. You know, the question of the linear no-threshold model is a very important one, as you well know, Senator. In a sense, it has become the tail that wags the dog. If it were understood that low-level radioactivity is essentially harmless, and I think there is good evidence that that is so, and may, indeed, even be beneficial, which is a more controversial discussion, the problem of disposing of spent fuel would suddenly be trivial. We have this problem because the standards that are being discussed are so very low, much, much lower than the natural diversity of radiation in our natural environment.

So settling, or at least renewing the debate scientifically about the linear no-threshold theory is a very important part of these future possible developments.

Senator DOMENICI. Thank you very much.

Senator Craig.

Senator CRAIG. A couple of questions, and I will not hold any of you here any longer.

First of all, I notice that you spent some time in Idaho at the INEEL.

Ms. MACLEAN. Yes, I have.

Senator CRAIG. I hope that was a meaningful experience for you.

Ms. MACLEAN. The people that I worked with through the lab have been great. We have had a lot of very positive interactions. One of the reasons I chose the project that I am working on, which is design of pebble bed reactor, is because of the involvement of the national labs. Because they were involved there were other scientists interested. It elevated its importance in my mind. It was not just somebody's pie-in-the-sky idea. It was an actual project that had serious interest from the Government and from the labs.

Senator CRAIG. Mr. McNeill, in your view—I am going to play off from what Heather has just said. How do DOE's national laboratories fit into the research picture for advanced nuclear design, and do you think the labs should be looking beyond technologies such as pebble bed to even more advanced concepts, so-called Generation 4 type designs?

Mr. MCNEILL. As you know, from a corporate interest, my interest is in making profit serving humanity in the selling of electricity, and I tend to look at the shorter-term ideas.

There is a place—in fact, I think we have had some discussions with DOE about the testing of fuel designs associated with the pebble bed reactor in the United States here. There has not been a great deal of testing of that, although there has been extensive testing in Germany, and Russia, and I think now some in China, and we have been exploring with DOE the possibility of doing some testing here in the United States in that field, so that is one immediate application with respect to U.S. research interest.

The second thing is, I do believe that in the longer term, as you move beyond these advanced designs that we are talking about here today that, given world energy needs, the longevity of energy consumption, there may, in fact, be needs for continued liquid metal reactor research, because they do offer some advances in terms of automated refueling processing using metallic fuels and things of that nature that offer almost a complete fuel cycle with the generation of only modest amounts of radioactive waste when we get done, so I do not want to discourage that. It is just that my near-term interests tend to be more commercial in nature.

Senator CRAIG. Well, of course, in the long term, to be able to not only use more of the energy source available, but to use it in a way that produces less of a waste stream has got to be part of what we look at.

Mr. Chairman, in your testimony, you discussed the role that research needs to play in laying the groundwork for licensing these advanced reactor designs such as the pebble bed. What role should the Office of Research within the NRC be playing in this process, and is the NRC's research staff involved in the future licensing project organization which you describe in your testimony?

Mr. MESERVE. We have recently had the benefit of an evaluation of research at the NRC and John Ahearne was a participant in that exercise. In a nutshell, the group as a whole saw that research was an essential ingredient to enable us to fulfill our mission in assuring safety, and in particular with regard to advanced reactors. Because of the fact that advanced reactors raise issues that are at the technical forefront, and that we need to understand, we have a group within our research organization that is very much involved in such matters.

In fact, the people from Exelon were in to visit with NRC this week, and had a meeting that was sponsored by our research organization, in order to discuss a variety of the issues associated in particular with the pebble bed reactor. Our research staff are very actively involved in this process, and it is essential that they be involved.

Senator DOMENICI. Senator, could I just indicate that I am going to leave, and you are in control. I want to thank all of you very much for your testimony and for your help.

Senator CRAIG. Yes, John.

Dr. AHEARNE. I just want to point out that just as DOE's research budget has shrank to close to disappearances, the NRC's research budget also went to a free fall and decline, and I think part of that was based upon when the decision was made that the NRC had to recover all of its cost from fees and licensees, it is difficult to justify the fundamental preparation research necessary, and I think that is the real issue.

Now, when you come in with basically a newer type design, such as the pebble bed—they ran into the same problems some years ago when the can-do people were interested in perhaps getting a review. The staff has to have time in advance to work through and develop the necessary review codes and analysis. That takes money.

Senator CRAIG. Yes.

Gentlemen, lady, thank you all very much for your testimony and your presence. I am excited, as I think most of us are, of an opportunity to produce some clean energy for our country. Thank you for coming.

The committee will stand adjourned.

[Whereupon, at 12:02 p.m., the hearing was adjourned.]

[Following is the answer of Chairman Meserve to a question from Senator Domenici:]

Question. Would you please provide for the record, the NRC views on needs for funding to develop a research basis in support of licensing requests for new technologies, including new reactor concepts. I've been concerned that the NRC, with its current reliance solely on user-generated fees, may have been forced to sacrifice this forward-looking component of your capabilities. And it's hard to justify such development from user fees when the requests have not come in yet.

Answer. The NRC's FY 2002 budget request includes some funds to evaluate new technologies as they apply to existing operating reactors. This includes funding for certain new technology applications, such as: 1) advanced fuel and cladding designs, 2) digital instrumentation and control systems, and advanced sensor equipment, 3) techniques for evaluating the condition of existing wiring systems and potential replacement wiring materials, 4) management of spent fuel, and 5) risk assessments of new technologies. This research is generally focused on near term applications. However, the NRC's FY 2002 budget does not include funding for more forward looking research in these areas or for other new technology applications.

Subsequent to submission of the NRC's FY 2002 budget request, considerable industry interest and activity has developed with respect to new reactor siting, new reactor concepts, and the new technologies upon which they are based. Since there was no indication of serious industry interest in new reactor licensing activities at the time our FY 2002 budget was developed, it does not include resources to develop a research basis to evaluate licensing requests for new reactor concepts and facility siting reviews. As described in response to question 2, the NRC's preliminary estimate of resources to review early site permit applications, conduct pre-application and license review activities, and begin to assess the advanced technologies being considered by industry is approximately $15-18 million. This includes approximately $12 million for research related to new reactor licensing activities.

These research resources would support the initial evaluation of new data and technology in the pre-application phase to understand the new designs and technology, and would allow the NRC to identify the needed infrastructure for evaluation of license applications as well as support the development of analytical tools and data, review guidance, and expertise to facilitate regulatory action.

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