No. S-18-92
Tel. 301-504-2240

THE FUTURE OF NUCLEAR TECHNOLOGY

COMMISSIONER FORREST J. REMICK
U.S. NUCLEAR REGULATORY COMMISSION

CEREMONY OF COMMEMORATION AND DEDICATION
PENN STATE BREAZEALE REACTOR
UNIVERSITY PARK, PENNSYLVANIA
MAY 29, 1992

Good afternoon, ladies and gentlemen. It truly is a pleasure for me to return to the Pennsylvania State University to participate in this commemoration and dedication ceremony. Amongst the pleasures of this return for me is that of seeing many friends and colleagues with whom I worked for many years at this fine institution. As I look back on my early years at the Breazeale Reactor, I see those years as some of the most technically interesting and satisfying of my professional career. The satisfaction came from being an integral part of an pioneering effort; however, of equal importance was working with such a fine group of people at a fine institution. In fact, my memories of my many years at Penn State in numerous capacities are dominated by my memories of working with fine, outstanding, dedicated, friendly people.

Bill Breazeale, the man for whom this facility is named, greatly influenced the direction of my professional life because it was he who stimulated me to learn about this new technology and thus to become a practicing nuclear engineer. In June 1971, at the Annual Meeting of the American Nuclear Society in Boston, I had the sad honor of giving the invited William H. Breazeale Memorial Lecture memorializing the many contributions that fine man made to nuclear engineering and to higher education. As one of his many accomplishments and public services, Bill was one of the seven original incorporators of the American Nuclear Society, as well as its first executive and elected secretary. He worked untiringly to arrange for the first meeting of the Society, which was held on 27-29 June 1955 at Penn State. His pioneering contributions to the American Nuclear Society and the fact that he is known as the "Father of Swimming Pool Reactors" makes it most appropriate that this ANS Nuclear Historic Landmark bears his name.

The Penn State Breazeale Reactor has played an historic national and international role in the use of the atom for the well-being of mankind. Literally thousands and thousands of undergraduate, graduate, continuing education and special students have utilized this the second licensed reactor facility in this country as part of their education, research or specialized training. Thousands upon thousands of students and members of the general public have seen their first nuclear reactor and learned of its instructional and research applications through visits to the facility. Innumerable lectures, papers, theses, and publications by diverse faculty, staff and students have resulted from its utilization.

As a Commissioner, I travel to meet with nuclear science and engineering officials and experts in many parts of the world. Earlier this year I visited Indonesia and, like Dr. Long, our earlier speaker, recently returned from a visit to Taiwan. In Indonesia, I met with, among others, Djali Ahimsa, Director General of the Indonesian Atomic Energy Agency. In 1957, Mr. Ahimsa was a student in the International School of Nuclear Science and Engineering (ISNSE) held at Penn State and was in my classes on reactor theory and reactor laboratory at that time. The Deputy Director General of the Indonesian Atomic Energy Agency, Iyos Subki, was trained as a reactor operator during his two years at this facility and received his M.S. Degree in Nuclear Engineering in 1965 under Dr. Kenney's tutelage. Mr. Subki's son is soon to apply for admission as a graduate student in Nuclear Engineering. As an interesting sidelight, the Director of Indonesia's new 30 Mw research reactor facility said while giving me a tour of their impressive facility - "Commissioner, Mr. Subki was your student and I was his student. Therefore, that must mean that I'm your grandstudent."

While I was in Taiwan, the Penn State Alumni Club of Taiwan hosted a dinner in my honor, and Penn State Nuclear Engineering graduates were invited to attend. One who attended was "Clem" Shen, who was trained in reactor operations at this facility and received his M.S. degree in Nuclear Engineering in 1964, under my supervision. Clem is considered to be the Father of the nuclear power program in Taiwan and was the organizer and first president of the Penn State Alumni Club of Taiwan. The current president of the Club, who is Vice Minister for Education, was selected as a recent Penn State Distinguished Alumnus by the College of Education, where he received his doctorate degree. The two oldest alumni in attendance at the dinner also were graduates of the 1957 class of the International School of Nuclear Science and Engineering at Penn State and attended my classes as well as those of one or two of my former colleagues in the audience. Perhaps that's why those colleagues appear to be getting older. As my father once told me, life not only begins at forty -- it begins to show.

I and others here could continue to recount these experiences of meeting distinguished graduates who benefitted from this facility and this fine institution. My point in sharing these recollections with you is that I'm afraid we little appreciate what an influence this facility has had and continues to have in the national, but also most definitely in the international, use of the peaceful atom. Also, I share these recollections with you as a tribute to the wisdom of such individuals as Eric Walker, Milton Eisenhower and Bill

Breazeale in foreseeing the value of such a facility in a university environment, as a tribute to the many others, such as Paugh Ebaugh, Bob Cochran, Clyde Whitman and Joe Ellsworth who helped in making the idea become a reality, and as a tribute to the many who have supported, maintained and operated the facility safely over the many years.

Let me now turn briefly to the subject I was asked to discuss -- "The Future of Nuclear Technology." I've heard it said that "civilization" is that state of society in which the only people who speak about the future with any degree of confidence are the fortunetellers. And even many fortune tellers are quitting the business. They claim the future isn't what it used to be.

However, at the risk of being a little uncivilized, I am going to try to give you a panoramic view of how at least the near future of nuclear technology is taking shape. I think you will find the view remarkable and full of promise. I will also hazard some proposals -- common sense ones I hope you'll agree -- on what industry, education, and government should be doing, and in an encouraging number of cases are doing, to prepare for that future.

First, let me cite some numbers which will give you a rough but accurate idea of how much nuclear technology is used right now, how well it is used, and what some of the short term trends are. As you listen to these numbers, reflect on the extent to which the promise of the Atomic Energy Act of near 40 years ago has been realized, and see how difficult it is to imagine a future without nuclear technology. As Pope John Paul II said, "Some things have to be believed to be seen."

In the United States alone, there are over 23,000 licenses issued for the use of nuclear technology and nuclear materials. 111 of these are for the operation of nuclear power plants in 33 states, a little over a fourth of all the nuclear power plants in the world. Seven states receive more than 50% of their electricity from nuclear power, and 18 states receive more than 25% of their electricity from nuclear. In 1991, nuclear power accounted for 21.7% of net electricity production in this country, and, though most people aren't aware of it, about 3,500 net megawatts electric of capacity is still under construction here. American nuclear power plants operated at roughly 69% of capacity in 1991. In three of the past four years American plants exceeded the highly touted French in that percentage. More than a third of the top capacity performers worldwide are American.

With numbers such as these, it's no surprise that President Bush and the Department of Energy believe that nuclear power is making a very great contribution to national wealth and security. They have therefore made the nuclear option part of the National Energy Strategy. Congress appears to agree and probably will soon vote out legislation containing the President's proposals for reactor development and reactor licensing reform.

The DOE is already cooperating with private enterprize in the development of advanced reactor designs, and the Nuclear Regulatory Commission has before it now eight future standard reactor designs in various stages of review. Over the next two and a half years, the NRC staff expects to reach final judgment on four of these designs, all of them of American or mostly American origin, and one of them is being developed right down the road, near Pittsburgh.

Of course, nuclear technology makes an even greater percentage contribution to electrical production in France, Germany, Japan, and other countries. Thirty-two countries around the world have operating nuclear power plants, and approximately half of these countries produce a higher percentage of their electricity from nuclear power than we do. Their governments are therefore also pursuing the nuclear option.

In fact, the American Nuclear Society's publication, Nuclear News, reports that there are, all told, 97 reactors on order or in some phase of construction around the world, and I know from discussions I have had this year in Taiwan and Indonesia that this number is very likely to go up in the next few years. American engineering figures prominently in a large number of these plants, in Japan, Taiwan, Mexico, and Korea, for instance.

The Nuclear Regulatory Commission is particularly pleased that measures of the safety performance of American plants also continue to show improvement. For example, the average number of safety-significant events at plants has dropped to a tenth of what it was a mere six years ago. Also, the collective radiation exposure to plant workers continues to decline and is now less than half what it was when the NRC began tracking this figure.

Another 46 NRC licenses are for the operation of nonpower reactors, including the reactor we are commemorating and dedicating today. These reactors perform invaluable research and education functions across a large segment of the academic spectrum, including physics, anthropology, forensic science, agriculture, chemistry, biology, medicine, and materials sciences. These reactors also provide a unique and irreplaceable training ground for the current and future manpower for the utilities, manufacturers, national defense, and the research and education segments of our society. I will have more to say in a moment about the contribution which reactors such as yours make.

The tens of thousands of other licenses for the use of nuclear materials in the United States are for medical, academic, and industrial uses of nuclear materials. There are about a thousand material licensees in Pennsylvania. Consider, for a moment, the medical uses of nuclear materials. There are more than 7 million clinical procedures using radioactive material performed annually for medical diagnosis and therapy. Speaking again out of the NRC's primary concern, safety, I note with pleasure that the error rate in these procedures is extraordinarily low, unmatched elsewhere in medicine, I believe.

Enough numbers. I've quoted them only to give you a sense of the magnitude, importance, and immediate future of the peaceful and safe uses of the atom. I hope that the numbers may also have dispelled any thought you may have had that nuclear technology was in decline or that there was no longer any progress being made in the technology. Some would like it that way: I believe it was Ogden Nash who said, "Progress might have been all right once, but it has gone on too long." I also hope that I have dispelled any thought you may have had that American leadership in nuclear engineering is a thing of the past.

However, these numbers will not just by themselves continue to increase where we want them to increase, and decrease where we want them to decrease. With all due respect for the role of Fortune in human affairs, I think that these number are, in large measure, our creatures, and that we have it in our power either to increase the benefits we derive from the peaceful atom, or to leave the promise of the Atomic Energy Act unfulfilled. In these last few minutes, then, let me make a few proposals, in the spirit of the thought that we make our future by the best use of the present.

The future of nuclear technology will be in large measure a reflection of how widely those of us who are associated with the technology realize three human virtues. These are the acquisition of knowledge, the spirit of cooperation, and the practice of professionalism.

First, the acquisition of knowledge: The knowledge which underlies nuclear technology is a vast and seamless web, encompassing and interrelating the core disciplines in engineering; much of modern physics, chemistry, mathematics, probability, and statistics; biology, medicine, and epidemiology; theory, experiment, and practice; finance, management, and training; and more. We must not stop looking for more knowledge, and we must not fail to make what use we can of what we find.

Consider for a moment our knowledge of nuclear reactors alone. Since the first commercial operation of nuclear power plants, in 1957, American plants alone have accumulated 1,604 reactor years of operation. We have learned much in that millennium and a half of operational years. That experience must be incorporated into the new designs, and it appears that the designers are doing just that.

But, as this audience well knows, experience is not the only source of wisdom. There must be that refined form of experience called scientific experimentation, and there must be theory, both to suggest what experiments to do, and to interpret the results of those experiments.

In this connection, consider reactors again. The NRC expects that the next generation of nuclear power plants will be significantly safer than the already existing, and already adequately safe, designs. The new designs will be simpler, more tolerant of human error, more easily maintained, and less dependent upon active human or mechanical intervention to maintain normal operation. But the increases in safety will not come about through the incorporation of operating experience and new design features alone. Some of the new technology in these designs will require much testing. This is particularly true of control room designs and the thermal-hydraulic behavior of some of the new design elements. In some cases, we may stand in need of new methods of analysis.

Second, consider cooperation. This virtue is, in practice, a necessity. So many disciplines are needed, no one person, no one discipline, no one group, can expect to go it alone. There is here nothing contrary to the independence of mind which innovation in science and technology requires, or to the intellectual and moral discipline which is necessary for accomplishment. To the contrary, the person who is well-grounded in a discipline but who looks, when need be, beyond the boundaries set for him by some narrow body of knowledge is also the person to whom new insights are most likely to come. By looking beyond the traditional boundaries of scholarly disciplines, organizational units, and nations, but with the focus only disciplined people are capable of, we are more likely to understand fully whatever problem we face, and more likely to find an optimal solution to it. It was my distinct pleasure, while working with the Intercollege Research Program at Penn State for 22 years, to see the benefits and strengths of interdisciplinary and international cooperation.

International cooperation is particularly important in nuclear technology. Just last month I spoke at the 8th Pacific Basin Nuclear Conference, held in Taipei, Taiwan. The theme of the Conference was "A High Technology without Border - Nuclear," and the first day of the conference was given over to addresses and discussions on ways to promote further international cooperation. Such cooperation is increasing, because every nation which uses nuclear technology knows that its actions have potential international impact.

Third and last, consider the virtue of professionalism. This is really several virtues in one. It includes, among other things, knowledge and the readiness to cooperate, but also vigorous training and retraining, significant attention to detail, self-recognition of, and pride in, one's own accomplishments, and the recognition that complacency about one's accomplishments is a sure road to failure. I could point to many, many signs of increased professionalism in the use of nuclear materials, but let me single out the small revolution which the American nuclear industry's own Institute for Nuclear Power Operation has brought about in less than a decade.

These three then -- knowledge, cooperation, and professionalism -- will have much more to say about the future of nuclear technology than I could say here today. They will speak volumes. They are what we strive for at the NRC, and they have helped us increase our analytical capabilities, increase our cooperative efforts with other governments around the world, reform our licensing processes, and search out ways to regulate that will encourage innovation and constant improvement in the use of nuclear technology.

But I talk about these virtues to this audience in particular because it is to reactor facilities such as this one, and universities such as this one, that we all look for much of the knowledge, and many of the finest examples of the spirits of cooperation and professionalism, which sustain the safe and beneficial uses of nuclear energy. To you we look for the fundamental theories and experiments which underlie the technology. To this facility, and others like it, we look for examples of how to weave together the disciplines and how to encourage men and women of many nations to work together toward common ends. And to you we look for the professionals who will help us develop, regulate, and use wisely this technology -- still new, still full of promise.

Again, it is a real pleasure to return to be with you today, and participate in this fitting commemoration and dedication ceremony.