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"Leaping into the Future: Time, Careers, and Research"

by

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Introduction

Good afternoon everyone.

Let me begin by thanking the faculty and student leaders for inviting me and hosting me this afternoon. Dan Caputo, your ANS Chapter President, has been great.

As a speaker you always try to find some way to connect with your audience. So when Dan asked me to speak with you, I thought it would be insightful to see what kinds of research you all were doing up here, and I asked my staff to give me a read on the hot research topics. So we reviewed Dan's presentation on his research entitled "Understanding Environmental Actinide Transport and Speciation Using Nuclear Magnetic Resonance (NMR) Imaging with a Lanthanide Probe." Wow. So when that did not work, I asked my staff to talk with some other MIT graduates at the NRC (we have several) to see if they could provide any insights. We could not find them-- you know how researchers work unusual hours. Finally, I just tried to find a picture of Dr. Apostolakis goofing off at an Advisory

Committee meeting and was told that never happens. Wow. Dr. Apostolakis - your staff is well trained.

I am delighted to be in Cambridge, at the Massachusetts Institute of Technology, on the eve of a remarkable event. For those of you that followed the Year 2000 transition closely you know that tomorrow we mark a special leap year. A special leap year, a leap year that occurs once every 400 years. Some of you may know that the rules for determining whether a year is a leap year were established by Pope Gregory XIII in 1582, when he modified the Julian Calendar. It was good to be the Pope. The rules are:

- Years divisible by four **are** leap years, unless...
- They are also divisible by 100, in which case they **are not** leap years, except.
- Years that are divisible by 400 **are** leap years.

While we no longer worry whether the sun will come up or the moon will fall from the sky, we are now concerned with whether power will stay on and planes will continue to fly. In some cases we have changed so dramatically in the last 400 years, yet are remarkably similar. We have just modernized our worries and given time the chance to outsmart us. So if you need to excuse yourself to gather water, dust off your Y2K emergency shelter or test run your generator, I will understand.

You may be surprised to know that the NRC and the Federal government are taking some extra precautions during the "leap day" transition. Federal agencies have staffed the Information Coordination Center (ICC) Operations Center and Joint Public Information Center (JPIC). These two centers were in operation during the Y2K transition. During the "leap day" period a small NRC response team will be available to provide reports to the ICC. Nuclear power plant status information will be obtained by the NRC Headquarters Operations Officer shortly after midnight local time. The Y2K Early Warning System (YEWS), an internet-based communication system, will be operational this evening and NRC plans to use this system to notify the nuclear industry of potential leap-day problems.

At a recent meeting between the Commissioners and the Advisory Committee on Reactor Safeguards, one esteemed member of the Committee, present with us today, remarked, and I quote, "[b]ut the intent, Commissioner, was not to solve the problem. It was to contribute to the debate." See if that approach works on your next exam.

So let me adopt a similar approach and, together, we can contribute to the debate on two important topics. Those topics are nuclear careers and the role of research in a changing regulatory environment.

CAREERS IN NUCLEAR ENGINEERING AND HEALTH PHYSICS

I resisted the temptation to give you the "We need you" speech. But we do need you and the nuclear industry needs you. You are the best and brightest and I believe that one day, in the not too distant future, there will be a resurgence**.** The nuclear industry will grow and your skills and knowledge will be in high demand. That day may be today. Acquisitions and mergers are occurring at a record pace and Wall Street and foreign investors are more bullish on nuclear power investment opportunities.

Annually, NRC and DOE contract with the Oak Ridge Institute for Science and Education to prepare labor market trends for nuclear engineers and health physicists. The latest report, dated October 1999, provides some important insights that I would like to share with you.

First for Nuclear Engineers, the current labor market in terms of job opportunities for new nuclear engineering graduates continues to improve substantially since the mid-1990s. Starting salaries for nuclear engineers in the nuclear energy/nuclear weapons fields increased 6.6% for B.S. level graduates, 5.2% for M.S. level graduates, and 5.8% for Ph.D. level graduates between 1998 and 1999.

These are the largest increases reported during the 1990s. Moreover, the increases in starting salaries between 1997 and 1998 for B.S. and M.S. level graduates (3.6% and 4.6%, respectively) were also larger than any increases experienced since 1991. The improvement in job opportunities for nuclear engineering graduates resulted from a combination of two primary factors and one secondary factor. The primary factors were:

- The number of nuclear engineering degrees earned annually decreased by over 45% between 1995 and 1998 and
- Nuclear engineering majors are finding many job opportunities outside of the "traditional" nuclear energy/nuclear weapons fields.

Information provided by a limited number of university academic departments indicate that as many as 50% of their graduates are currently obtaining employment outside of the traditional nuclear energy/nuclear weapons fields either as nuclear engineers or in related occupational categories. Some new nuclear engineering positions are occurring in the nuclear energy/nuclear weapons fields due to growth and, as attrition occurs, more of the vacated positions are being replaced rather than left empty. Part of the growth has been in the DOE laboratories, especially in weapons laboratories. Based on data from a sample of utilities, employment of nuclear engineers in nuclear electric utilities has also increased slightly and some replacement hiring is occurring.

For health physicists, the total number of health physics degrees earned in 1999 was 215. The number of degrees earned in 1999 represented a decrease of over one-third in just two years. Health physics enrollments also decreased in a similar manner.

In addition, the employment of health physicists appears to have stabilized or to be decreasing very slowly. Thus, after several years of somewhat excess supply of new graduates, the demand for and supply of new graduates now appears to be fairly balanced. As a result, we saw a jump in the percentage increase in entry level salaries in 1999.

Projections of employment trends, job openings, and the supply of new graduates through 2005, indicates that the relative number of job openings available for new graduates should continue to increase as the employment level stabilizes. At the same time, the decreases in enrollments experienced during the 1997 to 1998 academic years should result in four-year or two-year college graduates with a wide variety of majors, and provided the training for them to become radiation protection technicians.

CHANGING REGULATORY ENVIRONMENT

Now for the good stuff. But, before I continue I need to first describe the NRC's regulatory environment to provide the context for my views of research in the future. In the last few years, the NRC has been transforming itself, with sweeping changes to many of our regulatory functions. Why are we doing this? We are doing it because the industry's environment is changing, and we must change with it if we are to carry out our mission effectively. We have taken a hard look -- helped by input from our stakeholders -- at the way we are doing business, and we have embarked on a path to change and to improve our regulatory programs. We are seeking greater efficiencies and effectiveness in our processes, and trying to eliminate unnecessary regulatory burdens where they may exist. At the same time, we are continuing to maintain safety and public confidence. This is no small undertaking, and I can tell you that the NRC staff and the Commission have devoted a great deal of time and energy to accomplish it.

The U.S. nuclear industry has accumulated a great deal of operating experience. The issues that we are dealing with today are more likely to be variations on issues that we are familiar with, rather than the new licensing issues that were present when we were forming our regulatory framework. For the near future, the issues of concern are those associated with aging, renewal of expiring licenses, and decommissioning. Although we have certified several advanced reactor designs, and stand ready to license new power reactor facilities, no orders are projected in the foreseeable future.

As a result of industry restructuring, several difficult issues have emerged. For example, cost-cutting measures and reduced staffing must be done in a manner that maintains safety; the availability of funds for decommissioning must be ensured when companies consolidate or split; the extent of foreign ownership must be considered on purchases to ensure the nation's security is protected; the extent of control by non-owner or contract operators of nuclear power plants must be evaluated to determine compliance with licensing requirement. Moreover, increased numbers of independent system operators supplying power to the North American grid can affect the reliability of offsite power supplies and increase the importance of emergency diesel generators.

NRC INITIATIVES IN RESPONSE TO THE ENVIRONMENT

In response to the changing environment, we started several initiatives. First, we have just launched a pilot version of our new power reactor oversight program. The new program offers sweeping changes to our inspection, assessment, and enforcement processes. We received feedback from our stakeholders that our processes were too subjective, difficult to understand, and therefore not predictable. In addition, our processes did not adequately recognize the improving performance of the nuclear industry as a whole. The new framework is designed to address these issues. We have worked closely with industry and our stakeholders to develop a concept of "cornerstones"-- key areas of licensee performance that must be monitored to ensure that unacceptable public risks do not arise from nuclear reactor operations. We utilized the results of our ongoing research in measures of performance to develop quantitative performance indicators in each of these cornerstones. This will allow both licensees and the NRC to more easily identify areas that need attention, and to focus our resources accordingly. We began testing this pilot program at nine sites in June of this year, and we are cautiously optimistic that the program will be able to be implemented for the entire industry in April 2000.

Another focus area for the NRC has been the renewal of licenses for our older plants, and I am very pleased to report to you on the progress that we have made. We have aggressively worked through literally hundreds of technical issues on the first two applications by Calvert Cliffs and Oconee

nuclear power plants, and the projected time to review a license has been reduced from over five years to about 24 months. The staff developed a technical basis for the reviews through research on aging issues, then reached regulatory resolution on the issues by working closely with industry. It really is a good example of firm, fair regulation, while considering stakeholder concerns.

You may have heard a good deal about "risk-informing" our regulations, but you may not be too sure what that means. In general terms, it represents a philosophy whereby risk insights are considered, along with other factors, to establish requirements that better focus attention on issues commensurate with their importance to public health and safety. Looking back, our regulatory framework was established years ago using experience, testing programs, engineering margins, and a philosophy of defense-in-depth, but without the benefit of quantitative estimates of risk. That framework has served our nation quite well for many years, and we don't expect to throw it out and start over. Rather, we are researching the technical basis for our current regulations, with an objective of reducing unnecessary conservation where appropriate and possibly identifying areas with insufficient conservatism. Is this easy? Absolutely not! But that doesn't mean we should not do it. I expect that we will approach this very carefully, and as our methods of analyzing risk improves, we will continue to refine our approach. The U.S. has taken a leadership role in this area, and I can tell you that the rest of the world is watching to see what we will come up with.

As I mentioned, decommissioning appears to be a growth area. We all recognize that our nuclear facilities are aging. Those that cannot demonstrate their value or are not economical will be shut down and decommissioned. We have recognized that there may be inefficiencies in our current regulatory framework, since we hold our decommissioned facilities bound by regulations that were designed primarily for operating facilities. As a result, in the power reactor area, the NRC is taking a formal look at our whole approach to decommissioning to see if we need to create a new regulatory framework, and to see if we can focus on the areas of greatest risk. Research is contributing by examining various analytical tools and studying the viability of possible approaches to decommissioning, such as entombment.

In developing these initiatives, the Commission has actively worked with our stakeholders to implement new processes that are commensurate with increased regulatory insights, improved industry performance, and continuing advancements in risk assessment methodology. I believe that we have demonstrated the willingness to re-examine our existing programs in a fundamental manner. However, this does not mean we are bowing to industry complaints and political pressures! In all of our efforts, we have not lost sight of our focus on the most safety significant aspects of facilities. We will not promise that our efforts will satisfy all of our stakeholders. However, we are committed to considering all inputs in making our regulatory decisions, and we strive to ensure that our stakeholders understand how we arrived at our decisions. My experience is that even if our stakeholders don't always agree with our decisions, if the process is understood, then their confidence in the NRC is enhanced. At the end of the day, we believe that what we are doing will both ensure safety and provide stability, clarity, and predictability to our regulatory processes. The key to ensuring this happens is having a solid technical basis for our decisions, a basis that is established by our research program.

NRC RESEARCH YESTERDAY AND TODAY

How should research continue to support our initiatives? To address this question, I will provide some historical perspective on our research program. The NRC has funded research on nuclear

issues for all of its existence, but not always at the same level. In the early 1980's, the NRC's budget for the Office of Research peaked at over $200 million. At the time, this research supported the development of the technical basis for many broad areas, including Three Mile Island items, severe accident phenomena, formulation of the NRC's Safety Goal and Severe Accident Policies, and modeling of thermal-hydraulic behavior. Many of these endeavors required the use of large scale experimental facilities. Subsequently, the focus of research shifted to issues such as the development and application of risk methods, revising the source term, aging research, and support of advanced reactor design reviews and certifications. However, this research has been less resource-intensive, and with no new plants being ordered in this country over the last two decades, the funding for research has gradually declined.

Today, as I look at where we are, I see that our research program still spans a wide variety of relevant technical issues. We categorize our research into two broad areas. The first is what we call Confirmatory Research, and it constitutes perhaps 80-90% of our budget. This area supports user needs requests from our front-line regulatory offices, and therefore focuses on current safety issues. This purpose of this type of research can generally be described as to remove unnecessary conservatism in our regulations and to provide assurance that our regulatory judgements are valid. Examples of this in the reactor area includes risk-informing our regulations in 10 CFR Part 50, independently reviewing industry operating experience, ongoing research into structural and geological engineering issues, and radionuclide transport and health effects.

A second area of NRC research is called Anticipatory Research, and it constitutes the remaining 10-20% of our research budget. The purpose of this type of research is to anticipate future needs, and to provide the technical basis to support future regulatory actions for emerging safety issues. Examples of this type of research include addressing PRA limitations as the NRC transitions to a risk-informed regulatory process, development of risk-based performance indicators, assessing links between performance and plant safety, and deregulation and its impact on plant safety.

From a program perspective, I believe that we are focusing our research in appropriate areas, and we are anticipating our future needs. From a resource perspective, we are operating with a FY2000 budget for research of around $40 million. We are actively pursuing opportunities to leverage our research funds through cooperative efforts. We are prioritizing our research activities in consideration of risk, uncertainties, and future challenges. And yet, I feel that we can do more, and I will elaborate on that in just a minute.

RESEARCH IN THE NEW MILLENNIUM

What is a vision for research for the new millennium? The challenge in answering this question is to be able to successfully project yourself into the future based on trends today. Of course, if I could do that consistently, my stock portfolio would be much healthier than it is, so you must treat any predictions with that fact in mind. Nonetheless, I shall attempt this rather lofty goal.

For trends, I think the industry is maturing and will focus on optimizing their current plant configurations rather than developing new and innovative designs. I also think that industry consolidation will continue, thereby reducing the number of utilities as well as the number of companies supporting the utilities. In addition, commercially available parts and hardware may be used more often rather than parts with a long Quality Assurance pedigree. Finally, the use of computers for modeling in lieu of actual experimentation will likely increase.

The NRC has already taken action to address some of the trends, and these are the new NRC initiatives that I had previously described to you. But these are just the start. New technology, such as advanced instrumentation and controls, can certainly have an impact on plant safety. For example, advancement in computers and information technology are coming at a rapid pace today, but research is needed on the reliability of this technology before it can be widely applied to nuclear power plants.

Advancements in fuel design and materials are an emerging area, particularly the use of high burnup and mixed oxide fuels. In addition, although the NRC is nearing a decision on issuance of the first renewals of licenses, research into aging and associated materials research will continue. Finally, risk-informing our regulations will require research to establish a sound basis in both technical issues and probabilistic risk assessment (PRA) techniques. I must also briefly mention high-level nuclear waste disposal, which remains a difficult problem that will only be resolved with continued research. Let me say that the Commission remains firmly convinced that a permanent geologic repository is the appropriate mechanism for the U.S. to ultimately manage spent fuel and other high-level radioactive waste. We are continuing to develop a Yucca Mountain review plan and to resolve key technical issues to prepare for reviewing a DOE license application for Yucca Mountain, should that occur. If a decision is made to submit a license application for Yucca Mountain, it is expected in 2002.

Earlier I said that I would elaborate on ways I thought we could continue to improve our research processes. I believe that we must reassess the way we do our research, just like we have done in other regulatory areas. Let me say at the outset that I believe in the value of research, and believe that the budget for it should be maintained as a minimum, and perhaps should even be increased. As a regulatory agency, we must preserve our independence and maintain a broad perspective to fulfill our mission of maintaining safety. Nonetheless, I also recognize that the environment is changing, and we do not have the ability to conduct extensive exploratory research. Long term research has a place, but many things today do not lend themselves to that. Instead, we must develop feedback mechanisms so that our programs can be continuously examined to ensure that the research is relevant. We must develop and refine our prioritization processes to ensure that our resources are being focused on the most significant issues. We must ensure that our research is linked to the needs of our stakeholders. In other words, our research programs must have a certain agility to respond to the environment.

Our research programs must be timely and responsive to both internal and external stakeholders. Too many times I have seen a well-thought out and well-executed research project completed, but not really used because it was either not timely or not responsive to user needs, or both. I recognize that high quality research takes time, so the challenge is to focus our available resources in a way that ensures a quality product in a timely manner. In addition, we must emphasize delivering products that contain recommendations for applicability. Again, I cannot tell you how many fine two-inch thick research projects I have seen that do not provide relevant recommendations and leave it up to the reader to figure out how the research should be applied. One way to improve our programs is to adopt the approach the NRC has learned in responding to the changing environment: listening carefully to its stakeholders. We recognize that our stakeholders have very valuable insights, and we have also found that they are not bashful about volunteering them! These insights can be used to help focus our resources and to shape our efforts in the future.

My vision of the NRC Office of Research in the new millennium would be a center of excellence and source of expertise. This center would maintain a cadre of reactor safety specialists in various key areas, with independent and unbiased expertise across a broad spectrum of advanced

nuclear technology, to provide the technical basis for robust and transparent regulatory decisions. Experimental facilities and resources would be maintained to ensure our ability to respond in a timely manner to new or emerging issues. The Office would complement the front-line regulatory activities of the agency and independently examine evolving technology and anticipated issues.

Finally, new and creative approaches to research will increasingly be used. Partnerships with industry, foreign organizations, and other government agencies will become more common. Our joint research with the European Union, and the recent Memorandum of Understanding with DOE on Cooperative Nuclear Safety Research are good examples of this. As the costs of large-scale experimentation rise, we will have an increased need to leverage the work of others, even while maintaining our necessary independence on regulatory matters.

So thank you for you patience and attention and I would be pleased to answer any questions.