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ENGINEERING'S ROLE IN DEVELOPING SOUND POLICY DECISIONS THE FIRST TIME

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PRESENTED AT THE ANS
EXECUTIVE CONFERENCE ON ENGINEERING EXCELLENCE:
ENGINEERING'S ROLE IN PROVIDING TECHNICALLY
EXCELLENT PRODUCTS IN A COST-EFFICIENT MANNER
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Introduction

Good morning, ladies and gentlemen. It's been a pleasure for me to be able to participate in this "Executive Conference on Engineering Excellence: Engineering's Role in Providing Technically Excellent Products in a Cost-Efficient Manner."

My goal today is to describe, from a regulator's point of view, the importance of engineering excellence in what we do. Thirteen years ago excellence meant revising a large part of the body of our regulations and procedures to prevent and mitigate severe accidents. Today, it means revising other regulations and procedures to prepare to renew operating licenses and approve advanced reactor designs. And although cost-efficiency considerations may come into play, making sound, well-thought out policy decisions the first time is a necessity for us, for you, and for the public.

You've been covering a lot of ground in your discussions of engineering excellence over the last two days. One conclusion I arrive at is that engineering excellence encompasses a lot of other terms and attributes. To me, engineering excellence encompasses as components technical and analytical knowledge, competence, ability, skill and capability; it encompasses training, experience, judgment, decisionmaking and professionalism. In my discussion today, I will use these various component terms and attributes

somewhat interchangeably for the broader concept of engineering excellence.

During my term as an NRC Commissioner, which is soon coming to an end, I have tried particularly hard to ensure that the NRC continues to uphold its reputation as an agency with one of the most technically and analytically competent staffs in Washington, and as an agency whose policies are solidly based on scientific and technical knowledge and experience. The NRC is very fortunate to have the cooperative relationship it does have with the industry it regulates. I truly believe that the public has been able to benefit in many ways because of the level of engineering excellence in the NRC and the industry, and because of the productiveness of our efforts to benefit from our combined knowledge and experience.

Engineering Excellence and Technical Competence

We all appreciate the general public's concern about the safety of the peaceful uses of nuclear energy. The accidents at Three Mile Island and at Chernobyl heightened the public's concern about nuclear technology. How should utilities, reactor vendors, and the NRC deal with such emotionally and politically charged concerns? The only way I know of is by capturing the public's trust in the competence of the people who design and operate the nuclear facilities and in those who regulate them.

The design, construction, operation and regulation of nuclear power plants require knowledgeable, trained, skilled and experienced people. They require people capable of knowing, interpreting and applying relevant knowledge in varied technical fields. They require people with diverse technical talents including those with great depth of knowledge and expertise in narrow technical areas; excellence requires those with knowledge based on broad experience who can make sound technical decisions based on the receipt of a variety of technical inputs, and it requires those who can carry out more routine activities in a competent and reliable manner. Important attributes of all of those who contribute to the endeavor are the ability and the willingness to convey their knowledge, findings or work product in a logical and concise manner, understandable to others. I am one who believes that conciseness and brevity are virtues. As written in Ecclesiastes 32:17, "Let thy speech be short, comprehending much in few words." All too many of us condense a one page brief into a ten page epistle. Talking or writing that is too long is generally the result of thinking that is too short. My father once told me that the best recipe for good communication is to add shortening.

Engineering excellence is essential to the future of nuclear energy in this country and abroad. But engineering excellence is only one part of the equation. Competent, capable, employees of many professions and skills working together for common purposes are necessary for continued success. Let me comment briefly on what

you can hope for from your employees and from changes in your organization as you continue to pursue excellence.
Richard Feynman, the great American physicist and Nobel Laureate, tells the following tale about working at Los Alamos on the Manhattan Project. At one point, he supervised a group of high school students who had to do the involved calculations necessary to predict the energy that would be released by the implosion bomb. For security reasons, the students were given just the numbers and told what calculations to do. But they were not told what the numbers measured, nor what Los Alamos was up to. Despite Feynman's supervision, the work went slowly.

Then Feynman got the bright idea of letting the students know what they were doing! With Oppenheimer's help, Feynman persuaded the military authorities to let the students in on the secret. The effect was explosive (no pun intended). Once they knew what the numbers meant, and why anyone was interested in them, the students ceased to need much supervision and on their own began finding better ways to calculate. Soon problems were getting solved at the rate of about three every month, instead of one every three months.

I can't promise you that telling people what they're doing will always unleash their productivity. But, my experience as an operator and trainer of operators taught me long ago that a well-informed employee can do a lot for you. For example, employees should not just memorize facts. They would be encouraged and trained to ask why certain techniques or procedures are followed. If one understands the how and the why, they'll know more of the what. Then they'll be better equipped to personally contribute to the continual improvement of the overall effort. It's true, a utility can't inspire employees by telling them that they're working on a bomb to end a war, but I have met both young and old trainees who had transferred from fossil-fueled plants who were extremely enthusiastic about the challenge of learning a new technology, and who later were very pleased by what they had learned during their training. You're not managing well if you don't capitalize on this enthusiasm and potential energy; you're missing out on the safety and more reliable operation these employees can help you achieve, and you will not benefit from the contributions to excellence these employees can make.

The essential lesson in Feynman's story and in my experience with training is that there must be communication and cooperation among different disciplines, different ranks of employees, and different offices of an organization. Not that everybody has to do everything, but people should have the big picture in mind and share with each other what they know. In this way, they will achieve a more panoramic view of shared problems, and develop more optimal solutions than could be developed by individuals, disciplines, or ranks working in isolation.

We now have new names for such concepts, such as employee empowerment, but I call it good old-fashioned common sense.

Engineering Excellence in Industry

The importance of engineering excellence in the nuclear industry has never been more dramatically demonstrated than during and following the 1979 accident at Three Mile Island. During the accident, the reactor operators were faced with plant conditions with which they were not prepared to cope.

One of the lessons learned from the accident was that there was a need to increase the technical expertise readily available to assist the reactor operators during an accident. This need has been met, in part, by establishing a technical support center closer to the control room; by expanding the operating procedures to include severe accident conditions, thereby minimizing reliance on engineering assistance; by developing accident management procedures; by reviewing and minimizing plant vulnerabilities to severe accidents; and by strengthening the training of the reactor operators and other plant personnel.

The industry responded in other ways also to the lessons of TMI. The formation of INPO, the Institute of Nuclear Power Operations, has had dramatic effects on the safe and professional operation of nuclear power reactors in the U.S., because through INPO utilities help one another in improving and seeking excellence in the operation of their plants. The initiative of training program accreditation, the establishment of the National Academy of Nuclear Training and the emphasis on professionalism have contributed immensely to the goal of excellence set by the industry.

The formation and growing importance of WANO, the World Association of Nuclear Operators, is in essence a world-wide extension of INPO wherein utilities in one country help, assist and learn from sister utilities in other countries, transcending the restriction of political, geographical or government agency boundaries. The importance of this effort to excellence is immeasurable, especially to utility personnel in countries with single nuclear plants and in countries shut off from open communications with the rest of the world.

The formation and development of NUMARC, the Nuclear Management and Resources Council, in the United States has led to a highly productive exchange of views between the NRC and the nuclear power industry on regulatory matters. No one individual and no one organization, be it regulatory or industry, has the knowledge or the smarts to know the best answer to the myriad of technical issues that arise from time to time. But an open exchange of views, with mutual respect for one another's role and responsibility, frequently leads to solutions which more readily satisfy the requirements of the issue at hand.

It is apparent that industry's efforts towards excellence through the training of plant personnel has benefitted the public image of

nuclear power plant operators. In a recent public poll conducted by Bruskin/Goldring for the USCEA it was found that:

> Operators were described as "intelligent," "competent," "well-educated" and "well-trained."
>
> They possess the personal qualities needed to perform "difficult" and "dangerous" work.
>
> Plant operators were judged to be more highly educated than airline pilots, and were rated similarly high in terms of training, conscientiousness and trustworthiness.

As many of you are aware, the NRC is in the process of reviewing the next generation of nuclear power plants. These power plants are categorized as Advanced Light Water Reactors, and are improved versions of the newest currently operating reactors. They include the Advanced Boiling Water Reactor (ABWR), submitted by the General Electric Company; the System 80+, submitted by ABB-Combustion Engineering; the Advanced Passive 600 MWe (AP600), submitted by Westinghouse; and the Simplified Boiling Water Reactor (SBWR), submitted by General Electric.

The industry is to be commended for innovation in its pursuit of the design and certification of the advanced nuclear power plants. For the first time in its history, and through the leadership of the Nuclear Power Oversight Committee, the industry structured a common course of action on the next generation of reactors. The industry plans to have advanced reactors operating around the year 2000. To achieve this objective, the industry, through EPRI, developed a consortium of international experts and reactor owners to establish standards and requirements for the next generation of nuclear power plants. These standards are brought together in the Utility's Requirements Document.

The reviews the NRC conducted in support of the advanced reactors did not begin without some difficulties. After a decade in which the NRC received no applications for new reactor licenses and concentrated instead on operating reactor reviews and inspections, the NRC was not prepared to meet the challenge of reviewing new reactor designs. In 1990, the NRC allocated approximately 18 full time equivalent reviewers per year on these programs. Today, the number is around 367 full time equivalent reviewers per year as we have rediscovered what it takes to perform competent safety reviews.

There is no question that the reviewers have been challenged. They have had to familiarize themselves with, and develop new processes for reviewing, power plant designs submitted for design certification. No longer can they walk through the plant and inspect it. No longer can they pass off resolution of generic safety issues to the future. The reviewers have to review a design as they never had to in the past. All the safety issues have to be

resolved prior to design certification and prior to the plant's being constructed. The reviewers have to close severe accident issues which they never had to consider in the past, and consider insights gained from probabilistic safety analyses. They know that, except for a quite limited opportunity to backfit, they only have one shot at the design, that they are not going to rubber stamp any submittal, and that they must do it right the first time.

The industry also has been surprised at the level of detail its submittals had to provide and the quality of the product required. The task of certifying a nuclear power plant under Part 52 has been greater than anyone had expected. The lessons are clear. Detailed submittals of high quality, and detailed reviews of high quality are required. Those lessons are still being learned. Not everyone has learned yet that it should be done right the first time.

New policies were required to address the unknowns surrounding the design certification process. Definition of the level of detail required for design certification was a major issue. The industry had never defined the inspections, tests, analyses and acceptance criteria (ITAACs) for a nuclear power plant prior to its construction. The industry has not had to develop design acceptance criteria for technologies which change on a frequent basis.

Industry's and NRC's efforts to justify and review the safety of the next generation of nuclear power plants constitute a current example of the importance of engineering excellence. Both the industry and the NRC staff are finding the road bumpy, but both see the light at the end of the tunnel.

Technical competence and cooperative understanding will be necessary also for the successful and effective implementation of the license renewal process. Successful implementation of the process will result from a combination of generating and utilizing the best information we can from ongoing aging research programs, ensuring that licensee programs for monitoring, maintenance, replacement and refurbishment are well developed and comprehensive, and taking care to craft regulatory guidance that recognizes and gives proper credit to the effective programs in place to mitigate the effects of aging.

The NRC and industry held a workshop on license renewal on September 30, 1993, in order discuss what progress has been made in determining how best to do all the things I just enumerated. We expect to receive a report from the staff and any suggested changes the staff suggests to the current rule in December of this year [the report is SECY-93-331, December 7, 1993.]

Engineering Excellence in the Regulatory Body

Whether one likes it or not, the regulatory presence around the world probably will continue to grow. For one thing, regulation of

the safety of nuclear power is politically necessary -- the public will demand it for safety reasons. For another, regulation of the safety of any large engineering project, whether by government or by private bodies, is economically necessary. Buyers want to know the worth of their purchase, owners the value of their assets and liabilities, and insurers their risks. These people will ask questions, set standards, and demand performance.

But more important, regulation satisfies a technical need. A concern for safety is at the very heart of large engineering projects like nuclear power plants, bridges, airplanes, and the like, because failure in the engineering of these projects can spell disaster for public safety. In these projects, regulators, whether governmental or private, can provide some of the independent judgement to which any major technical effort needs to be subjected. Of course, a regulator can provide that independent judgement only if the regulator has the necessary scientific and engineering capabilities.

Now that the expert working groups on an international nuclear safety convention are concluding their work in Vienna and formal negotiations on the convention are about to begin, it is apparent that there is a near consensus internationally that the nuclear safety regulator must be independent. A capable regulator with no power is useless. However, this independence is more a matter of competence than of law. The United States Atomic Energy Act declares that the Commissioners of the Nuclear Regulatory Commission shall serve for fixed terms rather than at the pleasure of the President, but this framework is neither necessary, nor even sufficient, for independence in a regulator. As the late U.S. Supreme Court Justice Felix Frankfurter said of the Interstate Commerce Commission, which is one of the oldest U.S. agencies headed by officers who do not serve at the pleasure of the President, "Independence must be asserted, it cannot be conferred, it cannot be granted."

However, assertiveness should be based on knowledge and competence. Whatever the legal structure of the regulatory body, its independence will always be threatened unless it has capabilities which command respect. And this is as it should be, because an independent regulator with no capability is dangerous. The regulatory body must have the freedom to act according the dictates of well-informed technical judgement, but one way the regulator can acquire the necessary freedom is to exercise well-informed technical judgment.

Independence, and the sound technical judgment on which it rests, encourage two other virtues which contribute to safety. One of these is stability. Sound technical judgment relies in part on the often harsh lessons of experience, especially the engineering failures which are part of that experience, and from which we often learn more than we do from our successes. A regulatory body which attends to the lessons of experience is often less likely to change

policy radically. For instance, the independent regulator will insist that the industry not neglect the lessons of experience. The regulator will thus reduce the need for backfitting, which is a great source of instability.

Another virtue which independent technical judgment in a regulator encourages is respect for the knowledge, competence and innovative power of the nuclear industry. Professionals respect the accomplishments and capabilities of their fellow professionals, but they also respect the limits of their own capabilities. Professionals in regulatory agencies are therefore likely to know that, although in carrying out their responsibilities they can make a great contribution to safety in design and operation, the greatest and most far-reaching innovations are likely to come from their colleagues in industry. Regulators must be ready to make room for innovations. If we have the necessary technical capabilities, we are more likely to have the confidence to make an independent assessment of the value of innovations. If we insist on the old things because we don't know what to make of the new ones, we will cut off one source of increased safety.

Although it may seem paradoxical, along with increasingly independent regulation, there is also a trend toward greater self-management by the industry. An independent, capable regulator is not enough for excellence in the nuclear industry. The ultimate responsibility for safety rests with the operators of plants and their emphasis on excellence in all that they do.

Generally speaking, I support a regulatory approach which stimulates licensees' and industry's initiatives, encourages innovation, permits self-management and produces positive results, under agency monitoring, in contrast to prescriptive, process-oriented regulation which requires rote adherence, stifles initiatives, and depends on punitive enforcement actions for compliance.

As I've said on a number of occasions, the kind of excellence everyone wants there to be in the nuclear industry cannot be choreographed from the outside. The NRC cannot prescribe the industry's every move without the industry ceasing to be the self-disciplined and innovative group of professionals who can shoulder the ultimate responsibility for safety.
Some members of the public may be comforted by the thought of a regulator which tells the industry exactly what to do and how to do it, and cracks the whip to make sure it gets done. But we don't want an industry run by slaves. Safety requires that the men and women who design, build, or operate nuclear power plants be independent-minded and capable, especially capable of setting high goals, goals of excellence, and of finding ways to meet those goals, with each other's help. The great improvement in the nuclear industry in the United States over the past 10 years is, in a very large part, the work of just such people, and there will be no further improvement without such people.

Conclusions

In conclusion, it is a pleasure to have been invited to speak to you today on a subject of considerable importance and interest to me both as an engineering professional, and as a person interested in the future of the safe use of nuclear power as a viable energy option for this great country and elsewhere in the world. Engineering excellence in all that we do, both on the part of those in industry and those in government, is a requisite to what we jointly seek to achieve. Engineering excellence encompasses a number of component attributes, all of which must be addressed and honed to the best of our ability. And as a regulator, I think that engineering excellence is what enables us to make good policy decisions the first time. We can't afford to make a mistake - on license renewal, design certification, or anything else. And working together to openly share our knowledge, experience, concerns and solutions, while respecting our individual roles, authorities and responsibility, will enable us to reach our mutual goal of excellence in all that we do.

Thank you for your attention.