NRC NEWS

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Contributions of Structural Mechanics to the Science of Nuclear Regulation
Dr. Peter B. Lyons, Commissioner
U.S. Nuclear Regulatory Commission

at the
19th International Conference on Structural Mechanics
in Reactor Technology

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It is an honor to speak to you during the 19th International Conference on Structural Mechanics in Reactor Technology (SMiRT-19). I am extremely pleased to share my perspectives on the role of this conference in the renewed global interest in nuclear energy and to discuss some of the U.S. Nuclear Regulatory Commission's (NRC) future challenges. I especially want to recognize the efforts of Vernon Matzen, conference chairman, and his committee in the planning and execution of this conference.

SMiRT-19 is taking place at a time of significant change in the global outlook of the industry. The technical issues related to design, manufacturing, and construction are becoming more important, similar to the situation in the early 1970s. These conferences, which bring together the world's experts from the structural mechanics community who are involved in the design, construction, and operational phases of nuclear power, have a significant role to play in readiness of this industry and its regulators.

The need for global cooperation on nuclear safety is an urgent matter, because nuclear energy can no longer be regarded as a strictly domestic matter for any individual country. Nuclear power is now a truly international industry, from the mining of the uranium ore, through nearly all the following steps of the fuel cycle. Furthermore, the regulatory and industrial infrastructures are now very different from those of the early 1970s, including the use of new materials, new construction and fabrication methods, and the associated new structural mechanics challenges.

Based on lessons from our past licensing and regulatory experiences, we have a new, improved, licensing process. The combination of the standardized design certification, early site permit, and combined construction and operating license has contributed significantly to the interest in and feasibility of new nuclear projects in the United States. The NRC is continuing to improve our licensing regulations. Recent changes to our Part 52 regulations will further enhance our effectiveness and efficiency.

The new regulatory scheme has undergone its first tests, with the review of early site permits at four locations. We have issued early site permits for Clinton and Grand Gulf, and are working on an early site permit for North Anna. Four reactor designs are certified, with three more in various stages of consideration. Later this year and for the first time in 30 years, the NRC expects to receive up to seven license applications to build and operate new nuclear plants. Eleven additional applications are expected in 2008. To date, we have received letters of interest from several potential applicants, which indicate that NRC may expect that first plant completion to be followed by as many as 30 others. We have even received part of the first combined operating license to be filed. These numbers change frequently, so stay tuned for further developments.

The U.S. manufacturing and industrial capacity to support new construction has been significantly diminished since the 1970s and 1980s. The number of U.S. companies certified by the American Society of Mechanical Engineers (ASME) to produce N-stamped parts has dropped by almost a factor of five since 1980. We also face a challenge in ensuring the quality of the thousands of smaller parts and materials that are manufactured in other parts of the world. The construction of a commercial nuclear plant today involves pumps, valves, motors, fans, pipes… and even bolts… that may be produced by any number of companies—both private and state-owned—around the world. The close scrutiny that regulatory agencies can enforce on major manufacturers to assure that quality components are produced is challenging to achieve for a vastly greater number of sub-vendors that supply parts and materials to the manufacturers.

The International Boiler and Pressure Vessel Code 2007 version was just released and establishes rules of safety governing the design, fabrication, and inspection of boilers, pressure vessels, and nuclear power plant components during construction. A section also provides requirements for (1) containment systems and transport packagings for spent fuel and high-level radioactive waste; and (2) concrete reactor vessels and containment. Some of you attending this conference probably participated in that recent and very important work.

The issue of constructing an advanced reactor around the world raises the importance of international communication and collaboration to a new height. This communication is necessary at regulatory, operational, and supply chain levels. A good example of international regulatory cooperation is the Multinational Design Evaluation Program, or MDEP. The MDEP is an initiative to enhance regulatory cooperation and, where feasible and desirable, to converge on common regulatory requirements and review practices associated with the design reviews of new reactors. Conferences like SMiRT enhance a common understanding of technical issues and facilitate communication and resolution, such that a design can be safely constructed at many locations under different regulatory requirements. In this regard, a common understanding of regulatory practices in different countries is important.

The issue of aircraft impact has obviously taken on new visibility in the post-9/11 world. While aircraft impact was considered in earlier designs in the context of accidental accidents, the explicit consideration of sabotage in designs raises a significant challenge for us all. Sharing of technical knowledge is vital to guard against such threats; however, it is also important that the security of sensitive information is maintained. In April 2007, in support of this issue, the NRC unveiled the third in a series of major steps to enhance the post-9/11 security of nuclear power plants. The agency proposed a rule that would require each applicant for a new reactor design to assess how the design, to the extent practicable, has greater built-in protections to avoid or mitigate the effects of a large commercial aircraft impact, making them less reliant on operator actions than existing plants. That approach allows designers to evaluate potential competing technical factors, such as the response to

earthquakes and passive safety systems, while at the same time addressing aircraft impacts. These assessments should look at areas such as core cooling capability, containment integrity, and spent-fuel-pool integrity.

The Commission emphasized that seeking security assessments and examining how designs can be improved is consistent with the traditional approach the NRC has taken to so-called "beyond-design-basis-events," which are considered to have such low probability of occurrence that design features to address them can meet realistic analysis criteria. These are events with conditions exceeding the stresses imposed by the "design-basis-event" conditions for which plants are required to be analyzed according to strict and prescriptive rules. Design-basis-event conditions include large pipe breaks, fires, earthquakes, hurricanes, tornados, and floods. Assessing a new reactor in the early design stages can enable modifications to reduce the need for operator mitigation actions in the event of an airplane crash.

In an August 1985, NRC Policy Statement, "Severe Reactor Accidents Regarding Future Designs and Existing Plants," the NRC said it expected future reactor designers to build in more safety features to cope with so-called severe accidents that went beyond the design basis. However, it did not require specific features, leaving that to plant designers. In the subsequent decades, reactor designs submitted to and approved by the Commission have achieved substantial safety improvements to address such beyond-design-basis-accidents.

To quote NRC Chairman Dale Klein's comment on issuing the proposed rule for public comment, "This is the most recent step in a broad, proactive effort to improve the security of reactors initiated by the NRC after Sept. 11, 2001. We need more technical analysis to understand how to address this." In my view, this proposed rule will give us the opportunity to assess and make changes to new reactor designs early in the design process. I should note that many of the challenges that will be reviewed in these assessments fall within the scope of the structural mechanics issues explored in this conference.

Along with the challenges associated with anticipated construction of new reactors of advanced designs, the prospect of the next generation of nuclear power plants involving technologies such as high-temperature and liquid-metal reactors, derived from the Next Generation Nuclear Plant and the Global Nuclear Energy Partnership initiatives, raises a different set of challenges to this community. The designs will involve new materials and different operational and accident conditions. In recognition of strong programs in other countries related to these technologies, codes and standards will have to be developed with an international perspective.

Despite the nuclear renaissance, the most important issue is still the safety of operating reactors. This conference will help us maintain this focus. Our experiences have shown that the understanding of aging and degradation mechanisms, timely detection through inspection technologies, and implementation of effective remedial measures are vital to maintain safety throughout the operating life. Operation beyond the current 60-year, license-renewal periods may also be sought and would challenge our knowledge of aging phenomena.

Other initiatives also use structural mechanics, such as modification to 10 CFR 50.46a, regarding improved safety through a more risk-informed approach for addressing double guillotine breaks of the largest reactor coolant pipes, which can allow better utilization of water supplies and optimization of safety systems to better cope with more likely events than the large loss of cooling accident. If a new version of 50.46a is approved, it will depend heavily on our ability to maintain very low likelihood of breaks in pipes greater in diameter than the so-called transition break size and on our

understanding of and ability to detect flaws and degradation in large pipes.

The incorporation of risk perspectives also raises challenges in realistically characterizing the performance of structures, systems, and components when subjected to beyond-design-basis environments. It is particularly difficult to characterize failure modes of passive components that can experience beyond-design-basis conditions for which the failure data can not be realistically obtained. This community will plan a significant role in establishing realistic assessments of passive component performance to enhance our progress toward risk-informed regulation. The recent NRC experiences, related to risk-informing the pressurized thermal shock rule to assure reactor pressure vessel integrity, highlight the benefit of risk-informed considerations and probabilistic methods.

Natural hazards are another area in which knowledge continues to evolve, and we continue to learn from each significant event worldwide. The December 2005 tsunami is a case in point. It is leading to rapid development in the state-of-the-art of prediction, propagation, and early warning systems. The implementation of performance-based seismic siting approaches in a recent early site permit also reflects a substantial change from the deterministic perspective of early years. The recent earthquake in Japan will provide important data to the entire nuclear community. SMiRT is a forum for both understanding and analyzing external hazards and developing safe designs to resist these hazards.

Let me now switch to the subject of human capital. Both the NRC and the industry are facing critical shortages of experienced staff. No nuclear reactor can operate without trained and dedicated people who have made safety a priority. Regulatory bodies must also have trained and knowledgeable staff. The global growth in nuclear power compels all of us to focus on training the next generation of construction workers, electricians, welders, engineers, operators, managers and regulators.

You may be aware that the NRC is engaged in strenuous efforts to increase our staff by a net of 600 people to handle the increased workload of new plant applications and other nuclear regulatory business. Obviously, we cannot simply hire people off the street and send them out to be nuclear power plant regulators the next day. Even when hiring people with substantial experience in industry, we have found that it takes 6 months to a year of training before they begin thinking and acting like regulators. For recent university graduates, it takes one to two years.

Perhaps one of the most important roles that conferences like SMiRT can play is in the area of knowledge management. The SMiRT conference planners may even consider accepting this as one of their challenges. These conferences, which began at the time of the design and construction of the current generation of plants, can provide historical perspectives on technical issues and lessons learned. Knowledge management is viewed as critical in the United States, and both the NRC and U.S. industry are exploring and implementing strategies for effective knowledge management programs. Your conference also affords opportunities for this professional growth and networking that are vital components of knowledge management. This is particularly important to the NRC, as we assimilate many engineers who are new to the nuclear field and strive to create a new generation of regulatory experts.

As I’ve indicated, the NRC considers participation in conferences such as SMiRT to be vital for many reasons. Among these reasons, it is consistent with agency policy to have effective outreach efforts with our diverse stakeholders. It is also important that we share information related to our research and regulatory initiatives, get feedback on them, and receive new perspectives from research conducted around the world. Our interest is evident from the diverse NRC staff presentations at this conference. The topics presented cover issues related to operating reactors, licensing of new reactors, and waste disposal facilities. One common thread in these presentations is consideration of risk-

informed and performance-based approaches.

I challenge all participants of this conference to move beyond knowledge sharing and to promote common understanding of issues among stakeholders with diverse perspectives, researchers, regulators, operators, and designers. This will facilitate development of universal implementation strategies, which could encourage the use of standardized designs worldwide and help to enable consensus and improved approaches to address safety issues.

Thank you for your attention this morning, I will be happy to take questions.