Foreword

Special section on the Seismic Analysis and Risk Assessment of Nuclear Facilities

Guest Editor

Chandrakanth Bolisetti

Idaho National Laboratory

The seismic design and risk assessment of nuclear facilities is critically important, not just for safety, but also for economics—the latter especially for commercial nuclear power plants (NPPs). The direct and indirect costs of seismic design and qualification are major contributors to the capital costs of NPPs. Furthermore, the site-dependent nature of seismic hazard stands as a barrier to standardization of the systems, structures, and components (SSCs) of NPPs. Standardization and the usage of off-the-shelf equipment can assuage the cost overruns and schedule delays seen in recent NPP construction projects. In existing nuclear facilities under the U.S. Department of Energy and National Nuclear Safety Administration, seismic-related costs predominantly arise from mandated periodic seismic reassessments that may result in expensive part replacements or upgrades to existing facilities.

While there is a need to improve the economics of nuclear facilities, ensuring adequate seismic safety is still paramount. This special section in *Nuclear Technology* features a collection of studies that share the common goal of advancing the state of practice in seismic design and risk assessment of nuclear facilities to improve their economics while ensuring their safety. These advancements can be in the form of (a) improving modeling and simulation methods and tools to reduce potential conservatisms in the calculation of seismic demands, (b) development of detailed guidance for performing seismic risk assessments and reassessments in a code-conforming manner, (c) implementation of design techniques such as embedment, seismic base isolation or component isolation, etc., for reducing seismic demand, or (d) others. The studies presented in this special section address these topics.

Seismic analysis and the estimation of seismic demands (forces, displacements, stresses, etc.) are required for both design and risk assessment. Two key components in the seismic analysis of nuclear structures are site response analysis and soil–structure interaction (SSI) analysis. The former involves simulating the amplification or deamplification of seismic waves at the site and determines the site effects on the seismic hazard. The latter involves simulating the interaction between the soil and the structure during an earthquake and is a necessary step for calculating seismic demands in the structure. Both site response analysis and SSI analysis are especially important for deeply embedded nuclear power plants, which are increasingly being considered for advanced reactors and microreactors. In the nuclear industry, both site response analysis and SSI analysis are performed using traditional, linear methods that are conservative and may not be accurate for intense earthquakes. Nonlinear site response and SSI analyses provide a more accurate and less conservative approach and can result in more economical and potentially safer designs.

Seismic isolation is a mature technology in construction sectors other than nuclear but has never been implemented in nuclear structures in the United States. It involves placing devices called isolators between a building and its foundation, or between a component and its support, in the case of component isolation. When properly designed, these isolators dissipate most of the energy during earthquake shaking, resulting in a drastic reduction in the seismic demands in the facility and its SSCs. Seismic isolation has a high potential to reduce the capital cost of NPPs, especially in *n*'th-of-a-kind facilities, where the reduction in seismic demands will have been leveraged to increase the standardization of the SSCs.

Despite the importance of structural engineering and seismic design on the safety and economics of nuclear structures, research in this area is scarce in comparison with other research areas in nuclear energy generation. This special section is dedicated to disseminating some of the seismic research being done at Idaho National Laboratory with the hope of increasing awareness of these concepts among the audience of *Nuclear Technology*.

ORCID

Chandrakanth Bolisetti http://orcid.org/0000-0001-8934-4835