Seismic Isolation Promises Reduced Vulnerabilities, Risks and Costs for New Plants

Design strategies and technologies proven in diverse applications could substantially mitigate or offset seismic hazards for new nuclear plants, helping address regulatory issues and increase public acceptance.

EPRI is leading a state-of-knowledge assessment and cost-benefit analysis of seismic isolation for protecting nuclear power plant structures, internal systems, and their components from the ground motions created by earthquakes. Research is designed to inform utilities and technology suppliers about the use of seismic isolation techniques to mitigate potential earthquake hazards for new plant designs.

Plant owners and new plant applicants are required to demonstrate that margins are adequate to withstand beyond-design-basis ground motions, which vary as a function of earthquake magnitude and likelihood, distance from the source to the plant site, subsurface geology, and other factors. Because margins must be updated to reflect the most current information, new plants being designed and licensed today could experience several revisions to seismic source and ground motion attenuation models over their lifetime.

Seismic isolation shows particular promise because it represents a proven solution for offsetting or mitigating seismic loads and earthquake-induced damage in a range of settings. The underlying principles are: (1) to decouple the base of a structure from its foundation, which remains in contact with the surrounding environment; and (2) to prevent ground motion from being transferred directly to the structure itself through the use of bearing or sliding systems. Base isolation is not new to the nuclear industry; it was used at two nuclear power plants built in the 1970s, one in France and a second in South Africa. Advanced seismic isolation designs and supplemental energy-dissipating technologies—such as friction-pendulum bearings and large-area elastomeric isolators—are increasingly being applied to protect housing, hospitals, bridges, and other safety-critical structures in the United States, Japan and other earthquake-prone regions.

Caption: Energy-dissipating technologies such as friction pendulum bearings isolate safety-critical structures, systems, and components from the ground motions caused by earthquakes, reducing seismic hazards. Photo courtesy of UC Berkeley.

According to EPRI's initial analyses, seismic isolation could be particularly helpful in preventing high-frequency ground motions from being transmitted to nuclear plant structures, while mitigating the potential damaging effects of low-frequency seismic waves. Seismic isolation technology has the potential to improve licensability, increase public acceptance, and reduce exposure to evolving seismic hazards and safety requirements.

A mid-2012 EPRI report will identify the planning, installation, and long-term maintenance issues associated with seismic isolation in future nuclear plant designs, as well as the possible advantages and disadvantages of alternative design and engineering approaches. A simplified cost-benefit analysis will compare the use of seismic isolation versus a standard fixed-base design for a generic plant. Follow-on work could include proof-of-concept testing of seismic isolation methods for reactor, turbine, and other systems, and development of practical guidance supporting nuclear power applications. Concurrently, the U.S. Nuclear Regulatory Commission is in the process of issuing regulatory guidance for the consideration of seismic isolation at nuclear plants.

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