



# Fact Sheet

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## Seismic Issues for Existing Nuclear Power Plants

### Background

The Nuclear Regulatory Commission is currently examining recent earthquake-related information to determine if the data affects hazard analyses for some U.S. nuclear power plants (NPP). The agency requires NPP designs to withstand the effects of natural phenomena including earthquakes (i.e., seismic events). The agency's requirements, including General Design Criteria (GDC) for licensing a plant, are described in Title 10 of the Code of Federal Regulations (10 CFR). These license requirements include traditional engineering practices such as "safety margins" in design, construction, and operations. The agency has always required NPP licensees to design, operate and maintain safety-significant structures, systems, and components to withstand the effects of earthquakes and maintain the capability to perform their intended safety functions. The agency ensures these requirements are satisfied through the licensing, reactor oversight, and enforcement processes.

### Earthquake (or Seismic) Hazard

The NRC requires safety-significant structures, systems, and components be designed to take into account: (1) The most severe natural phenomena historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed.

An earthquake (the result of abrupt fault movement within the earth's crust) releases energy that propagates away from the fault and causes ground movement. As the ground moves, objects (in this case, NPP structures) on or in the ground also move. The nature of the movement depends on how the earthquake releases energy and on how the soil conditions absorb (or dissipate) the energy as it moves away from the fault to an NPP location. The ground shaking and building movement from an earthquake is typically characterized by both the frequency of the shaking and by the force applied at the building location. These characteristics describe how the energy released from the earthquake impacts the building structure and the systems and components of the building. These earthquake characteristics provide information used in designing existing

nuclear plants. The frequency of the shaking is measured in cycles per second (or Hz) and the force is typically expressed as some fraction of the force of gravity (denoted as 0.15 g or 15% of gravity for example).

### **Probability (or Likelihood) of Earthquakes Occurring**

The licensing basis for existing NPPs used historical data at each site to analyze design basis loads from the area's maximum credible earthquake. This process assumes an earthquake could happen at any time. While the initial licensing process did not include a probabilistic assessment of earthquake hazards or their potential impact, the NRC later required all NPPs to assess their potential vulnerability to earthquake events, including those that might exceed the design basis, as part of the Individual Plant Examination of External Events (IPEEE) Program. This process considered the available safety margins of existing NPPs for various earthquakes and ensured these margins, together with the plant's accident management programs, continues to protect public health and safety. The NRC's fact sheets on Probabilistic Risk Assessment (<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/probabilistic-risk-asses.html>) and Nuclear Reactor Risk (<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/reactor-risk.html>) provide more information on use of probability in evaluating hazards (including earthquakes) and their potential impact on NPP safety margins. Any new NPP the NRC licenses will use a probabilistic, performance-based approach to establish the plant's seismic hazard and the seismic loads for the plant's design basis.

### **Evolving Knowledge about Earthquakes**

The NRC regularly reviews new information on earthquake source and ground motion models. For example, the NRC reviewed updated earthquake information provided by applicants in support of Early Site Permits for new reactors. This additional information included new models to estimate earthquake ground motion and updated models for earthquake sources in seismic regions such as eastern Tennessee, and around both Charleston, S.C., and New Madrid, Mo. Analysis of these updates resulted in slight increases to earthquake hazards for some plants in the Central and Eastern United States (CEUS). The NRC also reviewed and evaluated recent U.S. Geological Survey (USGS) earthquake hazard estimates for the CEUS that are used for building code applications outside of nuclear power plant licensing. These reviews showed that the estimated earthquake hazard levels at some current CEUS operating sites might be slightly higher than what was used in design and previous evaluations.

The CEUS is generally an area of low to moderate earthquake hazard with few active faults, in contrast to the western United States. The largest observed CEUS earthquakes have no obvious relationship to geologically mapped surface faults, but some of the largest earthquakes documented in the continental United States have occurred in the CEUS. In 1811-1812 three major earthquakes (Magnitude 7 to 7.7 on the commonly used Richter Scale) shook much of the CEUS. These earthquakes occurred near the town of New Madrid. In 1886 a large earthquake (Richter Scale magnitude of approximately 7) occurred near Charleston. This earthquake caused extensive damage and was felt throughout much of the eastern United States. The USGS Web site provides general information about earthquakes here: <http://earthquake.usgs.gov/learning/index.php>.

## **NRC Response to Increased Estimated CEUS Earthquake Hazards**

The NRC began assessing the potential reduction in available safety margins through a May 26, 2005, memorandum (under Accession No. ML051450456 in the agency's Agencywide Documents Access and Management System (ADAMS)), where the staff recommended examining the new CEUS earthquake hazard information under the Generic Issue Program (GIP). The NRC staff identified the issue as GI-199 in a June 9, 2005, memorandum (ADAMS Accession No. ML051600272), and completed the screening analysis for the issue in January 2008. The staff will assess available earthquake data and models to determine whether any plant sites in the CEUS might have earthquake hazards that could result in appreciable increased estimates of the plant's risk for response to earthquake events. The GIP is now proceeding, under the safety/risk assessment stage, to estimate the potential increase in core damage frequency for any plants identified. The final stage of the GIP would identify appropriate regulatory actions should the staff's evaluations determine the earthquake risk increase exceeds established safety values. Information regarding this generic issue and the GIP in general is available at <http://www.nrc.gov/about-nrc/regulatory/gen-issues.html>.

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