

# Impacts of the Niigataken Chūetsu-Oki Earthquake to the Kashiwazaki-Kariwa Nuclear Power Plant, Post-Earthquake Response, and Lessons Learned: U.S. Perspective for Design Basis Earthquakes and Beyond Design Basis Earthquakes

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## Abstract

Over the years, a number of nuclear power plants (NPPs) in Japan have experienced earthquake shaking and some have experienced shaking in multiple earthquakes. The U.S. Nuclear Regulatory Commission (NRC) has identified a need to better understand the seismic performance of Japanese NPPs and to determine if any important lessons should be applied to NPPs in the United States (U.S.).

On July 16, 2007, a strong earthquake, the Niigataken Chūetsu-Oki (NCO) earthquake, with a moment magnitude (**M**) of **M6.6** occurred approximately 16 km north of the Kashiwazaki-Kariwa Nuclear Power Plant (KKNPP). KKNPP has seven NPP units that experienced the NCO earthquake ground motions. Numerous seismic instruments located at the KKNPP recorded motions from the NCO earthquake in the free-field, on foundations, and in-structures. The recorded motions showed that the NCO earthquake motions significantly exceeded the plant design basis earthquake ground motion response spectra. Although no safety-related structures, systems, and components (SSCs) experienced damage, non-safety-related SSCs experienced significant damage.

This presentation reviews the effects of the NCO earthquake on the KKNPP, with the objective to assess whether the potential for similar behavior (both positive and negative) is expected of U.S. NPPs and DOE facilities if subjected to earthquake ground motions exceeding the design bases.

### Positive performance: KKNPP behavior during and after the NCO earthquake

- KKNPP safe and stable – all 7 units;
- Significant safety margin exists above the design strength of foundations, structures, and equipment;

Reasons for KKNPP excellent performance are reviewed.

### KKNPP experienced effects to be addressed for critical facilities world-wide

- Common cause events – KKNPP seven units affected simultaneously;
- Multi-unit considerations;
- Cliff-edge effects;
- Not important to safety SSC failures
  - Soil failures, including liquefaction, significant consequences due to BDBE

- Administration building negatively affecting communication with off-site first responders and other important parties
- Seismic data acquisition system experienced malfunction causing main shock data to be lost
- Fire safety – systems interaction issues and inability to fight fires when called upon

This presentation touches on the observations (positive and negative) of the KKNPP performance due to the NCO earthquake ground motion. The many issues that are “generic” are highlighted with general and specific recommendations to operators, regulators, and other stake holders. The majority of issues are relevant to all external events and, specifically, to Beyond Design Basis External Events.

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