

## RECENT EARTHQUAKE IN JAPAN CONSIDERATIONS FOR US NUCLEAR POWER PLANTS

The purpose of this paper is to provide an overview of the earthquake that occurred in Japan on July 16, 2007 and its impact on the Kashiwazaki Kariwa nuclear power plant. This paper also provides summary information about the design of US nuclear power plants for earthquakes and discusses possible actions that may be considered by the NRC in relation to US operating reactors.

Based on information from public sources, the NRC has learned that an earthquake with a magnitude 6.6 (Mw, based on US Geological Survey) struck the west coast of Japan on July 16, 2003, at 10:13:28 AM local time, July 15, 09:13:28 PM Eastern Daylight Time. The epicenter of the main shock (37.574°N, 138.440°E) is located about 240 km North-West-North of Tokyo, Japan. The earthquake occurred at the depth of 10 km, according to USGS. The earthquake killed at least seven people, injured hundreds, collapsed houses, and cracked highways. It also affected the Kashiwazaki Kariwa Nuclear Power Plant, which has three operating units, three shutdown units, and one unit undergoing start-up. The plant site is not far away from the epicenter.

Based on the latest information sources, the most important thing is that the event did not affect the safety of the reactor and the maintenance of the reactor in a safe shutdown mode. The Kashiwazaki Kariwa nuclear power plant experienced two leaks and a fire. The first leak was detected at the Reactor Unit 6, which was shut down for maintenance at the time when the earthquake struck. The Tokyo Electric Power CO (TEPCO) suggested that the leak could have come from a special storage facility for spent fuel rods. The second leak, according to the Kyodo News Agency, could possibly have come from stacked drums containing – low level nuclear waste which tipped over during Monday's quake and some of the lids were open. The leaks did not affect the safety of the reactor. The earthquake also triggered a fire at an electrical transformer at the switchyard of Unit 3. It should be noted that the fire which was extinguished within two hours did not affect the nuclear reactor.

The seismic design in Japanese nuclear power plants is essentially similar to the US design. However, Japan is located in an earthquake-prone environment, therefore, its seismic design levels are generally higher than seismic design levels of most US nuclear power plants located east of the Rocky mountains.

The operating US nuclear power plants are robustly designed to meet site-specific seismic conditions. The issuance of a construction permit for a nuclear power plant requires NRC staff's review of licensees' characterization and evaluation of potential seismic activities.

According to NRC regulations, the nuclear power plants are designed to a Safe Shutdown Earthquake (SSE) ground motion. Where the peak ground accelerations at the foundations of a power plant are determined to be less than one-tenth the

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acceleration of gravity (0.1g), the SSE will be at least 0.1g. Operating US reactors are designed to a Safe Shutdown Earthquake (SSE) and to a lower magnitude Operating Basis Earthquake (OBE). The SSE for most operating reactors is established based on a criterion in Regulatory Guide 1.60 and to a different plant-specific criterion for older plants. The oldest ten US reactors were also subjected to a regulatory Systematic Evaluation Program (SEP) to ensure their seismic adequacy since they were not designed to the criteria in the Standard Review Plan (SRP), which was used in the design of later generation of US reactors.

Beside its inclusion in the design, the OBE level is also used for shutdown and inspection after a plant is subjected to such an earthquake. All operating US reactors were also evaluated under a program for Individual Plant Examination for External Events (IPEEE), which included earthquakes of magnitudes beyond the design basis earthquake. This evaluation was performed in response to NRC Generic Letter 88-20, supplement 4. The frequency and magnitudes of the earthquakes that are likely to occur in Japan result in seismic design levels which are generally higher than those employed in the design of US plants.

All of the US nuclear power plants are equipped with seismic instrumentation installed at various locations in the plant. The Diablo Canyon Nuclear Power Plant is the only US plant which has the auto-trip mechanism for earthquake initiated plant shut-down. Possible actions being considered by the NRC include monitoring the development of the post earthquake survey at the epicenter and conducting reviews of the inspection results of the nuclear power plant.