

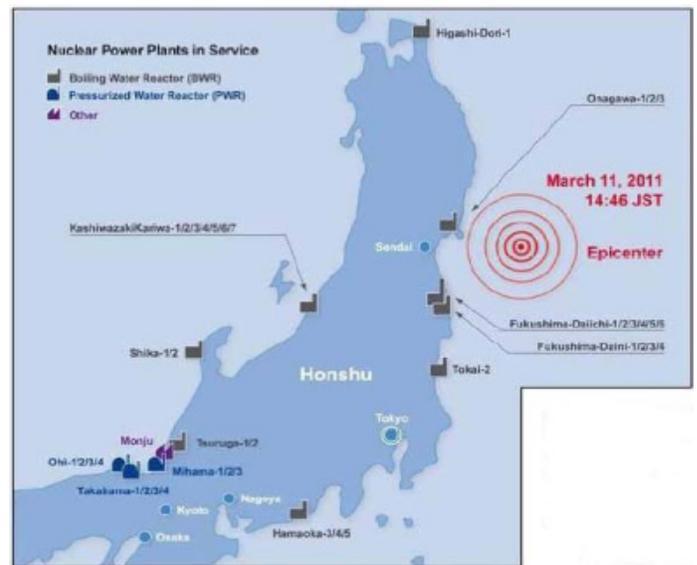
## NRC Response to Lessons Learned from Fukushima

### Summary

In March 2012 the NRC ordered U.S. nuclear power plants to meet 2016 deadlines for: 1) maintaining key safety functions even if installed electricity sources fail; 2) installing additional equipment to monitor spent fuel pool water levels; and 3) (for designs similar to Fukushima Dai-ichi) installing/improving systems to safely vent pressure during an accident. The NRC's March 2012 actions also asked all U.S. plants for information on comprehensive earthquake and flooding hazard analyses.

### The Fukushima Dai-ichi Nuclear Accident

On March 11, 2011, a 9.0-magnitude earthquake struck Japan about 231 miles (372 kilometers) northeast of Tokyo off the Honshu Island coast. Eleven reactors at four sites (Fukushima Dai-ichi, Fukushima Dai-ni, Onagawa, and Tokai) along the northeast coast automatically shut down after the quake. Fukushima Dai-ichi lost all power from the electric grid, with diesel generators providing power for about 40 minutes. At that point an estimated 45-



(AP Photo/Yomiuri Shimbun, Masamine Kawaguchi)

foot-high (14 meter) tsunami hit the site, damaging many of the generators. Four of six Fukushima Dai-ichi reactors lost all power from the generators. The tsunami also damaged some of the site's battery backup systems.

Units 1, 2 and 3 at Fukushima Dai-ichi were operating when the earthquake hit. Units 4, 5 and 6 were shut down for routine refueling and maintenance. One of Unit 6's diesel generators continued working, providing power to keep both Units 5 and 6 (at right in the photo) safely shut

down. Steam-driven and battery-powered safety systems at Units 1, 2 and 3 worked for several hours (and more than a day in some cases). Those systems eventually failed and all three reactors overheated, melting their cores to some degree. The conditions in the reactors generated extreme pressure, causing leaks of radioactive gas as well as hydrogen. The hydrogen exploded in Units 1, 2 and 4, damaging the buildings and releasing more radioactive material from Units 1 and 2. Radioactive contamination spread over a large area of Japan, requiring the relocation of tens of thousands of people. The Japanese government has reopened a very limited area for residents to return to, but many communities remain off-limits. Japanese authorities eventually stabilized the damaged reactors with alternate water sources. Work continues to isolate the damaged reactors and radioactive contamination from the environment.

## NRC's Short-Term Actions

The NRC's 24-hour Operations Center in Rockville, Md., began monitoring the situation shortly after the earthquake and tsunami occurred. The NRC's first focus was potential tsunami effects on California's nuclear power plants and other nuclear materials users on the West Coast and in Hawaii, Alaska, and U.S. Pacific Territories. By the afternoon of March 11 the agency had fully staffed the Operations Center and begun interactions with Japanese regulators. The NRC sent two experts that weekend to assist the U.S. Embassy in Tokyo. By March 14, the agency had sent additional staff to provide technical support to the U.S. Embassy and the Japanese government. The NRC maintained its presence at the U.S. Embassy through December 2011.

On March 16, the NRC, along with other U. S. government agencies, provided technical information supporting the U.S. Embassy's advisory for American citizens to avoid the area within 50 miles of Fukushima Dai-ichi. The 50-mile recommendation expired in October 2011. The NRC also ensured U.S. nuclear power plants [took action](#) to prepare for a Fukushima-like event. The [NRC told its inspectors](#) to independently assess each plant's level of preparedness. The inspections covered procedures to compensate for extensive onsite damage, loss of all alternating current power, and seismic and flooding issues, as well as procedures for dealing with a damaged reactor.

## NRC's Long-Term Response

In April 2011 the Commission named a formal task force of senior NRC experts to examine information from the accident. The task force then reviewed NRC regulations to determine whether any actions were needed to ensure the safety of U.S. nuclear power plants. The task force's July 2011 [report](#) concluded U.S. reactors can continue operating safely while the NRC considers enhancements to existing safety and emergency preparedness requirements. The task force recommended a dozen broad enhancement areas for the Commission to consider. Later in 2011 the



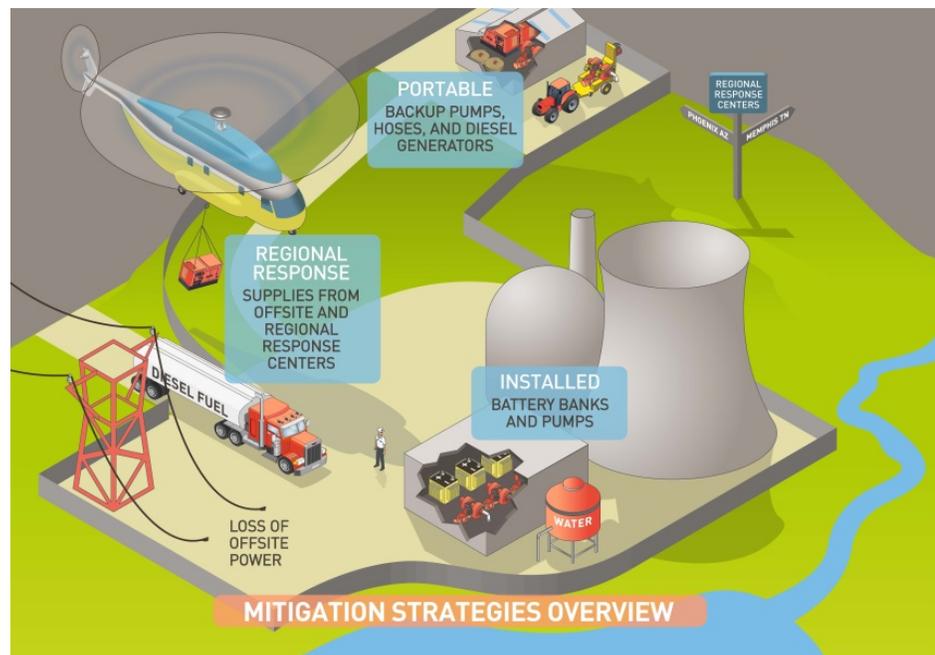
Commission approved [staff proposals](#) for prioritizing the specific actions suggested by the task force, as well as six additional topics related to the events at Fukushima.

The agency also created the Japan Lessons Learned Project Directorate, or JLD, to lead implementation of the task force recommendations. This approach lets the remainder of the agency focus on overseeing safety at operating reactors. The JLD's approximately 20 full-time employees work with experts from across the agency. The JLD is directed by a steering committee made up of NRC senior managers.

The agency issued three Orders in March 2012, requiring U.S. reactors to:

- Obtain and protect additional emergency equipment, such as pumps and generators, to support all reactors at a given site simultaneously following a natural disaster (pictured below).
- Install enhanced equipment for monitoring water levels in each plant's spent fuel pool.
- Improve/install emergency venting systems that can relieve pressure in the event of a serious accident (only for reactors with designs similar to the Fukushima plant).

Many U.S. reactors have obtained their additional onsite portable equipment. The U.S. nuclear industry has also established and stocked two offsite response centers. U.S. reactors are starting to report they have satisfied the requirements of the emergency equipment Order.



The NRC strengthened the venting Order in 2013, requiring the vents to handle the pressures, temperatures and radiation levels from a damaged reactor. The revised Order also calls for plants to ensure their personnel could operate the vents under those conditions. As part of the same action, the staff is using the NRC's rulemaking process to consider filtering methods to prevent radioactive material from escaping containment in an accident. The staff is looking at new filter systems or a combination of existing systems.

The NRC has also asked all U.S. reactors to re-confirm their flooding and earthquake preparedness, as well as re-analyze their earthquake and flooding hazards. All U.S. reactors east of the Rocky Mountains submitted their [earthquake re-analyses](#) in March 2014. Reactors west of the Rockies will submit their earthquake re-analyses in March 2015. Most U.S. plants have submitted their flooding re-analyses according to the [schedule](#) the NRC set out in May 2012.

Other NRC activities include creating or revising rules related to maintaining key safety functions if a plant loses all alternating-current power, and several aspects of emergency preparedness. The NRC's [website](#) includes more information on Fukushima-related actions.

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