

**NRC Understanding of the Structural Stability of the
Fukushima Dai-ichi, Unit 4 Spent Fuel Pool
July 5, 2012**

As a result of the events at the Fukushima Dai-ichi facility in March 2011, the Fukushima Dai-ichi, Unit 4 reactor building suffered considerable damage from a hydrogen explosion. Shortly after the event occurred, the damage to the reactor building raised concerns regarding its stability, and in particular the stability of the Unit 4 spent fuel pool (SFP), located at an elevation above ground level within the Unit 4 reactor building. As a precaution, the government of Japan took measures to add additional reinforcement to the existing structure supporting the Unit 4 SFP to address the potential risk of damage to the spent fuel pool from subsequent seismic events.

More specifically, in the summer of 2011, the Japanese government consulted with NRC about the potential issues with seismic stability of the Fukushima Dai-ichi, Unit 4 SFP. NRC staff in Japan met with representatives of Tokyo Electric Power Company (TEPCO) and the Japanese Nuclear Industrial and Safety Agency (NISA). TEPCO and NISA shared their plan to address these issues by installing additional support (steel beams with a concrete fill) to further stabilize the Unit 4 SFP. NRC staff in Japan transmitted the information received from TEPCO and NISA to NRC headquarters, so that NRC technical experts could provide comments on the stabilization plan. The NRC technical staff performed a general review of the plan to address the unit 4 SFP issues. The NRC technical staff provided the following comments to Japan:

1. TEPCO's plan stated that the necessary engineering calculations had been performed and the Unit 4 SFP could withstand another design basis seismic event in its current condition, even without the planned additional steel and concrete support.
2. TEPCO's plan for additional support underneath the Unit 4 SFP would provide additional margin against damage from a future seismic event (assuming the support was properly analyzed, designed, and installed); and
3. The analysis of the condition of the Unit 4 SFP performed by TEPCO (prior to the installation of additional support system) and the design of the additional support system for the Unit 4 SFP had been reviewed by cognizant structural engineers from Japan Nuclear Energy Safety (JNES) on behalf of NISA, and the JNES staff had concurred with TEPCO's analysis and design. The NRC was not asked to perform a detailed technical review of the plan. Available evidence indicates that the Unit 4 SFP could be capable of withstanding a future seismic event, if the supports were properly installed, and the TEPCO and JNES technical staff used recognized engineering codes and standards, and considered the thermal, seismic, and other design basis loading conditions, when designing the support structure.

TEPCO completed the installation of the additional support to the Unit 4 SFP on August 1, 2011.

Based upon TEPCO's reported actions and the independent review and acceptance of these actions by JNES on behalf of NISA, and on the assumptions the additional support was properly installed to widely-accepted engineering standards, the additional reinforcing features could be viewed as enhancing the support of the Fukushima Unit 4 SFP, which remains in a stable condition. The NRC will stay abreast of conditions at the site by communicating on an as needed basis with NISA and JNES, who have the authority and responsibility for decisions regarding the safety of the Fukushima Dai-ichi site.

Updated Information

The NRC received additional information from TEPCO regarding the stability of the Unit 4 reactor building and SFP on April 27, 2012. In response to recent concerns raised by interested Japanese stakeholders who believed the Unit 4 reactor building may be tilting and in danger of collapsing, TEPCO took measurements within the Unit 4 reactor building at the elevation of the Unit 4 SFP on February 7 and April 12, 2012, and confirmed that the Unit 4 reactor building remained level, and was not tilting. TEPCO also provided additional, summary information regarding their finite element analysis of the Unit 4 reactor building and its ability to withstand future seismic events. TEPCO has concluded that the Unit 4 reactor building is capable of withstanding a future seismic event with ground motion at the site that is equivalent to the earthquake that occurred on March 11, 2011 (which was in excess of the seismic ground motion for which the Fukushima Dai-ichi facility was originally designed).

In addition on May 25, 2012, TEPCO issued a press release confirming that the Unit 4 hydrogen explosion resulted in outward deformation of the reactor building west wall. The maximum deformation of 33 mm occurred near the southwest corner, adjacent to the equipment hatch and elevator shaft. TEPCO evaluated the observed deformation and concluded that it has little effect on the seismic stability of the Unit 4 SFP. TEPCO will continue to conduct inspections every three months to identify and repair, if necessary, cracking in the walls and floor of the structure supporting the Unit 4 SFP and to detect any change in the deformation noted above.

Additional information regarding these topics is available from the TEPCO website at:

http://www.tepco.co.jp/en/nu/fukushima-np/images/handouts_120525_05-e.pdf

Spent Fuel Removal from Spent Fuel Pools at Fukushima Dai-ichi Units 1-4

The Japanese government and TEPCO published a December 21, 2011, roadmap for the decommissioning of the Fukushima Dai-ichi Nuclear Power Station facilities entitled, "Mid-and-Long-Term Roadmap toward the Decommissioning of Fukushima Dai-ichi Nuclear Power Station Units 1-4, TEPCO," (Roadmap). The Roadmap identifies three phases of decommissioning.

- Phase 1 consists of preparation for spent fuel removal activities from the Unit 1 through Unit 4 SFPs. Research into the removal of spent fuel and fuel debris (damaged fuel remaining in

the reactor vessels) will be performed during this period, with a target of spent fuel removal beginning sometime in late 2013.

- Phase 2 targets a period up to 10 years in which spent fuel will be removed from the four SFPs, with spent fuel removal beginning in 2013 from Unit 4. As lessons are learned in the removal of fuel from each subsequent facility, those lessons, coupled with the unique challenges presented by each unit, will determine the timeframe by which all fuel will be removed from SFPs.
- Phase 3 addresses the removal of fuel debris from the reactor vessels and final decommissioning activities, lasting from 30 to 40 years from the beginning of Phase 1.

To date, no additional information has been provided that challenges the current approach and timeline for spent fuel removal activities.

Remediation and Fuel Removal Challenges Identified by TEPCO

On its website, TEPCO identified the following issues that will impact the process timeline for spent fuel removal including the removal of rubble in each phase of remediation activities, installation of covers for fuel removal, and preparation of and removal of fuel from the common pool (the pool to which spent fuel will be transferred). The design, manufacture, installation, and start of operation of specialized equipment required for remediation activities may introduce particular challenges before undertaking Phase 2 fuel removal. Recent discussions about the placement and operation of specialized cranes above the SFPs, to be used for transferring spent fuel at well-above ground level heights, reflect the unique engineering and logistics challenges presented by spent fuel removal at the site. The work will require dedicated planning to effectively address the operational and safety challenges unique to these fuel transfer activities. Additional effort may also be required to evaluate and confirm fuel integrity, to remotely operate, handle and inspect spent and potentially damaged fuel, and to repair equipment.

In their approach to fuel removal, and to decommissioning in total, the government of Japan and TEPCO, have communicated their commitment to systematic, structured, and well controlled and coordinated operations at the site. Safety of the general public and workers at the site during all three phases of remediation and decommissioning is a priority, and operational procedures will reflect that priority. To this end, throughout all remediation planning and implementation activities, TEPCO has indicated that operations at the site will be well planned and coordinated, and lessons learned in early operations within each phase of activity will be incorporated into future operations.