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NUCLEAR ENERGY INSTITUTE

October 30, 2013

The Honorable Allison M. Macfarlane
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Lessons Learned and Observations from U.S. Chief Nuclear Officers Meeting with Japanese Counterparts at Fukushima Daiichi and Daini

Project Number: 689

Dear Chairman Macfarlane:

Recently, the chief nuclear officers (CNO) representing companies that operate U.S. nuclear energy facilities toured Tokyo Electric Power Company's (TEPCO) Fukushima Daiichi and Daini nuclear plants in Japan and participated in an historic dialogue with our executive counterparts at Japan's electric companies. I want to share with you the most important lessons learned and observations from that trip.

Twenty-three U.S. CNOs toured the two Fukushima facilities, met with the Japan Nuclear Safety Institute (JANSI) and held a day-long exchange with all of the CNOs representing Japanese electric utilities with nuclear energy operations. This was an exchange of unprecedented scope, with the Japanese CNOs sharing their response to the earthquake and tsunami at various sites on Japan's east coast. The purpose of the visit was to reinforce, through personal experience by the CNOs, the significance of the Fukushima accident, and to enable our industry to communicate these experiences firsthand to each nuclear power plant's organization.

The detailed tours and discussions provided U.S. CNOs with unique insights and observations, including many that validate the actions that the industry has initiated and the NRC is requiring in order to be ready to manage extreme natural events that may exceed a plant's design basis. These insights can be grouped into the following areas:

- Leadership is paramount during an extreme event, together with the training and skills of the facility staff needed to mitigate the event.

- TEPCO's response to the tsunami at Fukushima Daini demonstrates that the diverse and flexible coping strategy (FLEX) concept is effective.
- The spent fuel storage pools at Fukushima Daiichi survived the earthquake, tsunami and hydrogen explosions without significant damage to the fuel or significant radiological release.

Leadership Is Paramount

At Fukushima Daini, all four reactors shut down automatically as a result of the earthquake, but water damage from the tsunami resulted in the loss of cooling capability to remove decay heat in three of the reactors. The one reactor retaining core cooling capability was brought to cold shutdown in less than a day. Core cooling capability was re-established for the other three reactors over the subsequent three days, allowing operators to bring them to cold shutdown.[1]

Conditions at Fukushima Daini were not drastically different than at its sister plant six miles up the coast of Japan. Key factors in the stabilization of the Daini reactors were the strong and active leadership during the crisis, in-depth knowledge of the station that was applied to the situation, and motivated personnel who took extraordinary actions to maintain safety at the plant.

There was no prior planning or training by TEPCO for such an event, no pre-staged portable equipment such as that added at U.S. plants after the 2001 terrorist attacks, and only limited off-site support for supplying equipment. As the tsunami waters receded, Fukushima Daini site superintendent Naohiro Masuda marshaled plant personnel to assess the situation and take immediate actions to bring the four reactors to a safe condition. Learning that Unit 3 had partial AC power and a partially operable residual heat removal system, control room operators brought it to an orderly shutdown. At Units 1, 2 and 4, core cooling by the steam-operated reactor core isolation cooling (RCIC) system was time-limited because of rising temperatures in the suppression pool. They also determined that one incoming transmission line was energized, but due to the loss of the regional power grid as a result of the earthquake, the line was weak and fluctuating.

Masuda assessed the situation and articulated a clear and compelling vision to plant personnel to return the plant to a safe condition. He helped them understand the success path and focused efforts on the few actions that would provide the greatest opportunity for success. In a period of 30 hours, plant staff replaced residual heat removal pump motors and laid and energized 5.5 miles of heavy-duty electric cables. Core cooling was restored at all reactors, and they were brought to cold shutdown.[2]

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[1] EPRI (Electric Power Research Institute, 2011), *EPRI Fukushima Daini Independent Review and Walkdown* (EPRI Product No. 1023422) Palo Alto, CA: EPRI (available on EPRI.com) p.v.

[2] *Id.* p. 2-7.

The primary lesson learned is that leadership and training matter just as much as having the right equipment. The secondary lesson is that such capability cannot reside in a single individual. One can only contemplate the outcome at Fukushima Daini if Masuda had been away from the station at the time. Perhaps there were others who could have stepped up to lead, but leadership in a crisis must be assured. Our industry's CNOs believe that our plant leaders and staff are rigorously trained and qualified, exhibit the necessary attributes to succeed in such events, and they will work closely with NEI and INPO to ensure this capability remains in place.

FLEX Concepts Proven Effective at Fukushima Daini

TEPCO's response to the events at Fukushima Daini was directly aligned with the concepts embodied in the industry's diverse and flexible coping strategy (FLEX). Based on industry response to the NRC security requirements (B.b.5) after the 2001 terrorist attacks, the strategic use of portable equipment placed throughout plant sites was expanded to provide an another layer of protection for responding to beyond design basis events.

Of course, the significant difference at Fukushima Daini was that there were no pre-planned procedures and training and no portable or replacement equipment staged at the site. Nuclear energy stations in Japan did not implement measures similar to B.5.b capability after the 2001 terrorist attacks. Nonetheless, there are several elements of TEPCO's response at Fukushima Daini that match the U.S. FLEX approach planned under NEI 12-06, including steps taken by control room operators, use of equipment from other nearby sites or suppliers, and the use of government assets to assist with transportation or other logistics. At U.S. reactors, the primary FLEX objective is to develop a plant-specific capability for coping for an indefinite period through a combination of installed plant capability, portable on-site equipment and off-site resources.

If the personnel at Fukushima Daini were successful in preventing core damage in the units lacking AC power without pre-planning, pre-staging, off-site support and training—all facets included in the FLEX strategy—then the U.S. industry has great confidence we will be able to respond successfully to similar extreme natural events.

Spent Fuel Storage Pools are Robust and Resilient

The Fukushima Daiichi and Daini sites have 10 spent fuel pools within the reactor buildings. As demonstrated by events at these plants, especially Fukushima Daiichi Unit 4, the spent fuel pools survived one of the strongest earthquakes in Japan's history, a massive tsunami and hydrogen explosions in the secondary containment buildings without significant radiological release and damage to the fuel.

We discussed with our Japanese counterparts the safety of spent fuel at both plant sites. Even after the force of the earthquake and explosion rocked the Daiichi facility, the fuel racks and fuel assemblies were intact and did not pose a threat to public safety. Evidence gained from water sampling and videos of the

Fukushima Daiichi spent fuel pools[3] bolsters recent NRC staff comprehensive evaluations that conclude there is no need for additional regulatory action to require the expedited removal of spent fuel from the storage pools. In fact, the NRC evaluation subjected the reference plant to an earthquake much stronger than both its design basis earthquake as well as the earthquake that occurred at Fukushima.

The September plant tours and dialogues in Japan confirmed for our industry executives that leadership during a crisis, ongoing personnel training and FLEX can work together to maintain safety even after an extreme event. Please let me know if you have any questions or wish additional information from this exchange. We would be pleased to meet with you and to provide a briefing on the lessons learned by the U.S. CNOs.

Sincerely,

Anthony R. Pietrangelo

c: The Honorable Kristine L. Svinicki, Commissioner, NRC
The Honorable George Apostolakis, Commissioner, NRC
The Honorable William D. Magwood, IV, Commissioner, NRC
The Honorable William C. Ostendorff, Commissioner, NRC
Mr. Mark A. Satorius, Executive Director for Operations, NRC

[3] EPRI (Electric Power Research Institute, 2012), *Summary of the EPRI Early Event Analysis of the Fukushima Daiichi Spent Fuel Pools Following the March 11, 2011 Earthquake and Tsunami in Japan* (EPRI Product No. 1025058) Palo Alto, CA: EPRI (available on EPRI.com) p. 1-1.