NUCLEAR ENERGY INSTITUTE

Adrian P. Heymer
Executive Director
Strategic Programs

December 16, 2011

Mr. David L. Skeen
Director, Japan Lessons Learned Project Directorate
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: An Integrated, Safety-Focused Approach to Expediting Implementation of Fukushima Daiichi Lessons Learned

Project Number: 689

Dear Mr. Skeen:

Enclosed for your information is a copy of the NEI paper, *An Integrated, Safety-Focused Approach to Expediting Implementation of Fukushima Daiichi Lessons-Learned.* The paper describes the industry's diverse and flexible approach (FLEX) for mitigating the effects of severe natural phenomena that exceed the design basis of the plant. The FLEX approach was discussed in the December 1, 2011 meeting between the NRC Fukushima Steering Committee and the industry's Fukushima Response Steering Committee. Discussions on FLEX are continuing in the public meetings on the NRC's Fukushima Tier 1 topics.

The industry believes that FLEX will enable greater safety benefits to be realized in a shorter period of time. We look forward to discussing the details of the FLEX approach and other issues related to implementing safety enhancements based on the lessons learned from the Fukushima events in Japan in the next meeting of the industry and NRC steering committees early in 2012.

1776 I Street, NW | Suite 400 | Washington, DC | 20006-3708 | P: 202.739.8094 | F: 202.785.4019 | aph@nei.org |
www.nei.org

If you or your staff has questions, please contact me.

Sincerely,

Adrian Heymer

c: Mr. Martin J. Virgilio, Deputy Executive Director for Reactor and Emergency Preparedness Programs
Mr. James T. Wiggins, Director, Office of Nuclear Security and Incident Response
Mr. Eric J. Leeds, Director, Office of Nuclear Reactor Regulation
Mr. Brian W. Sheerin, Office of Nuclear Regulatory Research
Mr. Michael M. Johnson, Office of New Reactors
Ms. Catherine Haney, Office of Nuclear Material Safety and Safeguards
Mr. Mark A. Satorius, Director, Federal and State Materials and Environmental Management Programs
Mr. Victor McCree, NRC Region II Regional Administrator
Mr. Elmo Collins, Jr, NRC Region IV Regional Administrator
Mr. Robert M. Taylor, Deputy Director, Japan Lessons Learned Project Directorate

Enclosure

An Integrated, Safety-Focused Approach to Expediting Implementation of Fukushima Daiichi Lessons-Learned

Introduction

Since the March 11 accident at Fukushima Daiichi, the U.S. Nuclear Regulatory Commission and the commercial nuclear industry have systematically reviewed the events for applicable lessons and independently assessed what areas could be targeted for safety improvements at U.S. nuclear energy facilities. There is alignment between the NRC's Tier 1 recommendations discussed in SECY 11-0137 and the industry's priority areas.

The challenge before the industry and the NRC: how to implement safety enhancements smartly and expeditiously while meeting the expectations of the commission, Congress, and the public. Simply stated, what sequencing of actions would result in the most significant improvement to safety and preparedness in the shortest amount of time? We want to take prompt action that makes safe nuclear energy facilities even safer.

The industry believes that an integrated approach, built around Recommendation 4 in the NRC's Near-Term Task Force (NTTF) report, would provide the greatest safety benefit in the most expeditious manner. Recommendation 4 includes actions to further safeguard against prolonged station blackout conditions at single reactor and multi-reactor sites—without damage to fuel in the reactor or spent fuel pool and without the loss of the reactor coolant system or primary containment integrity. An integrated approach built around Recommendation 4 also mitigates risk from many of the other areas addressed by the NRC's Tier 1 recommendations.

This approach reflects the two principal lessons learned from Fukushima: 1) the importance of mitigating an extended loss of AC power and loss of ultimate heat sink to preclude fuel damage, and 2) companies must be prepared to mitigate events that affect multiple reactors at a site. The success criteria for this approach are to provide diverse and flexible means to obtain power and water to support key safety functions, to provide a response capability that addresses multiple reactors at a site, and to establish an appropriate regulatory footprint for oversight of implementation of this approach.

The purpose of this white paper is to describe the elements of an integrated approach based on Recommendation 4 in the NTTF report, provide the rationale for why this approach would result in the greatest improvement in safety, and how it could be effectively implemented in an expeditious manner.

Primary Response Actions

The Fukushima Daiichi accident was the result of a tsunami that exceeded the plant's design basis and flooded the site's emergency power supplies and electrical distribution system. This extended loss of power severely compromised the key safety functions of core cooling and containment integrity and ultimately led to core damage in three reactors. While the loss of power also compromised the spent fuel pool cooling function, sufficient water inventory was maintained in the pools to preclude significant fuel damage.

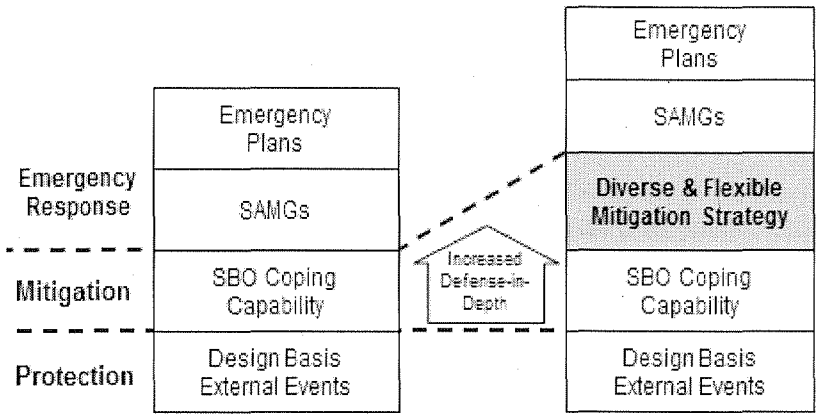
The size of the tsunami that hit Fukushima Daiichi was not accounted for in the plant's design basis. Thus, it is reasonable to revalidate the design bases for natural phenomena at U.S. sites. This is essentially what Recommendation 2 in the NTTF report calls for, and the industry already is

inspecting protective measures in place and validating the original plant design bases information for natural phenomena.

Although our ability to predict the magnitude and frequency of natural phenomena such as earthquakes and floods may be improving, some level of uncertainty will always remain. As a result, natural phenomena could exceed the assumptions used in the design and licensing of a plant, as demonstrated by the events at Fukushima. Additional steps that address the consequences of these "beyond design basis events" would enhance safety at each site.

The consequences that are most impactful to reactor safety are loss of power and loss of the ultimate heat sink. This is why Recommendation 4 is the top priority of the Tier 1 recommendations. Implementation of Recommendation 4 will mitigate risk in the majority of the targeted areas. An integrated approach built around this recommendation, i.e. adding a diverse and flexible mitigation capability—or FLEX capability—to address extended loss of power and loss of ultimate heat sink would increase defense-in-depth for beyond design basis scenarios (see Figure 1.)

Figure 1
Increase Defense-in-Depth with Diverse & Flexible Mitigation Capabilities (FLEX)



What is FLEX Capability?

FLEX capability is a diverse and flexible mitigation capability that would provide a backup to permanently installed plant equipment that could be unavailable following severe or extreme natural phenomena or malevolent acts. FLEX would provide multiple means of obtaining power and water needed to fulfill the key safety functions of core cooling, containment integrity and spent fuel pool cooling that would preclude damage to nuclear fuel and release of radio-nuclides.

FLEX consists of the following elements:

- **Portable equipment that provides multiple means of obtaining power and water to support key safety functions for all reactors at a site.** This equipment includes portable pumps, generators, batteries and battery chargers, compressors, hoses, couplings, tools, debris clearing equipment, temporary flood protection equipment and other equipment or tools needed to provide power and/or water to support key safety functions.

- **Reasonable staging and protection of portable equipment from natural phenomena applicable to a site.** The equipment used for FLEX would be staged and protected from applicable site-specific severe natural phenomena to assure its availability.

- **Procedures and guidance for emergency response personnel use of the FLEX capability if needed.** This guidance would be a symptom-based approach to supporting the key safety functions across multiple reactors and would assure command and control of multiple site activities.

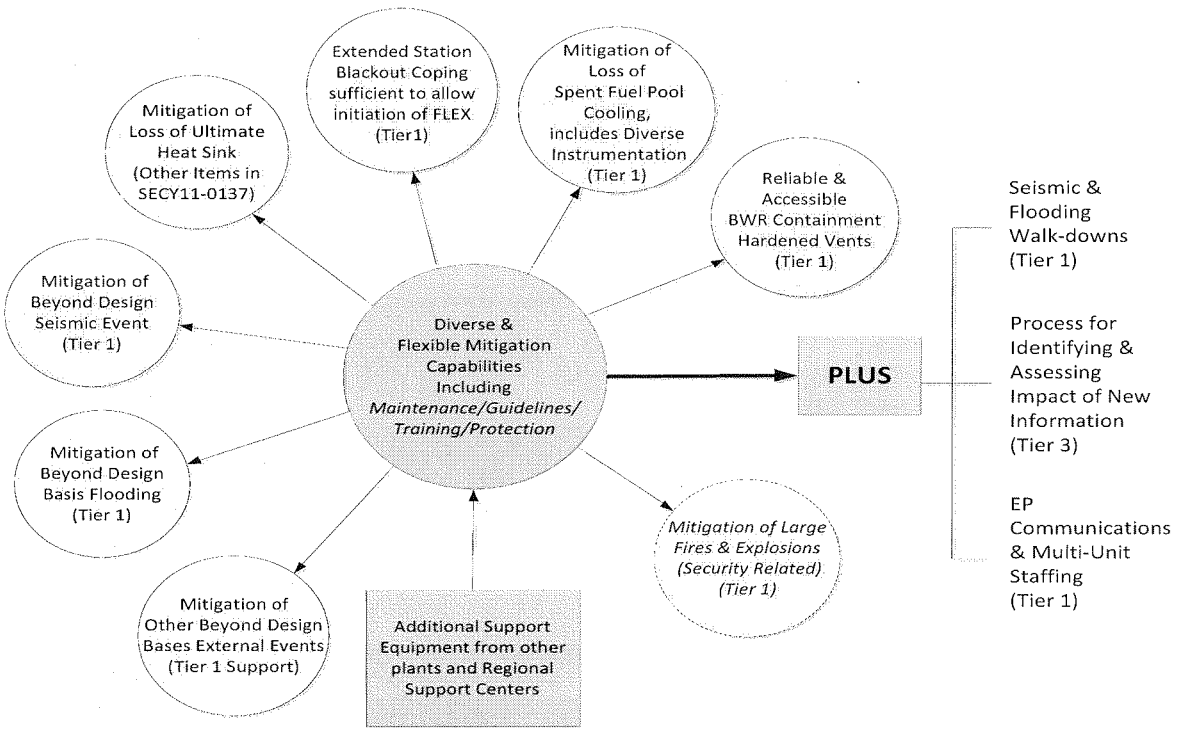
- **Programmatic controls that assure the continued viability and reliability of the FLEX capability.** These controls would establish standards for maintenance and testing of FLEX equipment, configuration management and periodic training of personnel.

FLEX will also be supplemented by establishing protocols with other plants or offsite support centers that could provide additional materials and personnel for longer-term response to extreme natural events. The industry is developing a plan and approach for providing this additional capability.

Why Should FLEX Be the Top Priority?

By providing multiple means of power and water supply to support vital safety functions, FLEX can mitigate the consequences of severe natural phenomena. Figure 2 depicts how FLEX can provide a common solution to mitigate multiple risks in an integrated manner. The figure also shows how FLEX comprehensively addresses the majority of the NRC's Tier 1 recommendations.

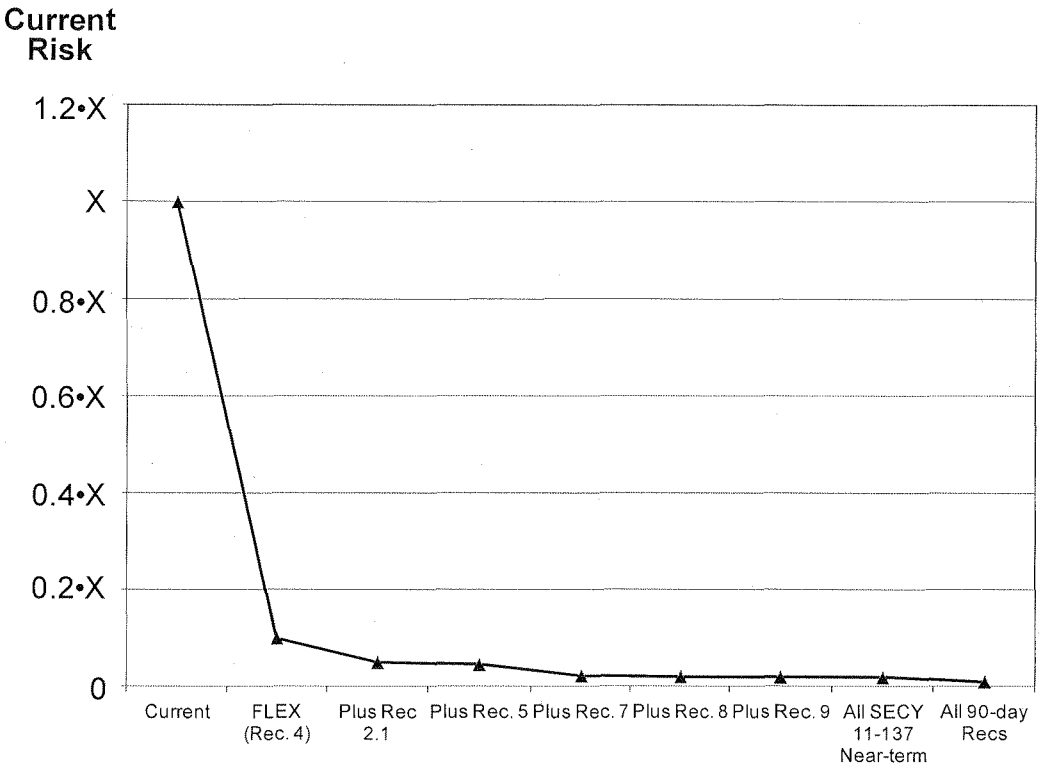
Figure 2
Improved Tier 1 with FLEX



Because FLEX mitigates the consequences of many different scenarios, it results in a significant reduction in risk. A risk-informed evaluation of the Tier 1 recommendations confirms that the most

significant safety benefit can be accrued by focusing on implementation of the FLEX approach for Recommendation 4. Figure 3 depicts the diminishing benefit of adopting additional Tier 1 recommendations from SECY 11-0137 beyond the FLEX approach for Recommendation 4. This generalized evaluation was confirmed by plant-specific reviews by the engineering staffs at a representative boiling water reactor and pressurized water reactor.

Figure 3
Representation of FLEX Safety Benefit



FLEX Can Be Implemented Expeditiously

The FLEX approach builds on the existing safety and preparedness capability established after September 11, 2001 under the NRC's B.5.b order, which was codified in 10 CFR 50.54(hh). That capability includes portable equipment to support key safety functions in the event of large fires and explosions. FLEX would significantly supplement that capability to address multiple unit effects from extreme natural phenomena.

Many companies have begun ordering additional portable equipment to supplement the post-9/11 enhancements so that multiple reactor effects can be mitigated. To expedite implementation of FLEX, focused interactions on the FLEX elements with the NRC staff, industry and other stakeholders are needed to provide the details associated with each element. The industry believes that this could be accomplished within six months and be ready for Commission consideration. Early implementation could be accomplished by a variety of regulatory mechanisms, but ultimate codification would require rulemaking. If a broad consensus can be reached on elements of the approach, this would facilitate a more efficient and effective rulemaking that can both enhance safety at the sites and meet the Commission's expectations for expeditious action by the agency and the industry.