UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

December 13, 2016

The Honorable Stephen G. Burns
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: CLOSURE OF FUKUSHIMA RECOMMENDATIONS RELATED TO EVALUATION OF NATURAL HAZARDS OTHER THAN SEISMIC AND FLOODING, PERIODIC CONFIRMATION OF NATURAL HAZARDS, AND REAL-TIME RADIATION MONITORING

Dear Chairman Burns:

During the 639th meeting of the Advisory Committee on Reactor Safeguards, November 30-December 2, 2016, we reviewed the NRC staff's publicly available white paper and enclosures documenting the draft final assessments for closure of Fukushima recommendations related to evaluation of natural hazards other than seismic and flooding, periodic confirmation of natural hazards, and real-time radiation monitoring. Our Fukushima Subcommittee reviewed material related to these matters on October 6, 2015, April 21, 2016, and October 19, 2016. During these reviews, we had the benefit of discussions with the staff. We also had the benefit of the referenced documents.

CONCLUSIONS AND RECOMMENDATIONS

1. Additional regulatory actions related to high winds and wind-driven missiles, snow and ice loads, failures of downstream dams, low water conditions due to a seiche or tsunami, and other conditions that result in degraded intake water quality or air quality cannot be justified.

2. The staff should ensure that the integrated procedures and guidelines for implementation of plant-specific diverse and flexible (FLEX) strategies contain adequate guidance for actions to trip affected operating equipment and reduce major heat loads if the plant experiences a loss of all cooling water with continued availability of AC power.

3. At sites which are vulnerable to conditions that may adversely affect the plant cooling water quality, the staff should review the plant-specific FLEX strategies to ensure that alternative sources of clean water are readily available, or the FLEX equipment has adequate filtration capabilities.

4. At sites which are vulnerable to conditions that may adversely affect the plant intake air quality for an extended period of time, the staff should review the plant-specific FLEX strategies to ensure that needed ventilation will remain available, and emergency generators or FLEX generators have adequate filtration capabilities.

5. The staff's proposed resolution of Fukushima Near-Term Task Force Recommendation 2.2 should be modified as follows:

    - The scope of external hazards to be assessed by the External Hazards Center of Expertise should be expanded to include man-made hazards, except for intentional acts.

    - The assessment process should contain a requirement for periodic reporting of the staff's state of knowledge about all external hazards.

6. Regulatory requirements for real-time radiation monitoring capability using fixed-station monitors onsite and within the Emergency Planning Zone at each site are not warranted. Decisions regarding augmentation of current offsite radiation monitoring capabilities are best left to the licensee, local, and state authorities who are most directly involved with implementing the emergency response plans.

BACKGROUND

The staff proposed, in SECY-11-0137, a three-tiered prioritization of the Fukushima Near-Term Task Force (NTTF) recommendations. Tier 1 consisted of those recommendations that the staff determined would lead to the most safety benefit, could be started without significant delay, and for which sufficient resources and critical skill sets were available. Tier 2 consisted of those recommendations that could not be initiated in the near-term due to factors that included the need for further technical assessment and alignment, dependence on Tier 1 issues, or availability of critical skill sets. Tier 3 consisted of those recommendations that required further study to support a regulatory action, had an associated shorter-term action that needed to be completed to inform the longer-term action, depended on the availability of critical skill sets, or depended on the resolution of NTTF Recommendation 1.

Many of the initial Tier 2 and Tier 3 recommendations were subsumed into Tier 1 activities and other focused evaluations (e.g., expedited transfer of spent fuel to dry cask storage). The staff presented, in SECY-15-0137, their plans to resolve and close the remaining open Tier 2 and Tier 3 recommendations. The September 22, 2016 white paper that is the subject of our review addresses the staff's resolution of the last group of those recommendations:

- Evaluation of other natural hazards (ACRS Recommendation)

- Periodic reconfirmation of natural hazards (NTTF Recommendation 2.2)

- Efficacy of real-time radiation monitoring in the Emergency Planning Zone and onsite (NTTF Recommendation 11.3)

DISCUSSION

The following sections summarize our comments on each major topic of the white paper and other elements of our review of the closure of these recommendations.

Evaluation of Natural Hazards other than Seismic and Flooding

The staff presented, in SECY-16-0074, the results from Task 1 and Task 2 of their assessments of natural hazards other than seismic and flooding. Our May 17, 2016 letter summarized our review of a white paper on those interim assessments, which was subsequently issued as Enclosure 1 to SECY-16-0074. We concurred with the staff's justifications for excluding most other hazards from further evaluation and with their conclusion regarding the need for further evaluations of the effects from high winds and snow loads at some sites. We also indicated that we would review the Task 2 assessments of selected hazards to better understand the bases for the staff's recommendations.

Enclosure 1 to the September 22, 2016 white paper contains the staff evaluations of the high wind and snow hazards. The results of our review of the staff analyses of natural hazards other than seismic and flooding are presented in the following sections.

High Winds

Current guidance for the determination of design basis wind speeds and wind-driven missiles is found in Regulatory Guide 1.76, Revision 1, for tornadoes and Regulatory Guide 1.221 for hurricanes. The staff examined the high wind design bases for all currently operating reactors to identify situations where the existing design basis does not bound requirements of the current guidance. Several differences were identified. In some cases, those differences arise from limitations in the criteria that applied when a particular plant was licensed. In other cases, the regulatory guidance has changed. That is particularly true for the evaluation of wind-driven missiles. Both the physical characterization of those missiles and the determining wind speeds have evolved over time. For example, it was historically assumed that tornado-wind-driven missiles provide the most limiting impact loads. That conclusion remains valid for most sites in the U.S. However, current evaluations conclude that hurricane winds can produce more energetic missiles at some sites along the southern and eastern seaboard.

The staff identified three units that do not have well-defined design bases for high winds and a fourth unit for which the existing design basis tornado wind speed does not bound the tornado wind speed from Regulatory Guide 1.76, Revision 1. Hurricane wind speeds at three other sites exceed the tornado wind speeds that were used for those units' design bases. At a number of additional sites, the existing design bases for specific types of wind-driven missiles do not meet the current guidance for evaluating the impacts from rigid pipes or large deformable masses that are equivalent to an automobile.

The staff examined each site for which the existing design basis does not bound the structural wind loading or missile impacts that would apply from the current guidance. Their evaluations were informed by the results from applicable Individual Plant Examination of External Events (IPEEE) studies, comparative analyses of structural design margins, assessments of the required protection for equipment that is currently being installed for mitigation of beyond-design-basis external events (FLEX equipment), and considerations of the regulatory analysis guidelines in NUREG/BR-0058. Based on the totality of this information, the staff concluded that additional regulatory actions cannot be justified for any of these sites.

We concur with the staff's conclusion that additional regulatory actions related to high winds and wind-driven missile hazards cannot be justified. We discount the cited risk information from the IPEEE studies. In many cases, those analyses were very simplified and were based on assumptions that did not critically examine damage from extreme wind speeds or wind-driven missiles. However, the staff's comparative structural assessments provide confidence that realistic analyses of the as-built safety-related buildings would show adequate margin against most, if not all, impacts from the current spectrum of missiles. Our conclusion also accounts for the experience that missile damage is typically localized and does not cause catastrophic structural failure. For example, more realistic analyses of interior damage from penetrating missiles would evaluate effects on equipment, piping, and cables in the vicinity of the point of impact and account for the remaining available systems, subsystems, and functions.

The white paper provides useful supporting information about the proposed high wind protection for FLEX equipment at ten of the sites examined by the staff. That equipment and the FLEX strategies provide additional defense in depth against damage to plant structures and equipment. The designs vary according to the site-specific application of the guidance in NEI 12-06 and Interim Staff Guidance JLD-ISG-2012-01. Many are consistent with the existing plant design basis, while some are based on the guidance in Regulatory Guide 1.76, Revision 1.

The data in NUREG/CR-4461 show that expected occurrence frequencies for tornado wind speeds that are used for the existing plant design bases are very small, typically less than $1x10^{-5}$ event per year, accounting for both the frequency of a severe tornado and the likelihood that it will impact a particular site. The current design basis exceedance frequencies for tornado, hurricane, and wind-driven missile speeds from Regulatory Guide 1.76, Revision 1, and Regulatory Guide 1.221 are $1x10^{-7}$ event per year. Based on the very low frequency of these extreme wind hazards and the extent of their expected damage, additional regulatory requirements to further improve operating plants to make their designs consistent with the current guidance cannot be justified.

Snow Loads

Current guidance for the determination of design basis loads from snow, ice, and winter precipitation is found in Interim Staff Guidance DC/COL-ISG-007. The staff used a process similar to that summarized above for high winds to examine the snow loading design bases for all currently operating reactors and to identify situations where the existing design basis does not meet the current guidance. Based on that review, the staff identified five sites for further assessment.

The staff's evaluations were informed by the results from IPEEE studies, comparative analyses of structural design margins, reviews of site-specific severe weather procedures, and assessments of the required protection for FLEX equipment. Based on the totality of this information, the staff concluded that additional regulatory actions cannot be justified for any of these sites.

We concur with the staff's conclusion that additional regulatory actions related to snow and ice loads cannot be justified. As with the high wind assessments, we discount the cited information from the IPEEE studies. The white paper notes that the effects from snow and ice loading were included only in the IPEEE submittal for Haddam Neck, with a relatively low contribution to overall plant risk. The fact that no other licensee reported any vulnerability from this hazard is likely due to the simplified analyses and broad screening assumptions that were applied in most IPEEE studies, which did not critically examine damage from rare extreme natural hazards, other than seismic events. We were not briefed on the site-specific procedures related to preparations for severe winter storms or removal of accumulating snow from building roofs. However, the staff's simplified comparative structural assessments provide confidence that realistic analyses of the as-built safety-related buildings would show adequate margin against the current design basis loads, even if the accumulated precipitation were not removed proactively.

The staff's evaluation notes that guidance in NEI 12-06 indicates that FLEX equipment storage structures should be designed to withstand the site's design basis snow and ice loading. The guidance further specifies that each site should have sufficient snow removal equipment to clear the necessary transportation routes and connection locations.

Failures of Downstream Dams

The staff concluded, in Enclosure 1 to SECY-16-0074, that no further regulatory actions are needed to address the issue of failures of downstream dams that impound plant cooling water supplies. That conclusion was based primarily on the staff's resolution of a proposed generic issue on “Effects of Downstream Dam Failures on Nuclear Power Plants,” supplemented by a more in-depth examination of the cooling water supplies at the H.B. Robinson site.

At the time of our May 17, 2016 letter, we had not been briefed on the analyses that were performed to support resolution of the proposed generic issue. That issue pertains to random (so-called “sunny day”) failures of downstream dams that are deemed to be robust against seismic events. All other causes for downstream dam failures are currently being evaluated by licensees as part of their responses to NRC Order EA-12-049, the guidance in Interim Staff Guidance JLD-ISG-2012-01, and the NRC-endorsed industry guidance in NEI 12-06.

The staff initially examined 13 sites with this potential vulnerability and concluded that four warranted additional evaluation. The screening analyses for those sites were risk-informed, but they relied only on estimates of core damage frequency, due to limitations in the NRC's plant-specific Standardized Plant Analysis of Risk (SPAR) models. The staff then performed more detailed assessments of downstream dam failures at each of four sites, which had small margins to the applied screening criteria. Those analyses accounted more thoroughly for the site-specific configuration of normal and alternative cooling water supplies, their capacities, and their impoundments.

We reviewed the analyses for each of the four sites, including the supplemental evaluation of H.B. Robinson. They are developed to an appropriate level of detail for the purpose of this application. In some cases, the analyses rely on assumptions about plant-specific system

configurations, success criteria, and operating practices that could benefit from confirmation by the respective licensees. We identified several sources of numerical values that would increase the staff's calculated core damage frequencies substantially for some plant-specific scenarios. However, even with those corrections, all estimates remain very small and are well below thresholds that would justify additional regulatory actions according to the guidance in NUREG/BR-0058. Based on these considerations, we concur with the staff's conclusion that additional regulatory actions related to random failures of downstream dams cannot be justified.

Seiche and Tsunami Effects on Water Intakes

The staff concluded, in Enclosure 1 to SECY-16-0074, that no further regulatory actions are needed to address the issue of low water conditions due to the effects from a seiche or tsunami. The white paper that was available for our May 17, 2016 letter contained limited justification for the staff's assessments of each site that may be affected by these conditions. The final version of Enclosure 1 to SECY-16-0074 contains enhanced bases for the staff's conclusion.

The low intake water conditions associated with a seiche or tsunami are transitory. Depending on the plant-specific design, they may result in loss of suction, air ingestion, and damage to all pumps that normally supply flow from the cooling water intake. The site FLEX equipment and its mobilization pathways are to be protected from damage by flooding (e.g., during a tsunami). Therefore, the FLEX equipment and strategies should have the capability to restore core cooling, containment, and spent fuel cooling after the intake water level stabilizes.

Baseline FLEX response strategies are based on the assumed conditions of an extended loss of AC power combined with loss of access to the ultimate heat sink. Transitory low water scenarios are different. In particular, if AC power remains available, the requirements for cooling plant equipment and rooms may be more limiting, and the corresponding time windows for personnel response may be shorter than those assumed in the baseline FLEX guidance. An example of this concern is the amount of time until reactor coolant pump seals may be damaged when the pumps remain running with no source of cooling, compared to a condition when the pumps are stationary after loss of their AC power supplies.

We discussed these types of scenarios with the staff in the context of their assessments of low water conditions and intake water quality. We were informed that the staff accounts for the availability of plant-specific procedural guidance for operator actions to trip equipment that continues to run without cooling and to isolate other major plant heat loads. These actions would then extend the amount of time that is available to restore needed cooling functions according to the FLEX strategies.

Considering the low frequency of these particular hazards and the availability of FLEX strategies to restore alternative cooling, we concur with the staff's conclusion that additional regulatory actions related to these causes for low water conditions cannot be justified. However, the staff should ensure that the integrated procedures and guidelines for implementation of the plant-specific FLEX strategies contain adequate guidance for actions to trip affected operating equipment and reduce major heat loads if the plant experiences a loss of all cooling water with continued availability of AC power.

Ultimate Heat Sink Water Quality

Our May 17, 2016 letter discussed other possible hazards that may adversely affect the quality of the plant cooling water supply and render it unsuitable for reliable heat removal. The initial effects from these hazards may be similar to the low water level conditions that are discussed above. However, the degraded water quality may persist for an extended period of time and affect the capability of alternative cooling from the FLEX equipment.

The potential causes, frequency, and consequences from these conditions are site-specific and vary substantially. Based on current knowledge and operating experience, we conclude that realistic risk-informed evaluations would show that additional regulatory actions related to these hazards cannot be justified. They are best addressed by site-specific protection and mitigation strategies. The staff should review the plant-specific FLEX strategies at sites that are vulnerable to conditions which may adversely affect the plant cooling water quality to ensure that alternative sources of clean water are readily available, or the FLEX equipment has adequate filtration capabilities.

Volcanic Ash and Intake Air Quality

At the time of our May 17, 2016 letter, we did not have sufficient information about the staff's assessments of the effects of volcanic ash to support a conclusion that no further regulatory action is needed. We have since been briefed on more details of those evaluations and specific features of the Columbia Generating Station ventilation systems, emergency diesel generators, and FLEX diesel generators. We concur with the staff's conclusion regarding Columbia Generating Station and six other sites that were examined for this hazard.

Our consideration of other potential causes for adverse air quality (e.g., sandstorms, dust storms, heavy smoke from fires) is similar to the preceding discussion about intake water quality. These conditions are best addressed by site-specific protection and mitigation strategies. The staff should review the plant-specific FLEX strategies for sites vulnerable to atmospheric conditions that adversely affect air quality for extended periods to ensure that needed ventilation will remain available, and emergency generators or FLEX generators have adequate filtration capabilities.

Evaluation of Periodic Confirmation of Natural Hazards

Enclosure 2 to the current white paper contains the staff's evaluation of NTTF Recommendation 2.2 regarding the need for rulemaking to require that licensees confirm seismic hazards and flooding hazards every ten years and address any new and significant information. The staff's proposed resolution provides for enhancement of existing processes for ongoing assessment of natural hazards, to provide a proactive approach without adding undue regulatory burden. Staff activities will be coordinated by the NRC External Hazards Center of Expertise and will include assessments of all natural hazards, without restriction to only seismic and flooding hazards. We concur with the staff's proposed process to close Recommendation 2.2 and recommend the following enhancements.

The scope of external hazards to be assessed by the Center should be expanded to include man-made hazards, except for intentional acts. The recommendations in Enclosure 2 of the white paper explicitly limit the assessments to include only “natural hazards”, and the staff has further clarified that intent in their briefings to us. Information about the frequency and consequences of man-made hazards continues to evolve. Examples include the frequency and spatial distributions of private, commercial, and military aircraft crashes; industrial, rail, highway, and shipping accidents; pipeline leaks and explosions; models and methods for evaluating consequential deflagrations, detonations, and toxic gas dispersal. The staff, operating reactor licensees, and new reactor applicants will benefit from a more comprehensive and contemporary understanding of these hazards.

The proposed hazard assessment process should contain an explicit requirement for periodic reporting of the staff's state of knowledge about all external hazards. A distinct benefit from a formal periodic update is that it focuses the organization's attention on comprehensive issues, including an appreciation of subtle interrelationships and the cumulative effects from evolving knowledge which may be missed during routine information collection and processing. The NTTF also recognized the importance of this periodic reconfirmation process.

Evaluation of Real-Time Radiation Monitoring

Enclosure 3 to the current white paper contains the staff's evaluation of NTTF Recommendation 11.3 regarding the need for real-time radiation monitoring capability using fixed-station environs monitors (FSEMs) onsite and within the Emergency Planning Zone. The NTTF also recommended that the FSEMs be capable of operating independently of AC power and that their readings be made available publicly on the Internet.

The staff endorsed retention of current onsite and offsite monitoring and assessment capabilities, without further enhancement. The staff also concluded that real-time dissemination of the monitored data should be limited to local and state authorities who are directly involved with implementation of emergency responses.

The staff notes that a large number of FSEMs would be needed to provide accurate information about the characteristics of any possible release. The circumferential and radial distribution of those monitors would also need to carefully account for local topography and meteorology to effectively track the evolution of a plume over the duration of its release. The staff notes further that initial protective actions are triggered by evolving conditions inside the plant, without information from offsite monitors. Therefore, implementation of the first phases of offsite emergency plans would not be influenced by the FSEM data.

We concur with the conclusion that a regulatory requirement for installation of a comprehensive network of FSEMs at each site is not warranted. Over-reliance on those monitors might also inadvertently reduce the effectiveness of current offsite monitoring capabilities by curtailing the number of personnel and deployment plans for portable monitoring functions. Decisions regarding augmentation of current offsite radiation monitoring capabilities are best left to the licensee, local, and state authorities who are most directly involved with emergency response.

We also agree with the conclusion that distribution of real-time monitoring information should be limited to authorities who are responsible for the site, local, regional, and state emergency plans. Immediate public availability of the monitored data can result in unexpected and undesired reactions that interfere with implementation of the emergency plans and endanger the health and safety of the local populace.

Sincerely,

/RA/

Dennis C. Bley
Chairman

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