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August 1, 2013

Ms. Cindy K. Bladey
Chief, Rules, Announcements, and Directives Branch
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Nuclear Industry Comments on U.S. Nuclear Regulatory Commission Draft Report "Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor," 78 *Fed. Reg.* 39781, July 2, 2013; Docket ID: NRC-2013-0136

Project Number: 689

Dear Ms. Bladey:

On behalf of the nuclear industry, the Nuclear Energy Institute (NEI)[1] is pleased to provide the U.S. Nuclear Regulatory Commission (NRC) comments on the draft June 2013 report "Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor." The industry agrees with and supports the overarching conclusion of the report that the "...NRC continues to believe, based on this study and previous studies that spent fuel pools protect public health and safety."

The industry compliments the NRC staff and, in particular, the authors and writers of the study for a well written report. While the topic—spent fuel storage safety—is complicated, the report is organized and composed to be easy and compelling to read. The Executive Summary, Introduction and Background (Sec. 1), and the Summary and Conclusions (Sec. 12) provide any reader with an understanding of the subject.

Of special note is the Overview of Past Studies (Sec. 1.7), which provides an important catalogue of spent fuel pool evaluations to date and makes clear the importance of the phrase "...this study and previous studies..." in the overarching conclusion of the study.

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[1] NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

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The Study Further Confirms the Safety of Spent Fuel Pools Under Current Practice

The study is a comprehensive evaluation of the dominant risk (a severe earthquake) at a reference plant that has the potential to result in radioactive releases from the spent fuel pool. The evaluation extensively considered both high-density pool loadings, which is the current practice,[2] and low-density pool loadings, which would require expedited off-loading of spent fuel to dry casks to achieve.

The industry concurs with the conclusions of the NRC's Advisory Committee on Reactor Safeguards (ACRS) as stated in its July 18, 2013 letter:

"The study has demonstrated that health effects from seismically initiated spent fuel pool damage scenarios are very low for both low-density and high-density pool loadings."

And that the ACRS "...agree(s) with the staff's conclusion that the expedited transfer of spent fuel from the pool to dry cask storage does not provide a substantial safety enhancement for the reference plant."

The NRC will use the insights from the study as part of a broader regulatory review of spent fuel pools at all operating nuclear power plants in the U.S. The nuclear industry looks forward to participating with the other stakeholders in that evaluation to determine what, if any, regulatory changes are needed in this area.

Spent Fuel Storage is Safe in Either Pools or Dry Storage

A number of studies have confirmed that spent nuclear fuel is safe in both storage pools and in dry storage systems. The difference in safety between pool and dry storage, as documented in the study, is very small. More particularly, the public health risk of either storage option is extremely low, so the difference between the risks of the two options is the small difference between already extremely small values.

To ensure that the study could analyze a failed pool scenario that results in spent fuel damage, the study assumed the occurrence of an earthquake that produced a ground motion of four to eight times that used in the reference plant design. Even with such a large earthquake, the study predicted that leakage of pool water would only occur with an extremely small likelihood.

Even with the low likelihood for pool damage, the study shows that it is even less likely that the spent fuel will be damaged such that radioactive release takes place. Thus, the public health risk from such a rare event is very, very small and thousands of times lower than the NRC's quantitative health objective.

How does that compare with what happened on March 11, 2011, at the Fukushima Daiichi site in Japan? According to the study, the earthquake assumed in the study was greater than the Tohoku earthquake that

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[2] Largely due to the federal government's failure to remove spent fuel from commercial nuclear power plants, which was statutorily and contractually required to have begun on January 31, 1998.

led to the tsunami that ultimately caused the accident at the Fukushima Daiichi site. As shown on the U.S. Geologic Survey Earthquake Hazards Program website (http://earthquake.usgs.gov/earthquakes/world/historical.php), the Tohoku earthquake was the fourth largest in the world since about the year 1556. The assumed earthquake in the study was larger.

In addition, as mentioned in the study and documented in a number of Fukushima Daiichi post-accident reviews (referenced in the study), notwithstanding that four of the six Fukushima Daiichi units were severely damaged by the tsunami and then three of the four subjected to major hydrogen explosions, the fuel in the pools remained underwater, there was no damage to the fuel, and there have been no releases from the fuel in any of the four spent fuel pools. The reference plant was selected, because—among other factors—it is similar to the Fukushima Daiichi units.

This is an important context in which to view the results of the study. Despite analytically subjecting the reference plant spent fuel pool to an earthquake much larger than that for which it was designed and larger than one of the largest earthquakes known worldwide, the worst the study could find was an extremely small chance that the spent fuel pool would leak.

This is no surprise. Spent nuclear fuel is extremely well-protected from potential natural events and terrorist attacks by a combination of sturdy plant design and construction, ongoing surveillance and inspection, and armed, well-trained security forces. Fuel storage pools are very large, very robust structures, some 40-feet deep, designed with reinforced concrete walls several feet thick and lined with steel. All used fuel pools are designed to seismic standards consistent with other important safety-related structures on plant sites.

Event Mitigation

Water occupies most of the space in the pool regardless of whether high-density or low-density fuel storage is employed. The water provides an excellent shield for radiation, with 23 to 30 feet of water shielding above the fuel and also provides fuel cooling. The volume of water in the pools is so large that there would be time for operators to establish backup water supply before any significant water loss could occur. The study results reflect this capability. However, as shown in the study, mitigation of the event—the provision of emergency water and power if built-in plant systems are rendered unavailable—provides a significant benefit in lowering the potential for releases in the very unlikely event a pool is damaged.

After the terrorist attacks on September 11, 2001, the NRC issued orders to all plants requiring several measures aimed at mitigating the effects of a large fire or explosion that damages the ability to cool the spent fuel pool. These orders, now codified at 10 CFR 50.54(hh)(2), were meant to address the aftermath of a terrorist attack or plane crash. The study considers two cases: mitigation based on these requirements and no mitigation.

A separate human reliability assessment considered how successful plant personnel would be in instituting these measures in this situation. The study showed that in most situations, spent fuel pool mitigation can be deployed in time to prevent releases. Recommendations for improvements are provided for those few situations where mitigation might not be as effective.

Following Fukushima, capabilities to mitigate the effects of natural phenomena, such as tornadoes, earthquakes or tsunami, have been enhanced and made more reliable. The study acknowledges the post-Fukushima orders requiring nuclear plants to mitigate beyond-design-basis events (such as the earthquake evaluated in the study) and to have reliable spent fuel pool level instrumentation. While the study doesn't credit these improvements, it agrees that they improve the capability to mitigate such events.

The effect of these improvements based on lessons learned from the Fukushima Daiichi accident cannot be overstated. The mitigation capability of each site will be greatly increased by the industry's diverse and flexible coping strategies (FLEX), which provide more emergency equipment onsite than required by 10 CFR 50.54(hh)(2) and additional equipment available from regional response centers. The FLEX equipment will be protected against natural hazards, which is not required by 10 CFR 50.54(hh)(2). In addition, the reliable spent fuel pool level instrumentation will provide improved knowledge of conditions in the pool. This capability greatly exceeds what was at the Fukushima Daiichi plant and will provide greater capability and reliability to mitigate a beyond-design-basis event. If the study had accounted for the FLEX capabilities, it is likely that the small chance of release would have been even smaller and the recommendations stemming from the human-reliability analysis may have been included.

Safe Spent Fuel Pool Operation

The industry is required to control the configuration of fuel assemblies in the pool to enhance the ability to keep the fuel cool and recover from damage to the pool. Placing newer (hotter) spent fuel assemblies next to older (cooler) assemblies enhances the ability to keep the fuel cool if cooling systems are inoperable and there is the unlikely loss water from the pool. The study evaluated two spent fuel configurations and performed sensitivity analyses on several other configurations to determine the effects of spent fuel configurations on the results of the study.

The first configuration evaluated consisted of hot fuel assemblies surrounded by four cooler assemblies in a 1x4 array. The second configuration evaluated was a spent fuel pool only containing fuel with less than five years cooling where the hot assemblies are surrounded by empty water cells (the low-density configuration). Sensitivity analyses evaluated a 1x8 array, in which the hot fuel assemblies are surrounded by eight cooler assemblies, and a uniform array.

While the study concluded there was no reason to require expedited unloading of spent fuel from pools to achieve the low-density configuration, the study showed consistent advantages associated with dispersed fuel loading patterns. Dispersed fuel loading is already required through implementation of 10 CFR 50.54(hh)(2).[3]

Risks of Expedited Pool Unloading

The study did not evaluate the risks associated with increased movement and loading of dry storage casks, which would be unnecessary, to expedite unloading of the pools. Removing fuel from the spent fuel pools earlier will result in loading higher heat load and higher dose casks due to the fuel not having decayed as long (increasing occupational doses for workers); loading more casks due to having to load either de-rated casks (fewer assemblies) or smaller casks to accommodate the higher heat loads; greater frequency of postulated cask drops with greater potential for pool damage and releases; increased number of cask shipments when being sent to a repository, etc.

The study recognizes, but does not quantify, the increase in risk that this represents for the low-density pool storage case. If the study had accounted for these risks, it is likely that the conclusion that "...the expedited transfer of spent fuel from pools to dry cask storage containers does not provide a substantial safety enhancement for the reference plant" would have been more strongly supported.

Off-Site Effects

The study considered the effects of releases in the very unlikely event that the spent fuel pool is damaged. As the study points out, "while the likelihood of release is very low, offsite protective measures and population relocation, may be extensive." It goes on to point out that that successful mitigation measures *or* low-density pool loading will considerably reduce the off-site effects.

The study also identifies that for certain scenarios the amount of off-site effects (particularly the amount of land potentially affected) is driven by hydrogen-combustion events and the associated releases. The study further states that these situations can be avoided by successful mitigation.

There are two very important points to draw from this part of the study:

- In cases where the fuel is damaged, existing emergency procedures would keep the population around the plant safe.
- Mitigation is the key. Off-site effects will be greatly reduced (or prevented altogether) through successful mitigation.

[3] The communication from the NRC to licensees requiring dispersed fuel loading is not available to the public.

As discussed above, the industry is engaged in improving its ability (by individual plants and collectively) to mitigate a beyond-design-basis event by implementing the diverse and flexible coping strategy, as described above.

Cumulative Effects of Regulations

In both the short and long term, the most basic obligation that the industry and the NRC have is to maintain the nation's commercial nuclear power plants in a safe and secure condition. This is accomplished through the industry operating and maintaining nuclear plants in a safe and secure manner in accordance with NRC's rules, regulations, guidance, etc.

The amount of regulatory activity affecting commercial nuclear plants has been increasing since 2005, and in particular since the accident at Fukushima Daiichi. As the regulatory workload increases, it is important that the industry and NRC continue to focus on activities that will maintain or elevate our nation's high standards of nuclear plant safety, security and reliability.

The results of the study make clear that the risks of spent nuclear fuel storage in pools under current practices is very, very small and that the spent fuel pools are safe and secure. Based on the risk of storage as identified in this and previous studies and the ability of plants to mitigate beyond-design-basis events, there is no reason for the NRC to require a reduction of the density of spent fuel storage in pools.

The industry appreciates the opportunity to comment on the NRC draft spent fuel pool study and look forward to participating with other stakeholders in the forthcoming regulatory evaluation.

Please do not hesitate to contact me if you have any questions.

Sincerely,

SPKraft

Steven P. Kraft