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U. S. Nuclear Regulatory Commission
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RE: Response to Generic Letter 2016-01 from The Ohio State University Research Reactor (OSURR), License R-75, Docket 50-150

This resubmission of our response to GL 2016-01 originally dated October 31, 2016, removes extraneous header information and adds one additional piece of information as requested by the NRC. A change bar on the right side of the document notes the additional information; the remainder of the letter is unchanged.

NRC Generic Letter 2016-01 requested of non-power reactor licensees answers to three questions regarding their use of neutron absorbing materials for reactor fuel storage. This letter provides answers to these questions for The Ohio State University Research Reactor (OSURR). The questions and answers follow, with the questions in italics.

1. *Are neutron-absorbing materials used in a reactor pool, fuel storage pool, or other wet locations designed for the storage of reactor or spent fuel?*

   Yes, a boron carbide and aluminum metal matrix material (Boral) is used in the OSURR fuel storage well in the form of ¼" Boral plates that span the width of the fuel rack in the well.

2. *If neutron-absorbing materials are used, is their use credited in the licensing or design basis (i.e., criticality safety analysis) for the storage of reactor fuel or spent fuel in a reactor pool, fuel storage pool, or other wet locations, as applicable?*

   Yes, OSURR Technical Specification (TS) 5.4 states that k_{eff} shall not exceed 0.90 for the fuel storage well. Monte Carlo analysis indicates that the storage-well rack fully loaded with fuel elements and with the Boral plates would have $k_{eff} < 0.9$. Without the Boral plates, a fully-loaded rack would be subcritical but would have $k_{eff} > 0.9$.

3. *If neutron-absorbing materials are credited in the facility licensing or design basis for the storage of reactor or spent fuel in a reactor pool, fuel storage pool, or other wet locations, as applicable, then provide a description of, and technical basis for, any surveillance or monitoring programs used to confirm continued acceptable performance of the neutron-absorbing materials over time.*

   The Electric Power Research Institute (EPRI) published a report in July 2012 entitled "Strategy for Managing the Long Term Use of BORAL in Spent Fuel Storage Pools" (Report No. 1025204), and this report looked at long-term performance of Boral used in power-reactor spent fuel pools. The report states:

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> It is important to note that the corrosion observed to date has not led to any significant loss or redistribution of B-10, nor have any mechanisms been identified that would lead to either of these conditions.

In conjunction with fabrication and delivery of LEU fuel to the OSURR in 1988, a Monte Carlo criticality analysis was performed using KENO at Idaho National Engineering Laboratory (INEL, now Idaho National Laboratory or INL). This analysis indicated that the k_{eff} of the LEU fuel would be well below the TS limit for the OSURR fuel storage well fully loaded with fuel and with the Boral plates. To expand upon this analysis from 1988, the OSURR staff has performed criticality analysis for the fuel storage well using MCNP. This effort involved creation of a detailed model of the fuel and storage well, benchmarking the model against the INEL results, and analyzing numerous configurations.

In addition to confirming that the storage well rack fully loaded with fuel elements would be under the TS limit for k_{eff} with the Boral plates in place, the modeling shows that even if 99% of the B-10 was removed from the Boral plates, the TS limit would still be met. Therefore, even if there were a significant loss of B-10 from the Boral (which is very unlikely according to the EPRI report), there is no danger of exceeding the TS limit.

In order for the TS k_{eff} limit to be exceeded, 100% of the B-10 would have to be removed from the Boral plates with the fuel storage well fully loaded with fuel elements. Under those conditions, k_{eff} would be 0.9658 ± 0.0008, so the upper bound on k_{eff} would be 0.968 using a confidence interval of 3σ. Note that even under this unrealistic scenario of complete B-10 loss, the fuel storage well would still be subcritical.

Furthermore, the modeling shows that removal of the highest-worth Boral plate would not result in the TS k_{eff} limit being exceeded. When the fuel storage well covers are removed for semi-annual inventory of fuel, the plates are obviously in place as viewed from the pool top, where the OSURR staff is performing the inventory. Therefore, the staff regularly observes that the Boral plates are in place, and even if a plate was not in place in the storage well, the TS k_{eff} limit would not be exceeded.

Finally, regarding the TS k_{eff} limit, credit for the Boral plates is only needed when the reactor core is unloaded for a full fuel inspection, which typically occurs every 5 yrs or when maintenance is performed in the pool. Under normal circumstances, the majority of fuel elements are located in the reactor core, leaving only about ¼ of the fuel elements in the fuel storage well. MCNP modeling indicates that even without Boral plates in the fuel storage well, the fuel that is stored there under normal operating conditions does not result in $k_{eff} > 0.9$.

Regarding blistering of Boral, the EPRI report cited above has the following to say:

> Similarly, in-pool blistering of BORAL® has, to date, proven to primarily affect the operational aspects of the storage racks by impacting fuel assembly dimensional clearances.

In addition, it also states:

> For most metals, including aluminum, an increased environmental temperature produces an increased potential for corrosion.

Due to a significantly lower inventory of fission fragments in its fuel, the OSURR fuel storage well has much lower temperatures than that seen in power reactor spent-fuel

pools, so the potential for the Boral plates to blister should correspondingly be lower. This assertion is supported by operational experience with the fuel storage well. When inserting or removing fuel elements from either the reactor core or the fuel storage well, the OSURR staff is mindful to notice if there is any sticking or binding, and there has been none to date. This has most recently been observed in the summer of 2016, when all of the fuel elements in the core were unloaded to the storage well and all of the fuel elements were inspected. There was no sticking or binding of fuel elements, and there were no marks on fuel elements that would indicate scraping on the Boral plates.

Therefore, given that there are no criticality concerns and there are no operational concerns, the Boral used in the OSURR fuel storage well continues to exhibit acceptable performance.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 23-Mar-2017.

Sincerely,

Andrew C. Kauffman, Associate Director
The Ohio State University Research Reactor