UNITED STATES
NUCLEAR REGULATORY COMMISSION
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September 27, 2018

MEMORANDUM TO: George A. Wilson, Director
Division of Materials and License Renewal
Office of Nuclear Reactor Regulation

FROM: David L. Rudland, Senior Level Advisor ***/RA/***
Division of Materials and License Renewal
Office of Nuclear Reactor Regulation

SUBJECT: TECHNICAL ASSESSMENT OF POTENTIAL CONTROL ROD DRIVE MECHANISM THERMAL SLEEVE FAILURE

In accordance with the Office of Nuclear Reactor Regulation (NRR) Instruction LIC-504, Revision 4, "Integrated Risk-Informed Decision-Making Process for Emergent Issues," dated June 2, 2014, the staff of the U.S. Nuclear Regulatory Commission (NRC) has performed a risk-informed evaluation of the potential safety significance of control rod drive mechanism (CRDM) thermal sleeve wear issues at U.S. Westinghouse pressurized-water reactors.

During a spring outage in 2014, a CRDM thermal sleeve wear issue was identified at a U.S. plant when a single thermal sleeve fell from the reactor vessel (RV) closure head at an unrodded CRDM during an inservice inspection (ISI). Examination of the fallen sleeve confirmed that the upper flange, which rests inside the CRDM head adapter tube, had worn through. It was determined that the wear could be correlated to a change in elevation of the bottom of the thermal sleeve (guide funnel) when compared to the as-designed condition. Measurements of elevations taken showed significant but acceptable wear and all rodded locations had low-to-moderate wear.

In December 2017, Unit 2 at Belleville nuclear power plant in France experienced a complete wear through and separation of one of their thermal sleeves at a rodded CRDM location. Belleville is a four-loop, 1300 MW Electricite de France (EdF) plant. During low power physics testing and rod drop testing, the plant had difficulty stepping the rod into the core. The rod was freed by exercising the drive rod but was then stopped prior to full insertion during the rod drop test. The failure to insert the rod was caused by the worn thermal sleeve flange remnant. Investigation of the incident showed the same wear behavior as was discovered in 2014.

In response to this operational experience, Westinghouse notified the NRC of this defect pursuant to the requirements of Title 10 of the Code of Federal Regulations (10 CFR) Part 21. This notifications states that there was no immediate safety concern, but a substantial safety concern may be possible in the unlikely event that there is interference with the movement of more than one control rod.

The enclosure to this memorandum summarizes the NRC staff's current knowledge regarding indications of CRDM thermal sleeve wear and provides options for U.S. Nuclear Regulatory Commission (NRC) action related to plants in the United States. The NRC staff assessment concludes that the safety significance of CRDM thermal sleeve wear is low for susceptible U.S. plants. However, additional information is needed for the staff to ensure that the analyses discussed in the enclosure have an adequate degree of conservatism.

The options considered by staff include the following:

1. Issue Orders Suspending Operation—shut down some or all operating reactors, through a regulatory process such as an order, until inspections, analyses and mitigation are conducted to provide reasonable assurance that the calculated risk levels are acceptable.
2. Issue Orders Requiring Inspections and Mitigation—require the inspection and mitigation of this issue through a regulatory process such as an order within a certain timeframe.
3. Conduct a Smart Sample—first conduct a smart sample for those Tier 1 plants that are currently operating with their original upper heads to determine on a plant specific basis if an adequate degree of conservatism is present in their analyses. Follow up with a generic communication if needed.
4. Monitor and Evaluate—continue to monitor and evaluate the industry plans and actions without any additional actions by the NRC.

Option 1 and 2 restore margins in a timely manner but the uncertainty in the analyses conducted, which include the assumption of plant specific wear rates, makes it difficult to support these actions. Option 4 is not preferred, in part because of the extended time that plants may operate with CRDM thermal sleeve that continue to degrade.

Option 3 will allow the NRC staff to gather information on plant-specific issues that would help to determine if the analyses presented in the NSAL and the LIC-504 have an adequate degree of conservatism. Some of the information needed would include:

- Plant-specific wear rates. The analyses in both the NSAL and here are based on the wear distributions from very limited measurements. If plants measure wear outside of this distribution, the resulting impact to risk could be large.
- Plant-specific inspection plans and supporting analyses. Currently the NSAL allows the susceptible plants to conduct a plant-specific analyses if their wear extends beyond the generic acceptance criteria in PWROG-16003-P. The results of these analyses may have a significant impact on predicted plant risk.
- Plant-specific mitigation plans. As described in the LIC-504 document, this degradation is driven by the operating behavior of the plants. Without mitigation, the wear will continue and the risk of CRDM thermal sleeve failure increases.

Therefore, given the risk determination, and the uncertainty associated with the plant-specific action, the NRC staff recommends Option 3. The NRC staff will re-evaluate the situation after the information from the smart sample is available.

Enclosure:
Technical Assessment of Potential Control Rod Drive Mechanism Thermal Sleeve Failure

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TECHNICAL ASSESSMENT OF POTENTIAL CONTROL ROD DRIVE MECHANISM THERMAL SLEEVE FAILURE DATED SEPTEMBER 27, 2018.

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