REQUEST FOR ADDITIONAL INFORMATION
US-APWR Topical Report: Non-LOCA Methodology, MUAP-07010-P(R1)

12/06/10
Mitsubishi Heavy Industries
Docket No. 52-021
SRSB Branch

The following Requests for Additional Information (RAIs) are the result of a recent effort by the NRC staff to maintain regulatory and technical consistency across design centers in the area of Rod Ejection Accident (REA) methodology and analysis results. This RAI will be referenced as the ninth set of RAIs for this Topical Report.

REA-1: The known assessment basis of the TWINKLE/TWINKLE-M codes primarily consists of comparisons with other kinetics codes as documented in [1], and codes used in the OECD Rod Ejection Benchmark project, as documented in [2]. Fundamentally lacking from this assessment matrix are comparisons with data from reactor kinetics experiments. Has TWINKLE-M been assessed against any such experiments? An example would be the SPERT tests conducted at INL in the late 1960's [3]. If such comparisons have not been made, justify why the lack of such comparisons is acceptable.

References:

1. D. H. Risher and R. F. Barry, "TWINKLE – A Multi-Dimensional Neutron Kinetics Computer Code", WCAP-7979-P-A (Proprietary), Westinghouse Electric Corporation, January 1975.
2. UAP-HF-08170, "MHI's Second Response to NRC's Request for Additional Information on US-APWR Topical Report MUAP-07010-P, Non-LOCA Methodology (Proprietary)," September 2008.
3. "Reactivity Accident Test Results and Analyses for the SPERT III E-Core-A Small, Oxide-Fueled, Pressurized Water Reactor," IDO-17281, U.S. Atomic Energy Commission, March 1969.

REA-2: Justify the delay of 0.6 seconds chosen between when the high neutron flux reactor trip setpoint is reached and when the reactor trip begins. Is this value consistent with the value chosen for MHI-analyzed operating reactors, or is there an additional delay accounted for in the US-APWR analyses? The NRC staff is concerned that the heavy metal reflector surrounding the US-APWR core will shield the ex-core detectors such that the Reactor Protection System response is sufficiently delayed such that resulting DNB fuel failures will be greater than expected. How does the heavy metal reflector impact the ex-core detector response?

REA-3: Is the approach used to calculate the effective fuel temperature for Doppler feedback in the TWINKLE-M code identical to the approach documented in WCAP-7979-P-A? Justify the use of this approach in light of other methods for effective fuel temperature that have been developed since the TWINKLE code was approved in 1975. For example, consider the approach documented in [1].

Reference:

1. NEACRP-L-335 (Revision 1), H. Finnemann and A. G. Galati, "NEACRP 3-D LWR Core Transient Benchmark," Final Specifications, October 1991 (January 1992).

REA-4: NRC understands from previous RAI responses that, prior to performing a Rod Ejection simulation using TWINKLE-M, the steady-state power distribution calculated by TWINKLE-M is adjusted to match the ANC-calculated power distributions. This adjustment is made manually and iteratively by modifying the reflector fast-neutron group nuclear data until the TWINKLE-M power distribution is within 10% of the ANC power distribution. Provide additional justification regarding the validity of this approach, since the flux-weighted cross sections of the reflector will change over the course of the transient, particularly if a control rod near the periphery of the core is ejected.

REA-5: Despite the discussion in MUAP-07010-P Revision 1, NRC staff is still not clear on how MHI demonstrates compliance with SRP Section 4.2 Appendix B acceptance criteria for allowable enthalpy rise as a function of local cladding oxidation. Provide additional details regarding how the fuel design information (such as core-elevation-dependent corrosion thickness) is factored into the REA analysis.

REA-6: What are the initial axial power distributions utilized in the REA analyses? What are their bases? Quantify the sensitivity of the results of the REA simulations on the initial axial power distribution.

REA-7: For the 1-D Hot Full Power (HFP) REA analyses, how does the axial power shape vary as a function of time? If the rod ejection is simulated by directly modifying the effective multiplication constant in the neutron kinetics equations, how is the localized effect of removing absorber material from near the top of the core captured? Based on the information the NRC staff has at this time, it appears as if the axial power distribution is considered constant throughout the transient. Correct this understanding if it is wrong, and provide axial power distribution as a function of time for both BOC and EOC conditions.