

March 30, 2010

Mrs. Sandra Sloan
AREVA NP Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

SUBJECT: SIXTH REQUEST FOR ADDITIONAL INFORMATION REGARDING
ANP-10285P, "FUEL ASSEMBLY MECHANICAL DESIGN TOPICAL REPORT"

Dear Mrs. Sloan:

By letter dated October 2, 2007, which can be accessed through NRC Agencywide Documents Access and Management System (ADAMS) Accession No. ML072840175, AREVA NP submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Topical Report (TR) ANP-10285P, "Fuel Assembly Mechanical Design." The first set of request for additional information (RAI) was issued by the NRC on April 29, 2008 (ML081080360), and the AREVA NP responses were received on May 29, 2008 (ADAMS ML081560318), and June 13, 2008 (ML081690558). Subsequent sets of RAIs were issued by the NRC on June 24, 2008 (ML081640135), January 15, 2009 (ML083330034), June 23, 2009 (ML091380286), and August 3, 2009 (ML092080469). The AREVA NP responses were received on July 24, 2008 (ML082100397), April 6, 2009 (ML090960483), August 14, 2009 (ML092310535), and December 16, 2009 (ML093520662).

The NRC staff's review has determined that some areas of this report require additional information in order to complete the review. The specific information requested is contained in the enclosure to this letter. The draft RAI was discussed with your staff in meetings on March 5, 2009, March 17, 2009, and March 23, 2009. AREVA NP has agreed to provide a response within 45 days of receipt of this letter.

If you have any questions regarding this matter, I may be reached at 301-415-3361 or at Getachew.Tesfaye@nrc.gov.

Sincerely,

/RA/

Getachew Tesfaye, Senior Project Manager
EPR Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-020
Enclosure:
Request for Additional Information
cc: DCWG - EPR Mailing List

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NRO-002

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6th REQUEST FOR ADDITIONAL INFORMATION (RAI)
ANP-10285P, "U. S. EPR FUEL ASSEMBLY MECHANICAL
DESIGN TOPICAL REPORT"
DOCKET NO. 52-020

RAI-53

Provide plots of the acceleration, velocity, and displacement time histories of the Safe Shutdown Earthquake (SSE) ground motion that was used to calculate the core plate time history data that corresponds to the two maximum perpendicular horizontal fuel assembly responses, SSE(x) and SSE(z). Since AREVA does not combine the SSE(x) and SSE(z) responses of the fuel assembly, are any scaling factors applied to the ground motion, core plate response, or fuel assembly response to account for three-dimensional earthquake motion?

RAI-54

Provide peak deflection information for all fuel assemblies calculated in the maximum SSE(x), maximum SSE(z), maximum loss of coolant accident (LOCA)(x), and maximum LOCA(z) cases. Compare this calculated deflection data to the range of experimental data used to generate the CASAC models, particularly the amplitude-dependant mode frequency data. If calculated results fall outside the experimental range, explain why this is acceptable.

RAI-55

The experimental data shows that fuel assembly modal frequencies vary considerably with amplitude, but the CASAC model is tuned to a single frequency. This method essentially assumes a constant amplitude/frequency relationship for the fuel assembly response. The reviewers request confirmation that this method of fuel assembly representation is adequate for the U.S. EPR, given that the fuel assemblies are predicted to respond over a large range of amplitudes. Evaluate the maximum SSE(x) and SSE(z) fuel assembly response cases with modified fuel assembly inputs that represent the high and low extremes of amplitude. Based on the experimental data made available at the audit, the maximum frequency is a certain value for the first mode and a certain value for the third mode. The minimum frequencies were given. If these cases reveal the fuel assembly dynamic responses are significantly sensitive to mode frequencies, justify the use of a constant amplitude/frequency relationship for the U.S. EPR.

RAI-56

The damping and stiffness parameters used in CASAC impact models were set to the maximum stiffness and minimum damping values witnessed in the experiments to ensure conservatism. Demonstrate with a set of sensitivity analyses that this assumption of conservatism is correct. For each impact stiffness (internal and external), and each damping parameter in the model (global damping, internal impact damping, external impact damping) report a minimum, maximum, and average value based on the

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experimental data. Using all other inputs from the maximum horizontal SSE case, perform CASAC analyses with modified damping (D) and stiffness (S) pairs as described in Table 1. The extent of this RAI is to report the experimentally-determined range of stiffness and damping values, run 9 CASAC models, and confirm that the stiffness and damping values used in the maximum horizontal SSE case do indeed lead to the most conservative results. These particular nine cases are requested to explore the trends of stiffness and damping within the experimentally established boundaries.

Table 1: Damping and Stiffness Sensitivity

Max D, Max S	Max D, Avg S	Max D, Min S
Avg D, Max S	Avg D, Avg S	Avg D, Min S
Min D, Max S	Min D, Avg S	Min D, Min S

RAI-57

The data used to define the mode frequencies of the U.S. EPR CASAC model came from a fuel assembly that was not identical to the EPR design. The locations of the grid spacers are different by up to a certain value. Demonstrate that this difference is insignificant to the dynamic calculations.

RAI-58

Perform the input sensitivity study as described in Standard Review Plan (SRP) Section 4.2, Appendix A.II.3 on the baseline CASAC models. This study considers the reaction to a 10 percent increase in input amplitude and input frequency (in separate analyses). Report the changes in peak impact force and peak fuel assembly deflection to demonstrate that they remain below a 15 percent increase.

RAI-59

Provide the full upper and lower core plate loading histories used by CASAC as comma-delimited text files corresponding to the maximum SSE(x), maximum SSE(z), maximum LOCA(x) and maximum LOCA(z) cases.

RAI-60

The following questions relate to demonstrating conservatism in the U.S. EPR linear heat generation rate (LHGR) limit for cladding strain and the strain capability of M5 irradiated cladding relative to the 1 percent total (elastic plus plastic) uniform strain limit, respectively.

1. The following is a follow-up request to the response to RAI-44. Provide test data that demonstrates fuel failure or non-failure as a function of strain and LHGR for time durations typical of an anticipated operational occurrence (AOO) event. Provide post-irradiation micrographs of the cladding post ramp along with measured strains and the local LHGR at each axial location the strains were measured.
2. Verify whether the uniform strain values in the response to RAI-40 (Table 40-1) and RAI-51 (Table 51-1) includes both elastic strain as well as plastic strain. If so, provide the elastic and plastic components of the total uniform strain. If not,

provide the elastic component of strain. These RAIs stated that these were tensile tests, provide a drawing or photograph that illustrates the geometry of the tensile test specimen. Provide those power ramp tests with fuel rods using M5 cladding where cladding strain was measured to demonstrate the strain capability. Discuss how this test data demonstrates that there is adequate conservatism in the 1 percent strain limit to cover any possible COPENIC underprediction in cladding strain of 0.2 percent.

RAI-61

The following question is related to clarification of Table RAI-52-2.

Examination of Table 52-2 appears to demonstrate that the UCBW event at power is limited by departure from nucleate boiling ratio (DNBR) rather than strain limited. Confirm that this observation is correct. If this observation is not correct, provide a further discussion on why this event is not DNBR limited.

RAI-62

The current 95/95 upper bound curve is based on low and high burnup data, this is not acceptable because the gap closure is only an issue at end-of-life (EOL), or high burnup, and not at low burnup. Propose a 95/95 upper bound curve for M5TM guide tube growth that is based only on high burnup M5TM growth data, greater than 40 GWd/MTU, for application to determine the gap size at EOL for the U.S. EPR.

RAI-63

Propose a hydride limit for M5TM and provide a justification for this limit per SRP Section II.1.A.IV.

DCWG - EPR Mailing List

(Revised 03/03/2010)

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