July 31, 2017

Mr. Gary Peters, Director
Licensing and Regulatory Affairs
AREVA Inc.
3315 Old Forest Road
Lynchburg, VA 24501

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RE: AREVA INC. Topical Report ANP-10338P, "AREA – ARCADIA ROD EJECTION ACCIDENT" (CAC NO. MF7009)

Dear Mr. Peters:

By letter dated October 9, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15300A298), AREVA INC. (AREVA) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review and approval Topical Report (TR) ANP-10338P, "AREA – ARCADIA Rod Ejection Accident." Upon review of the information provided, the NRC staff has determined that additional information is needed to complete the review. On July 14, 2017, Jerald Holm, AREVA Product Licensing Manager, and I agreed that the NRC staff will receive the response to the enclosed request for additional information (RAIs) questions by August 15, 2017.

If you have any questions regarding the enclosed RAI questions, please contact me at 301-415-4053.

Sincerely,

/RA/

Jonathan G. Rowley, Project Manager
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 728

Enclosure:
RAI Questions

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RE: AREVA INC. TOPICAL REPORT ANP-10338P, "AREA – ARCADIA ROD EJECTION ACCIDENT" (CAC NO. MF7009) DATED: JULY 31, 2017

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REQUEST FOR ADDITIONAL INFORMATION

RELATED TO TOPICAL REPORT ANP-10338P

"AREA – ARCADIA ROD EJECTION ACCIDENT"

AREVA INC.

(CAC NO. MF7009)

RAI 2:

The methodology for the ARCADIA Rod Ejection Accident (AREA™) analysis code (ANP-10338P, Revision 0) is predicated on the U.S. Nuclear Regulatory Commission (NRC) approved methodology of the ARCADIA® code system (ANP-10297P and ANP-10297P-A, Revision 0, Supplement 1). However, in lieu of the fuel rod model (FRM) of the approved ARCADIA® code system, AREA™ applies the NRC unapproved fuel performance code GALILEO (ANP-10323P) to provide the thermal-mechanical properties of the fuel pins for analyses performed with AREA™. In line with the Update Process set forth in Section 6.1 of ANP-10338P, Revision 0, for including codes without current NRC approval, this RAI requests the following information.

A. Justify the motivation for using GALILEO derived thermal-mechanical properties of fuel pins rather than those of the NRC approved FRM in ARCADIA®.

B. List the capabilities that are introduced by the GALILEO models to ARCADIA® that either do not exist or introduce better estimates with less uncertainty of the figures of merit for meeting regulatory reactivity-insertion accident (RIA) acceptance criteria.

C. The FRM in the ARCADIA® code solves the heat transfer equation given by Equation 5-1 in ANP-10297P, Revision 0. Is the FRM thermal solver identical to the one in GALILEO?

D. The thermal equation solver given by Equation 5-1, in order to compute the time-dependent spatial distribution of the local temperature, requires values for the spatially dependent local heat generation source term, local thermal conductivity, local specific heat, and local density. The description for the computation of the thermal models for these physical properties is given, in the case of GALILEO, in Chapter 5 of GALILEO Fuel Rod Performance Code Theory Manual FS1-0004682, Revision 2.0. Comparable detailed descriptions do not exist in the ARCADIA® topical report.

   Thus, in the context of the supplementary summary of the interfaces with GALILEO in the AREA™ methodology, submitted by AREVA to facilitate a teleconference with NRC on May 31, 2017 (shown below), the following information is requested.

i. Indicate for the six usages in the context of the GALILEO models given in Chapter 5 of the GALILEO Theory Manual the differences, if any, with the models in FRM of ARCADIA® for the lookup tables for the requisite spatially dependent physical constants or the information for the post processing of the ARTEMIS™ results.

ii. Is the radially dependent source computed with the same codes and fitting procedures in FRM and GALILEO?

iii. Furthermore, indicate which differences delineated above are the main contributors to the ARTEMIS™ – GALILEO differences shown in Figures 5-2 through 5-7 in the AREA™ topical report under review.

Interfaces with GALILEO

The different uses of the fuel rod code in AREA™ to determine fuel pin performance relative to the RIA criteria are highlighted below by showing the use of GALILEO™ in the sample problems. There are six different types of usage of the data as listed below. Note that any of this information can be derived from any NRC approved fuel rod code and that information from GALILEO™ for AREA™ would only be used after its approval by the NRC.

1. The fuel rod thermal properties are equations included in the ARTEMIS™ Fuel Rod Module and are listed below. The ARTEMIS™ default equations are equivalent to the thermal property equations in GALILEO™.

    a. For uranium oxide (UO_2), UO_2-Gd_2O_3 [gadolinium oxide], zircaloy-4 (Zr4), and M5 clad

        i. Thermal conductivity
        ii. Specific heat

    b. Fuel pellet radial power profile fit function

2. Data generated by GALILEO™ computer runs that are used as input (lookup tables) to ARTEMIS™.

    a. Gap Conductance
    b. Porosity (used to calculate fuel thermal conductivity)

3. Data generated by GALILEO™ are compared to ARTEMIS™ results to verify the adequacy of the gap conductance lookup table model in ARTEMIS™.

    a. Fuel centerline, average, and surface temperatures
    b. Clad internal and average temperatures

4. The GALILEO™ equations that are used to post process the ARTEMIS™ results.

    a. Fuel melt temperature equation and its uncertainty for UO_2 and UO_2-Gd_2O_3

5. Data generated by GALILEO™ that are used to post process the ARTEMIS™ results for comparison to limiting conditions for RIA criteria.

    a. Maximum rim burnup versus average pellet burnup for rim melt temperature
    b. Clad corrosion versus burnup to convert to enthalpy rise failure limits
    c. Max internal pressure and back fill pressure versus burnup for pressure related requirements
    d. Fission gas release versus burnup

6. The following data from GALILEO™ models are used for AREA™ sensitivity studies to establish the need for biasing.

    a. Uncertainties for thermal conductivity and specific heat
    b. Oxide results
    c. Fuel expansion