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April 24, 2018

MEMORANDUM TO: Dr. Mirela Gavrilas, Director
Division of Safety Systems
Office of Nuclear Reactor Regulation

FROM: Brian E. Thomas, Director ***/RA/***
Division of Engineering
Office of Nuclear Regulatory Research

SUBJECT: IMPENDING PUBLICATION OF TECHNICAL LETTER REPORT, ORNL/SPR-2017/355, ENTITLED "REACTOR PRESSURE VESSEL FLUENCE EVALUATION METHODOLOGY GUIDANCE"

The Office of Nuclear Regulatory Research (RES) has completed, via its contractor Oak Ridge National Laboratory (ORNL), Technical Letter Report (TLR) ORNL/SPR-2017/355, entitled "Reactor Pressure Vessel Fluence Evaluation Methodology Guidance" (ADAMS Accession ML17264A085). This report documents work performed under Task 1, "Documenting the important phenomena in calculating the fluence, literature survey for available fluence data and associated model geometries based on survey results," under User Need Request (UNR) NRR-2015-002, "Reactor Pressure Vessel Fluence Evaluation Methodology Guidance."

As power uprates and plant life extensions are considered, there is an increasing need to address the appropriate methodology to be applied for fluence calculations at locations outside (i.e., above and below) what has historically been considered the reactor pressure vessel (RPV) beltline, and for reactor vessel internal (RVI) components. The fluence evaluation methodology for these regions is not addressed in the guidance provided in Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." This UNR focuses on methods for determining the important phenomena in calculating the fluence, as well as for determining the overall uncertainty associated with the use of best-estimate values, in regions outside of the active core.

The efforts undertaken as part of UNR Task 1 involve developing pressurized water reactor (PWR) and boiling-water reactor (BWR) model geometries and performing sensitivity analyses to determine the parameters that can influence the neutron fluence results. The attached TLR documents ORNL's work addressing this task under the auspices of RES.
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The research to develop the model geometries began with a survey of open literature to develop BWR and PWR reference model geometries for fluence evaluations. The reference models were based on a Westinghouse four-loop design and a GE-4 design, and were chosen based on their prevalence in the US fleet as well as the availability of data needed to construct the core and structural components of the models.

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Highlights of the effort include:

- The PWR reference model is based on Unit 1 of the Watts Bar Nuclear Plant (WBN1), a Westinghouse four-loop design with a licensed power of 3,456 MWt. The fuel assemblies are a Westinghouse 17 x 17 design with three different ^{235}U enrichments: 2.11 wt%, 2.619 wt%, and 3.1 wt%
- The BWR reference model is based on Hatch Unit 2, a GE-4 design with a licensed power of 2,804 MWt. The fuel assemblies are modeled as a GE 7 x 7 design with four different ^{235}U enrichments: 2.97 wt%, 1.94 wt%, 1.69 wt%, and 1.27 wt%
- Calculations were performed using a hybrid deterministic/Monte Carlo transport method
- Parameter sensitivity analyses were conducted for the PWR model geometry for the following parameters:
    - Source energy spectrum
    - Bioshield concrete composition
    - Geometry of the RV/bioshield cavity gap
    - Coolant temperature
    - Modeling of top and bottom core plate and assembly nozzles
    - Thermal insulation
    - Steel bioshield liner
    - Angular Quadrature in deterministic calculations

The results of these sensitivity analyses show changes in the calculated neutron flux for each of the parameters investigated, with geometry of the RV/cavity/bioshield having a minor effect on the flux in the RV within the active core region but, due to cavity streaming effects, a significant effect at locations around the nozzles and on the RV outside diameter. The effects of each of the other parameters investigated on fluence outside the beltline were much less significant than the cavity streaming effects and are documented in the TLR.

Staff representatives from the Division of Safety Systems in NRR have reviewed a draft of this TLR, and the enclosed final TLR reflects the resolution of their comments. Nonetheless, please feel free to notify the responsible RES contact if you have any questions concerning the impending public release of this TLR.

If additional information is required, please contact Jay Wallace of my staff at 301-415-2418 or jsw6@nrc.gov.

Enclosure:
As stated

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