framatome

May 8, 2024
NRC:24:011

U.S. Nuclear Regulatory Commission
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Request for NRC Confirmation of Framatome Interpretation of Limitation and Condition 2 of ANP-10297, Revision 0, Supplement 1P-A, Revision 1, "The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results"

Ref. 1: ANP-10297P-A, Revision 0, "The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results," AREVA Inc., February 2013.

Ref. 2. ANP-10297, Revision 0, and Supplement 1P-A, Revision 1, "The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results," Framatome Inc., December 2020.

On April 25, 2024, Framatome Inc. (Framatome) met with NRC staff to discuss Limitation and Condition (L&C) 2 in the NRC Safety Evaluation for the ARCADIA topical reports (References 1 and 2). In that meeting NRC staff requested that Framatome send a formal letter describing Framatome's interpretation of L&C 2 with supporting information.

Enclosure 1 describes Framatome's interpretation of L&C 2 as it relates to changes in detector systems and includes supporting information.

This letter requests the NRC's confirmation that Framatome's L&C 2 interpretation of References 1 and 2 described in Enclosure 1 is consistent with NRC intent. Framatome does not intend to submit a revision to either Reference 1 or Reference 2 topical reports.

Framatome would appreciate NRC confirmation in a letter response by June 28, 2024.

There are no regulatory commitments within this letter or its enclosures.

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If you have any questions related to this submittal, please contact Mr. Morris Byram, Licensing Manager. He may be reached by telephone at 434-221-1082 or by e-mail at Morris.Byram@framatome.com.

Sincerely,

ELLIOTT
Gayle

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Gayle Elliott, Director
Licensing & Regulatory Affairs
Framatome Inc.

cc: N. Otto
Project 728

Enclosures:

1) ARCADIA L&C 2 Interpretation

Enclosure 1

ARCADIA L&C 2 Interpretation

Background

As part of on-going improvements, the Nuclear Industry is considering alternatives to existing incore detector systems. These may include replacement of movable incore detectors with fixed incore detectors or the replacement of current detector emitter materials for new materials (e.g., Vanadium replacing Rhodium). Advantages include constant power monitoring with fixed incore detectors or longevity of the detectors themselves with newer emitter materials.

To accommodate the anticipated changes, Framatome has reviewed the requirements of Limitation and Condition (L&C) 2 in the ARCADIA Topical Report (Reference 1) and Supplement 1 of the ARCADIA Topical Report (Reference 2) as it applies to changes in the detector system. The L&C is presented below for completeness:

> The benchmarks provided in the ARCADIA TR include uncertainty verification for plants that use moveable incore, rhodium fixed incore, and Aeroball incore detectors. Framatome will evaluate at least three cycles of data relative to these criteria prior to licensing the first cycle with Framatome fuel with ARCADIA. Additionally, application of ARCADIA to a new uncertainty measurement system(s) would require review and approval by the NRC staff prior to implementation.

Framatome L&C 2 Application Interpretation

It is Framatome's interpretation that this L&C is relevant when ARCADIA, using ARTEMIS as the nodal simulator, with either the MEDIAN or INPAX methodologies is used for the purposes of incore monitoring. In this case, the power peaking uncertainties are based on the MEDIAN or INPAX methodology described in the referenced topical reports. However, when a monitoring system is implemented using a non-MEDIAN/INPAX based measurement system, the power peaking uncertainties relative to that monitoring system should be used, whether or not the detector type is considered in the reference topical reports.

Supporting Information

In the referenced topical reports, Framatome states that uncertainties generated with ARTEMIS and the MEDIAN or INPAX methodologies are to remain within the uncertainties previously generated for each specific detector and plant configuration. This is consistent with Framatome's interpretation of L&C 2.

The measurement uncertainty has two components. These are the ARCADIA model uncertainty and the plant computer measurement uncertainty. The ARCADIA model uncertainty is the ability of the ARTEMIS code to predict the core power distribution which depend on the analytical solutions and model validation defined in the reference topical reports.

The plant computer measurement uncertainty is the ability of the plant computer to measure a core power distribution. This depends on the accuracy of the hardware (i.e., incore detector) signal processors to measure neutron flux or reaction rates at the point of the detector and also the ability of the measurement software to process the signal and reconstruct a 3D power distribution. Changes to the hardware or measurement software would require a reevaluation of these uncertainties.

When ARCADIA with MEDIAN or INPAX are used as the measurement software in the plant computer, then these uncertainties are linked. If ARCADIA is not used as the measurement software, then these uncertainties are independent. For the latter, the combined uncertainties associated with plant monitoring hardware and software would be supplied to Framatome for use in core design analysis activities.

The processing of detector signals to create a 3D power distribution is based on measured signals that are converted to power at the detector locations. The powers in the remaining assemblies are then inferred by imposing a shape onto the core that is dependent on the code used in the monitoring software. This inferred shape defines the radial and axial powers at the point in cycle where the flux map was performed. This process defines the uncertainties associated with the measured peaking values (e.g., $F_{\Delta H}$ and F_Q) and is dependent on the detector hardware and the core monitoring software. The inferred powers also become the measured values which are used for comparison to the powers predicted by the code used in core design (i.e., calculated powers).

Uncertainties associated with the ability of a code to calculate the power distribution is independent of the above process because no detector signal processing is required. For ARCADIA, the ability of ARTEMIS to generate a 3D power distribution is proven through the benchmarking process. Per the referenced Topical Reports, ARTEMIS predicted power distributions are benchmarked against measured values for multiple points in cycle. This same process is continued to keep a running three cycle benchmark for all plants supported by ARCADIA. The check against the RMS differences between ARTEMIS and measured radial and axial power distributions provides assurance that ARTEMIS is predicting powers that are consistent with the measured (inferred) power distributions from the core monitoring system.

Application of the power peaking uncertainties preclude core designs from exceeding Technical Specification peaking limits. At the core design phase, these uncertainties are used to reduce the Technical Specification peaking limits to provide a design limit. For core design, the measurement uncertainties are used as a conservative bias to ensure that Technical Specifications limits are not exceeded. Consistency between transient analyses and core design development are maintained by using the same uncertainties in the transient analyses.

Conclusion

For instances where the incore monitoring system does not use ARTEMIS/MEDIAN or ARTEMIS/INPAX to reconstruct power distributions, it is more accurate to use the measurement uncertainties associated with the actual core monitoring system in Framatome reload analyses. Therefore, L&C 2 is not applicable in these cases.

References:

1. ANP-10297P-A, Revision 0, “The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results,” AREVA Inc., February 2013.
2. ANP-10297, Revision 0, and Supplement 1P-A, Revision 1, “The ARCADIA Reactor Analysis System for PWRs Methodology Description and Benchmarking Results,” Framatome Inc., December 2020.