

## UNITED STATES NUCLEAR REGULATORY COMMISSION WASHINGTON, D.C. 20555-0001

July 30, 2024

Gayle Elliott, Director Licensing and Regulatory Affairs Framatome, Inc. 3315 Old Forest Road Lynchburg, VA 24501

SUBJECT: REQUEST FOR U.S. NUCLEAR REGULATORY COMMISSION STAFF'S CONFIRMATION OF FRAMATOME INTERPRETATION OF LIMITATION AND CONDITION 2 OF TOPICAL REPORT, ANP-10297, REVISION 0, SUPPLEMENT 1P-A, REVISION 1, "THE ARCADIA® REACTOR ANALYSIS SYSTEM FOR PWRS METHODOLOGY DESCRIPTION AND BENCHMARKING RESULTS" (EPID L-2024-LRO-0015)

Dear Gayle Elliott:

By letter dated May 8, 2024 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML24129A171), Framatome, Inc. (Framatome) requested the U.S. Nuclear Regulatory Commission (NRC) staff's confirmation that Framatome's interpretation of Limitation and Condition (L&C) 2 in the NRC safety evaluations (SEs) for the ARCADIA<sup>®</sup> Code System (ARCADIA<sup>®</sup>) topical reports (TRs) are consistent with the NRC staff's interpretation. ARCADIA<sup>®</sup> is described in TRs ANP-10297P-A, Revision 0, "The ARCADIA<sup>®</sup> Reactor Analysis System for PWRs [Pressurized Water Reactors] Methodology Description and Benchmarking Results" (ADAMS Accession No. ML14195A145) and ANP-10297, Revision 0, Supplement 1P-A, Revision 1, "The ARCADIA<sup>®</sup> Reactor Analysis System for PWRs [Methodology Description and Benchmarking Results" (ADAMS Package Accession No. ML21071A062).

Description and benchmarking of ARCADIA<sup>®</sup> was presented in TR ANP-10297P-A, Revision 0 (the original ARCADIA<sup>®</sup> TR). The original ARCADIA<sup>®</sup> TR was approved for use by the NRC staff in February 2013. ANP-10297P-A, Revision 0, Supplement 1P-A, Revision 1 (Supplement 1) is the first supplement to the original ARCADIA<sup>®</sup> TR and was approved for use by the NRC staff in August 2018.

The subject matter of L&C 2 considers quantified power peaking uncertainties for various incore neutron flux detectors and associated measurement systems for which the ARCADIA<sup>®</sup> methodology is approved for use. L&C 2 was first introduced in the NRC staff's SE for the original ARCADIA<sup>®</sup> TR, and with the introduction of Supplement 1, its scope was expanded in the associated NRC staff's SE to include additional incore neutron flux detectors and associated measurement systems. L&C 2 from the NRC SE to Supplement 1 states:

The benchmarks provided in the ARCADIA<sup>®</sup> TR, as supplemented, 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<sup>®</sup>. Additionally, application of ARCADIA<sup>®</sup> to a new uncertainty measurement system(s) would require review and approval by the NRC staff prior to implementation. (*This is Condition 2 of the SE for the original ARCADIA<sup>®</sup> TR (ANP-10297P-A, Revision 0). It remains applicable to Supplement 1, and it has been updated to include the incore detector systems presented within Supplement 1).<sup>[1]</sup>* 

For the present discussion, a monitoring system is comprised of both monitoring software and a measurement system (see Figure 1, below). A measurement system is itself comprised of a measurement software and incore detector hardware. When ARCADIA<sup>®</sup> is used for incore monitoring, it is functioning as a monitoring system wherein the monitoring software is ARTEMIS (the three-dimensional nodal code core simulator), and the measurement system is either the MEDIAN or INPAX measurement software (the three-dimensional relative power distribution reconstruction methodologies) and the associated incore detector hardware.



Figure 1: Components of a Monitoring System

Various measurement systems (i.e., specific combinations of MEDIAN/INPAX and incore detectors) are discussed within the ARCADIA<sup>®</sup> TRs and approved for use in the NRC staff's SEs. Specifically, in the original ARCADIA<sup>®</sup> TR, the power peaking factor uncertainties for the following measurement systems were quantified, and the measurement systems were approved for use in the staff's SE:

- INPAX-W with moveable incore fission detectors
- INPAX-CE with fixed incore Rhodium detectors
- MEDIAN AMS (MEDIAN with Aeroball detectors)

In Supplement 1, additional measurement systems were discussed. The power peaking factor uncertainties for the following measurement systems were quantified, and the measurement systems were approved for use in the NRC staff's SE:

- MEDIAN with moveable incore fission detectors
- MEDIAN with CE fixed incore Rhodium detectors
- MEDIAN AMS (revalidation)
- MEDIAN with B&W fixed incore Rhodium detectors

<sup>&</sup>lt;sup>1</sup> Italics in original.

Enclosure 1 of the May 8, 2024, Confirmation Request Letter describes Framatome's interpretation of the above L&C. Specifically, Enclosure 1 indicates that Framatome finds the uncertainty verification benchmarks discussed in the above L&C to be relevant when ARTEMIS, the nodal simulator within ARCADIA<sup>®</sup>, is used with either the MEDIAN or INPAX measurement software in conjunction with one of the specified detector hardware types for purposes of incore monitoring. In such instances, the power peaking uncertainties (i.e., the uncertainty verification mentioned in L&C 2) are based on the MEDIAN or INPAX methodologies. However, when a monitoring system other than ARCADIA<sup>®</sup> is implemented at a plant, the power peaking uncertainties associated with that monitoring system should be used to compute power peaking design limits, regardless of whether the associated incore detector hardware type is considered in the ARCADIA<sup>®</sup> TRs.

The NRC staff confirms that Framatome's interpretation of L&C 2 is consistent with the NRC staff's interpretation for the introduction of L&C 2 within the SEs for each of the ARCADIA<sup>®</sup> TRs. The power peaking uncertainties quantified within the TRs are specific to the combination of the ARTEMIS monitoring software and the various incore detector types discussed in L&C 2 when used with MEDIAN/INPAX measurement software. L&C 2 includes no provision for the direct implementation of a non-MEDIAN/INPAX based measurement system or the implementation of MEDIAN/INPAX measurement software with a new detector hardware type (e.g., Vanadium) in combination with the ARTEMIS monitoring software for purposes of incore monitoring. Considering that such configurations would be beyond the scope considered in the ARCADIA<sup>®</sup> TRs, prior NRC review and approval of the resulting power peaking uncertainties would be necessary.

Further, L&C 2 does not preclude the use of the core design analysis capabilities of ARCADIA® when a monitoring system other than ARCADIA® is implemented at a plant. This is because the uncertainties associated with the ability of ARTEMIS to calculate core power distributions for purposes of core design analysis are: 1) independent of the processing of detector signals to determine power at instrumented locations and infer power at uninstrumented locations (i.e., no detector signal processing is required), and 2) quantified via the validation benchmarking process presented in the ARCADIA® TRs. Also, as identified in Enclosure 1 of the Confirmation Request Letter, if ARCADIA® is not used as the monitoring system at a plant, then the power peaking uncertainties associated with the implemented monitoring system will be supplied to Framatome and used at the core design phase to assure selection of design peaking limits that incorporate appropriate margin to the applicable Technical Specification peaking limits. Such an approach would be acceptable because the power peaking uncertainties for the implemented monitoring system do not impact the core power predictive capabilities of ARTEMIS, and the monitoring system uncertainties would be used to determine limits that core design analyses must meet. Lastly, the same uncertainties are used between core design and transient analyses to maintain consistency.

G. Elliott

In the next revision of Supplement 1, the NRC staff requests that Framatome include this letter in the revised document.

Please contact Ngola Otto at 301-415-6695 or via e-mail at <u>Ngola.Otto@nrc.gov</u> with any questions you may have regarding this letter.

Sincerely,

/**RA**/

Gerond George, Chief Licensing Projects Branch Division of Operating Reactor Licensing Office of Nuclear Reactor Regulation

Docket No. 99902041

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