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PROPRIETARY INFORMATION – WITHHOLD UNDER 10 CFR 2.390

August 10, 2022 10 CFR 50.90

RS-22-095

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Response to Request for Additional Information Regarding Quad Cities Request to Expand Applicability of GNF Thermal Mechanical Analysis Methods to Framatome Fuel

References:

1. Letter from P.R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Request to Expand Applicability of PRIME Methods to Evaluate Fuel Centerline Melt and Cladding Strain Compliance for Framatome Fuel at Quad Cities," dated January 20, 2022 (ADAMS Accession No. ML22020A398 (prop) / ML22020A399 (non-prop))

2. Email from R. Kuntz (U.S. NRC) to R. Steinman (Constellation Energy Generation), "RAI RE: Quad Cities License Amendment to expand the use of PRIME methods (EPID L-2022-LLA-0014)," dated July 11, 2022 (ADAMS Accession No. ML22193A041)

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to Renewed Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2, respectively. Subsequently, the QCNPS facility operating licenses were transferred to Constellation Energy Generation, LLC (CEG). The proposed changes support the transition from Framatome (formerly AREVA) ATRIUM 10 XM fuel to Global Nuclear Fuel – Americas, LLC (GNF-A) GNF3 fuel by allowing CEG to use PRIME and its associated methodologies to demonstrate compliance with the fuel melt and cladding strain criteria for the co-resident Framatome ATRIUM 10XM fuel in the QCNPS transition cores.

In Reference 2, the NRC requested additional information that is needed to complete review of the proposed methodology change. Attachments 1 (non-proprietary) and 3 (proprietary) provide the additional information requested. Attachment 3 contains information proprietary to GNF-A. As a result, this document is supported by signed affidavit from the owners of the information, which is included as Attachment 2. The affidavit sets forth the basis on which GNF-A's

information may be withheld from public disclosure by the NRC and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.390, "Public inspections, exemptions, requests for withholding." Accordingly, it is respectfully requested that the information in Attachment 3, which is proprietary to GNF-A, be withheld from public disclosure.

CEG has reviewed the information supporting the finding of no significant hazards consideration, and the environmental consideration that were previously provided to the NRC in Reference 1. The additional information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration. In addition, the information provided in this submittal does not affect the bases for concluding that neither an environmental impact statement nor an environmental assessment needs to be prepared in connection with the proposed amendment.

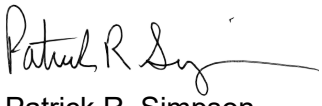
CEG is notifying the State of Illinois of this supplement to a previous application for a change to the operating license by sending a copy of this letter and its attachments to the designated State Official in accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b).

There are no regulatory commitments included in this letter.

Should you have any questions concerning this letter, please contact Ms. Rebecca L. Steinman at 630-657-2831.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 10th day of August 2022.

Respectfully,



Patrick R. Simpson
Sr. Manager Licensing
Constellation Energy Generation, LLC

Attachments:

1. Response to Request for Additional Information (**Non-Proprietary**)
2. Global Nuclear Fuels – Americas, LLC 10 CFR 2.390 Affidavit for Attachment 3
3. Response to Request for Additional Information (**Proprietary**)

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station
Illinois Emergency Management Agency – Department of Nuclear Safety

ATTACHMENT 1

QUAD CITIES NUCLEAR POWER STATION
UNITS 1 AND 2

Docket Nos. 50-254 and 50-265

Response to Request for Additional Information

(Non-Proprietary)

ATTACHMENT 1

Response to Request for Additional Information (Non-Proprietary)

REQUEST FOR ADDITIONAL INFORMATION

CONSTELLATION ENERGY GENERATION

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

REQUEST TO EXPAND APPLICABILITY OF

GLOBAL NUCLEAR FUELS FUEL THERMAL-MECHCANICAL ANALYSIS METHODS

TO FRAMATOME FUEL

DOCKET NOS. 50-254 AND 50-265

L-2022-LLA-0014

Background

By letter dated January 20, 2022, Exelon Generation Company, LLC, proposed to revise the Technical Specifications (TSs) for Quad Cities Nuclear Power Station, Units 1 and 2 (Quad Cities 1 and 2) as necessary to add a reference to Report 006N8642-P, Revision 1, "Justification of PRIME Methodologies for Evaluating TOP [Thermal Overpower] and MOP [Mechanical Overpower] for non-GNF [Global Nuclear Fuels] Fuels," (006N8642-P) to TS 5.6.5.b, the Core Operating Limits Report (COLR) references (Agencywide Document Access and Management System (ADAMS) Package Accession No. ML22020A398). Subsequently, the Quad Cities 1 and 2 facility operating licenses were transferred to Constellation Energy Generation, LLC (Constellation, the licensee). The letter above was supplemented by letter dated March 16, 2022 (ML22075A212).

Requirements

The regulatory requirements applicable to the fuel thermal-mechanical limits are based on General Design Criterion (GDC) 10, "Thermal Hydraulic System Design," contained in Appendix A, "General Design Criteria for Nuclear Power Plants," to part 50, "Domestic Licensing of Production and Utilization Facilities," of Title 10, "Energy" of the Code of Federal Regulations (10 CFR 50 Appendix A). However, Quad Cities Units 1 and 2 were licensed prior to the promulgation of these criteria and hence meet the intent of the draft Principal Design Criteria published in 1967 by the Atomic Energy Commission, as discussed in Chapter 3 of the Quad Cities Updated Final Safety Analysis Report (UFSAR). Therefore, the review is based on the criteria contained Section 3.1.2 of the Quad Cities UFSAR. Specifically, the NRC staff considered Criterion 6, "Reactor Core Design," which states:

> The reactor core shall be designed to function throughout its design lifetime, without exceeding acceptable fuel damage limits which have been stipulated and justified. The core design, together with reliable process and decay heat removal systems, shall provide for this capability under all expected conditions of normal operation with appropriate margins for uncertainties and for transient situations which can be anticipated, including the effects of the loss of power to

recirculation pumps, tripping out of a turbine generator set, isolation of the reactor from its primary heat sink, and loss of all offsite power.

Issue

Adequate fuel performance modeling helps to establish the above-mentioned acceptable fuel damage limits. In the present request, Constellation proposes to apply new correlations within the Global Nuclear Fuels (GNF) PRIME fuel analysis methodology to account for the properties and behavior of the Framatome fuel.[1] While PRIME has been approved for use by the NRC staff, it is not explicitly approved to analyze Framatome fuel. Thus, the new correlations have not been reviewed and approved by the NRC staff.

Request

1. Demonstrate that the properties of the Framatome fuel are adequately represented by Equation 4-1 of 006N8642-P. Explain which data sets illustrated in Figure 4-2 are most representative of the Framatome fuel. In terms of the application of Equation 4-1 within the PRIME methodology, demonstrate that the modeling for Framatome, cold-worked, stress-relieved (CWSR) fuel cladding is consistent with the existing models and methods used for GNF (i.e., recrystallized, annealed) fuel cladding, insofar as the treatment of uncertainties and amount of conservatism are concerned.

2. The modified model described in Section 4.2 of 006N8642-P appears to have been adjusted to reflect a somewhat qualitative assessment of differences between CWSR and RXA zircaloy claddings published in Reference 20[2] of 006N8642-P. By comparison, the PRIME methodology includes a rather extensive assessment of the adequacy of the model as applied to RXA zircaloy. Justify that the treatment adopted within Section 4.2 of 006N8642-P is suitably adequate for the requested application.

CEG Response to Request 1

As demonstrated in Figure 4-2, PRIME Axial Growth Models, of 006N8642-P, Revision 1, Zircaloy irradiation-induced axial growth for cold-worked, stress-relieved (CWSR) cladding is influenced by the degree of cold working, with higher degrees of cold working resulting in increased axial growth. The degree of cold working represented by the PRIME CWSR model proposed as Equation 4-1 in 006N8642-P, Revision 1 (Reference 1), for modeling Framatome fuel is **[[**

[1] Global Nuclear Fuels, "The PRIME Model for Analysis of Fuel Rod Thermal – Mechanical Performance: Part 1 – Technical Bases, NEDC-33256P-A, Part 2 – Qualification, NEDC-33257P-A, and Part 3, Application Methodology, NEDC-33258P-A," September 2010, ML102600259.

[2] F. Garzarolli, R. Adamson and P. Rudling, *Optimization of BWR Fuel Rod Cladding Condition for High Burnups.* Proceedings of 2010 Light Water Reactor Fuel Performance/TopFuel/WRFPM, September 2010. [Obtained from NRC Technical Library via inter-library loan].

]], it is expected that a net conservatism would be maintained for total axial growth. As discussed in GNF's response to RAI 43 in NEDC-33256P-A Revision 2 (Reference 2), the total axial elongation is a combination of both irradiation growth and pellet-clad axial interaction. The approved Zircaloy-2 Recrystallized Annealed (RXA) model in PRIME tends to slightly under-predict the stress free irradiation growth data, which was deemed acceptable during the review of PRIME due to PRIME's ability to adequately predict the net total axial cladding elongation (due to the PRIME axial locking model, which increases the net axial cladding strain caused by fuel expansion).

In addition, the overall sensitivity to the irradiation growth model for demonstrating compliance to the no fuel melt and cladding transient strain criteria is negligible **[[**

]]. This impact is significantly less than the uncertainties in the PRIME models, measured qualification data and manufacturing tolerances.

For demonstrating compliance to the no fuel melting criterion, the statistical methodology employed uses a "model uncertainty" perturbation, **[[**
]]. The model uncertainty value was derived such that, **[[**
]], PRIME calculated fuel centerline temperatures adequately bound the PRIME fuel temperature qualification database. Although the criterion for a 2 sigma value to bound (1-sided) is ~97.7%, the model uncertainty bounds > 99% of the PRIME qualification data. The qualification data for fuel temperature is comprised of **[[**
]]. The model uncertainty established in NEDC-33258P-A Revision 2 **[[**
]]. As described in Section 2.2 and 2.3 of 006N8642-P, Revision 1, **[[**

]].

For demonstrating compliance to the transient cladding strain criterion, the worst tolerance methodology **[[**
]]. This methodology perturbs manufacturing inputs to the worst tolerance manufacturing conditions, **[[**

]]. Similar to the fuel temperature qualification, the cladding diametral strain qualification is comprised of **[[**
]]. As described in Section 3.3 of 006N8642-P, Revision 1, **[[**
]] to account for additional uncertainties associated with non-GNF fuel.

Uncertainties regarding corrosion performance of Framatome's CWSR Zircaloy-2 cladding **[[ ]]** and used consistent with the treatment of uncertainties for GNF's RXA Zircaloy-2.

CEG Response to Request 2

The Zircaloy-2 RXA creep model described in the PRIME Technical Basis Licensing Topical Report (LTR) (NEDC-33256P-A Revision 2), and supplemented in the RAIs, is provided in more detail than the Zircaloy-2 CWSR model in 006N8642-P for several reasons. First, GNF Zircaloy-2 cladding does not utilize the CWSR heat treatment, and therefore GNF does not have access to as extensive of a historical database of creep performance in the same manner as it does for RXA. The use of external data sources (e.g., Reference 20 of 006N8642-P, Revision 1) was required to support the development of the proposed CWSR model. Given there is limited publicly available data, it was decided to modify the currently approved RXA model to reflect the expected difference with the CWSR heat treatment.

Secondly, it is important to understand the differences in the application of the creep model between 006N8642-P and the PRIME Technical Basis LTR, as supplemented in the methodology LTRs NEDC-33258P-A Revision 2 (Reference 2) and NEDC-33840P-A Revision 1 (Reference 3), and the impact of the creep model on the application figure of merit. The approved PRIME application methodologies describe the use of PRIME in showing compliance to the following licensing limits:

- Fuel rod internal pressure limit
- Overpower to incipient fuel center melting (for both slow and fast transients)
- High strain rate cladding strain limit (for both slow and fast transients)
- Cladding fatigue limit

Of these licensing limits, the creep model plays the most significant role in evaluating the fuel rod internal pressure limit. The criteria used by GNF to show compliance to the rod internal pressure limit is the cladding creepout rate, which must be less than or equal to the fuel pellet swelling rate. As such, the cladding creep rate is a primary contributor to showing compliance to this limit. This is illustrated in the NRC RAIs corresponding to the GNF creep model which are focused on the evaluation performed to demonstrate compliance to the rod internal pressure limit (e.g., RAIs 32 and 42 of NEDC-33256P-A Revision 2).

The methodology being requested in 006N8642-P, Revision 1, is only to show compliance to the limits on fuel center melt and cladding transient strain. For this application, the fuel/clad gap closes, and the cladding strain accumulated during the transient is driven by the fuel thermal expansion as opposed to cladding creep (some creep relaxation may occur for sufficiently long transients, but it is a secondary impact). Given the closed gap condition, there is little impact to the fuel temperatures as the gap conductance is controlled by the solid-conduction between the fuel and cladding as well as any gases trapped within fuel and cladding surface roughness interfaces. The overall small sensitivity to cladding creep is demonstrated in Figure 4-3, Impact of CWSR Properties on Melt Margin and Strain Compliance for a Limiting BWR/3 HPCI AOO, of 006N8642-P Revision 1 **[[**

]]. Given the small sensitivity to the limiting results, and the requirement that the methodology demonstrate compliance for all exposures at which the Framatome fuel may be operating at, the proposed CWSR creep model is deemed sufficient for this application.

References:

1. 006N8642-P/-NP, "Justification of PRIME Methodologies for Evaluating TOP and MOP Compliance for non-GNF Fuels," Revision 1, dated January 2022 [Attachments 6 and 3, respectively of ADAMS Accession No. ML22020A399 (non-proprietary version)]

2. Global Nuclear Fuels, “The PRIME Model for Analysis of Fuel Rod Thermal – Mechanical Performance: Part 1 – Technical Bases, NEDC-33256P-A Revision 2, Part 2 – Qualification, NEDC-33257P-A Revision 2, and Part 3, Application Methodology, NEDC-33258P-A Revision 2,” dated October 2021 [ADAMS Accession No. ML21279A283 for non-proprietary NEDO-33257].

3. Global Nuclear Fuels, “The PRIME Model for Transient Analysis of Fuel Rod Thermal – Mechanical Performance, NEDC-33840P-A Revision 1”, dated August 2017 [ADAMS Accession No. ML17230A012 for non-proprietary NEDO-33840].

ATTACHMENT 2

QUAD CITIES NUCLEAR POWER STATION
UNITS 1 AND 2

Docket Nos. 50-254 and 50-265

Global Nuclear Fuels – Americas, LLC 10 CFR 2.390 Affidavit for Attachment 3

Global Nuclear Fuel – Americas, LLC

AFFIDAVIT

I, Kent Halac, state as follows:

(1) I am the Senior Engineer, Global Nuclear Fuel – Americas, LLC ("GNF-A"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the letter from P. R. Simpson (Constellation Energy Generation, LLC) to the Nuclear Regulatory Commission, RS-22-095, "Response to Request for Additional Information Regarding Quad Cities Request to Expand Applicability of GNF Thermal Mechanical Analysis Methods to Framatome Fuel," dated August 2022. GNF-A proprietary information in RS-22-095 is identified by a dotted underline inside double square brackets. [[This sentence is an example {3}]]. GNF-A proprietary information in figures and large objects is identified by double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GNF-A relies upon the exemption from disclosure set forth in the *Freedom of Information Act* ("FOIA"), 5 U.S.C. §552(b)(4), and the *Trade Secrets Act*, 18 U.S.C. §1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F.2d 871 (D.C. Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F.2d 1280 (D.C. Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GNF-A's competitors without a license from GNF-A constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce its expenditure of resources or improve its competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GNF-A customer-funded development plans and programs, resulting in potential products to GNF-A;

d. Information that discloses trade secret or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GNF-A and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GNF-A, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions for proprietary or confidentiality agreements or both that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GNF-A.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GNF-A are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary and/or confidentiality agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains the detailed GNF-A methodology for fuel analyses for the GNF-A Boiling Water Reactor (BWR). These methods, techniques, and data along with their application to the design, modification, and analyses associated with the fuel analyses were achieved at a significant cost to GNF-A.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute a major GNF-A asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GNF-A's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GNF-A's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and

analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GNF-A. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GNF-A's competitive advantage will be lost if its competitors are able to use the results of the GNF-A experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GNF-A would be lost if the information were disclosed to the public. Making such information available to competitors without there having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall and deprive GNF-A of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 8th day of August 2022.

Kent Halac
Senior Engineer, Regulatory Affairs
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