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RS-19-051

10 CFR 50.90

May 30, 2019

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN-50-456 and STN-50-457

Subject: Response to Request for Additional Information for the License Amendment
Request to Utilize TVEL TVS-K Lead Test Assemblies

- References:
1. Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request to Utilize TVEL TVS-K Lead Test Assemblies," dated July 19, 2018 (ML18204A169)
 2. Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "Supplement to License Amendment Request to Utilize TVEL TVS-K Lead Test Assemblies," dated October 19, 2018 (ML18296A288)
 3. "Audit Plan for Exelon Generation Company, LLC License Amendment Request to Utilize TVEL TVS-K Lead Test Assemblies at Braidwood Station, Units 1 and 2 (EPID L-2018-LLA-0208)," audit dates February 11-15, 2019 (ML19038A489)
 4. Email from J. Wiebe (U.S. Nuclear Regulatory Commission) to R. Steinman (Exelon Generation Company, LLC), Subject: Preliminary RAIs for Quality Assurance Review of Braidwood TVEL LTA Application, dated March 7, 2019 (ML19066A043)
 5. Email from J. Wiebe (U.S. Nuclear Regulatory Commission) to R. Steinman (Exelon Generation Company, LLC), Subject: RAIs Braidwood TVEL LTA Application, dated March 2, 2019 (ML19128A236)

In the Reference 1 letter, Exelon Generation Company, LLC, (EGC) requested an amendment to Renewed Facility Operating License Nos. NPF-72 for Braidwood Station, Unit 1 and NPF-77 for Braidwood Station, Unit 2. The proposed change would add a License Condition to

**Attachment 2 contains Proprietary Information.
When separated from Attachment 2, this document is decontrolled.**

Appendix C, "Additional Conditions," of the Braidwood Station Operating Licenses for Unit 1 and Unit 2, respectively, that authorizes the use of up to eight Joint Stock Company "TVEL" (Fuel Company of Rosatom) TVS-K lead test assemblies (LTAs) in non-limiting reactor core locations for operation and evaluation.

The audit described in Reference 3 resulted in a request to docket additional information to support the NRC's review of the EGC request submitted on July 19, 2018 (References 4 and 5). Attachment 2 contains the responses to the NRC request for additional information and includes information proprietary to GNF and/or TVEL. GNF and TVEL request that Attachment 2 be withheld from public disclosure in accordance with 10 CFR 2.390. Affidavits supporting this request are provided in Attachment 1. Attachment 3 contains a non-proprietary version of the responses where the proprietary content has been redacted.

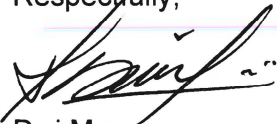
EGC has reviewed the information supporting a finding of no significant hazards consideration, and the environmental consideration, that were previously provided to the NRC in Reference 1. The additional information provided in this submittal does not affect the bases for concluding that the proposed 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.

EGC 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).

Attachment 6 provides a summary of the regulatory commitments contained 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 30th day of May 2019.

Respectfully,



Dwi Murray
Manager - Licensing
Exelon Generation Company, LLC

Attachments:

- 1 Affidavits Requesting to Withhold Proprietary Information Under 10 CFR 2.390
- 2 Response to NRC Request for Additional Information [Proprietary]
- 3 Response to NRC Request for Additional Information [Non-Proprietary]
- 4 Proposed License Condition for the Renewed Facility Operating License No. NPF-72
- 5 Proposed License Condition for the Renewed Facility Operating License No. NPF-77
- 6 List of Regulatory Commitments

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector, Braidwood Station
Illinois Emergency Management Agency – Division of Nuclear Safety

ATTACHMENT 1

Affidavits Requesting to Withhold Proprietary Information Under 10 CFR 2.390

Global Nuclear Fuel – Americas LLC

AFFIDAVIT

I, **Kevin Ledford**, state as follows:

- (1) I am an Engineering Manager, Fuel Performance & Design, 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 Enclosure 1 of GNF letter, M190090, Kevin Ledford (GNF) to Bob Close (Exelon), *Response to Request for Additional Information for the Exelon "License Amendment Request to Utilize TVEL TVS-K Lead Test Assemblies"* May 16, 2019. GNF proprietary text in Enclosure 1, which is entitled “Response to Requests for Additional Information,” is identified by double square brackets. [[This sentence is an example. ^{3}]] Figures and large objects containing GNF proprietary information are identified with double square brackets before and after the object. In all cases, 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 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 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 qualify 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, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).
- (4) Some examples of categories of information which 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 license from GNF-A constitutes a competitive economic advantage over other companies;
 - b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;
 - c. Information which reveals aspects of past, present, or future GNF-A customer-funded development plans and programs, resulting in potential products to GNF-A;
 - d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. above.

Global Nuclear Fuel – Americas LLC

- (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, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.
- (6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or 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, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, 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 agreements.
- (8) The information identified in paragraph (2) is classified as proprietary because it contains details of GNF-A's fuel design and licensing methodology. The development of this methodology, along with the testing, development and approval was achieved at a significant cost to GNF-A.

The development of the fuel design and licensing methodology along with the interpretation and application of the analytical results is derived from an extensive experience database that constitutes 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.

Global Nuclear Fuel – Americas LLC

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 their 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 24th day of May 2019.



Kevin Ledford
Engineering Manager, Fuel Performance & Design
Global Nuclear Fuel – Americas, LLC
3901 Castle Hayne Road
Wilmington, NC 28401
Kevin.Ledford@gnf.com

Joint Stock Company TVEL

AFFIDAVIT

I, **Alexander Ugryumov**, state as follows:

- (1) I am the Vice President of Research and Development of Joint Stock Company TVEL (TVEL) and have been delegated the function of reviewing the information described in paragraph which is sought to be withheld, and have been authorized to apply for its withholding.

The information sought to be withheld as TVEL proprietary information is contained in the Attachment to Exelon's letter RS-19-051, "Response to Request for Additional Information for the License Amendment Request to Utilize TVEL TVS-K Lead Test Assemblies" dated May 24, 2019.

- (1) In making this application for withholding of proprietary information of which it is the owner or licensee, TVEL relies upon the exemption from disclosure set forth in the Freedom of Information Act (FOIA), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 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 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).
- (2) 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 TVEL's competitors without license from TVEL constitutes a competitive economic advantage over TVEL and/or other companies.
 - b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their 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 TVEL customer-funded development plans and programs, that may include potential products of TVEL.
 - d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.
- (3) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to the NRC in confidence. The information is of a sort customarily held in confidence by TVEL, 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

TVEL, 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 or proprietary and/or confidentiality agreements 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).

- (4) 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 TVEL.
- (5) 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 TVEL 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.
- (6) The information identified in paragraph (2) above is classified as proprietary because it contains details of TVEL's fuel design for a Pressurized Water Reactor (PWR). Development of this information and their application for the design, modification, and analyses methodologies and processes was achieved at a significant cost to TVEL. The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major TVEL asset.
- (7) Public disclosure of the information sought to be withheld is likely to cause substantial harm to TVEL's competitive position and foreclose or reduce the availability of profit-making opportunities. The fuel design is part of TVEL's comprehensive PWR 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 TVEL. 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. TVEL's competitive advantage will be lost if its competitors are able to use the results of the TVEL 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 TVEL would be lost if the information were disclosed to the public. Making such information available to competitors without their having

been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive TVEL 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 affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

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

Executed on this 24th day of May 2019.



Alexander Ugryumov
Vice President of Research and Development
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ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

RAI 1

By letter, dated July 19, 2018 (ADAMS Accession No. ML18204A181), as supplemented by letter dated October 19, 2018 (ADAMS Accession No. ML18296A288), Exelon Generation Company, LLC, (Exelon) requested an amendment to add new License Conditions to Appendix C, "Additional Conditions," of the Braidwood Station Operating Licenses for Unit 1 and Unit 2, respectively, that would authorize the use of up to eight Joint Stock Company TVEL (TVEL) TVS-K lead test assemblies (LTAs) in non-limiting reactor core locations for operation and evaluation. Based on the staff's review of the submittal, the interface responsibility and relationships among the multiple organizations involved in this project (i.e. Exelon, Global Nuclear Fuels America, and TVEL) is not clear. Provide a description of the organizational structure, functional responsibilities, levels of authority and organizational interfaces that support the overall flow of quality assurance requirements for design, testing and fabrication of the TVS-K lead test assemblies. Also, provide a description of the procurement and fabrication processes with respect to compliance with the quality assurance requirements of Appendix B to 10 CFR Part 50 and the evaluation and reporting responsibilities of 10 CFR Part 21.

EGC Response to RAI 1

As described in the license amendment request submitted on July 19, 2018, the TVS-K Lead Test Assembly (LTA) project is a joint initiative among Exelon Generation Company, LLC (EGC), Joint Stock Company "TVEL", and Global Nuclear Fuels – Americas, LLC (GNF-A). The project is unusual compared to the previous Braidwood LTA project in that the engineering services vendor responsible for evaluation of the TVS-K LTAs (GNF-A), the fuel vendor (TVEL), and the licensing methodology vendor (Westinghouse Electric Company, LLC (WEC)) are separate entities. Figure 1-1 graphically depicts these relationships, which are described in more detail below.

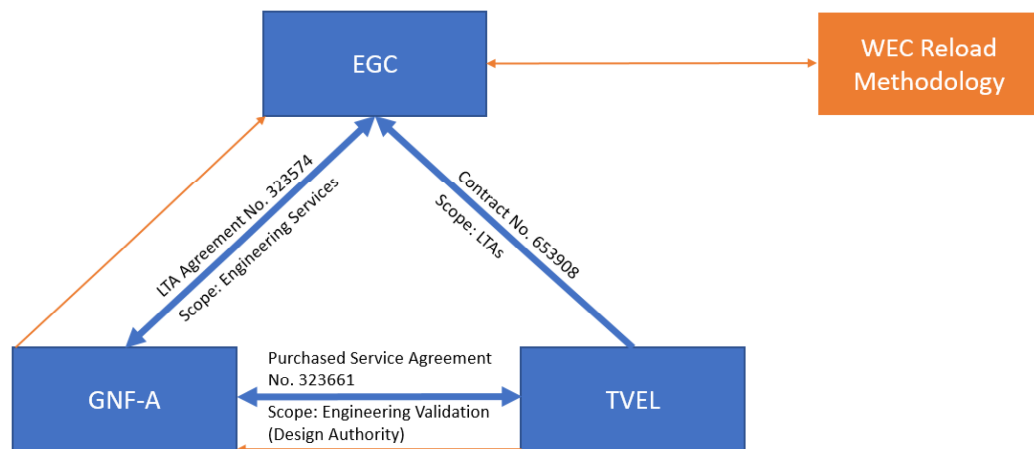


Figure 1-1: TVS-K LTA Project Relationships

ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

TVS-K LTA Project Roles and Relationships

EGC is procuring eight LTAs for irradiation at the Braidwood Station directly from TVEL under the conditions of EGC Contract No. 653908, "Contract for the Braidwood Nuclear Station Lead Test Assembly Program, Lead Test Assemblies Supply and Associated Service between Joint Stock Company TVEL and Exelon Generation Company, LLC," dated July 13, 2016. This contract requires fabrication of the Braidwood LTAs under the TVEL 10 CFR 50 Appendix B Quality Assurance (QA) program and requires TVEL to maintain a complete 10 CFR 21 program to report any fabrication or design reportable conditions to both EGC and the U.S. Nuclear Regulatory Commission (NRC).

TVEL is an established manufacturer of commercial nuclear power reactor fuel assemblies. The TVS-K fuel assembly was developed by TVEL for operation in Westinghouse 3 and 4 loop pressurized water reactors (PWRs) outside the United States. TVEL will fabricate the eight Braidwood LTAs using their manufacturing facilities in Russia. The fabrication of the Braidwood LTAs is governed by the TVEL 10 CFR 50 Appendix B QA manual, RKK(USA)-1-2018, "Fuel Company Quality Manual for Operation at the American Market," which also includes 10 CFR 21.

While TVEL is the original designer of the TVS-K fuel and responsible for the fabrication of the Braidwood LTAs, GNF-A will bring the TVS-K design under the GNF-A QA program per GNF-A Opportunity 323661, "Purchased Service Agreement between TVEL and GNF-A for the Engineering Support of the US TVS-K LTA Program and Other Related Services," Revision 0, December 23, 2016. As a result, GNF-A will be the design authority for the Braidwood LTAs with engineering services being performed in accordance with NEDO-11209-A, "GE Hitachi Nuclear Energy Quality Assurance Program Description," and PLM 004N5794, "TVS-K Braidwood LTA Project Plan." Details about the design validation process utilized by GNF-A are provided separately below. GNF-A will apply their 10 CFR 21 program as it relates to the design of the TVS-K fuel assemblies.

Exelon has separately procured TVS-K LTA technical support services direct from GNF-A under GNF-A Opportunity 323574, "GNF-A and Exelon TVS-K LTA Program Agreement for the Braidwood Nuclear Station", Revision 0, dated March 20, 2017. Per this agreement, GNF-A will provide engineering services and technical support, safety analysis services (e.g. Technical Evaluation Report, Core Operating Limits) and licensing support to EGC. In addition, this agreement states that GNF-A will provide QA Services to support TVEL in implementation of a 10 CFR 50 Appendix B and 10 CFR 21 program. It is this requirement that led to development of the sequential facility audit strategy described below.

Figure 1-2 provides a graphical representation of the overall flow of QA requirements and technical data for design, testing and fabrication of the TVS-K lead test assemblies.

ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

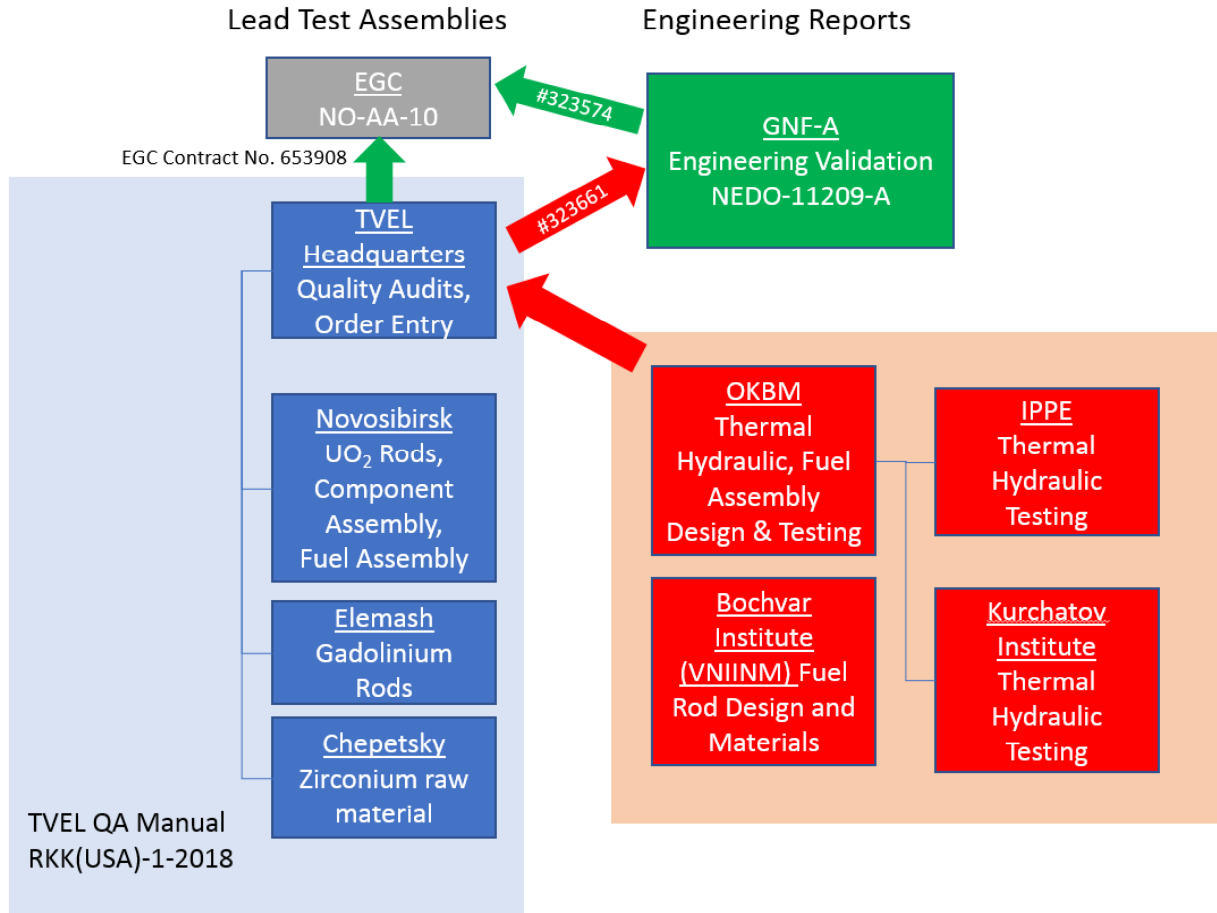


Figure 1-2: TVS-K LTA Project QA Requirement and Technical Data Flow

Quality Assurance

Fabrication

TVEL needs to be placed on the EGC Approved Suppliers List (ASL) as part of the purchase of the Braidwood LTAs. TVEL contracted GNF-A for services to identify gaps in the TVEL Quality Programs to 10 CFR 50 Appendix B to allow TVEL to develop the necessary controls and processes to support U.S. customers. GNF-A also provided support to TVEL for the establishment and implementation of a 10 CFR 21 program. TVEL developed RKK(USA)-1-2018 to provide quality requirements to all TVEL facilities working on a U.S. project.

Table 1-1 summarizes the TVEL facilities that support the manufacture of the Braidwood LTAs. Both EGC and GNF-A separately audited these facilities to evaluate the adequacy of the TVEL QA Program and the implementing procedures for compliance with 10 CFR 50 Appendix B, 10 CFR 21, and NQA-1-2008/2009a for the fabrication of TVS-K fuel assemblies. Subsequent surveillances are planned to provide fabrication oversight. Documentation supporting these audit activities were reviewed by the NRC during an audit performed February 11-15, 2019

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(ADAMS Accession No. ML19038A489). EGC concluded the TVEL audits in March 2019 and will be adding them to the EGC ASL as an approved supplier with conditional clauses requiring surveillance of fabrication activities for verification of TVEL QA Program implementation.

Table 1-1 TVEL Facilities Used for the Fabrication
of the Braidwood TVS-K LTAs

Organization	Location	Product/Service
TVEL HQ	Moscow	Order entry, quality assurance
Elemash	Moscow region	Gadolinium pellet and rod fabrication
Chepetsky	Glazov	Zirconium component production
NCCP	Novosibirsk	Fabrication of UO ₂ pellets and rods Component assembly TVS-K bundle assembly

Engineering

PLM 004N5794, "TVS-K Braidwood LTA Project Plan," describes the overall process GNF-A will use to bring the TVEL TVS-K design under the GNF-A QA Program. PLM DOC-0009-0707, "TVS-K PWR Fuel LTA Program and Reload Licensing Plan," describes the validation process used to evaluate the input information and documents provided by TVEL to determine the acceptability of the items as Design Inputs to EGC under the GNF-A QA Program, including the development of Engineering Quality Assurance Plans to implement the topic specific aspects of the validation process. The generic overall validation process is depicted in Figure 1-3. EGC will perform a Limited Scope Audit (LSA) on GNF to verify design (and software, as described below) activities associated with design for the TVEL TVS-K project.

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ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]



Figure 1-3: GNF-A Design Validation Approach

Table 1-2: TVEL Engineering and Testing Locations

Organization	Location	Product/Service
----- Russian Government Facilities -----		
IPPE	Obninsk	Critical heat flux testing
Kurchatov Institute	Moscow	Critical heat flux testing
Bochvar Institute	Moscow	Fuel rod design and thermal mechanical Zirconium alloy research
----- Rosatom Facilities -----		
OKBM	Nizhny Novgorod	Fuel assembly design and testing (thermal hydraulic, mechanical and nuclear)
RIAR	Dimitrovgrad	BOR-60 test reactor Irradiated materials property testing

Engineering Analyses Codes

To support the engineering analyses for the Braidwood LTAs, GNF-A procured three computer codes from ASL vendors (See Figure 1-4). VIPRE and RETRAN were procured from Zachry Nuclear Engineering Inc. and CMS5 was procured from Studsvik Scandpower Inc. GNF-A also modified their thermal mechanical code, PRIME, to support PWR fuel analyses. Software Verification and Validation of each program was performed in accordance with the GNF-A QA Program. EGC will include verification of software-related activities associated with TVEL TVS-K project as part of the planned design-related LSA.

ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

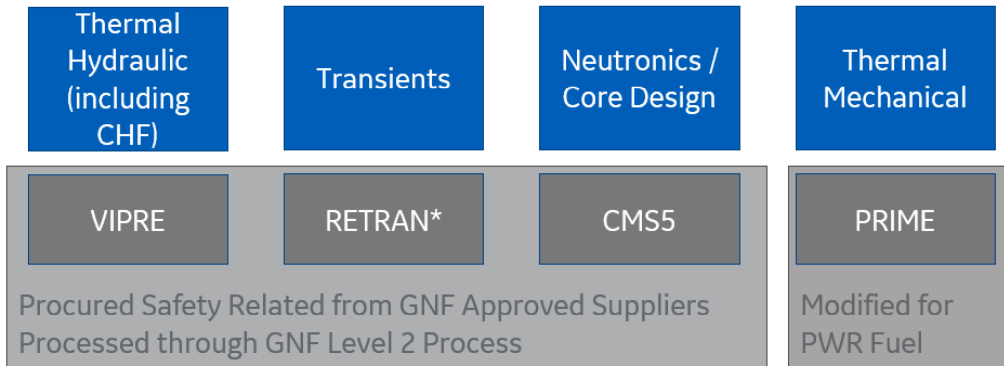


Figure 1-4: Engineering Analyses Codes for the TVS-K LTA Project

10 CFR 21 Reporting Responsibilities

TVEL maintains a complete 10 CFR 21 program to report any fabrication or design Reportable Conditions to both EGC and the U.S. NRC. GNF-A will use their 10 CFR 21 program as it relates to the design of the TVS-K fuel assemblies and to support TVEL with any Part 21 evaluations related to design and fabrication.

ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

RAI 2

In its letter dated July 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18204A169), Exelon discussed power margin calculations that were performed to determine the cutback in the enthalpy rise hot channel factor ($F\Delta H$) needed to ensure the requested TVS-K lead test assemblies (LTAs) will not be limiting with respect to critical heat flux (CHF) during anticipated operational occurrences (AOOs) and normal operation. The letter stated that the power margin calculations used the CRK CHF correlation, which was developed by TVEL specifically for TVS-K fuel. By letter dated October 19, 2018 (ADAMS Accession No. ML18296A288), Exelon provided additional information on the CRK correlation and its development.

In its letter dated July 19, 2018, Exelon also stated that the prior LTA experience at the Ringhals Unit 3 nuclear power plant in Sweden prompted changes to the TVS-K LTA design for Braidwood. One of the listed changes includes “a new mixing vane next to the guide thimble to improve flow mixing.” During its audit, the NRC staff learned that the CRK correlation was developed based on CHF testing performed prior to the spacer grid changes made for the Braidwood LTAs. Since changes to the spacer grid configuration can substantially affect the thermal-hydraulic performance of a fuel assembly, the NRC staff requests the following information to ensure the adequacy of the assembly power cutback calculations.

Provide a more detailed description of the spacer grid updates that were made for the TVS-K lead LTAs proposed for use at Braidwood relative to the spacer grids irradiated in TVS-K LTAs at Ringhals and tested to support development of the CRK CHF correlation. Discuss any additional testing that may have been done to validate that the CRK correlation provided adequate or conservative predictions of CHF for the updated spacer grid. If new CHF testing using the updated spacer grids was performed at a facility other than those already discussed in letters dated July 19 and October 19, 2018, provide a description of the test facility consistent with the level of detail provided for the two facilities already described.

EGC Response to RAI 2

Following the initial Critical Heat Flux (CHF) TVS-K testing performed by Rosatom subsidiaries Afrikantov OKB Mechanical Engineering (OKBM) and the Institute of Physics and Power Engineering (IPPE), additional CHF testing was performed at the Kurchatov Institute (KS) National Research Center in Moscow, Russian Federation. Full-scale **[[** CHF testing was performed on a TVS-K assembly mockup based on spacer grid components more consistent with the Braidwood Lead Test Assemblies (LTAs). The spacer grid components were slightly modified in comparison to the TVS-K assembly components originally tested at OKBM and IPPE and implemented at Ringhals Unit 3. The purpose of the KS tests was to evaluate the CHF performance for the modified spacer design and confirm the application of the CRK CHF correlation to the Braidwood LTAs. CHF testing was performed in accordance with established testing procedures at the KS test facility.

The spacer grid components of TVS-K section tested at the KS facility included enhancements based on the operating experience of the TVS-K assembly at Ringhals Unit 3. Pertinent to CHF testing, **[[**

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ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

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The heat generation and removal equipment of the KS test facility is similar to that in the SVD-2 test facility of IPPE. The high-pressure loop includes a [[]] assembly test section that accommodates heated lengths up to approximately [[]]. DC power with a total capacity of [[]] is supplied by four operated thyristor rectifiers to the test section heater rods. The maximum operating parameters of the KS facility are summarized in Table 2-1. Heat removal in the high-pressure loop is accomplished by using coil heat exchangers with distilled water as the coolant on the secondary side. Experimental data is obtained by a high-speed data acquisition system that transmits the test data to computer storage.



Figure 2-1 Braidwood LTA IFM Grid Cross Section

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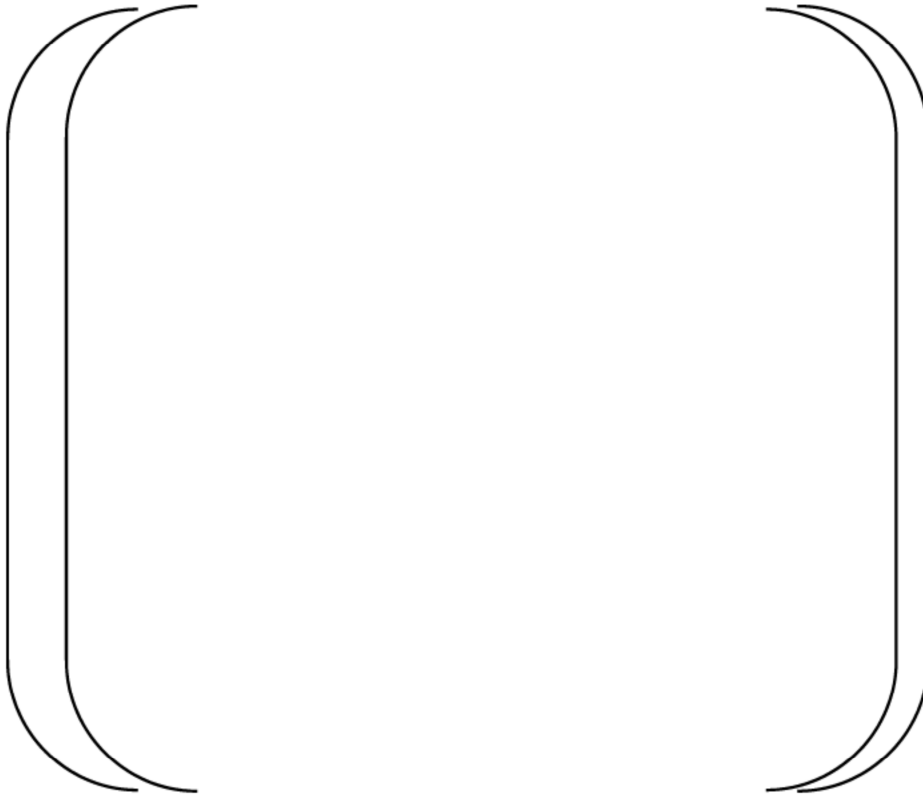


Figure 2-2 Ringhals Unit 3 IFM Grid Cross Section

Table 2-1 Summary of KS Test Facility Operating Parameters

Parameter	Maximum Operating Value
Pressure	
Coolant Inlet Temperature	
Flow Rate	

The test section was oriented vertically into a solid housing with coolant flow directed upward. The heater rods were cylindrical tubes of stainless steel. The heat generation was carried out by a direct electric current passing through the tubes, which is supplied to the models by copper conducting parts. The heater rods and GTs in the test section had the same dimensions as the TVS-K LTAs. Simple supporting grids were placed between the MVGs to prevent a potential electro-magnetic force induced geometry change during the tests. The test section parameters and the CHF test parameters are summarized in Table 2-2 and Table 2-3, respectively.

ATTACHMENT 3
Response to NRC Request for Additional Information [Non-Proprietary]

Table 2-2 Summary of KS Test Section Parameters

Test ID	Rod Array	No. of Heated Rods	No. of Guide Tubes	Axial Power Profile	Heated Length m (in)	No. MVGs	No. IMF Grids	No. of Test Points
[[]]

Table 2-3 Summary of KS CHF Test Parameters

Parameter	Test Condition
Pressure	[[[[[[[[]]]]]]]]
Coolant Inlet Temperature	
Mass Velocity	
Local Quality	

Following testing, VIPRE-01 benchmarks of the KS-25-2 test section were performed [[
]]]. Predictions of CHF were calculated using the CRK CHF correlation, which was developed from the original test data at the OKBM and IPPE test facilities. Figure 2-3 illustrates a comparison of experimental CHF test values from the KS-25-2 test section and predicted CHF values based on the CRK correlation. Figure 2-3 indicates that [[

]] The benchmark comparisons confirmed that the application of the CRK correlation for the Braidwood TVS-K LTAs is conservative for CHF calculations.

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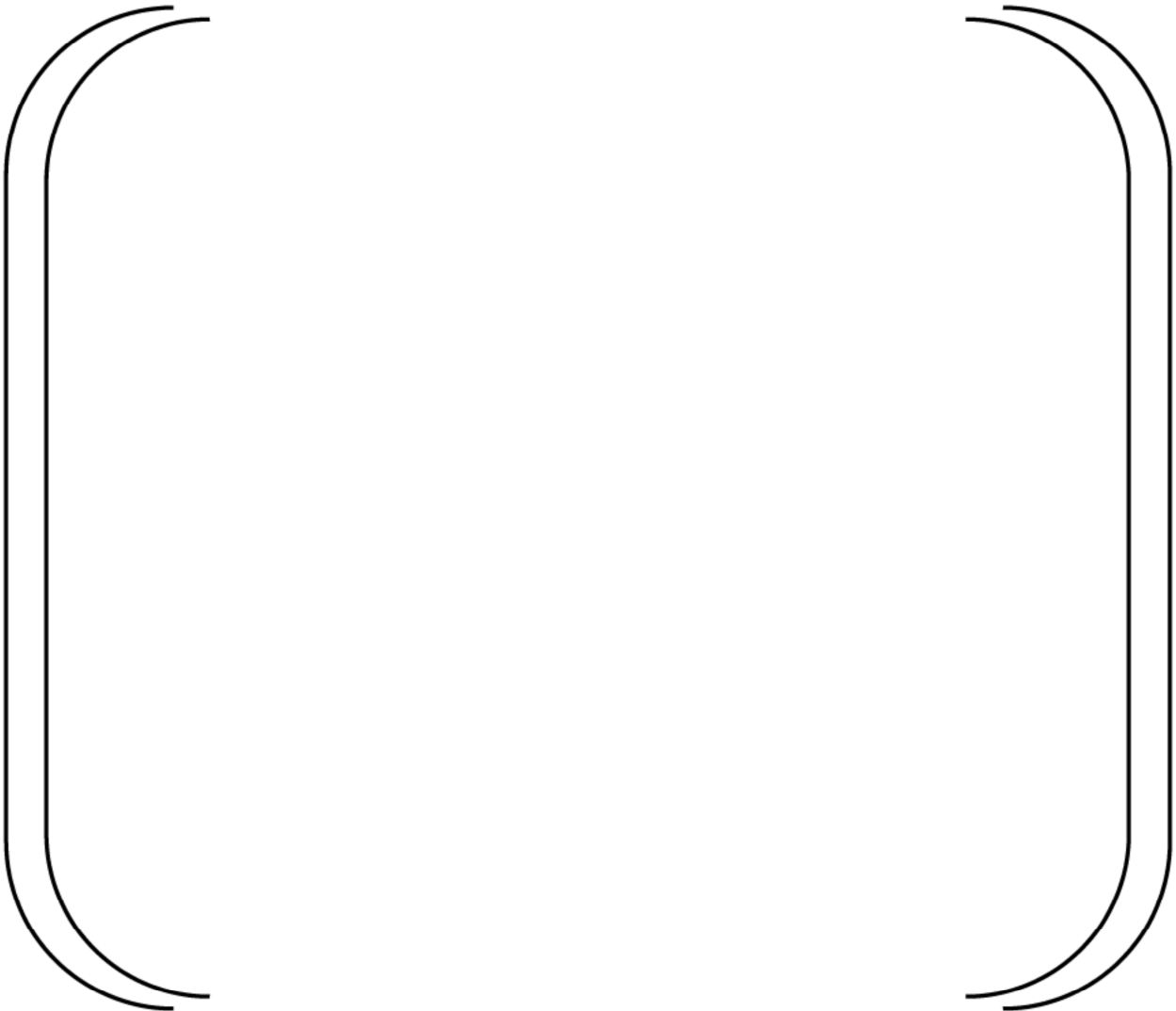


Figure 2-3 Comparison between experimental CHF values of TVS-K mockup assembly at KS test facility and predicted CHF values by the CRK correlation

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RAI 3

The NRC staff's initial look at the qualification and validation of PRIME models for the TVEL LTAs and the Braidwood fuel rod thermal mechanical evaluation reveals sufficient information to demonstrate acceptable results for the first cycle. However, information is currently not available that demonstrates acceptability for additional cycles as allowed by the requested license condition. Provide information regarding the controls that are in place to require obtaining this additional information and verification that acceptable performance is demonstrated prior to continuing use of the TVEL LTAs in additional cycles. In particular, explain how the PRIME models and application methodology will be updated to accommodate [[

]], and address DNB propagation during accident conditions. Discuss how the updates will be validated against relevant measurements from experiments or post-irradiation examination.

EGC Response to RAI 3

Attachment 1, Section 3.5 of EGC letter RS-18-068 dated July 19, 2018 stated that GNF-A would evaluate the TVS-K LTA fuel rod design using a version of the PRIME03 code modified to augment the qualification database with E110opt cladding material characteristics. Additional details regarding the GNF-A validation of PRIME03 were provided in letter RS-18-129 dated October 19, 2018. This RAI response updates and supplements the previous submittals regarding the qualification database for PRIME03. Initial GNF-A efforts to expand PRIME03's qualification range to encompass TVS-K rod operation under PWR conditions included two aspects:

- i. [[]] differentiate PWR experiments from the overall database to look for trends and,
- ii. [[]] with new experimental data.

As part of the effort, the current integral rod experiment qualification database for PRIME03 was found to include a considerable number of cases (including 110 cases, or ~20% of the qualification database) at conditions representative of PWR operation. Evaluation of PRIME03 performance for these PWR-specific cases [[

]], providing some initial confidence in PRIME03's ability to evaluate the TVS-K LTA design.

The qualification database was then augmented with additional test data for experiments on fuel very similar to the Braidwood TVS-K design (i.e., similar dimensions, E110opt cladding material, and similar pellet characteristics). The measured data from these tests encompass qualification parameters consistent with those typically examined for thermal mechanical performance. PRIME03's predictive capability using the augmented qualification database is generally [[

]]

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Results supporting the limited expansion of the PRIME03 qualification basis described above and evaluations of LTA fuel rod performance for the first cycle of operation are documented in a Technical Evaluation Report (TER), which was made available for NRC audit in February and April 2019. The TER concludes the [[

]]

Additional assessments and tests are planned to better characterize the TVS-K fuel rod [[

evaluate TVS-K performance, [[

]]

]].

Ensuring Subsequent Cycle Performance Adequacy

Acceptance criteria related to PRIME03 qualification and Braidwood LTA performance evaluations of pellet/cladding interaction and RIP for subsequent cycles are provided below. GNF-A shall document how the acceptance criteria have been met to support operation beyond the first cycle at Braidwood in a revision to the TER. Prior to operation of the LTAs in Cycle 23, EGC will transmit a letter to the NRC documenting which option was used to demonstrate acceptable LTA performance in the areas of pellet/cladding interaction and RIP.

Pellet/Cladding Interaction Acceptance Criteria

Completion of any one of the following options is considered an acceptable mechanism to demonstrate adequate performance for the LTAs in the area of pellet/cladding interaction [[

]]

Rod Internal Pressure Acceptance Criteria

Completion of all of the following is considered an acceptable mechanism to demonstrate adequate performance for the LTAs in the area of RIP [[

]]

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[[

]]

Update to Proposed License Condition

As a result of the open issues related to PRIME03 prediction of pellet/cladding interaction and RIP, EGC proposes to augment the license condition submitted in RS-18-068 dated July 19, 2018 as shown below, where additions are denoted by underlined text. A mark-up of the revised proposed license condition wording for Unit 1 and Unit 2 is provided in Attachments 4 and 5, respectively.

Up to eight TVEL TVS-K Lead Test Assemblies may be placed in nonlimiting Unit X core locations during operation of Unit X, Cycles 22, 23, and 24. Prior to operation of the LTAs in Cycle 23 Exelon Generation Company, LLC shall validate that fuel rod strain and rod internal pressure comply with applicable performance criteria. The process used to confirm compliance shall be consistent with TVS-K specific experimental data and computational methods described in Exelon letter RS-19-051 dated May 30, 2019.

EGC will transmit a letter to the NRC documenting which option was used to demonstrate acceptable LTA performance in the areas of pellet/cladding interaction and RIP. This notification shall occur prior to the operation of any TVS-K LTA beyond Cycle 22.

ATTACHMENT 4

**BRAIDWOOD STATION
UNIT 1**

Docket No. STN-50-456

**Proposed License Condition for the
Renewed Facility Operating License No. NPF-72**

APPENDIX C

ADDITIONAL CONDITIONS

RENEWED FACILITY OPERATING LICENSE NO. NPF-72

The licensee shall comply with the following conditions on the schedules noted below:

<u>Amendment Number</u>	<u>Additional Condition</u>	<u>Implementation Date</u>
145	<p>The safety limit equation specified in TS 2.1.1.3 regarding fuel centerline melt temperature (i.e., less than 5080 °F, decreasing by 58 °F per 10,000 MWD/MTU burnup as described in WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995) is valid for uranium oxide fuel without the presence of poisons mixed homogeneously into the fuel pellets. If fuel pellets incorporating homogeneous poisons are used, the topical report documenting the fuel centerline melt temperature basis must be reviewed and approved by the NRC and referenced in this license condition. TS 2.1.1.3 must be modified to also include the fuel centerline melt temperature limit for the fuel with homogeneous poison.</p> <p>Up to eight TVEL TVS-K Lead Test Assemblies may be placed in nonlimiting Unit 1 core locations during operation of Unit 1, Cycles 22, 23, and 24. Prior to operation of the LTAs in Cycle 23 Exelon Generation Company, LLC shall validate that fuel rod strain and rod internal pressure comply with applicable performance criteria. The process used to confirm compliance shall be consistent with TVS-K specific experimental data and computational methods described in Exelon letter RS-19-051 dated May 30, 2019.</p>	<p>With implementation of the amendment</p> <p>With implementation of the amendment</p>

ATTACHMENT 5

**BRAIDWOOD STATION
UNIT 2**

Docket No. STN-50-457

**Proposed License Condition for the
Renewed Facility Operating License No. NPF-77**

APPENDIX C

ADDITIONAL CONDITIONS

RENEWED FACILITY OPERATING LICENSE NO. NPF-77

The licensee shall comply with the following conditions on the schedules noted below:

<u>Amendment Number</u>	<u>Additional Condition</u>	<u>Implementation Date</u>
122	<p>The safety limit equation specified in TS 2.1.1.3 regarding fuel centerline melt temperature (i.e., less than 5080 °F, decreasing by 58 °F per 10,000 MWD/MTU burnup as described in WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995) is valid for uranium oxide fuel without the presence of poisons mixed homogeneously into the fuel pellets. If fuel pellets incorporating homogeneous poisons are used, the topical report documenting the fuel centerline melt temperature basis must be reviewed and approved by the NRC and referenced in this license condition. TS 2.1.1.3 must be modified to also include the fuel centerline melt temperature limit for the fuel with homogeneous poison.</p> <p>Up to eight TVEL TVS-K Lead Test Assemblies may be placed in nonlimiting Unit 2 core locations during operation of Unit 2, Cycles 22, 23, and 24. Prior to operation of the LTAs in Cycle 23 Exelon Generation Company, LLC shall validate that fuel rod strain and rod internal pressure comply with applicable performance criteria. The process used to confirm compliance shall be consistent with TVS-K specific experimental data and computational methods described in Exelon letter RS-19-051 dated May 30, 2019.</p>	<p>With implementation of the amendment</p> <p>With implementation of the amendment</p>

ATTACHMENT 6
List of Regulatory Commitments

The following table identifies commitments provided in this submittal.

COMMITMENT	COMMITTED DATE OR "OUTAGE"	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
Notify the NRC by letter which option was used to demonstrate acceptable LTA performance in the areas of pellet/cladding interaction and rod internal pressure.	Prior to operation of the LTAs beyond Cycle 22	Yes	No