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LTR-NRC-19-81

December 17, 2019

Subject: Submittal of Comments and Proprietary Markings on the Draft Safety Evaluation for Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, "Reference Fuel Design SVEA-96 Optima3," (EPID L-2014-TOP-0003) (Proprietary/Non-Proprietary)

Enclosed are the proprietary and non-proprietary versions of the Submittal of Comments and Proprietary Markings on the Draft Safety Evaluation for Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, "Reference Fuel Design SVEA-96 Optima3," (EPID L-2014-TOP-0003) (Proprietary/Non-Proprietary).

This submittal contains proprietary information of Westinghouse Electric Company LLC ("Westinghouse"). In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Nuclear Regulatory Commission's ("Commission's") regulations, we are enclosing with this submittal an Affidavit. The Affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the proprietary aspects of the this submittal or the Westinghouse Affidavit should reference AW-19-4985 and should be addressed to Korey L. Hosack, Manager, Licensing, Analysis, & Testing, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 1, Suite 133, Cranberry Township, PA 16066.

Korey L. Hosack, Manager
Licensing, Analysis, & Testing

cc: Ekaterina Lenning (NRC)
Dennis Morey (NRC)

Enclosures:

1. Affidavit AW-19-4985
2. Proprietary Information Notice and Copyright Notice
3. Submittal of Comments and Proprietary Markings on the Draft Safety Evaluation for Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, "Reference Fuel Design SVEA-96 Optima3," (EPID L-2014-TOP-0003) (Proprietary)
4. Submittal of Comments and Proprietary Markings on the Draft Safety Evaluation for Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, "Reference Fuel Design SVEA-96 Optima3," (EPID L-2014-TOP-0003) (Non-Proprietary)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

COUNTY OF BUTLER:

(1) I, Korey L. Hosack, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).

(2) I am requesting the proprietary portions of LTR-NRC-19-81 be withheld from public disclosure under 10 CFR 2.390.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.

(ii) Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

(5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

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(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use 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 a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (5)(f) of this Affidavit.

AFFIDAVIT

I declare that the averments of fact set forth in this Affidavit 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: 2019/12/17

Korey L. Hosack, Manager
Licensing, Analysis, & Testing

## PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and non-proprietary versions of a document, furnished to the NRC in connection with requests for generic review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the Affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

## COPYRIGHT NOTICE

**Enclosure 4**

**Submittal of Comments and Proprietary Markings on the Draft Safety Evaluation for Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, "Reference Fuel Design SVEA-96 Optima3," (EPID L 2014-TOP-0003)**

**(Non-Proprietary)**

**December 2019**

**Westinghouse Electric Company**
**1000 Westinghouse Drive**
**Cranberry Township, PA 16066**

Westinghouse has reviewed the NRCs Draft Safety Evaluation (SE) and offers the following comments.

Westinghouse is in agreement with the NRC's suggested proprietary information markings as indicated on SE pages 3 (lines 13-23), 5 (lines 34 and 38), and 14 (lines 21 and 22). In addition, we offer the following editorial comments and additional suggested proprietary markings. These changes are listed below and included in the attached mark-up of the draft SE.

| SE Page | Line(s) | Comment |
|---|---|---|
| 1 | 5 | Change "WCAP-17796" to "WCAP-17769" |
| 5 | 9-12 | Add Proprietary marking |
| | 21-25 | Add Proprietary marking |
| | 30-31 | Add Proprietary marking |
| | 34 | Remove extraneous "s"; change "that" to "than" |
| 6 | 35-36 | Add Proprietary marking |
| | 41-44 | Add Proprietary marking |
| 7 | 13-14 | Add Proprietary marking |
| | 16-18 | Add Proprietary marking |
| | 24 | Add Proprietary marking |
| | 26-27 | Add Proprietary marking |
| 8 | 40-45 | Add Proprietary marking |
| 9 | 25-27 | Add Proprietary marking |
| | 30 | Add Proprietary marking |
| | 38-40 | Add Proprietary marking |
| 11 | 29-34 | Add Proprietary marking |
| 13 | 40 | Add Proprietary marking |
| | 42 | Add Proprietary marking |
| 14 | 38 | Add Proprietary marking |

**U.S. NUCLEAR REGULATORY COMMISSION**

**DRAFT SAFETY EVALUATION FOR**

**TOPICAL REPORT WCAP-~~1779~~617769-P/NP, REVISION 0,**

**"REFERENCE FUEL DESIGN SVEA-96 OPTIMA3"**

**(EPID: L-2014-TOP-0003)**

**WESTINGHOUSE ELECTRIC COMPANY**

## 1.0 INTRODUCTION

By letter dated November 13, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13323A100), Westinghouse Electric Company (Westinghouse) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review topical report (TR) WCAP-17769-P/NP, Revision 0, “Reference Fuel Design SVEA-96 Optima3” (Proprietary/Non-Proprietary) (Ref. 1). This TR describes improvements to the previously approved boiling water reactor (BWR) fuel mechanical design methodology intended to support fuel design and licensing applications up to a rod average burnup of 62 gigawatt-days per metric ton of uranium (GWd/MTU). This TR also provides a reference product description, including mechanical specifications and performance aspects, of the SVEA-96 Optima3 fuel assembly design.

The NRC staff's review was assisted by Pacific Northwest National Laboratory (PNNL). The NRC staff’s conclusions on the acceptability of WCAP-17769-P/NP, Revision 0, are supported by the PNNL Technical Evaluation Report, which is being withheld from public availability as it contains Westinghouse proprietary information.

During this review, two rounds of request for additional information (RAI) questions were issued by the NRC and responded to by Westinghouse (Refs. 3 and 4). Additionally, the NRC staff performed a regulatory audit on May 19-20, 2016 (Audit Plan: Ref. 5, Audit Summary: Ref. 6).

## 2.0 REGULATORY EVALUATION

Regulatory guidance for the review of fuel system designs and adherence to applicable General Design Criteria (GDCs) is provided in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (SRP) Section 4.2, “Fuel System Design” (Ref. 7). As stated in Section 4.2 of SRP:

> The fuel system safety review provides assurance that (1) the fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs), (2) fuel system damage is never so severe as to prevent control rod insertion when it is required, (3) the number of fuel rod failures is not underestimated for postulated accidents, and (4) coolability is always maintained. General Design Criterion (GDC) 10, within Appendix A to 10 CFR Part 50, also addresses item 1 above. Specifically, GDC 10 establishes specified acceptable fuel design limits (SAFDLs) that should not be exceeded during any condition of

normal operation, including the effects of AOOs. Therefore, the SAFDLs are established to ensure that the fuel is not damaged. Within this context, "not damaged" means that the fuel rods do not fail, fuel system dimensions remain within operational tolerances, and functional capabilities are not reduced below those assumed in the safety analysis. The design limits of GDC 10 (i.e., the SAFDLs) accomplish these objectives. In a "fuel rod failure," the fuel rod leaks and the first fission product barrier (the cladding) is breached. The dose analysis required by 10 CFR Part 100 for postulated accidents must account for fuel rod failures. "Coolability," in general, means that the fuel assembly retains its rod-bundle geometry with adequate coolant channels to permit removal of residual heat even after a severe accident. The general requirements to maintain control rod insertability and core coolability appear repeatedly in the GDC found in Appendix A to 10 CFR Part 50 (e.g., GDC 27 and 35).
In particular, 10 CFR 50.46 provides the specific coolability requirements for the loss-of-coolant accident (LOCA).

The NRC staff's review of WCAP-17769-P/NP, Revision 0, was to ensure that the mechanical design methodology adequately addresses the applicable regulatory requirements identified in SRP Section 4.2. In addition, the NRC staff reviewed the SVEA-96 Optima3 fuel assembly design to ensure its performance satisfies these requirements.

## 3.0 TECHNICAL EVALUATION

The objectives of the NRC staff's review of WCAP-17769-P/NP, Revision 0, were to verify that:

1. The fuel assembly component and fuel rod design criteria are consistent with applicable regulations and the acceptance criteria identified in SRP Section 4.2.

2. The fuel mechanical design methodology is capable of accurately or conservatively evaluating each component with respect to its applicable design criteria.

3. The reference SVEA-96 Optima3 fuel assembly design satisfies the regulatory requirements.

4. The Westinghouse experience database supports the operating limits being requested.

This TR also describes the evolutionary design features of the SVEA-96 Optima3 fuel assembly that distinguish this design from the previous SVEA-96 Optima2 fuel assembly design. Since a separate review of a material change for the Optima2 fuel channel was still ongoing when this TR was submitted (Ref. 11), and as this TR includes the same fuel channel material, it was noted that any changes, conditions, and limitations required by the safety evaluation (SE) for the Optima2 channel would be likewise required for the Optima3 design with Low Tin ZIRLO™ channels.

Sections 3.2, 3.3, and 3.4 of the draft SE describe the NRC staff's review of Westinghouse's BWR fuel assembly and fuel rod design criteria supporting a peak rod average burnup of 62 GWd/MTU. Licensees must ensure that all of these design criteria are satisfied on a cycle-specific basis.

3.1 <u>General Description</u>

Section 2 of WCAP-17769-P/NP, Revision 0, provides a description of the reference Optima3 fuel assembly design and is supported by detailed illustrations in Figures 2-1a through 2-15 of the TR. This description focusses on features that are different from the previously approved SVEA-96 Optima2 design described in WCAP-15942-P-A, Revision 1 (Ref. 7).

Westinghouse also included, in Section 2.5 of the TR, plant dependent features that are modified to accommodate the reactor internals dimensions and co-resident fuel dimensions and may vary between plants. These features are:

**[**

**]**[a,c]

Westinghouse currently does not have an approved fuel design change process for its BWR fuel designs. As such, modifications to the fuel assembly design, beyond the mechanical compatibility changes identified in Section 2.5 of the TR, fall outside the scope of the NRC staff's review and approval of the SVEA-96 Optima3 reference fuel design and would require further review by the NRC staff. The provisions described in TR's Section 3.1.4, "New Design Features," are not approved. As part of their license amendment request, licensees must describe any plant-specific changes to the reference SVEA-96 Optima3 assembly design and demonstrate that these changes are within the scope of the review performed by the NRC staff, as noted in Section 4.0, "Limitations and Conditions," of this SE.

3.2 <u>Design Criteria</u>

Westinghouse has applied the previously-approved design criteria described in WCAP-15942-P-A (Ref. 8) and CENPD-287-P-A, "Fuel Assembly Mechanical Design Methodology for Boiling Water Reactors" (Ref. 12) to the Optima3 fuel assembly.

Section 3.1.1 of the submittal identifies the design criteria for normal operations and AOOs. The design criteria in this section are unchanged from CENPD-287-P-A. During its review PNNL concluded that the design criteria are consistent with GDC 10 as specified in SRP Section 4.2 and are acceptable for application to SVEA-96 designs. Based on compliance to SRP Section 4.2 guidance and PNNL's technical assessment, the NRC staff finds the design criteria for normal operation and AOOs acceptable. Section 3.1.2 of the TR identifies the design criteria for accident conditions. In Section 3.2 of PNNL report it is concluded that the design criteria are consistent with SRP Section 4.2 and are acceptable for application to SVEA-96 designs. Based

upon compliance to SRP Section 4.2 guidance and PNNL's technical assessment, the NRC staff finds the design criteria for accident conditions acceptable.

Section 3.2 of the TR identifies the design criteria for Fuel Assembly Components. These criteria are consistent with previous SVEA-96 fuel, including Optima2. As Optima3 represents only an evolutionary change to these components, and based on PNNL's technical assessment, the NRC staff finds this design criteria acceptable for use with SVEA-96 Optima3.
Section 3.3 of the TR identifies the design criteria for fuel rods. While the design bases remain unchanged from previously approved methods, the modeling methodology used in the structural design evaluation has been modified. As described in PNNL's assessment, the source of the design bases is the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code 2010, Section III Subsection NB, which offered different options for demonstrating that the design rules have been met. These criteria are met with the exception of the Level B load limit, which WCAP-17769-P/NP, Revision 0, defines to be 10% greater than the Level A load limit, while Subsection NB stress limits are the same for Level A and B loads. This was the topic of RAI-02 and was discussed during the regulatory audit. The NRC does not require adherence to ASME Boiler and Pressure Vessel Committee (BPVC) criteria. The 10% increase in the Level B load limit is a small deviation from the ASME BPVC criteria and still maintains significant margin to the actual collapse limit. Additionally, this same modified Level B load limit was previously found acceptable by the NRC staff for Westinghouse's CR-99 control blade analysis (Ref. 13). PNNL therefore found it acceptable through the use of engineering judgement. Based on PNNL's technical evaluation, the NRC staff finds the criteria acceptable.

## 3.3 Design Methodology and SVEA-96 Optima3 Evaluation

The fuel assembly mechanical design methodology applied to SVEA-96 Optima3 fuel is largely unchanged from that previously approved for application to SVEA-96 Optima2 in WCAP-15942-P-A and CENPD-287-P-A (Ref. 7). The methodology is used to evaluate the fuel assembly mechanical integrity for normal operation and AOOs relative to the design criteria described in Section 3.2 of this SE, and Section 3 of the TR. The changes from the previously approved methodologies will be the focus of this section of the SE.

WCAP-15942-P-A/WCAP-15942-NP-A, Supplement 1, Revision 1, "Material Changes for SVEA-96 Optima2 Fuel Assemblies" (Ref. 11) that supersedes original Westinghouse' submittal of TR WCAP-15942-P-A/WCAP-15942-NP-A, Supplement 1, Revision 0, "Material Changes for SVEA-96 Optima2 Fuel Assemblies," for the NRC review and approval (Ref. 10), requested an approval of a new fuel channel material was reviewed concurrently with the review of this TR, and the NRC staff's final SE was issued on August 6, 2019 (Ref. 16). This channel is also approved for use with Optima3 fuel assemblies, provided the conditions and limitations included in the NRC's SE for that TR (Ref. 16) are met.

### 3.3.1 Methodology for evaluation of General Design Criteria

The methodology for evaluating GDC is consistent with the previously approved methodology and, since these criteria are administrative, identification of technical methods for their evaluation is not applicable.

The NRC staff finds the use of a previously approved methodology for evaluating the GDC appropriate and applicable to the Optima3 fuel design.

3.3.2 Fuel Assembly Components Evaluation

The fuel assembly components evaluation addresses compatibility considerations regarding other fuel assembly types as well as reactor internals for the lifetime of the assembly.

3.3.2.1 Compatibility with Other Fuel Types and Reactor Internals

The approach used to evaluate compatibility with other fuel types and reactor internals has been updated to state that **[**

**]**$^{a,c}$ Sample applications are provided in TR.

Based on the supporting information and sample applications, the NRC staff finds this acceptable.

3.3.2.2 Geometric Changes in the Assembly During Operation

Two items were added to the methodology for Optima3 under the heading “Geometric Changes in the Assembly during Operation”: **[**

**]**$^{a,c}$ Sample applications of these evaluations were provided. Based on the data provided and the sample evaluations, the NRC staff finds these evaluations acceptable.

Part of the methodology for evaluating geometric changes that is unchanged from Optima2 involves ensuring that the **[**
**]**$^{a,c}$ As the spacer grid for Optima3 is constructed using a different welding technique, RAI-03 was asked to clarify two points regarding structural component burnup limits. The first part requests further justification for the requested burnup limits given that no spacer grids from lead test assemblies ~~s~~ had been examined at burnups greater ~~that~~ than **[** **]**$^{a,c}$ (assembly average).

Westinghouse responded that there is more recent data collected at an assembly average burnup of **[** **]**$^{a,c}$ and that Optima2 assemblies, which use the same alloy as Optima3, have been irradiated to the requested burnup limit without incident. They also state that Optima3 assemblies have been operated in excess of the requested limit, and while structural component data has not been collected, there were no failures related to burnup effects on structural components. Based on the recommendation of PNNL, the NRC staff finds this explanation acceptable.

The second part of RAI-3 asked if any part of the Optima3 fuel assembly was intended to be reused after discharge. Westinghouse responded that no assembly parts are intended for reuse, apart from test assembly programs designed to collect high burnup data. The NRC staff finds this clarification acceptable.

3.3.2.3 Transport and Handling Loads

The Westinghouse criterion for transport and handling loads is that assembly components shall be able to withstand handling and shipping loads without damage. This criterion is not discussed in SRP. However, PNNL has reviewed this criterion and concludes that this criterion is acceptable for application to SVEA-96 designs.

Section 4.2.3 of WCAP-17769-P/NP, Revision 0, describes the methodology associated with transportation and handling loads and provides an application for Optima3. PNNL reviewed the methodology associated with ensuring that assembly components are able to withstand handling loads without damage and concluded that it is acceptable for application to SVEA-96 fuel designs. PNNL's technical evaluation did not include transportation loads which need to be addressed in a separate review on shipping container design.

PNNL identified the simplified bottom tie plate as a change from the Optima2 design that could impact the ability of the bundle to withstand handling loads. This tie plate was evaluated by Westinghouse and found to have no measurable deformation when loaded significantly above the design load.

The NRC finds the handling loads criteria, methodology, and sample application to Optima3 acceptable. Transportation loads were not included as part of this review.

3.3.2.4 Hydraulic Lifting Loads During Normal Operation and Anticipated Operational Occurrences

The Westinghouse criterion is that hydraulic lift loads on the assembly during normal operation and AOOs are not sufficient to unseat the assembly bottom nozzle from the fuel support piece. The impact of these hydraulic lift forces on the sub-bundles are also evaluated to confirm that they are insufficient to unseat sub-bundles from the lower support piece in the bottom nozzle. PNNL concluded that this criterion is consistent with SRP Section 4.2 and applicable to SVEA-96 fuel designs.

Section 4.2.4 of WCAP-17769-P/WCAP-17769-NP, Revision 0, describes the methodology associated with hydraulic lift loads and provides a sample application for Optima3. Westinghouse states that **[**

**]**[a,c]

PNNL reviewed the hydraulic lift loads methodology, which relies on an approved core thermal-hydraulic code and concluded that it is acceptable for application to SVEA-96 fuel designs.

PNNL identified **[** **]**[a,c] as a modification from the Optima2 design that impacts hydraulic lifting loads. **[**

**]**[a,c] The NRC staff finds that the hydraulic lift criterion, methodology, and sample application to Optima3 are acceptable.

3.3.2.5 Assembly Stress and Strain during Normal Operation and Anticipated Operational Occurrences

The Westinghouse criterion for assembly stress and strain is that assembly component mechanical failure shall not occur. This is consistent with SRP Section 4.2 and therefore is acceptable for application to SVEA-96 designs.

Section 4.2.5 of WCAP-17769-P/NP, Revision 0, describes the methodology associated with evaluating component stress and strain and provides an application for Optima3. PNNL reviewed the methodology for ensuring that excess stress or strain does not result in mechanical failure in assembly components and concluded that it is acceptable for application to SVEA-96 fuel designs. PNNL evaluated the example stress analyses on SVEA-96 Optima3 which considered the spacer and fuel channel. **[** **]**$^{a,c}$

Optima2 spacers are constructed using **[** **]**$^{a,c}$ while Optima3 spacers use a **[** **]**$^{a,c}$ This change resulted in RAI-04, in which Westinghouse was asked to clarify the qualification of the **[** **]**$^{a,c}$ In response, Westinghouse described the ASME standards used to qualify the welds and the personnel performing the welds. The NRC staff finds this process acceptable.

PNNL concluded that the mechanical tests and in-reactor performance confirm that the spacer will not fail in SVEA-96 Optima3 due to operational stress. For structural analysis, an FE model was created in ANSYS by PNNL. For the design limit of **[** **]**$^{a,c}$ the displacement of the channel is slightly different than that calculated for the Optima2 channel, but still negligible with respect to the ability to affect the function of the fuel. The NRC staff notes that **[** **]**$^{a,c}$ The NRC staff reviewed WCAP-17769-P/NP, Revision 0, the response to RAI-04, and finds the stress and strain evaluation criterion, methodology, and sample application to Optima3 acceptable.

3.3.2.6 Fatigue of Assembly Components

The Westinghouse criterion for fatigue of assembly components is that fatigue failure shall not occur. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.2.6 of WCAP-17769-P/NP, Revision 0, describes the methodology associated with evaluating fatigue failure of assembly components and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.2.7 Fretting Wear of Assembly Components

The Westinghouse criterion for fretting wear of assembly components is that fuel rod failure due to fretting shall not occur in an environment free of foreign material (i.e., debris). Assembly fretting wear must be accounted for in evaluating stress and fatigue limits. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.2.7 of WCAP-17769-P/NP, Revision 0, describes the methodology and strategies for avoiding fretting failure and provides an application for Optima3. The methodology is

unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.2.8 Corrosion of Assembly Components

The Westinghouse criterion for corrosion of assembly components is that corrosion and crud from assembly components must be accounted for in evaluating functionality, stress, dimensional changes, and thermal hydraulics. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.2.8 of WCAP-17769-P/NP, Revision 0, describes the methodology for minimizing the impact of corrosion and evaluating its effect on assembly components and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.2.9 Hydriding of Zirconium Assembly Components other than Fuel Rods

The Westinghouse criterion for hydriding of Zircaloy assembly components (other than fuel rods) is that hydriding shall not result in unacceptable strength loss. The impact of hydriding on calculated stress in assembly components shall be addressed. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.2.9 of WCAP-17769-P/NP, Revision 0, describes the methodology for minimizing the impact of hydriding and evaluating its effect on assembly components and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3 Fuel Rods Evaluation

Westinghouse has identified ten specific criteria to prevent fuel rod damage or failure during normal operation and AOOs. These design criteria, the supporting methodology, and application to the sample Optima3 fuel assembly design are discussed below. As described in Section 3.1 of the SRP, plant-specific changes may be needed to ensure mechanical compatibility with core components and co-resident fuel. As a result, each licensee must ensure that all of the design criteria are satisfied for its specific Optima3 fuel assembly.

3.3.3.1 Fuel Rod Power Histories

Section 4.3.1 of WCAP-17769-P/NP, Revision 0, described the fuel rod power histories used in the fuel rod design analyses. **[**

**]**[a,c]

The methodology for evaluation of fuel histories is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.2 Rod Internal Pressure

The Westinghouse criterion for rod internal pressure is not to exceed a value which would cause the outward cladding creep rate to exceed the fuel swelling rate. This is often referred to as the no-clad-lift-off criterion and is consistent with previous rod pressure criteria approved by the NRC. Section 4.3.2 of WCAP-17769-P/NP, Revision 0, describes the methodology and application to Optima3. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable. RAI-05 was asked because of a lack of clarity regarding uncertainties included in the rod internal pressure methodology. In the response, Westinghouse revised the text in the TR to indicate which uncertainties were considered. The NRC staff finds this clarification (and the updated TR text) acceptable.

3.3.3.3 Cladding Stress

Westinghouse is using a different methodology for evaluating cladding stress in Optima3 than it used for Optima2. Whereas Optima2 used the VIK-3 code, the vendor will use finite element simulations in the ANSYS program, following ASME Boiler and Pressure Vessel Code 2010, Section III, Subsection NB (Ref. 9).

Due to the change in methodology, RAI-06 requested additional details of the ANSYS model. Additionally, clarification of Table 4.3.3-1 (of the TR) was requested. Westinghouse responded by providing a review of the ANSYS models during an audit conducted on May 19-20, 2016 (Ref. 5). Westinghouse updated Table 4.3.3-1 and clarified that the values in Table 4.3.3-1 **[** **]**a,c In a supplemental response, Westinghouse further clarified that these **[** **]**a,c Westinghouse provided additional details regarding the stress analyses, which are described in greater detail in Section 3.2 of this SE. Among the details discussed during the audit was that the Level B collapse load limit was **[** **]**a,c described in ASME Boiler and Pressure Vessel Code 2010, Section III Subsection NB. As discussed in Section 3 of this SE, this was not a safety concern.

The NRC staff reviewed information provided by Westinghouse and finds this new methodology acceptable for evaluating the cladding stress in Optima3 fuel rods.

RAI-07 asked how cladding corrosion is accounted for in the cladding stress methodology. Westinghouse replied that **[** **]**a,c The NRC staff finds this clarification to be acceptable.

3.3.3.4 Cladding Strain

The Westinghouse criterion for fuel rod cladding strain is that the total transient-induced elastic and plastic circumferential strain shall not exceed 1%. The 1% strain criterion is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.4 of WCAP-17769-P/NP, Revision 0, describes the methodology for performing the cladding stresses analysis and provides a sample application for Optima3. The methodology is

unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.5 Hydriding

The Westinghouse criterion for cladding hydriding is to prevent premature failure due to either internal hydriding or waterside corrosion. The impact of hydrides is accounted for in the stress and strain calculations. The treatment of cladding hydriding is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs. Section 4.3.5 of WCAP-17769-P/NP, Revision 0, describes the methodology to evaluate hydriding and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

RAI-08 requested additional information on Westinghouse's plans to submit a new hydrogen pickup model for analyzing transients outside of the scope of this TR. Westinghouse responded that it intends to submit such a model as part of a separate TR. The NRC staff finds this acceptable.

3.3.3.6 Cladding Corrosion

The Westinghouse criterion for cladding corrosion is that excessive corrosion shall not lead to fuel rod failure. In addition, the effect of cladding corrosion shall be included in the thermal and mechanical evaluation of the fuel design. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs. The methodology for evaluating cladding corrosion is unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.7 Cladding Collapse (Elastic and Plastic Instability)

The Westinghouse criterion for cladding collapse (elastic and plastic instability) is that collapse will not occur during the life of the fuel rod. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.7 of WCAP-15942-P describes the methodology for cladding collapse and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.8 Cladding Fatigue

The Westinghouse criterion for fatigue damage is that failure shall not occur, taking into account the effects of cladding corrosion. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.8 of WCAP-17769-P/NP, Revision 0, describes the methodology for cladding fatigue and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2 (Ref. 7), and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.9 Cladding Temperature

The Westinghouse criterion for cladding temperature is that cladding overheating shall not cause fuel rod failure. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.9 of WCAP-17769-P/NP, Revision 0, describes the methodology for avoiding cladding overheating. This methodology is based on maintaining adequate margin to boiling transition. This approach has been previously approved by the NRC staff for Optima2. The critical power correlation for the Optima3 fuel design was reviewed outside of this topical report (Ref. 15). Associated methods for determining the minimum critical power ratio safety limit have been previously approved by the NRC staff. These methods are applicable to Optima2 fuel and therefore continue to be applicable to Optima3 fuel. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.10 Fuel Temperature

The Westinghouse criterion for fuel temperature is that the maximum fuel centerline temperature shall remain below the fuel melting temperature. This is consistent with Section 4.2 of the SRP and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.10 of WCAP-17769-P/NP, Revision 0, describes the methodology for predicting the maximum fuel temperature during normal operations and AOOs to compare those temperatures to the fuel melting temperatures of the limiting pellets and provides a sample application for Optima3. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

RAI-09 requested justification for **[** **]**$^{a,c}$ Westinghouse responded in a supplement to the RAI response by stating that the Westinghouse **[** **]**$^{a,c}$ The NRC staff finds this explanation acceptable.

3.3.3.11 Fuel Rod Bow

The Westinghouse criterion for fuel rod bowing is that excessive bowing shall be precluded for the fuel assembly life and its impact on fuel rod performance shall be accounted for, if necessary, in the thermal and mechanical evaluation of the fuel rods and assembly. This is consistent with SRP Section 4.2 and, therefore, is acceptable for application to SVEA-96 designs.

Section 4.3.11 of WCAP-17769-P/NP, Revision 0, describes the methodology for confirming that excessive bowing shall not occur during the life of the fuel. Excessive bowing is defined as that degree of fuel rod bow which leads to fuel rod damage or significantly impacts the nuclear or thermal-hydraulic performance of the assembly. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.3.12 Pellet-Cladding Interaction

SRP Section 4.2 identifies PCI as a failure mechanism but does not specify criteria to prevent PCI failure other than the 1 percent uniform strain and no fuel melting criteria, both of which reduce the potential for fuel failure due to PCI. These design criteria have been addressed in Section 3.4.4 and Section 3.4.10 of this SE.

Section 4.3.12 of WCAP-17769-P/NP, Revision 0, describes the additional measures employed to avoid PCI- related fuel failure, which is unchanged from the Optima2 TR. This methodology applies to fuel without a liner; however, the Optima3 fuel assembly features LK3 fuel, which is lined with a Zirc-tin alloy shown to reduce the potential for PCI damage. TR states that the lined fuel clad is the most effective measure in the Westinghouse long-term program for PCI failure mitigation. Westinghouse also institutes generic/plant-specific PCI guidelines and best practices, including ramp rate restrictions, conditioning thresholds, and preconditioning requirements.

Due to the adherence to the cladding strain and fuel melt requirements, the addition of the cladding liner, and the guidelines and best practices, the NRC staff finds Westinghouse's PCI criteria and methodology acceptable.

3.3.4 Steady-State Initialization of Transients and Accidents

The initialization of transients and accidents using STAV7.2 is largely unchanged from that approved for Optima2 fuel. The few changes from the previously reviewed methods are detailed in this section.

3.3.4.1 Calculation of Gap Heat Transfer Coefficients

Section 4.4.1 of WCAP-17769-P/NP, Revision 0, describes the methodology for calculating nominal, upper bound, and lower bound gap heat transfer coefficients. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.4.2 Fast Transient Analysis

Section 4.4.2 of WCAP-17769-P/NP, Revision 0, describes the methodology for selecting the gap heat transfer coefficients for the average and hot channel calculations. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.4.3 Control Rod Drop Accident Analysis

Control rod drop accident (CRDA) analyses use gap heat transfer coefficients based on a built-in best-estimate STAV7.2 model in POLCA-T. The CRDA methodology, including treatment of uncertainties, is described in Appendix A of WCAP-16747-P-A, "POLCA-T: System Analysis Code with Three-Dimensional Core Model."

RAI-10 resulted from confusion over whether or not Westinghouse intends to use the boiling water reactor (BWR) pellet-clad mechanical interaction (PCMI) fuel cladding failure criteria from SRP 4.2 for control rod drop accident (CRDA). It was also unclear if a dose would be calculated

for CRDA with failed fuel. Westinghouse responded by indicating that the CRDA methodology and acceptance criteria are addressed outside the scope of WCAP-17769-P/NP, Revision 0, which provides only the description of the fuel design and determination of the SAFDLs for the fuel design in question as specified in SRP Chapter 4.

The methodology, including acceptance criteria, for the safety analyses described in SRP Chapter 15 are described in other TRs. Evaluation of the dose consequence based on fuel damage determined with either POLCA-T or RAMONA is beyond the scope of the subject TR. In WCAP-16747-P-A (POLCA-T), Westinghouse has committed to the following criteria:

- Until final acceptance criteria are published by the NRC, POLCA-T methodology will determine the extent of fuel damage using the interim acceptance criteria in SRP 4.2, Revision 3 Appendix B for new reactor applications.

- Once the final acceptance criteria are published by the NRC, the POLCA-T methodology will adopt these criteria for all CRDA analysis.

Based on the information presented in WCAP-17769-P/NP, Revision 0, and PNNL's technical evaluation, the NRC staff finds the methodology for initializing CRDA analysis acceptable.

3.3.4.4 Loss-of-Coolant Accident Analyses

Section 4.4.4 of WCAP-17769-P/NP, Revision 0, describes the use of the STAV7.2 and CHACHA-3 codes in the LOCA analysis and the treatment of uncertainties. Inputs to STAV7.2 assure that the gap heat transfer coefficient will be conservatively small and ensure that 10 CFR Part 50 Appendix K requirement I.A.1 is met. The methodology is unchanged from that previously approved for Optima2, and the NRC staff therefore finds its application to Optima3 acceptable.

3.3.4.5 Stability Analysis

Section 4.4.5 of WCAP-17769-P/NP, Revision 0, describes the methodology for selecting the gap heat transfer coefficients for the stability analysis. As this methodology was previously approved for Optima2, and the uncertainties are appropriately accounted for, the NRC staff finds its application to Optima3 acceptable.

3.3.4.6 Dose Calculations

Section 4.4.6 of WCAP-17769-P/NP, Revision 0, states that the fission product inventory predicted by STAV7.2 **[** **]**$^{a,c}$ The dose calculations are performed in accordance with current NRC regulations and guidance on radiological source terms. Since the **[** **]**$^{a,c}$ the assumptions used in the dose calculations are outside the scope of this review.

3.3.5 Applicability of the Loss-of-Coolant Accident Methods and Methodology

The Westinghouse Emergency Core Cooling System (ECCS) evaluation methodology is implemented using two computer codes: GOBLIN and CHACHA-3D (Ref. 16). The GOBLIN code is used to determine the thermal-hydraulic response of the reactor system to postulated

large- and small-break LOCAs. These calculations include interactions between the reactor system and the various safety systems. The CHACHA-3D code determines the detailed temperature distribution and cladding oxidation at selected axial cross sections of the hot assembly analyzed by GOBLIN. The results include peak cladding temperature, local maximum oxidation, core wide oxidations, and maximum average planer linear heat generation rate operating limits for each new fuel design.

As this methodology was previously approved for Optima2, the NRC staff finds its application to Optima3 acceptable. The modest differences between Optima2 and Optima3 do not invalidate the applicability of the methodologies.

An Optima3-specific critical power correlation must be approved by the NRC prior to the application of these LOCA methods.

3.3.6 Additional Assessments of Applying the Westinghouse Methodology to Optima3 Fuel Assembly

Three RAI questions were asked that cover multiple sections or additional topics.

RAI-01 was asked to clarify the discrepancy between a statement made in Section 2.1, which describes changes to **[ ]**$^{a,c}$ and a statement In Section 4.3.1 of the TR that Optima3 fuel assemblies are **[ ]**$^{a,c}$ Westinghouse responded that the statement in Section 4.3.1 was only illustrative of the strong similarities. The NRC staff finds this explanation acceptable.

RAI-11 requested clarification as to why the cladding strain sample application for Optima3 was evaluated at 1 effective full power day (EFPD), while Optima2 was evaluated at 30 EFPD. Westinghouse responded that this was a typo and corrected the text in question. The NRC staff finds this correction acceptable.

RAI-12 asked whether the rod burnup limits were the same for full and part-length fuel rods. It further requested information on peak pellet burnup limits. Westinghouse stated that the supporting analysis show that part length rods satisfy the 62 MWd/kgU rod burnup limit. They further stated that the maximum achievable pellet burnups are covered by the analyses presented in the TR. Based on this response, and the PNNL's technical evaluation, the NRC staff finds that the fuel assembly can satisfy the fuel performance, mechanical, thermal, and materials design bases under normal operations and AOOs to a maximum rod-average burnup of 62 MWd/kgU. This burnup corresponds to an assembly average of **[ ]**$^{a,c}$

### 3.4 Technical Data

Westinghouse provides technical data and specifications for the Optima3 fuel bundle in Section 5 of the TR. SRP 4.2 lists description and design drawings as an area of review. The NRC staff finds these specifications to be acceptable and sufficient to provide an accurate representation of the fuel assembly design.

## 4.0 LIMITATIONS AND CONDITIONS

Licensees referencing WCAP-17769-P/NP, Revision 0, must comply with the following limitations and conditions:

1) Following the fuel assembly and fuel rod mechanical design methodology described in WCAP-17769-P/NP, Revision 0, as amended by RAI responses, the licensee must ensure that all of the design criteria (described in Sections 3.2, 3.3, and 3.4 of this SE) are satisfied on a cycle-specific basis.

2) The reference fuel assembly design, SVEA-96 Optima3, is approved up to a peak rod average burnup of 62 GWd/MTU.

    a. In addition to referencing this report in their license amendment request submittal for implementing SVEA-96 Optima3, licensees must include a description of the plant-specific changes which are being made to ensure mechanical compatibility with core components and co-resident fuel. Further, the licensee must demonstrate that these changes are within the envelope of approved plant-specific changes discussed in Section 3.1.
    b. Modifications to the fuel assembly design, beyond the mechanical compatibility changes identified in Section 3.1, fall outside the envelope of the staff's approval of the SVEA-96 Optima3 reference fuel design and would require further review by the NRC staff. The provisions described in Section 3.1.4 of WCAP-17769-P/NP, Revision 0, "New Design Features," are not approved.

3) The fuel mechanical design methodology and design criteria are approved up to a peak rod average burnup of 62 GWd/MTU.

4) For SVEA-96 Optima3 fuel bundles utilizing Low Tin Zirlo as a channel material, all limitations and conditions imposed in the SE for WCAP-15942-NP Supplement 1, Revision 1, "Material Changes for SVEA-96 Optima2 Fuel Assemblies" (Reference XX – will be inserted when Optima2 is approved) must also be met.

## 5.0 CONCLUSION

Based on its review of this TR and technical support provided by PNNL, the NRC staff finds Westinghouse's fuel mechanical design methodology acceptable. Licensees referencing this TR will need to comply with the conditions listed in Section 4.0 of this SE.

The fuel design criteria presented in WCAP-17769-P/NP, Revision 0, as amended by the RAI responses, satisfy all SRP Section 4.2 fuel assembly criteria and are acceptable for application to SVEA-96 designs.

The fuel mechanical design methodology presented in WCAP-17769-P/NP, Revision 0, as amended by the RAI responses, is acceptable for application to SVEA-96 fuel designs up to a peak rod average burnup of 62 GWd/MTU.

Section 3.1, of WCAP-17769-P/NP, Revision 0, defines the SVEA-96 Optima3 fuel assembly design product description, including the allowed mechanical compatibility changes. The sample application reviewed by the NRC staff demonstrates that this fuel assembly design

meets all of the requirements. Plant-specific and cycle-specific evaluations are required to ensure that the Optima3 assembly design continues to satisfy all of the design criteria.

The NRC staff's review did not include the performance of the SVEA-96 Optima3 fuel design under Seismic/LOCA and transportation loads. In addition to the provisions described in Section 3.1.4 of WCAP-17769-P/NP, Revision 0, “New Design Features,” are not approved.

The NRC staff’s approval of WCAP-17769-P/NP, Revision 0, establishes the licensing basis of Westinghouse’s BWR fuel design criteria and fuel mechanical design methodology and of the SVEA-96 Optima3 reference fuel design. Licensees wishing to implement this fuel design criteria and methodology, which supports a peak rod average burnup of 62 GWd/MTU, are required to submit a license amendment request updating their core operating limit report list of methodologies to include the approved “-A” version of WCAP-17769-P/NP, Revision 0.

## 6.0 <u>REFERENCES</u>

1. Letter from J. Gresham (Westinghouse Electric Company (Westinghouse)), to U. S. Nuclear Regulatory Commission (NRC), “Submittal of WCAP-17769-P, Revision 0 and WCAP-17769-NP, Revision 0, ‘Reference Fuel Design SVEA-96 Optima3’ (Proprietary/Non-Proprietary),” November 13, 2013 ((Agencywide Documents Access and Management System (ADAMS) Accession No. ML13323A100).

2. Letter from J. Gresham (Westinghouse), to NRC, “Responses to NRC Request for Additional Information for the Westinghouse Electric Company (Westinghouse) Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, ‘Reference Fuel Design SVEA-96 Optima 3,’” August 1, 2016 (ADAMS Accession No. ML16313A350).

3. Letter from J. Gresham (Westinghouse), to NRC, “Responses to NRC Request for Additional Information for the Westinghouse Electric Company Topical Report WCAP-17769-P/WCAP-17769-NP, Revision 0, ‘Reference Fuel Design SVEA-96 Optima3,’” LTR-NRC-17-2 dated January 10, 2017 (ADAMS Accession No. ML17018A109).

4. Memorandum from E. Lenning (NRC) to K. Hsueh (NRC), “Meeting Notice with Agenda for May 17-20, 2016, ‘Forthcoming Closed Audit for the WCAP-16182-P/NP, Revision2, ‘Westinghouse BWR Control Rod CR 99 Licensing Report – Update to Mechanical Design Limits,’ and WCAP-17769-P/NP, Revision 0, ‘Reference Fuel Design SVEA-96 Optima3,’” May 13, 2016 (ADAMS Accession No. ML16126A636).

5. Memorandum from E. Lenning (NRC) to K. Hsueh (NRC), “Summary of May 17-20, 2016, Closed Audit with Westinghouse Electric Company to Discuss Responses to the Requests for Additional Information for the Topical Reports WCAP-16182-P/NP, Revision 2, ‘Westinghouse BWR Control Rod CR 99 Licensing Report – Update to Mechanical Design Limits,’ and WCAP-17769-P/NP, Revision 0, ‘Reference Fuel Design SVEA-96 Optima3,’” November 10, 2016 (ADAMS Accession No. ML16242A311).

6. NUREG-0800, NRC Standard Review Plan, Section 4.2., Revision 3, “Fuel System Design,” March 2007.

7. Letter from B. Maurer, Westinghouse, to NRC, "Submittal of WCAP-15942-P-A/WCAP-15942-NP-A, 'Fuel Assembly Mechanical Design Methodology for Boiling Water Reactors, Supplement 1 to CENP-287,'" March 31, 2006 (ADAMS Accession No. ML061110247).

8. NRC Title 10 of the Code of Federal Regulations Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."

9. ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Facility Components," American Society of Mechanical Engineers.

10. Letter from J. Gresham (Westinghouse), to NRC, "Submittal of WCAP-15942-P-A/WCAP-15942-NP-A, Supplement 1, Revision 0, 'Material Changes for SVEA-96 Optima2 Fuel Assemblies' (Proprietary/Non-Proprietary)," September 9, 2010 (ADAMS Accession No. ML102590063).

11. Letter from J. Gresham (Westinghouse), to NRC, "Response to the NRC's Request for Additional Information on WCAP-15942-P-A, Supplement 1, 'Material Changes for SVEA-96 Optima2 Fuel Assemblies' and Submittal of WCAP-15942-P-A, Supplement 1, Revision 1, 'Material Changes for SVEA-96 Optima 2 Fuel Assemblies' (Proprietary/Non-Proprietary)," LTR-NRC-12-60, August 29, 2012 (ADAMS Accession No. ML12262A251).

12. Westinghouse TR CENPD-287-P-A, Revision 0 (Proprietary), CENPD-287-NP-A, Revision 0 (Non-Proprietary), "Fuel Assembly Mechanical Design Methodology for Boiling Water Reactors," July 31, 1996.

13. Letter from J. Gresham (Westinghouse), to NRC, "Submittal of WCAP-16182-P-A/WCAP-16182-NP-A, Revision 3, 'Westinghouse BWR Control Rod CR 99 Licensing Report - Update to Mechanical Design Limits' (Proprietary/Non-Proprietary)," November 9, 2017 (ADAMS Accession No. ML17321A717).

14. Letter from J. Gresham (Westinghouse), to NRC, "Submittal of WCAP-17794-P, Revision 0 and WCAP-17794-NP, Revision 0, '10x10 SVEA Fuel Critical Power Experiments and New CPR Correlation: D5 for SVEA-96 Optima3' (Proprietary/Non-Proprietary)," LTR-13-76, November 22, 2013 (ADAMS Accession No. ML13333A274).

15. Letter from J. Gresham (Westinghouse), to NRC, "Submittal of the approved version of WCAP-16865-P-A, Revision 1, and WCAP-16865-NP-A, Revision 1, 'Westinghouse BWR ECCS Evaluation Model Updates: Supplement 4 to Code Description, Qualification, and Application," October 28, 2011 (ADAMS Accession No. ML11308A063).

16. Letter from D. Morey (NRC) to C. Zozula (Westinghouse), "Final Safety Evaluation For Westinghouse Electric Company Topical Report WCAP-15942-P-A/WCAP-15492-NP-A, Supplement 1, Revision 1, 'Material Changes For Svea-96 Optima2 Fuel Assemblies' (EPID: L-2018-TOP-0032)," August 9, 2019 (ADAMS Accession No. ML19190A293).

17. Letter from K. Hosack (Westinghouse), to NRC, “Submittal of WCAP-15942-P-A Supplement 1-A /WCAP-15942-NP-A Supplement 1-A, Revision 1, ‘Material Changes for SVEA-96 Optima2 Fuel Assemblies" (Proprietary/Non-Proprietary),’” LTR-19-57, September 23, 2019 (ADAMS Accession No. ML19273B312).

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