

**Slides to Support a Meeting on June 14, 2018 for the Continuation of the NRC Review of
WCAP-15942-P-A / WCAP 15942-NP-A, Supplement 1, Revision 1,
“Material Changes for SVEA-96 Optima2 Fuel Assemblies”
(Non-Proprietary)**

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Meeting to Support the Continuation of the NRC Review of WCAP-15942-P-A / WCAP-15942-NP-A, Supplement 1, Revision 1, “Material Changes for SVEA-96 Optima2 Fuel Assemblies,” June 14, 2018

Outline for meeting

- Introduction
- Background
- Strategy moving forward
- Discussion on the Conditions and Limitations in the Draft SER
 - Maximum inch-days Exposure
 - Maximum Oxide Thickness
- Summary
- Questions/Open Discussion

Westinghouse Team Members

- Sweden Fuel Engineering (via telephone)
 - Helena Larsson
 - Björn Andersson
 - Tommy Gustafsson

- Fuel Licensing & Regulatory Support
 - Ed Mercier
 - Parvez Khambatta

Introduction

- Westinghouse is requesting the NRC resume its review of WCAP-15942-P/NP, Supplement 1, Revision 1, “Material Changes for SVEA-96 Optima2 Fuel Assemblies”
- Over the last two years, new data has been collected from Boiling Water Reactors (BWRs) in Europe that use **Low Tin ZIRLO™** fuel channel material. This data warrants revising the Conditions and Limitations in the Draft Safety Evaluation Report (SER) that was prepared in 2016 for the subject Topical Report.
- Westinghouse plans to submit an information package to the NRC by July 2018 to supplement the original Topical Report.

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Background

- In January 2016, the NRC provided Westinghouse with a Draft SER on WCAP-15942-P/NP, Supp. 1, Rev. 1
- One condition in the Draft SER limited the use of Low Tin ZIRLO channels to a maximum exposure of []^{a,c} inch-days.
 - This limitation was imposed due to a lack of data for Low Tin ZIRLO material at exposures beyond []^{a,c} inch-days
- Westinghouse committed to gather supplemental channel-bow data by early 2018 which would demonstrate the channel behavior at higher exposures.
- Westinghouse requested the NRC suspend its review of the subject Topical Report until that data was available.



Strategy moving forward – An Improvement in Safety Margin

- Operation of fuel assemblies in BWR plants operated for long cycles (>18 months) requires fuel channels with low channel bow
 - Low irradiation growth and hydrogen pick-up will limit the channel bow
- Low Tin ZIRLO material channels are designed to have [

]a,c
- To verify the behavior of Low Tin ZIRLO channels, operation in very demanding core locations in [

]a,c has been performed and measured for channel bow at the end of life (EOL)
- Approval of WCAP-15942-P/NP, Supp. 1, Rev. 1, which will make Low Tin ZIRLO channels available in the US BWR market, will significantly reduce the probability and magnitude of channel bow, thus improving the safety of those BWRs using this advanced channel material.



Strategy moving forward – Submittal of Supplemental Information

- Westinghouse plans to submit a supplement to the original Topical Report, which contains this new test data. This submittal will also justify the following two requested changes:
 - An increase in the Draft SER limitation on maximum inch-days from []^{a,c} to []^{a,c} inch-days
 - Rewording of the limitation on maximum internal/external oxide thickness so that it relates instead to ‘total oxide thickness’

Conditions and Limitations in Draft SER – Maximum inch-days Exposure

- Westinghouse would like to replace the term ECBE* (Effective Control Blade Exposure) in the draft SER to the term “Total inch-days”
 - 5.1 5c. EOL control blade exposure (ECBE) shall not exceed []^{a,c} inch-days. (p14)
- Westinghouse would like to change the limitation of the control rod exposure calculated as total inch-days in the draft SER from []^{a,c} inch-days to []^{a,c} inch-days.



Conditions and Limitations in Draft SER – Maximum inch-days Exposure (contd.)

- Inch-days is the unit for measuring the total exposure of control blade operation adjacent to fuel channels, and is the integral value of inserted control blade length (inch) multiplied by the time of exposure (days)
- Total inch-days is the term describing the inch-days accumulated for the entire life of the channel (without the use of any factors)
- ECBE (Effective Control Blade Exposure) is a Global Nuclear Fuel (GNF) proprietary term with factors for the second and third cycle of operation (24 month cycles)
- The ECBE value will be less than the corresponding inch-day value for a given operating condition if a channel was exposed to a control blade in the second, and/or third cycle of operation

Conditions and Limitations in Draft SER – Maximum inch-days Exposure (contd.)

- Based on the additional performance experience for the Low Tin ZIRLO channels, a higher inch-day limit is proposed for the Safety Evaluation Report (SER)
- This revised value will provide greater operational flexibility, on par with that currently available to BWRs with a competitor's fuel channels, or with Westinghouse Zircaloy-2 (Zry-2) channels
- The basis for the proposed operating limit is developed from channel bow measurements of Low Tin ZIRLO channel material performance compared to the performance of Westinghouse Zry-2 channels

Conditions and Limitations in Draft SER – Maximum inch-days Exposure (contd.)

- Channel bow measurements for channels that have been exposed to up to []^{a,c} inch-days show no excessive channel bow in a plant operating with early control blade exposure
 - []^{a,c} channels have been measured with total inch-days []^{a,c}
 - Channel Bow []^{a,c}
 - No accelerated channel bow seen for Low Tin ZIRLO
 - []^{a,c}



Conditions and Limitations in Draft SER – Maximum inch-days Exposure (contd.)



a,b



Proposed SER Conditions and Limitations for Maximum inch-days Exposure

- Westinghouse proposes a control blade exposure limit of []^{a,c} total inch-days
- The limitation of the total inch-days will []^{a,c}
- []^{a,c}
 - []^{a,c}
 - []^{a,c}
 - []^{a,c}



Conditions and Limitations in Draft SER – Maximum Oxide Thickness

- Based on the data from recent pool-side measurements Westinghouse recommends that the NRC revisit the limitations on maximum oxide thickness in the Draft SER
- 3.3 Material Properties of Low Tin ZIRLO
 - Corrosion (p 6)
 - “Maximum oxide thickness on sheet side affected by shadow corrosion of []^{a,c}
- 3.5.8 Corrosion of Assembly Components
 - “Predicted maximum oxide on channel sheet affected by shadow corrosion is []^{a,c} (p 11)
- 5.2 Conditions and Limitations (3.e)
 - “Plots of average oxide thickness vs equivalent channel burn up, maximum oxide thickness vs equivalent channel burn up, and maximum oxide thickness for faces near a control rod vs equivalent channel burn up. Each of these plots should show the applicable oxide limit []^{a,c} (p 15)

Conditions and Limitations in Draft SER – Maximum Oxide Thickness (contd.)

- **The NRC’s conclusions are based on:**
 - WCAP-15942-P-A , Supplement 1, Revision 1, section 4.2.5
page 4-17 (2012)

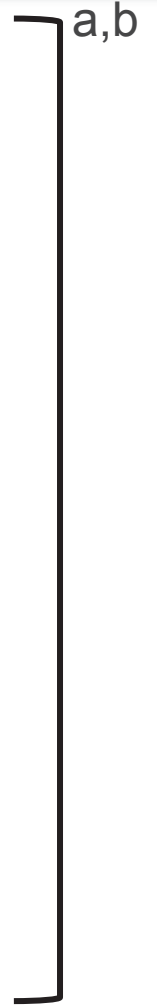
[

]a,c

Conditions and Limitations in Draft SER – Maximum Oxide Thickness (contd.)

- []
]a,c
- []
]a,c
- []
]a,c
- []
]a,c

Conditions and Limitations in Draft SER – Maximum Oxide Thickness (contd.)



Conditions and Limitations in Draft SER – Oxide Thickness and Mechanical Design Analyses

- [

]a,c

- [

]a,c

Proposed SER Conditions and Limitations for Maximum Oxide Thickness

- Westinghouse proposes a slight rewording of the Draft SER limitations on corrosion. As discussed on the previous slide, this change does not have an impact on any actual limits for the analyses, or any safety analysis margins for the fuel:

– [\dots]^{a,c}

– [\dots]^{a,c}

– [\dots]^{a,c}



Proposed SER Conditions and Limitations for Maximum Oxide Thickness (contd.)

- Note that [

(from Section 4.2.5 of the Topical Report):

]a,c For example

– [

]a,c

– [

]a,c

– [

]a,c

– [

]a,c

– [

]a,c



Proposed SER Conditions and Limitations for Maximum Oxide Thickness (contd.)

- [

]a,c

- []a,c

- []a,c

- []a,c

- []a,c

- Using NRC approved methods, an analysis using actual data for the inputs listed above would [

]a,c



Summary

- Westinghouse requests the NRC to resume its review of WCAP-15942-P/NP, Supplement 1, Revision 1, “Material Changes for SVEA-96 Optima2 Fuel Assemblies.”
- In light of the new test data, and justification to be submitted via a supplemental information package in July, 2018, Westinghouse requests that the NRC revisit the Conditions and Limitations in the Draft SER as they pertain to maximum inch-days exposure, and to total oxide thickness.

Questions/Open Discussion