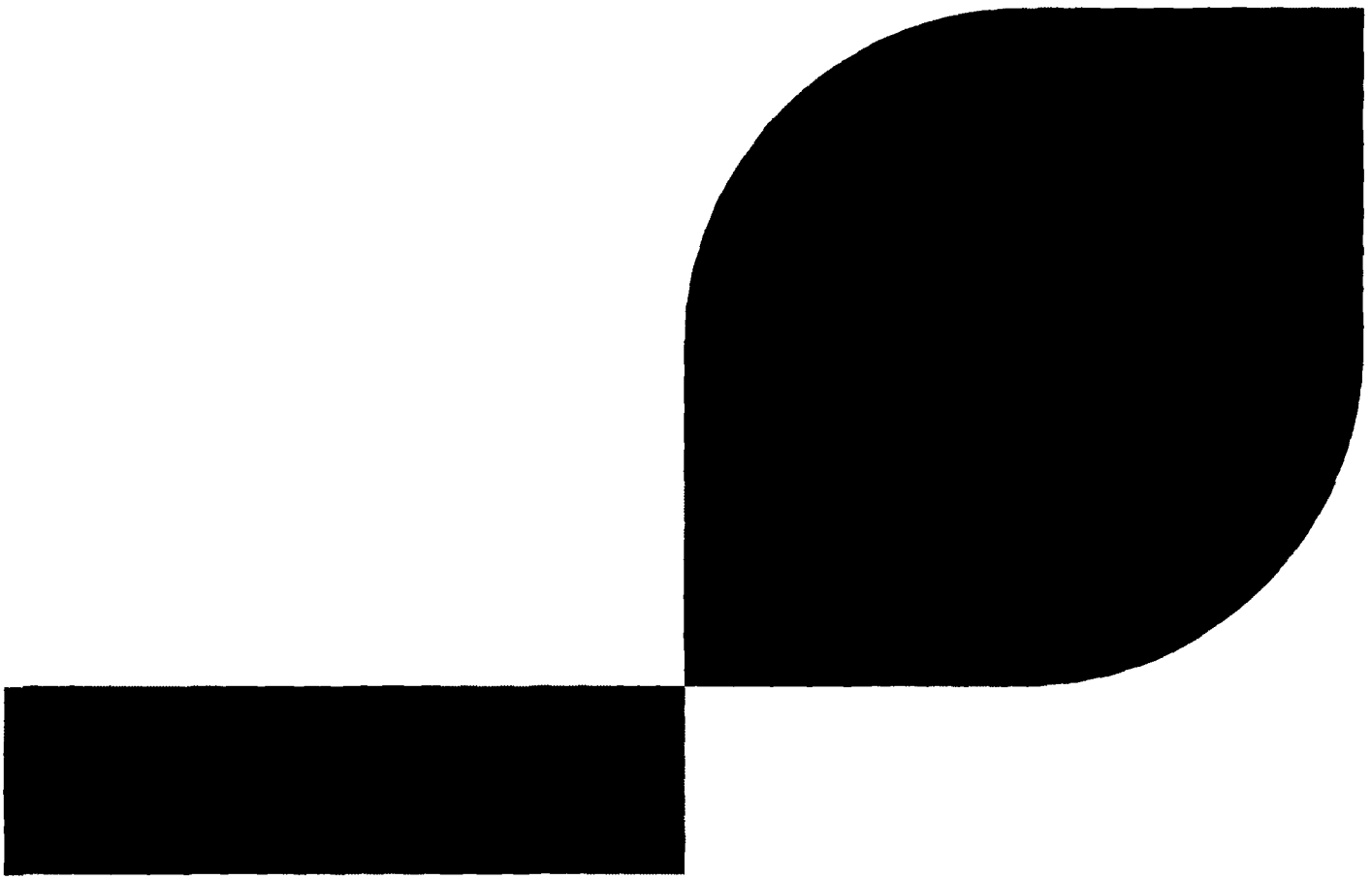

ANP-3261NP
Revision 0

Zircaloy-BWR Beta-Quenched Lead Use Channel Program at Brunswick Nuclear Plant

December 2013

AREVA Inc.

AREVA

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Nature of Changes

Item	Revision Number	Section(s) or Page(s)	Description and Justification
1.	0	All	This is the initial release.

Contents

Tables

This document contains a total of 13 pages.

Nomenclature

Acronym	Definition
ASTM	American Society for Testing and Materials
BQ	Beta-quench
BRK1-20	Brunswick Unit 1 Cycle 20
BWR	Boiling Water Reactor
LUC	Lead Use Channel
MCPR	Minimum critical power ratio
MWd/kgU	MegaWatt days per kilogram Uranium
NRC	Nuclear Regulatory Commission
SE	Safety Evaluation
Zry-BWR	Zircaloy-BWR
Zry-2	Zircaloy-2
Zry-4	Zircaloy-4

1.0 Introduction and Summary

Excessive control blade friction due to fuel channel bow remains a significant technical challenge to the boiling water reactor (BWR) industry. As part of its efforts to resolve this issue, AREVA NP Inc. (AREVA) has developed a lead fuel channel program to implement a new material that may demonstrate an improved resistance to bow and reduced corrosion relative to Zircaloy-4 (Zry-4) fuel channels. The Lead Use Channels (LUC) are made from Zircaloy-BWR™ (*) material that has received a beta-quench (BQ) heat treatment. Twenty Zry-BWR BQ fuel channels will be placed on ATRIUM 10XM™† fuel assemblies and will start irradiation in Brunswick Unit 1 Cycle 20 (BRK1-20). The intent of this letter is to provide a description of the program and information on the approach used to ensure that all licensing requirements have been satisfied.

2.0 Technical Background

Zry-BWR represents the culmination of AREVA's extensive research and experience with Zircaloy-2 (Zry-2) and Zry-4 alloys. While Zry-BWR is closely related to Zry-4, [

]

* Zircaloy-BWR is a trademark of AREVA.

† ATRIUM is a trademark of AREVA.

[

]

Over the past 20 years, components made from Zry-BWR have been included in material test programs and fuel channel lead programs and shown excellent in-reactor material performance for demanding conditions reaching assembly burnups [ ] MWd/kgU. Post irradiation examination (PIE) campaigns have demonstrated that Zry-BWR [

]

The Brunswick LUCs will [

] Based on the existing irradiation experience stated above, [

] reduce the amount of fuel channel bow.

The Brunswick LUCs have also received [

]

[

].

3.0 Licensing Assessment

The AREVA fuel channel topical report (Reference 1) has been approved by the NRC with the restriction of using either Zry-2 or Zry-4. Therefore, the Zry-BWR fuel channels will be treated as LUCs in accordance with AREVA's approved methodology (Reference 2) for introducing new products. Under this methodology, AREVA has demonstrated that all performance criteria are met by the LUCs and that an examination program will confirm the satisfactory performance of the fuel while under irradiation. Duke Energy will insert the LUCs according to the provisions of 10 CFR 50.59 on the basis of reload licensing documentation performed by AREVA.

The Zircaloy-BWR LUCs are within AREVA's approved process for introducing new products, which includes the demonstration that all licensing criteria are met. The LUCs will not affect any neutronic, thermal-hydraulic, or safety analyses. Fuel channel performance can indirectly affect Minimum Critical Power Ratio (MCPR) safety limits if the channel bow is outside predictions. However, channel bow for the LUCs will be predicted based on Zry-4 fuel channel performance, which post irradiation data have shown bounds Zry-BWR BQ fuel channel performance. The LUCs performance will also be monitored via in-service testing as a precautionary measure to detect bow beyond the amount assumed in the safety analyses.

Regarding mechanical performance, the Safety Evaluation (SE) for Reference 1 restricts AREVA to using Zry-2 or Zry-4 channel material with strength greater than or equal to the

values approved in Reference 1. The small chemistry differences between Zircaloy per ASTM B352 and Zry-BWR are not significant enough to affect the material properties.

Table 2 shows the minimum mechanical properties approved in Reference 1 compared to the specified minimum mechanical properties for the Zry-BWR BQ sheets. [

] . The material properties in the topical report conservatively apply to the LUCs.

[

]

The chemical composition of Zry-BWR, [

] .

The Zry-4 fuel channel corrosion analyses performed for the reload fuel channels are conservative for the LUCs.

The growth model for AREVA fuel channels based on the experience with Zry-2 and Zry-4 has been documented and approved by the NRC in Reference 3. The switch to Zry-BWR will not increase the upper limit on fuel channel growth. [

] .

Therefore, the fuel channel maximum growth correlation documented in Reference 3 remains conservative for the LUCs. The lower bound of the growth correlation [

] .

In general, fuel channel bulge is well understood, predictable, and can be accurately modeled [

] . Channel bow is not as predictable and therefore not as accurately modeled as bulge. [

] it is reasonable to expect that fuel channels made of Zry-BWR will not have greater bow than Zry-4 fuel channels. [

]

[ ]. The Zry-4 fuel channel deformation analyses performed for the reload fuel channels are conservative for the LUCs.

A key objective of the LUC program at Brunswick is to obtain performance data for these fuel channels. The scope of the recommended PIE includes [

]

4.0 References

1. EMF-93-177(P)(A) Revision 1, *Mechanical Design for BWR Fuel Channels*, Framatome ANP, Inc., August 2005.

2. ANF-89-98(P)(A) Revision 1 and Supplement 1, *Generic Mechanical Design Criteria for BWR Fuel Designs*, Advanced Nuclear Fuels Corporation, May 1995.

3. EMF-85-74(P) Revision 0 Supplement 1(P)(A) and Supplement 2(P)(A), *RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model*, Siemens Power Corporation, February 1998.