



## **Brunswick Advanced AREVA Methods LAR**

NRC Pre-Application Meeting 8/22/17



## Background

- On a 6/15/17 teleconference, Duke Energy and the NRC discussed our intent to submit an LAR to adopt Advanced AREVA Methods
- Advanced AREVA Methods are needed to support ATRIUM 11 deployment
- Advanced AREVA Methods LAR approval needed by Feb 2020 to support first reload of ATRIUM 11

## Background (cont)

- Based upon 6/15 NRC feedback additional information will be presented on,
  - Motivation for LAR
  - Proposed Milestones/Schedule
  - LAR Content
    - Staged submittal for some cycle specific items for first reload of ATRIUM 11
  - LAR Methodologies
    - Generic Advanced AREVA Methods
    - Plant specific methodologies
    - Other Technical Considerations
  - Challenges, Risk Reduction
    - Prioritization of NRC reviews
  - Relationship to MELLLA+

## Motivation for LAR

- Eight Brunswick Unit 2 ATRIUM 11 LUAs operating since 2015
  - remaining fuel is ATRIUM 10XM in both units
- Duke Energy desires to deploy ATRIUM 11 fuel in reload quantities
  - 11x11 array reduces LHGR (~19%) and fuel duty improving safety margin
  - Improved debris protection features (fuel failure risk reduction)
  - Improved channel performance
  - Improved fuel cycle economics
- First ATRIUM 11 reloads
  - Unit 1 Cycle 23 – Startup April 2020
  - Unit 2 Cycle 25 – Startup April 2021

## Proposed Milestones

- Date for LAR submittal
  - September 2018
  - After MELLLA+ LAR approval
- SER need date
  - February 2020
- 17 months available for review of *Advanced AREVA Methods* LAR

## LAR Content

- Reports submitted with LAR based upon BNP equilibrium ATRIUM 11 Design:
  - Assembly Mechanical Design reports
  - Methods Applicability Supplement Document
  - Thermal Hydraulic Design Report
  - LOCA/MAPLHGR Report
  - BWR Licensing Methodology Compendium
    - Updated for new methods (AURORA-B [LOCA / Transients and Accidents / CRDA], ACE / ATRIUM 11, and Cr-Doped fuel)
  - ATWSi Plant Specific Methodology Analysis Report
  - Fuel Cycle Design Report
  - Nuclear Fuel Bundle Design Report
  - Fuel Rod Design Report
  - AURORA-B Limiting Transient Analysis Uncertainty Demonstration
  - DSS-CD Qualification for ATRIUM 11

## LAR Content (cont)

- Implementation cycle reports will be submitted post LAR for information:
  - Fuel Cycle Design Report – March 2019
  - Nuclear Fuel Bundle Design Report – March 2019
  - Safety Limit MCPR Report – May 2019
  - Fuel Rod Design Report – October 2019
  - Reload Safety Analysis Report – October 2019

(dates represent a 3 month acceleration compared to a normal reload schedule)
- Submittal strategy and timeline based upon successful BNP LAR submittals used to implement AREVA methods in 2007 and 2010.

## LAR Content: TS 5.6.5 Additions

- AREVA Thermal-mechanical methodologies
  - BAW-10247P-A, Supplement 2P, Revision 0, “Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods” – Submitted April 2016
  - ANP-10340P Revision 0, “Incorporation of Chromium-Doped Fuel in AREVA Approved Methods” – Submitted April 2016
- Plant specific Brunswick DSS-CD Qualification for ATRIUM 11



## LAR Content: TS 5.6.5 Additions (cont)

- AREVA Licensing methodologies
  - ANP-10335P Revision 0, "ACE/ATRIUM 11 Critical Power Correlation" – Submitted Feb 2015, SE Pending
  - ANP-10300P Revision 0, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Transient and Accident Scenarios" – Submitted December 2009, Draft SE July 2017
  - ANP-10332P Revision 0, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Loss of Coolant Accident Scenarios" – Submitted March 2014
  - ANP-10333P Revision 0, "AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Control Rod Drop Accident Scenarios" – Submitted March 2014

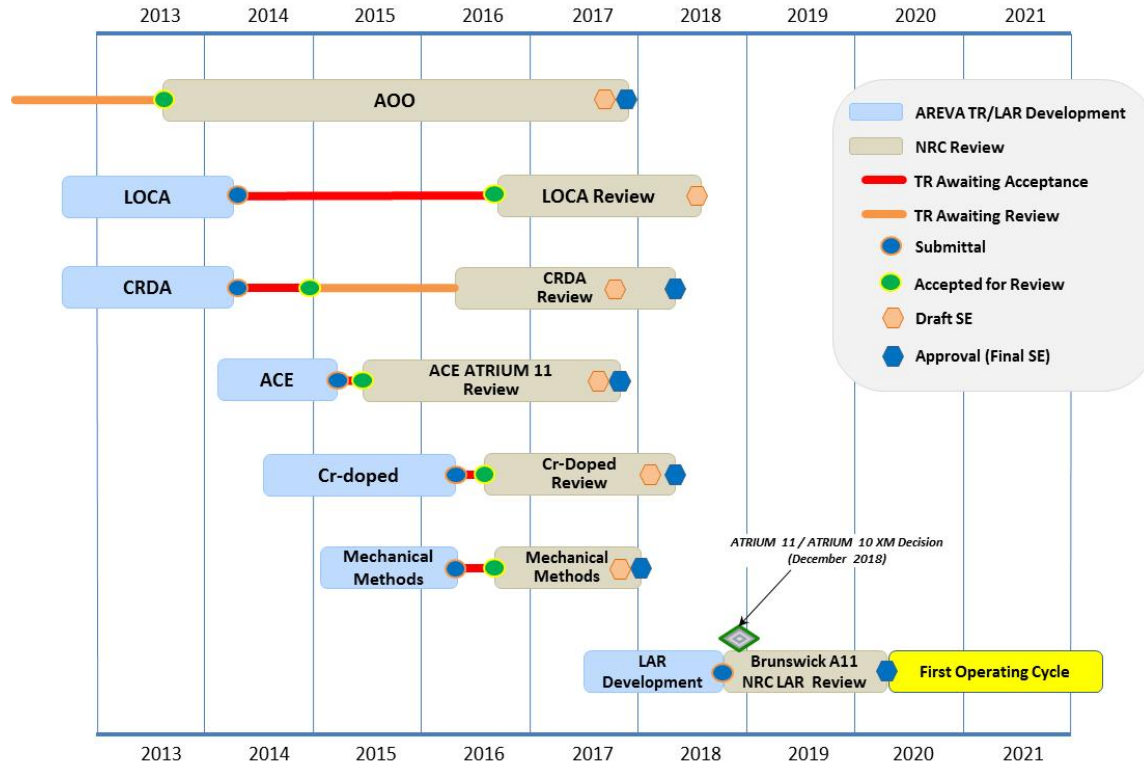
## LAR Methodologies: AREVA Generic

- 6 AREVA generic methodologies
- There is good potential for all AREVA generic methodologies to be approved by the time of submittal

<b>Methodology</b>	<b>Estimated Draft SE Date</b>	<b>Estimated Final SE Date</b>
<b>AURORA-B AOO</b>	<b>Complete</b>	<b>11/30/2017</b>
<b>AURORA-B CRDA</b>	<b>9/1/2017</b>	<b>4/30/2018</b>
<b>AURORA-B LOCA</b>	<b>6/30/2018</b>	<b>After LAR Submittal</b>
<b>ACE ATRIUM 11 Critical Power Correlation</b>	<b>Imminent</b>	<b>4<sup>th</sup> Quarter 2017</b>
<b>Cr-doped Extension to RODEX4</b>	<b>1/31/2018</b>	<b>4/30/2018</b>
<b>BWR Mechanical Methods</b>	<b>9/31/2017</b>	<b>12/31/2017</b>

# LAR Methodologies: AREVA Generic

## Current AREVA Advanced Methods Generic Methodology approval status



## LAR Methodologies: Plant Specific - Stability

- Upon Approval of MELLLA+ Brunswick will use GEH DSS-CD for stability monitoring
  - DSS-CD LAR requires qualification on a fuel type specific basis
  - Plant specific approach required to qualify for ATRIUM 11
- AREVA will submit their generic BEO-III methodology topical for review in 4Q2017
  - Includes previously approved RAMONA5-FA (other generic BEO-III elements not needed by this LAR)
  - Draft SE unlikely by September 2018
- Plant Specific Approach: evaluate Brunswick equilibrium ATRIUM 11 core with AREVA generic RAMONA5-FA
  - Approved RAMONA5-FA use will be extended to generate time dependent LPRM signals and critical power response for the limiting stability events
  - Feed GEH DSS-CD algorithm with RAMONA5-FA results to confirm margin to the SLMCPR at time of SCRAM
  - Duke to provide any needed translation between RAMONA5-FA output and GEH DSS-CD algorithm
- LAR to include description and details of plant specific DSS-CD qualification for ATRIUM 11

## LAR Methodologies: Plant Specific - ATWSi

- AREVA Generic ATWSi, ANP-10345P, to be submitted in late 2017
- Brunswick will be used as a sample problem for the AREVA generic topical report
  - Intent is to provide extensive overlap between the AREVA generic submittal in 2017 and the plant-specific submittal in 2018
  - Given the timeline, a plant-specific submittal will be required to support ATRIUM 11 introduction at Brunswick
- Plan to submit a plant specific version of the AREVA generic topical report which will minimize the differences to editorial
  - Allows for efficiencies as AREVA generic review will remain directly applicable to the plant-specific submittal

## Other Technical Considerations

- AREVA to generate generic ATRIUM 11 fuel-specific one-time document
  - ANF-89-98(P)(A), Generic Mechanical Design Criteria for BWR Fuel Designs
    - ATRIUM 11 compliance document provided by AREVA to NRC for information only
- TN-B1 License for ATRIUM 11 Shipments
  - Updated SAR submitted – NRC Approval Expected by Spring 2019

## Challenges, Risk Reduction

- Coordination of LAR submittal predecessors and successors
  - NRC approval of AREVA generic methodologies will minimize plant specific methodology submittals
  - MELLLA+ must be approved
- 2018 Advanced AREVA Methods LAR
  - Requesting 17 month review cycle
  - 6 AREVA generic methodologies, one plant specific methodology added to TS 5.6.5.b for ATRIUM 11
  - Initial LAR will provide examples of application of the AREVA methodologies to BNP
    - Thermal Hydraulic, LOCA, Fuel Cycle Design, Assembly Mechanical, ATWSi, Nuclear Fuel Bundle Design, Fuel Rod Mechanical, AURORA-B Limiting Transient Analysis, Stability
- 2007 AREVA Methods LAR – 14 month review supporting fuel vendor change
- 2010 AREVA Methods LAR – 11.5 month review supporting A10XM transition

## Prioritization of NRC Reviews

- Current schedule shows only the AREVA Generic LOCA methodology schedule may become limiting
  - Other AREVA generic methodology reviews are near completion or have good margin
  - Focus should remain on completing the AREVA Generic LOCA methodology draft SE on the current schedule to support submittal
- ATWSI – AREVA will submit generic methodology 4Q2017
  - Review of the generic methodology will be directly applicable to the BNP LAR
  - Review of the generic methodology would expedite the BNP plant specific application
- Stability
  - AREVA will submit generic BEO-III stability methodology 4Q2017
  - LAR will utilize only the RAMONA5-FA portion of BEO-III as part of the qualification of DSS-CD for ATRIUM 11
  - NRC review focus on the RAMONA5-FA portion prior to the BNP submittal would expedite review of BNP plant specific application submitted with LAR

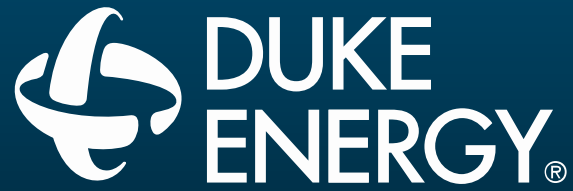


## Relationship to MELLLA+

- Advanced AREVA Methods LAR will not be submitted until MELLLA+ LAR approved
  - BNP MELLLA+ LAR with ATRIUM 10XM fuel submitted September 2016
  - Draft SE expected Spring 2018 with approval September 2018
- The LAR will demonstrate advanced AREVA methods applicability to an Expanded Flow Window (EFW)/MELLLA+ ATRIUM 11 equilibrium cycle
- To support ATRIUM 11 Reloads:
  - Application of AREVA ATWSi methodology to Brunswick
  - DSS-CD will continue to be used for stability protection for ATRIUM 11

## Summary

- Proposed date for LAR submittal – September 2018
- SER need date – February 2020
- 17 month LAR review
- LAR will request the use of many advanced AREVA methodologies that are currently under NRC review
- Two plant specific methodologies will be used to support the LAR
- Risk/Challenges identified and addressed along with review prioritization
- Critical NRC actions are approval of MELLLA+ and AURORA-B LOCA
- Proposed schedule/plan is challenging but achievable



## Backup Slide – Past LAR Experience

- 2007 AREVA Methods LAR
  - Approval obtained one month prior to startup after a 14 month review
  - 18 generic methodologies added to TS 5.6.5.b to introduce AREVA fuel (ATRIUM-10)
  - Initial LAR did not provide examples of application of the AREVA methodologies to BNP
    - Thermal Hydraulic, LOCA, Fuel Cycle Design, and Reload Safety Analysis reports were provided in supplemental transmittals
- 2010 AREVA Methods LAR
  - Approved a few days prior to startup after a 11.5 month review
  - Two additional generic methodologies added to TS 5.6.5.b to introduce ATRIUM 10XM
  - Initial LAR did not provide examples of application of the AREVA methodologies to BNP
    - Thermal Hydraulic, LOCA, Fuel Cycle Design, Fuel Rod Thermal Mechanical Evaluation, Mechanical Design Report, and Reload Safety Analysis reports were provided in supplemental transmittals