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EATF (Cr-Cr) Batch Licensing Plan

- June 6, 2018

Agenda

- Objectives
- Background
- Overview of plan
  - Advanced Methods Topical Reports
  - Advanced Products EATF Topical Reports
- Next Steps
- Schedule Summary

Meeting Objectives

- Outline a plan to support batch implementation of Chromia-doped fuel and Chromium coated cladding for Westinghouse and CE plants in conjunction with advanced methods
- Support NRC planning for review of topical reports in support of batch readiness by 2023

Improvement Objectives

- **Objective for Framatome's Advanced Products and Methods: License advanced codes/methods/materials to achieve US Nuclear industry goals**
  - **Improved accident behavior**
  - **Improved PCI performance**
  - **Improved load follow**

[ ]

  - **Increased enrichment**
    - Framatome will address increased enrichment separately

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EATF (Cr-Cr) Batch Licensing Plan – Topical Reports

- Jacqueline Stevens
- Materials Engineering

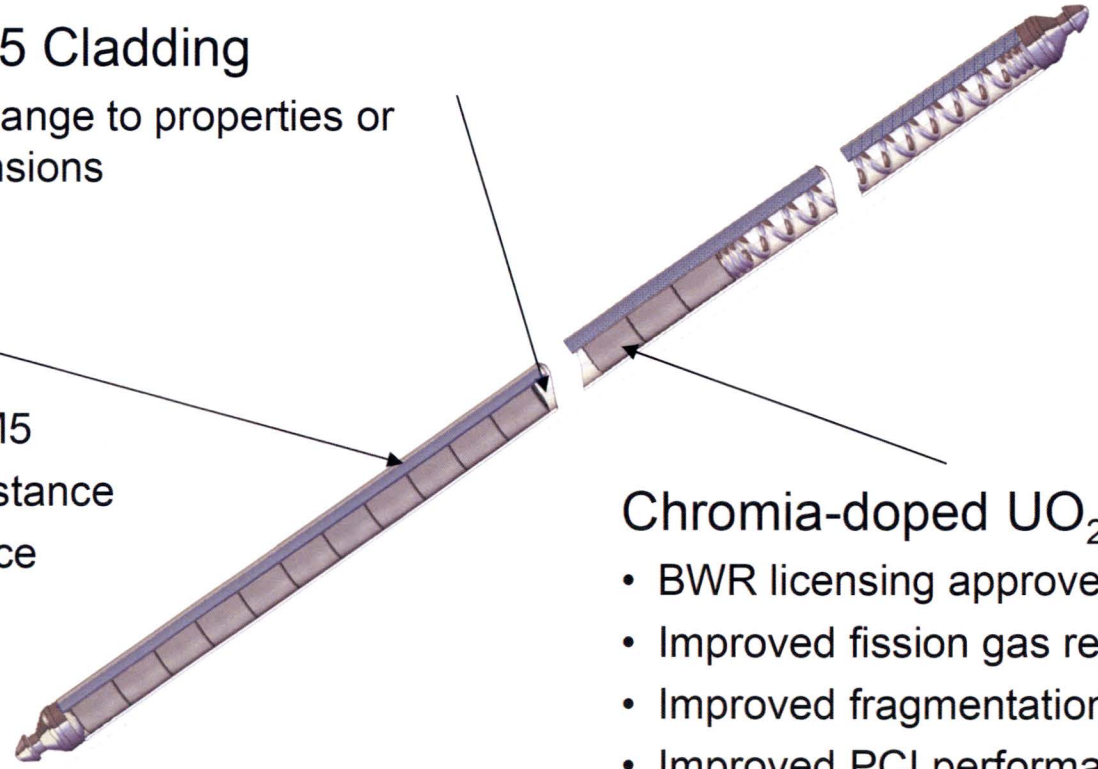
EATF Solution
Cr-Coated Cladding / Chromia Doped Pellets

Base M5 Cladding

- No change to properties or dimensions

Cr-coating

- 10-20 µm
- Does not impact base M5
- Improved oxidation resistance
- Improved wear resistance



Chromia-doped UO_2 pellets

- BWR licensing approved
- Improved fission gas retention
- Improved fragmentation behavior
- Improved PCI performance

Overview of Plan

- **Base Topical Reports for Advanced Methods**
  - ANP-10323P Revision 1 "Fuel Rod Thermal-Mechanical Methodology for Pressurized Water Reactors" - GALILEO
  - ANP-10339P "ARITA- ARCADIA/RELAP Integrated Transient Analysis Methodology"
  - BAW-10227P Revision 2 "M5 topical report"
  - Topical report for implementation of GALILEO in W&CE LOCA methodologies (SBLOCA and RLBLOCA)
- **Extension to Advanced Products (Cr-Cr EATF Solution)**
  - Chromia-doped pellet topical report supplement (ANP-10340P) report to extend material properties to PWR methodologies
  - M5 topical report supplement to incorporate chromium-coated cladding (addressing base methods)

Overview of Plan

Overview of Plan

Advanced Methods Topical Reports
GALILEO

- **ANP-10323P Revision 1 "Fuel Rod Thermal-Mechanical Methodology for Pressurized Water Reactors"**
- **Purpose**
  - Advanced fuel rod performance code
  - Statistical methodology
- **Schedule**
  - Submit revised topical report [ ]
  - Submit responses to Rev 0 RAIs [ ]
  - Requested NRC approval [ ]

Overview of Plan

Advanced Methods Topical Reports
ARITA

- **ANP-10339P "ARITA- ARCADIA/RELAP Integrated Transient Analysis Methodology"**
- **Purpose**
  - Based on GALILEO
  - Coupled code methodology
  - Analysis of fuel rod performance during non-LOCA transients
  - Transient cladding strain analysis
- **Schedule**
  - Submit topical report [ ]
  - Requested NRC approval [ ]

Overview of Plan

Advanced Methods Topical Reports
M5 TR Revision

- **Purpose**
  - **Update M5 models**
  - **[ ]**
  - **Modernize topical report**
  - **NO CHANGE to material**
- **Scope Detail**
  - **Revise M5 models to reflect current data**
  - **[ ]**
  - **Structure similar to ANP-10334PA, "Q12 Topical Report"**
    - Adding relevant content required for cladding material

C&M for W&CE Plants Overview

Advanced Methods Topical Reports Topical to Align LOCA Methodology 1/2

- **Purpose**
  - **W&CE LOCA methods use an embedded fuel rod code with the system code (S-RELAP5) to provide a coupled transient response**
    - SBLOCA, EMF-2328 is licensed for use with RODEX2
    - RLBLOCA, EMF-2103 Rev. 3 is licensed for use with COPERNIC
  - **This topical will:**
    - Add GALILEO as acceptable fuel rod code for use in the SBLOCA and RLBLOCA Rev. 3 methodologies
    - Request NRC approval to use any approved fuel performance code following process demonstrated for GALILEO
  - **This approach focuses NRC review on larger aspect of the two distinctly different aspects (Change in FRC vs. material changes)**

Advanced Methods Topical Reports Topical to Align LOCA Methodology 2/2

- **Scope Details**
  - One report will be submitted to demonstrate the implementation of GALILEO into the methods
  - Focus is the S-RELAP5 code transition and demonstration of consistency
  - Methodologies will be reviewed in light of the FRC and application changes and necessary changes will be described
  - Test benchmarks and sample problems will be provided

Overview of Plan

Overview of Plan

Advanced Products - EATF Chromia-Doped Pellet Topical Report

- **Purpose**
  - **Extend chromia-doped pellet properties provided in base report to PWR methodologies**
  - **Supplement to ANP-10340P-A**
- **Scope Details**
  - **Will address application of chromia-doped pellet models into**
    - GALILEO
    - SBLOCA
    - RLBLOCA
    - Non-LOCA (ARITA and AREA)
  - **PWR vs. BWR methodology differences may drive alternative treatment of some base material properties**
  - **Appropriate sample problems addressed**

Overview of Plan

Advanced Products - EATF
Cr-Coated Cladding Topical Report

- **Purpose**
  - **Implement Chromium coated cladding properties into PWR codes and methods**
  - **Supplement to BAW-10227P Revision 2**
- **Scope Detail**
  - **Chromium coated M5 cladding**
    - Define new properties / models for Cr-coated cladding
    - Disposition M5 properties where applicable
  - **Implementation of Cr-coated cladding in**
    - GALILEO
    - LOCA Methodologies
    - ARITA / AREA Methodologies
  - **Address failure mechanisms and surveillance plans**
  - **Appropriate sample problems for Cr-coated cladding addressed**

Overview of Plan

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EATF (Cr-Cr) Batch Licensing Plan – Schedule

- Jerry Holm
- Regulatory Affairs

Next Steps – Each Topical Report

- NRC pre-submittal meetings
- Product / Method specific PIRT (Cr-coating)
- Submittals
- Post submittal audits
- RAIs
- RAI responses
- Final SE

Cr-Coated Cladding Topical Report PIRT Approach

- **Product Bases**
  - **Design description including manufacturing process**
  - **Review of design impact against design requirements**
    - As defined by Chapter 4.2 of Standard Review Plan
  - **Review of potential new issues caused by design**
    - Beyond those covered by the above
    - For example: coating adherence
    - Following a PIRT mindset
- **Path Forward**
  - **Tactical pre-submittal meeting in Fall of 2018**
    - Early engagement to obtain NRC feedback to assure scope is adequate
  - **Provide a write-up for NRC information**
    - This could be used for an independent NRC review (or PIRT)
  - **Significantly in advance of currently planned topical report submittal date**

Schedule

Timeline

Acronyms/Nomenclature

- BWR — Boiling water reactor
- CE — Combustion Engineering
- EATF — Enhanced accident tolerant fuel
- EM — Evaluation Model
- FA — Fuel Assembly
- FRC — Fuel rod code
- LAR — License amendment request
- LOCA — Loss of coolant accident
- NRC — Nuclear Regulatory Commission
- PCI — Pellet cladding interaction
- RAI — Request for additional information
- PWR — Pressurized water reactor
- SE — Safety evaluation
- TR — Topical report
- W&CE — Westinghouse and Combustion Engineering

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