

# **PWR Chromia-doped Fuel – Pre-submittal Meeting**

**Buck Barner, Jerry Holm, Nathan Hottle, Yusen Qi**

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# Agenda

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# Objectives

Present plans for Chromia-doped fuel in PWRs

Provide an opportunity for NRC feedback

# Introduction and Background

Jerry Holm

# EATF Solution

## Cr-Coated Cladding / Chromia-doped Pellets

### Base M5 Cladding

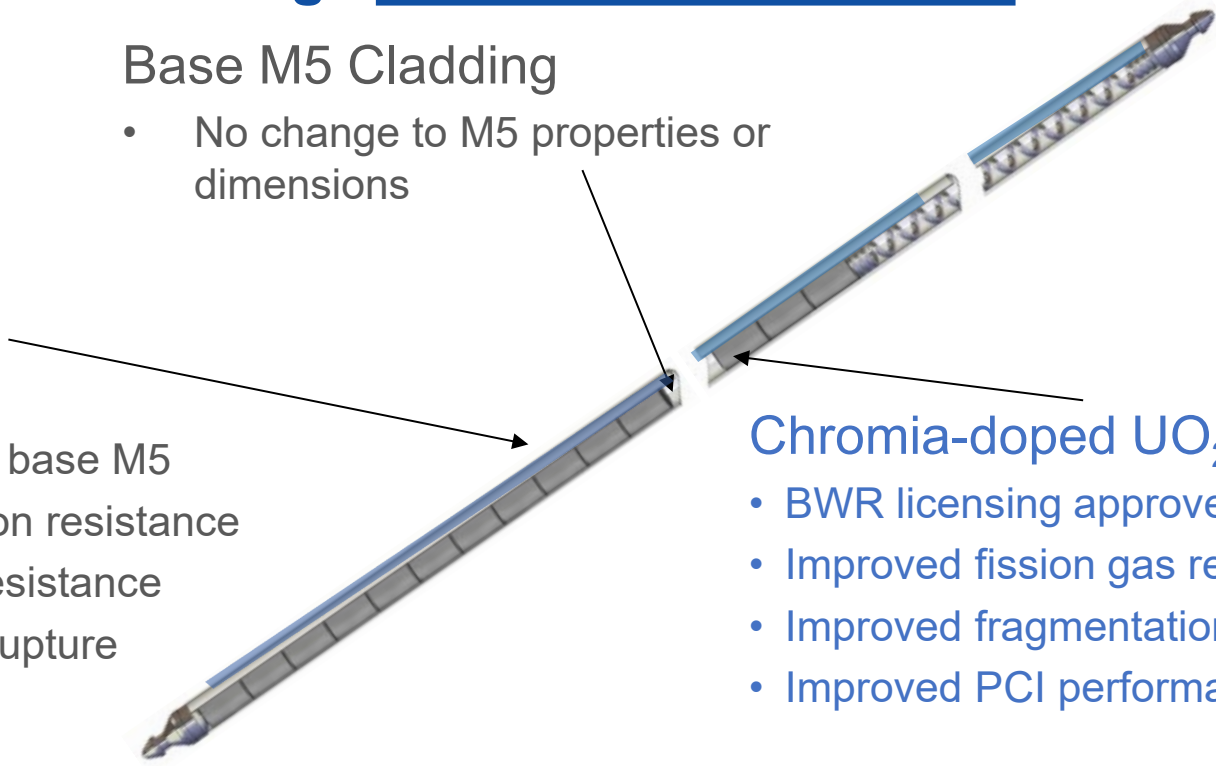
- No change to M5 properties or dimensions

### Cr-coating

- 10-20  $\mu\text{m}$
- Does not change base M5
- Improved oxidation resistance
- Improved wear resistance
- Reduced LOCA rupture

### Chromia-doped $\text{UO}_2$ pellets

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



# Background

ANP-10340PA “Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods”

- Base topical report – approved May 2018
- Basic properties
- Implementation into BWR methods

ANP-10340, Supplement 1P “Incorporation of Chromia-Doped Fuel Properties in Framatome PWR Methods”

# Table of Contents

Yusen Qi

# Topical Report Table of Contents

Introduction

Summary

Applicability of Base Topical Report

Qualification of GALILEO for Chromia-doped Fuel

Qualification of Methods

Licensing Criteria Assessment



# **Adaptation of GALILEO Models**

## **Qualification Database**

### **Qualification of GALILEO for Chromia-Doped Fuel**

Yusen Qi

# Adaptation of GALILEO Models

# Revised Models

Fuel thermal conductivity model

Fission gas release model

Intragranular gaseous swelling model

Fuel theoretical density

Fuel melting point

# Fuel Thermal Conductivity Model

# Fission Gas Release Model

# Intragranular Gaseous Swelling Model

# Theoretical Density Model

# Fuel Melting Point





# Qualification Database

# Qualification Data in Supplement



# Qualification of GALILEO for Chromia-Doped Fuel

# Thermal Conductivity

# Temperature

# Temperature

# Fission Gas Release

# Fuel Rod Internal Pressure



# Free Volume

# Transient Strain

# Density

# Sample Problems

Yusen Qi

# Sample Problems

The supplement will present sample analyses using PWR methods to illustrate the impact of chromia-doped fuel.

- Thermal mechanical evaluation
  - Fuel rod internal pressure
  - Fatigue
  - Creep collapse
  - Fuel rod oxidation
- Safety analysis
  - LOCA criteria – SBLOCA and RLBLOCA
  - Non-LOCA criteria – ARITA
  - Control rod ejection criteria – AREA

# Sample Problems – Normal Operation

Yusen Qi

# Licensing Criteria Assessment – Normal Operation – Preliminary Results



# Sample Problems - LOCA

Nathan Hottle



# Sample Problems - LOCA

## LOCA evaluation models

- ANP-10349P, GALILEO Implementation in LOCA Methods, incorporates GALILEO into Framatome's evaluation models for LBLOCA (EMF-2103 Rev. 3) and SBLOCA (EMF-2328 including Supplement 1)
- For chromia-doped fuel, evaluation models in ANP-10349P will be augmented to include GALILEO version with chromia-doped fuel models

## LOCA sample problems

- One LBLOCA and one SBLOCA sample problem to exercise EM and illustrate impact of chromia-doped fuel on LOCA figures of merit

# Sample Problems – Non-LOCA

Buck Barner

# Sample Problems– Non-LOCA

## ARITA – Non-LOCA Safety Analysis

- Perform Uncontrolled Bank Withdrawal from Part Power sample problem to demonstrate impact of chromia-doped fuel on FCM and TCS criteria
- The impact of chromia-doped fuel on the neutronics solution and DNB are negligible.
  - This is based on arguments already presented in the topical for BWR which remain applicable to PWRs.

## AREA – Rod Ejection Accident

- Perform sample problem to demonstrate impact of chromia-doped fuel in the AREA method

# Licensing Criteria Assessment – AOO – Preliminary Results



# Summary and Next Steps

Jerry Holm

# Summary

## ANP-10340, Supplement 1P

- The supplement will disposition material in base topical report that is not affected by PWR methods.
- The supplement will present the details of required new models for use in PWR methods.
  - Model description
  - Model assessment results
- PWR methods
  - GALILEO – fuel rod thermal mechanical evaluation
  - ARITA – non-LOCA safety analysis
  - AREA – ARCADIA Rod Ejection Accident
  - SBLOCA
  - RLBLOCA

# Next Steps



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