Enclosure 4

Presentation Slides for Closed Session
"Overview of Westinghouse Activities Supporting the EPRI ALS for FFRD"

(Non-Proprietary)

August 2022

(30 pages including this cover page)

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Overview of Westinghouse Activities Supporting the EPRI Alternate Licensing Strategy (ALS) for Fuel Fragmentation, Relocation, and Dispersal (FFRD)

Jeffrey Kobelak

August 2022

Westinghouse

Overview

- Introduction
- High Burnup Effects
- Model Refinements Relative to Current LOCA Methods
- [ ]a,c
- Boundary Condition Development and Analysis Limits
- Uncertainty Analysis Method

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Introduction

High Burnup Effects

Model Refinements Relative to Current LOCA Methods

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Boundary Condition Development and Analysis Limits

Uncertainty Analysis Method

Objective

- Provide an overview of the Westinghouse approach for performing the cladding rupture calculations to support the EPRI ALS for FFRD
- Highlight similarities and differences from prior Westinghouse methods which have been submitted to the staff
- Solicit feedback on the proposed approach

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Introduction

- The **FULL SPECTRUM**™ LOCA (**FSLOCA**™) evaluation model (EM) is NRC-approved to demonstrate compliance with the 10 CFR 50.46 ECCS acceptance criteria
  - Peak cladding temperature (PCT) less than 2,200°F
  - Maximum local oxidation (MLO) less than 17%
  - Core-wide oxidation (CWO) less than 1%
- WCOBRA/TRAC-TF2 (TF2) is the thermal-hydraulic system code associated with the FSLOCA EM
- Westinghouse has more recently submitted the Incremental Burnup Extension for NRC approval
  - Some elements of the approach for the cladding rupture calculations to support EPRI will be derived from the incremental burnup extension

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Introduction

- Westinghouse calculations supporting the EPRI ALS will attempt to demonstrate no cladding rupture occurs under SBLOCA and IBLOCA conditions
  - Cold leg breaks up to the accumulator line diameter
  - Hot leg breaks up to the pressurizer surge line diameter

- Code and method used to perform the calculations adapted from the FSLOCA EM and Incremental Burnup program
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  - TF2 code (modified to analyze higher burnup and enrichment) will be utilized for the calculations

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Introduction

High Burnup Effects

Model Refinements Relative to Current LOCA Methods

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Boundary Condition Development and Analysis Limits

Uncertainty Analysis Method

Impact of Higher Burnup

- Decay Heat and Kinetics Module
  - Nuclear designs to be covered extend beyond current burnup and enrichment limitations
- Transient Fission Gas Release
  - Experimental data has indicated the potential for transient fission gas release in higher burnup fuel during LOCA transients
- Pre-Burst Axial Fuel Relocation
  - Experimental data has indicated the potential for axial relocation of fuel fragments within fuel rods prior to rupture
- Cladding Rupture
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Decay Heat and Kinetics Module

- Nuclear physics data supporting existing module in TF2 code do not cover desired burnup & enrichment ranges

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Decay Heat and Kinetics Module

- TF2 will be updated with data from the NRC-approved PARAGON2 code
  - [ ]a,c burnup
  - [ ]a,c enrichment

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Transient Fission Gas Release

- The TF2 code [ ]a,c
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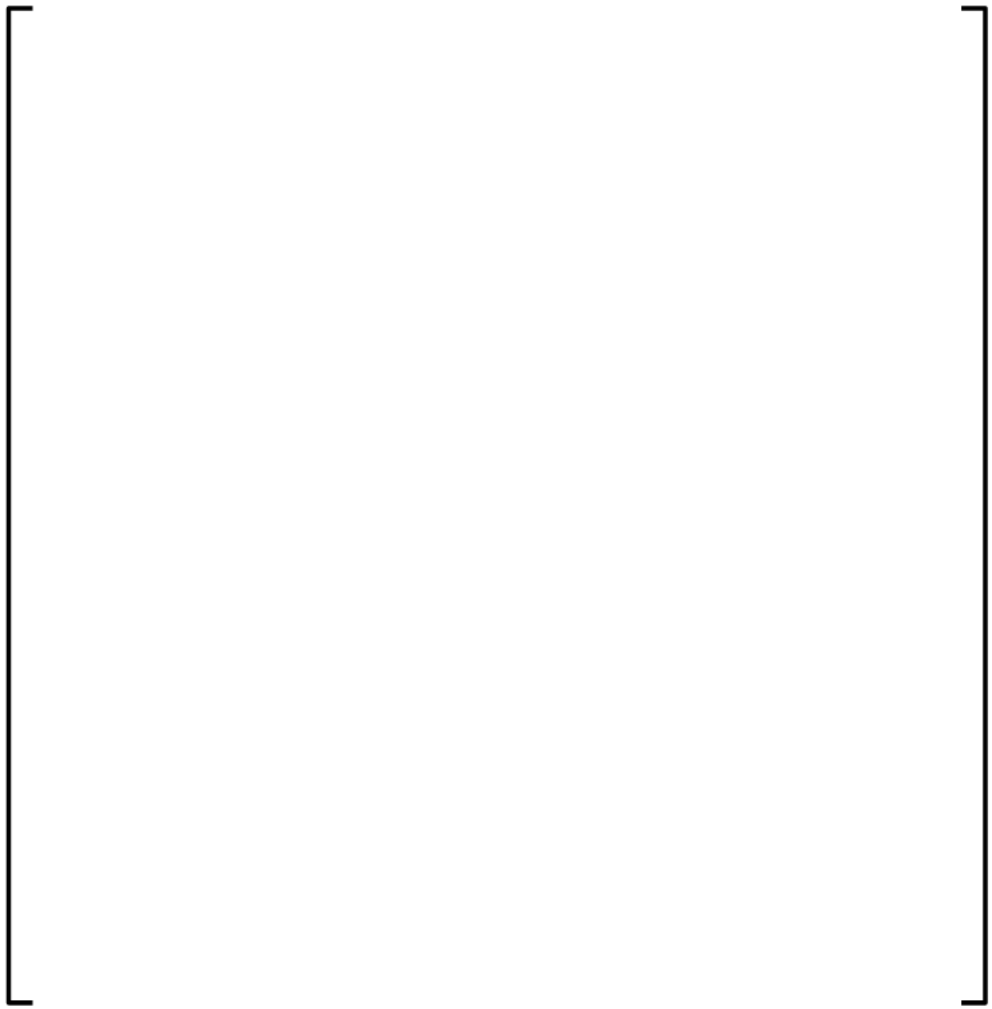
- All aspects of the model will be supported by experimental data



Pre-Burst Axial Fuel Relocation

- Data from Studsvik indicates that fuel fragments can relocate axially within a fuel rod prior to rupture once sufficient cladding strain is present

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Pre-Burst Axial Fuel Relocation

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Cladding Rupture

- Criterion for cladding rupture recently defined as part of the Incremental Burnup Extension
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- Expect that a similar criterion will be utilized for the cladding rupture calculations to support EPRI ALS

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Introduction

High Burnup Effects

Model Refinements Relative to Current LOCA Methods

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Boundary Condition Development and Analysis Limits

Uncertainty Analysis Method

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- Applicability of initial submittal is to Westinghouse NSSS PWRs with Westinghouse fuel

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Introduction

High Burnup Effects

Model Refinements Relative to Current LOCA Methods

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Boundary Condition Development and Analysis Limits

Uncertainty Analysis Method

Boundary Conditions Considered

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Allowable Envelope for Application

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Benchmarking to Existing Calculations

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Introduction

High Burnup Effects

Model Refinements Relative to Current LOCA Methods

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Boundary Condition Development and Analysis Limits

Uncertainty Analysis Method

Uncertainty Analysis Approach

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  - Some modifications are required similar to the incremental burnup extension
    - Updates to code models previously discussed
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  - Break sizes up to the largest connecting line diameters are considered
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    - Cold leg breaks will be analyzed up to the accumulator line diameter

Uncertainty Analysis Approach

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Questions

Acronyms / Codes / Labels

Acronym	Definition
ALS	Alternate Licensing Strategy (for FFRD)
CWO	Core-Wide Oxidation
ECCS	Emergency Core Cooling System
EM	Evaluation Model
EPRI	Electric Power Research Institute
FFRD	Fuel Fragmentation, Relocation, and Dispersal
FSLOCA	FULL SPECTRUM LOCA
IBLOCA	Intermediate-Break LOCA
LBLOCA	Large-Break LOCA
LOCA	Loss-of-Coolant Accident

Acronyms / Codes / Labels

Acronym	Definition
MLO	Maximum Local Oxidation
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
PCT	Peak Cladding Temperature
PIRT	Phenomena Identification and Ranking Table
PWR	Pressurized Water Reactor
SBLOCA	Small-Break LOCA
TF2	WCOBRA/TRAC-TF2; thermal-hydraulic code licensed as part of the FSLOCA EM
tFGR	Transient Fission Gas Release