



Advanced Fuel Management

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Agenda

Objectives

Introduction and background

Increased burnup

Increased enrichment

Summary

Next steps

Jerry Holm

Jerry Holm

Christina Jones

Michelle Guzzardo

Jerry Holm

Jerry Holm

Objectives

- Outline plan to support increased enrichment and burnup for SRP Chapter 4 and Chapter 15 methods
- Provide an opportunity for NRC feedback

Introduction and Background

Jerry Holm

Introduction and Background

- Advanced Codes and Methods topical reports
- Building blocks for increased burnup
- Scope of future topical report submittals – increased burnup and enrichment (Advanced Fuel Management (AFM))
- Additional topics
- Range of applicability for increased burnup and enrichment
- Update process
- Topical Reports and SRP Chapters 4 and 15

Background – Advanced Codes and Methods

Neutronics	ARCADIA (ANP-10297P-A and S1P-A)
Thermal–Hydraulic	COBRA-FLX (ANP-10311P-A Revision 1)
CHF	GAIA CHF (ANP-10341P-A)
Non-LOCA	ARITA (ANP-10339P) and AREA (ANP-10338P-A)
SB LOCA	S-RELAP5 (EMF-2328P-A and S1P-A)
LB LOCA	S-RELAP5 (EMF-2103P-A Revision 3)
SB and LB LOCA	with GALILEO (new topical report)
Fuel Performance Code	GALILEO (ANP-10323P Revision 1)
External Loads	ANP-10337PA and Supplement 1P
Fuel Design topical report	GAIA (ANP-10342P-A) with Q12 (ANP-10334P-A)
M5 _{Framatome}	BAW-10227P Revision 2 (new topical report)
Liftoff	BAW-10243P-A (statistical holddown)
Cladding Collapse	BAW-10084P-A Revision 3 (CROV)
Bow	XN-75-32P-A

Schedule Overview – Codes and Methods

Background – Building Blocks for Increased Burnup

ANP-10323P – New fuel performance code GALILEO

- Requested approval date – []
- Peak rod average burnup of []

BAW-10227P Revision 2 – M5_{Framatome}

- Requested approval date – []
- Peak rod average burnup of []

Framatome's High Burnup Operating Experience

Scope of Future Submittals Advanced Fuel Management - Enrichment

Scope

- Umbrella report to address all issues:



Scope of Future Submittals Advanced Fuel Management - Burnup

Scope

- Umbrella report to address all issues outside of:
 - ANP-10323P (GALILEO) & BAW-10227P Rev 2 (M5_{Framatome})

Additional Topics - Enrichment

- Enrichment facility capabilities
- Shipment of UF6 enriched to greater than 5 w/o
- Manufacturing plant license
- Shipping container license for fuel assemblies enriched to greater than 5 w/o U-235
- New fuel storage
- Spent fuel pool
- Dry cask storage
- Regulations

Additional Topics - Burnup

- Spent fuel pool
- Dry cask storage
- Regulations
- Radiological
- Beyond Design Basis Accidents
- Balance of Plant

Range of Applicability

Update Process

Correspondence to SRP Chapters 4 and 15

Increased Burnup

Christina Jones and Lisa Gerken

Agenda – Increased Burnup

Impact of Burnup

Neutronics- ARCADIA Extension

Mechanical Model Validations

LOCA Model Validations

Fuel Fragmentation, Relocation, and Dispersal (FFRD)

Decay Heat

Methods not requiring additional validation

Summary

Impact of Increased Burnup on Fuel Rod

Fuel Changes

- Fission Gas
- Rim Formation
- Fuel Restructuring and Cracking
- Pellet-cladding Interaction

Cladding Changes

- Corrosion
- Hydriding
- Growth

LOCA

FFRD

Phenomenon modeled in
GALILEO and M5_{Framatome}
Topical Report

**Umbrella Topical will validate and extend
methodologies not previously addressed**

Impact of Increased Burnup on Fuel Assembly

Areas of Review

- Neutronics
- Mechanical
- External Load
- Fuel Design topical report
- Liftoff
- LOCA
- Non-LOCA
- Decay Heat
- Thermal Hydraulics
- CHF
- Fuel Performance Code
- Materials
- Cladding Collapse

Umbrella Topical will validate and extend methodologies not previously addressed

Neutronics

Mechanical

LOCA

FFRD

FFRD

FFRD

FFRD

Decay Heat

Methods Not Requiring Additional Validation

Methods Not Requiring Additional Validation

Methods Not Requiring Additional Validation

Methods Not Requiring Additional Validation

Summary

Increased Enrichment

Michelle Guzzardo

Agenda – Increased Enrichment

Impact of Increased Enrichment

Neutronics

Decay Heat

Areas Not Impacted by Increased Enrichment

Summary

Impact of Increased Enrichment

Increasing enrichment impacts:

- Fission ratio between uranium and plutonium materials
 - Difference in fissile inventory as U-235 depletes
 - More U-235, less U-238 → less Plutonium
 - Results in different mixture of fission products
- End of life burnup
 - Ability to obtain higher burnups

Neutronics

Decay Heat

Areas Not Impacted by Increased Enrichment

Areas Not Impacted by Increased Enrichment cont.

Areas Not Impacted by Increased Enrichment cont.

Areas Not Impacted by Increased Enrichment cont.

Areas Not Impacted by Increased Enrichment cont.

Summary

Summary and Next Steps

Jerry Holm

Summary

Increased burnup

Increased enrichment

Range of applicability

Next Steps – Increased Burnup

Next Steps – Increased Enrichment

Acronyms

AFM – Advanced Fuel Management

ANS – American Nuclear Society

ANSI – American National Standards Institute

AREA – ARCADIA Rod Ejection Accident

CE – Combustion Engineering

CHF – Critical Heat Flux

DG – Draft Guidance

ECCS – Emergency Core Cooling System

FFRD – Fuel Fragmentation, Relocation, and Dispersal

FPC – Fuel Performance Code

HPU – Hydrogen Pickup

ICSBEP – International Criticality Safety Benchmark
Evaluation Project

LBLOCA – Large Break Loss of Coolant Accident

LB - Large Break

LCT – LEU-COMP-THERM

LOCA – Loss of Coolant Accident

NRC – U.S. Nuclear Regulatory Commission

PIE – Post Irradiation Examination

PNNL – Pacific Northwest National Laboratory

PWR – Pressurized Water Reactor

RAI – Request for Additional Information

RCS – Reactor Coolant system

RIA – Reactivity Insertion Accident

RLBLOCA – Realistic Large Break Loss of Coolant
Accident

SB – Small Break

SBLOCA – Small Break Loss of Coolant Accident

SRP – Standard Review Plan

W - Westinghouse

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