



GALILEO in LOCA

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AGENDA

- Objectives..... Jerry Holm
- Introduction and background..... Jerry Holm
- Topical report outline..... Andrei Burghelea
- Fuel Performance Code Models
in S-RELAP5..... Andrei Burghelea
- Fuel Performance Code Input
to S-RELAP5..... Andrei Burghelea
- SBLOCA..... Andrei Burghelea
- RLBLOCA..... Andrei Burghelea
- Summary..... Andrei Burghelea
- Next steps..... Jerry Holm

Objectives

- Communicate motivation for topical report:
 - Provide basis for inclusion of chromia-doped fuel and chromium coated cladding properties into LOCA methods
 - Provide basis for inclusion of increased enrichment and burnup properties into LOCA methods
- Describe content of topical report
- Provide opportunity for NRC feedback

Introduction and Background

Jerry Holm

Background – Advanced Codes and Methods

- Neutronics
 - Thermal–Hydraulic
 - CHF
 - Non-LOCA
 - SB LOCA
 - LB LOCA
 - SB and LB LOCA
 - Fuel Performance Code (FPC)
 - External Loads
 - Fuel Design topical report
 - M5_{Framatome}
 - Liftoff
 - Cladding Collapse
 - Bow
- ARCADIA (ANP-10297P-A and S1P-A)
COBRA-FLX (ANP-10311P-A Revision 1)
GAIA CHF (ANP-10341P-A)
ARITA ([ANP-10339P](#)) and AREA (ANP-10338P-A)
S-RELAP5 (EMF-2328P-A and S1P-A)
S-RELAP5 (EMF-2103P-A Revision 3)
with GALILEO ([new topical report](#))
GALILEO ([ANP-10323P Revision 1](#))
ANP-10337PA and [Supplement 1P](#)
GAIA (ANP-10342P-A) with Q12 (ANP-10334P-A)
[BAW-10227P Revision 2 \(new topical report\)](#)
BAW-10243P-A (statistical holdown)
BAW-10084P-A Revision 3 (CROV)
XN-75-32P-A (rod bow)

Introduction and Background

Current LOCA topical reports:

- SBLOCA
 - EMF-2328P-A (March 2001) and EMF-2328 Supplement 1P-A (December 2016)
 - Current fuel performance code – RODEX2
 - Appendix K
- RLBLOCA
 - EMF-2103P-A Revision 3 (June 2016)
 - Current fuel performance code – COPERNIC
 - Realistic

Applicable to Westinghouse (3 and 4 loop) and Combustion Engineering plants

Purpose of new topical report is add the fuel performance code GALILEO to LOCA methods

- ANP-10323P Revision 1
- Under review
- []

GALILEO in LOCA

Andrei Burghilea

Topical Report Outline

- Introduction
- Summary
- GALILEO Models in S-RELAP5
- SBLOCA EM Changes
- RLBLOCA EM Changes
- References
- Appendices

GALILEO in LOCA Methods

- Adding GALILEO fuel performance code to S-RELAP5
- Supplementing the RLBLOCA EM and SBLOCA EM to include GALILEO
- Applicable to W3/W4/CE2x4 plants
- Support Framatome objectives
 - Increased enrichment and burnup
 - Chromia-doped fuel and chromium coated cladding
- []

FPC Models in S-RELAP5

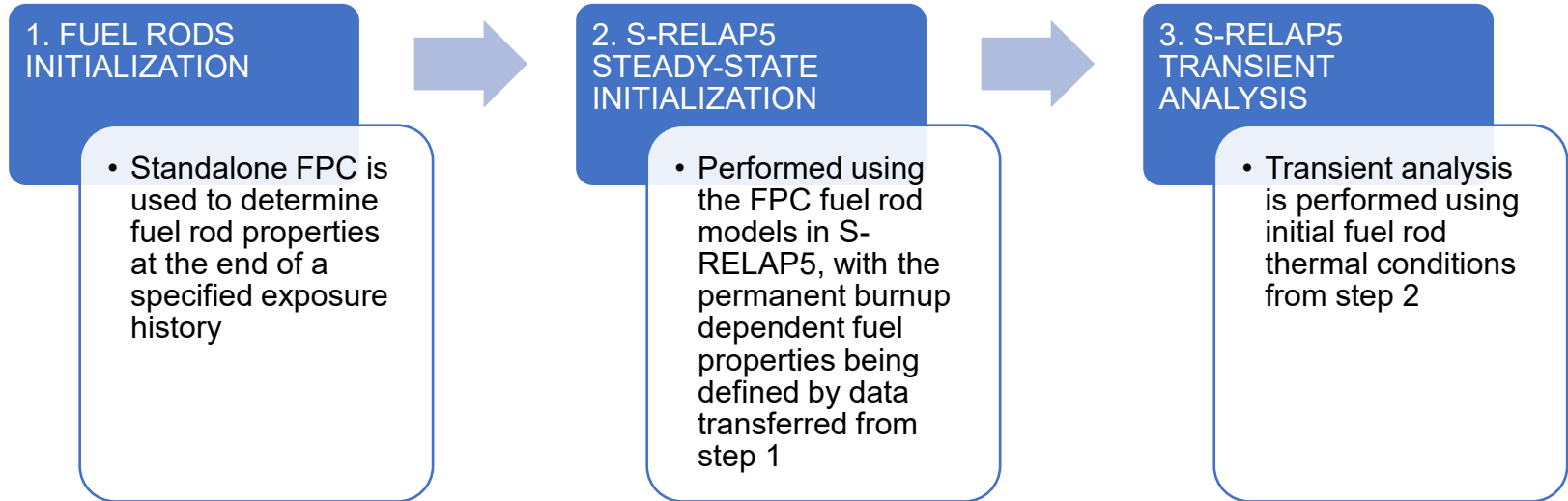
FPC Input to S-RELAP5

For GALILEO the approach remains essentially the same as currently used with COPERNIC/RODEX2:

- Long-term burnup dependent “permanent” fuel rod effects (pellet densification and swelling, cladding creep, and fission gas release) will not change appreciably during the course of a LOCA transient.
- Calculations of these long-term effects are performed to initialize the fuel rod parameters, but are not altered during the transient (not included in the fuel rod model routines in S-RELAP5).
- The fuel pellet and cladding strains associated with these “permanent” effects are calculated in separate executions of the standalone FPC code through the exposure histories required for the individual rods being analyzed.
- The results of these individual exposure runs are then transferred to S-RELAP5 and used to initialize the values of the burnup dependent “permanent” effects in the FPC routines.
- Short-term effects for significant parameters which affect the calculated PCT (see previous slide) are calculated by the FPC subroutines incorporated in S-RELAP5 throughout the transient.

SBLOCA Workflow

- The analysis workflow is the same as in the current EM

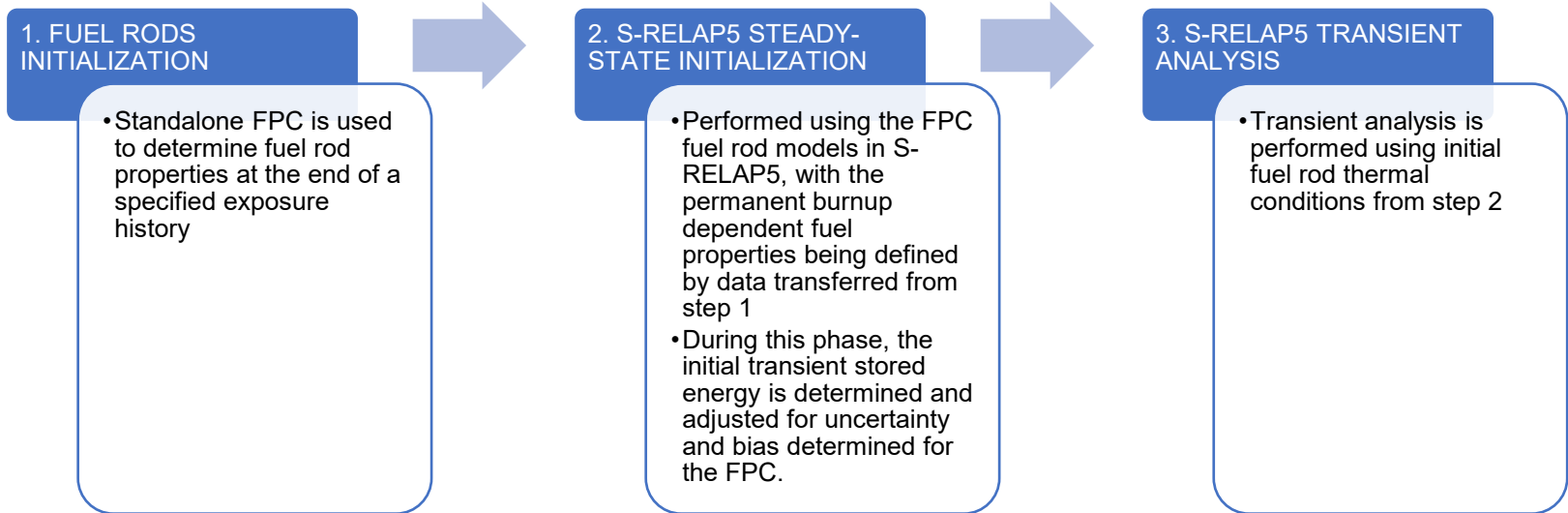


SBLOCA

- Regulatory Requirements
 - NUREG-0800
 - Appendix K
- EM Requirements
 - Analysis purpose, transient class, power plant class
 - Figures of merit
 - PIRT Review
- Assessment Base
 - []
 - []
- EM Implementation
 - []
- Sample Problems
 - []

RLBLOCA Workflow

- The analysis workflow is the same as in the current EM



RLBLOCA

- Regulatory Requirements
 - NUREG-0800
 - RG 1.157
 - RG 1.203 – Graded Approach to EMDAP
- EM Requirements
 - Analysis purpose, transient class, power plant class
 - Figures of merit
 - PIRT Review
- Assessment Base
 - []
 - []
- EM Implementation
 - []
- Sample Problems
 - []

Summary

- Straight forward process COPERNIC/RODEX2 \Rightarrow GALILEO
- EM evolution adding one FPC with the same functionality as the ones currently part of the methods
- Analysis workflow unchanged for both methods
- []
- []

Next Steps

Jerry Holm

Next Steps

Acronyms

EM – Evaluation Model

FPC – Fuel Performance Code

LBLOCA – Large Break Loss of Coolant Accident

LOCA – Loss of Coolant Accident

LOFT – Loss of Fluid Test

W3 – Westinghouse 3-loop type plant

W4 – Westinghouse 4-loop type plant

NRC – U.S. Nuclear Regulatory Commission

PIRT – Phenomena Identification and Ranking Table

PWR – Pressurized Water Reactor

RAI – Request for Additional Information

RG – Regulatory Guide

SBLOCA – Small Break Loss of Coolant Accident

CE – Combustion Engineering 2x4 type plant

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