

A

FRAMATOME ANP

***Revisions to
“MOX Fuel Design Report”
Kevin McCoy***

White Flint, MD, June 24, 2003

Revisions to Report

- > NRC concerns with Rev. 0***
- > Highlights of technical changes to report, chapter by chapter***
- > General changes in response to concerns***

Concerns with Rev. 0

- > Needed clearer focus on what specific approvals were being requested***
- > Needed to better identify relationship to other submittals***
- > Needed to include more specific data to support the application***

Chapter 1: Introduction and Summary

- > Provided a clear statement of what is being submitted for approval:**
 - ◆ Approval of MOX lead assemblies for two cycles**
 - ◆ Approval of fuel design for batch implementation (maximum rod burnup 50 GWd/MThm)**
 - ◆ Approval of lead assembly for a 3rd cycle (beyond 50 GWd/MThm but not beyond 60 GWd/MThm)**
- > Identified related topical reports**

Chapter 2: MOX Design Considerations

- > *Added section on mixed cores***
 - ◆ *Details of methodology are in Duke reports on neutronics and thermal-hydraulics***
- > *Updated typical isotopics for consistency***

Chapter 3: Weapons-Grade Plutonium

- > Provided better explanation and justification for using nuclear analysis methods for RG and LEU fuel to model WG MOX**
- > Expanded discussion of U/Pu ratio in master mix**
- > Updated tables and figures to reflect current calculations**

Chapter 3: Weapons-Grade Plutonium

- > Provided additional discussion on WG MOX pellet microstructure**
 - ◆ UO_2 matrix establishes pellet microstructure**
 - ◆ Grain size, particle size, and particle distribution same since same process parameters used (blending, sieving, pressing, and sintering)**
 - ◆ Local heating in agglomerates same (or less severe in WG MOX) because:**
 - Particle size same**
 - Master mix adjustment maintains or reduces density of fissile nuclei in the Pu-rich agglomerates**

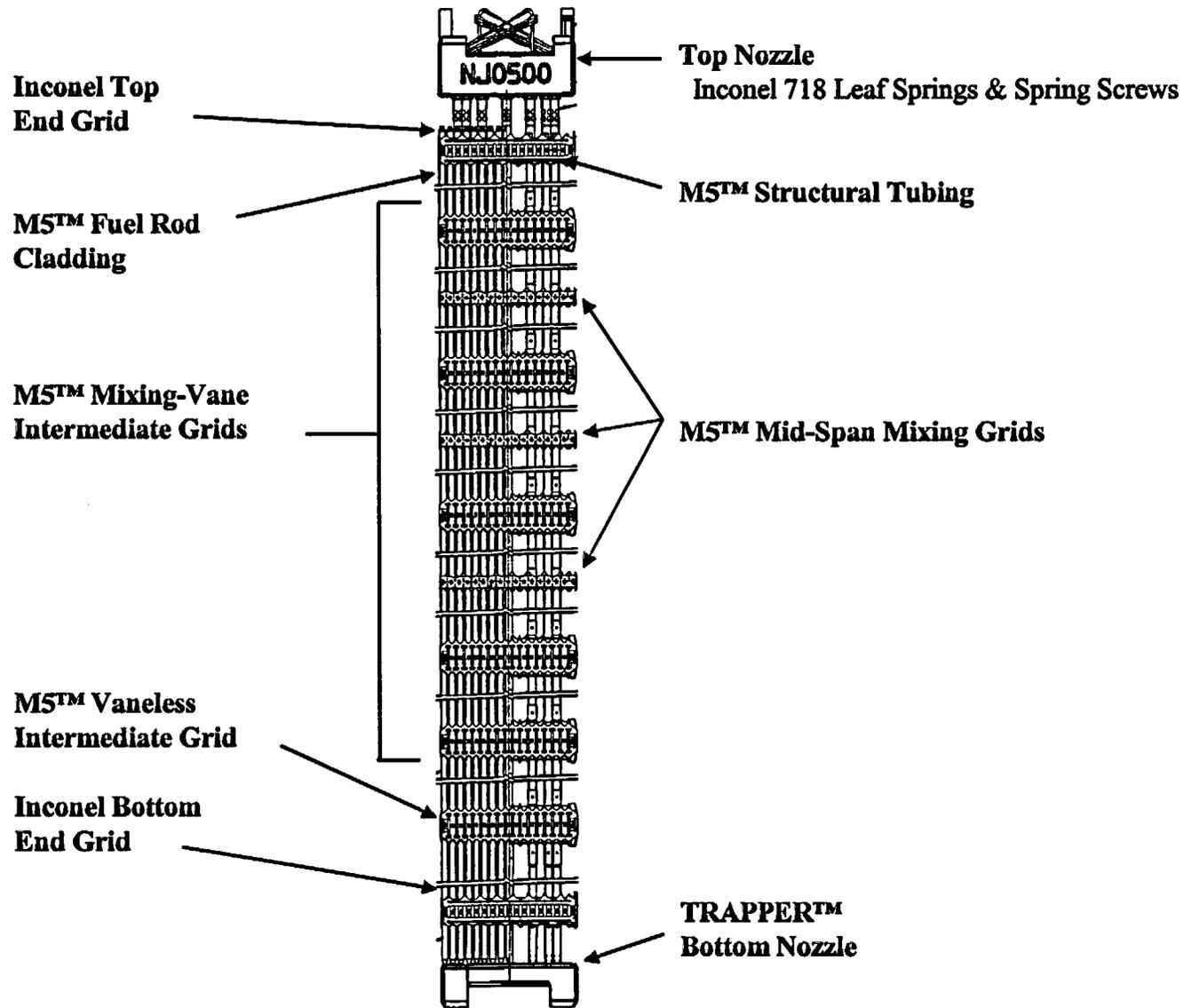
Chapter 4: Manufacturing Processes

- > *MIMAS (Micronized MASTer mix) process***
 - ◆ *Is proven and established***
 - ◆ *Is used in European MOX plants***
 - ◆ *Will be used for the lead assemblies***
 - ◆ *Will be used in the MFFF***

Chapter 5: Assembly Description

- > ***MOX fuel assembly design is the Advanced Mark-BW design with WG MOX pellets***
- > ***Changes to report are minor:***
 - ◆ ***Corrected terminology for mid-span spacer grids***
 - ◆ ***Increased burnup limit for Advanced Mark-BW (not Mark-BW/MOX1) to reflect recent submissions***
 - ◆ ***Adjusted precision of some values***
 - ◆ ***Moved discussions of Pu isotopics to Chapter 3***

Advanced Mark-BW Design Features



Chapter 6: Design Evaluation

- > **Provided linear heat rate for 1% transient cladding strain**
 - ◆ **[28.9 kW/ft at 20,000 MWd/MThm]**
 - ◆ **[16.2 kW/ft at 50,000 MWd/MThm]**
- > **Provided fatigue utilization factor: []**
- > **Provided limit on cross-flow velocity, 2 ft/s, and predicted maximum, []**

Chapter 6: Design Evaluation

- > **Provided more detail on M5™ parameters for hydrogen**
 - ◆ **Pick-up rate, []**
 - ◆ **Allowable hydrogen content, []**
 - ◆ **Predicted content at end of life, []**
- > **Provided additional clarification and discussion on**
 - ◆ **Fuel rod bow**
 - ◆ **Fuel rod axial growth and end-of-life pressure**
 - ◆ **Assembly liftoff**

Chapter 6: Design Evaluation

- > ***Provided minimum linear heat rate for centerline fuel melt***
 - ♦ []
 - ♦ [] at end of life
- > ***Revised discussion of fuel coolability for consistency with Duke's License Amendment Request***
- > ***Provided proprietary figure on oxide thickness***

Chapter 7: Experience Base

- > **Strengthened discussion of U.S. experience, added discussion of Saxton reactor MOX**
 - ◆ **94 ± 2 % dense**
 - ◆ **6.6% PuO_2**
 - ◆ **90.5% ^{239}Pu**
 - ◆ **51,000 MWd/MThm**
 - ◆ **No failures attributed to use of MOX**

Chapter 7: Experience Base

> Updated discussion of the European experience base

◆ German experience now includes

- Philippsburg 2: []

- Neckar 2: []

- Grafenrheinfeld: []

- Brokdorf: []

◆ New information on European MOX failures: []

],

no failures attributed to MOX

Chapter 7: Experience Base

- > *Over 500,000 MOX rods irradiated***
- > *Updated***
 - ◆ *List of plants using MIMAS MOX***
 - ◆ *Information on discharge burnups***
 - ◆ *Information on Mark-BW and MOX burnup experience***

Chapter 8: Lead Assembly Program

- > Clarified and updated discussion of fabrication**
- > Expanded discussion of examinations, classified into 3 levels**
 - ◆ Required poolside PIE each cycle**
 - ◆ Additional poolside PIE, to be performed as needed (based on results of required PIE)**
 - ◆ Updated scope of hot cell examination**
- > Clarified application of updated PIE acceptance criteria**

General Changes

- > **Clarified and better focused on what specific approvals were being requested**
- > **Clarified relationships to other topical reports**
- > **Improved traceability to supporting data**
 - ◆ **Increased number of references from 15 to 38**
 - ◆ **Tripled number of citations**
- > **Added proprietary supporting data**

Summary

- > ***Rev. 0 of report was reviewed and revised in light of NRC concerns***
- > ***Changes were made to***
 - ◆ ***Focus the review***
 - ◆ ***Improve / clarify relationship with other submittals***
 - ◆ ***Provide better traceability to data sources***

As a result, Rev. 1 is stronger, more detailed, and more traceable, to facilitate review and approval