UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 16, 2000

MEMORANDUM TO: Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: Stewart N. Bailey, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF THE JULY 26, 2000, MEETING WITH FRAMATOME COGEMA FUELS, INC. TO DISCUSS FUEL PERFORMANCE AND LICENSING ACTIVITIES

On July 26, 2000, the NRC staff met with Framatome Cogema Fuels, Inc. (FCF) to discuss the performance of their fabricated fuel and licensing activities. FCF discussed different assembly designs and their status (i.e., lead test assemblies or full reloads) in both US and foreign reactors. FCF noted that their fuel reliability is "best in class," and for Mark-B assemblies there have been no failures in fuel fabricated in 1996 or later. FCF also discussed minor changes in fuel assembly design and/or fuel handling procedures to resolve any identified problems, such as grid damage. They discussed fuel performance (such as oxide thickness and growth) and compared the results for Zr-4 and M5. FCF also provided the latest information on control rod drop times. The staff requested additional information on FCF's oxide measurement techniques.

FCF then discussed licensing activity, including recently approved topical reports, topical reports under review, and forthcoming topical reports. There was some discussion on mixed-oxide (MOX) fuel, since several of the FCF topical reports contain sections dealing with MOX fuel, but most topical reports on MOX application have not been submitted and the staff is not actively reviewing MOX yet. It was left as an open item for the staff and FCF, along with the consortium that will be using MOX, to decide how the review of MOX will proceed.

FCF then discussed their proposal for a lead test assembly (LTA) program. This discussion was in response to previous staff comments that the industry should propose a LTA program that would gather data on fuel with high burnup or other desired traits (such as new designs or materials). The staff's response to FCF's proposal was positive and the staff requested a formal proposal, but the staff also asked whether FCF and the other fuel vendors or user groups could collectively submit a common LTA program. FCF stated they would discuss this with other vendors.

Finally, FCF discussed proprietary information such as their post-irradiation examination (PIE) goals, their planned PIEs, and their schedule for implementing advanced cladding material M5.

A list of those attending the meeting is provided as Attachment 1. The non-proprietary slides used by FCF during the meeting are provided in Attachment 2.

Project No. 693

Attachments: 1. List of Attendees
2. FCF Slides

cc w/atts: See next page

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Rockville, MD 20852-1631

FRAMATOME COGEMA FUELS, INC.

LIST OF ATTENDEES

MEETING ON FUEL PERFORMANCE

JULY 26, 2000

NAME	AFFILIATION
Stewart Bailey	NRC/NRR/DLPM
Ralph Caruso	NRC/NRR/DSSA/SRXB
Margaret Chatterton	NRC/NRR/DSSA/SRXB
Edward Kendrick	NRC/NRR/DSSA/SRXB
Tom Coleman	FCF
Arthur B. Copsey	FCF
Frank McPhatter	FCF
Leslie Collins	Westinghouse/CE Nuclear Licensing

Attachment 1

FCF/NRC Meeting on Fuel Performance and Licensing July 26, 2000

Attachment 2

nrc7_00.ppt

Agenda

I. Introduction - T. A. Coleman

II. Fuel Performance - A. B. Copsey

III. Licensing Activity - C. F. McPhatter

IV. Discussion

V. Conclusion

Objectives of Meeting

- Provide NRC an update of FCF fuel performance
- Discuss future plans
- Summarize licensing activity
- Obtain NRC concurrence with activities and schedule

Performance of FCF Fuel

Presented to the NRC July 2000

Bernie Copsey

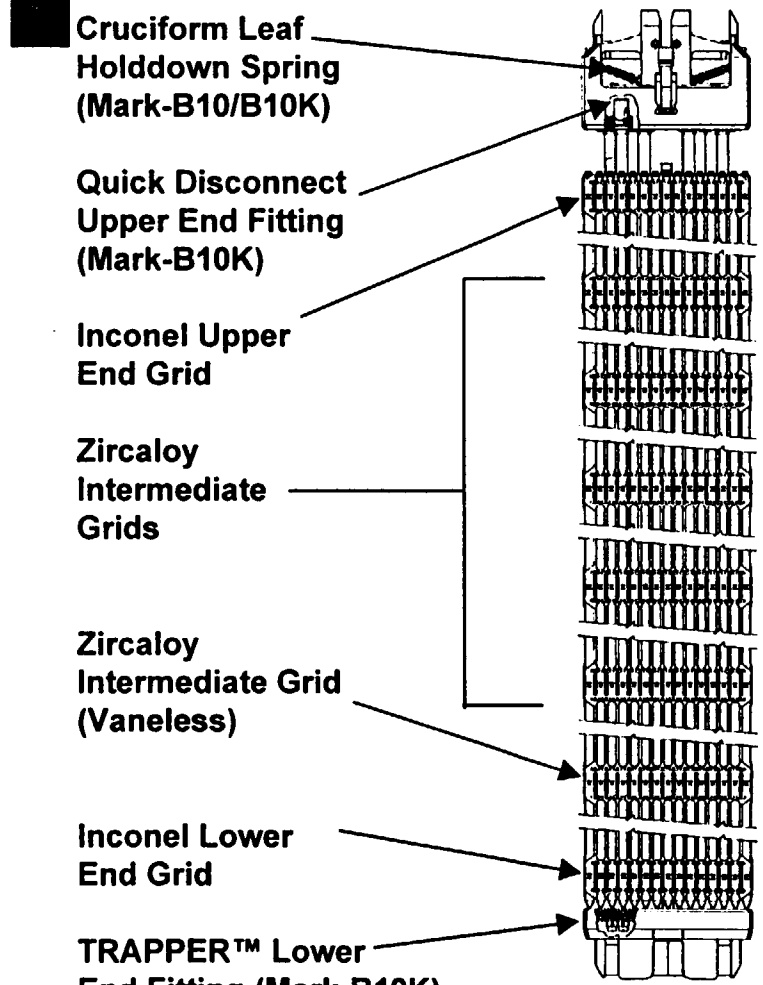
Manager, Analysis Technology

FRAMATOME TECHNOLOGIES

Outline

- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- Shoulder gap
- Control rod drop performance
- PIE plans

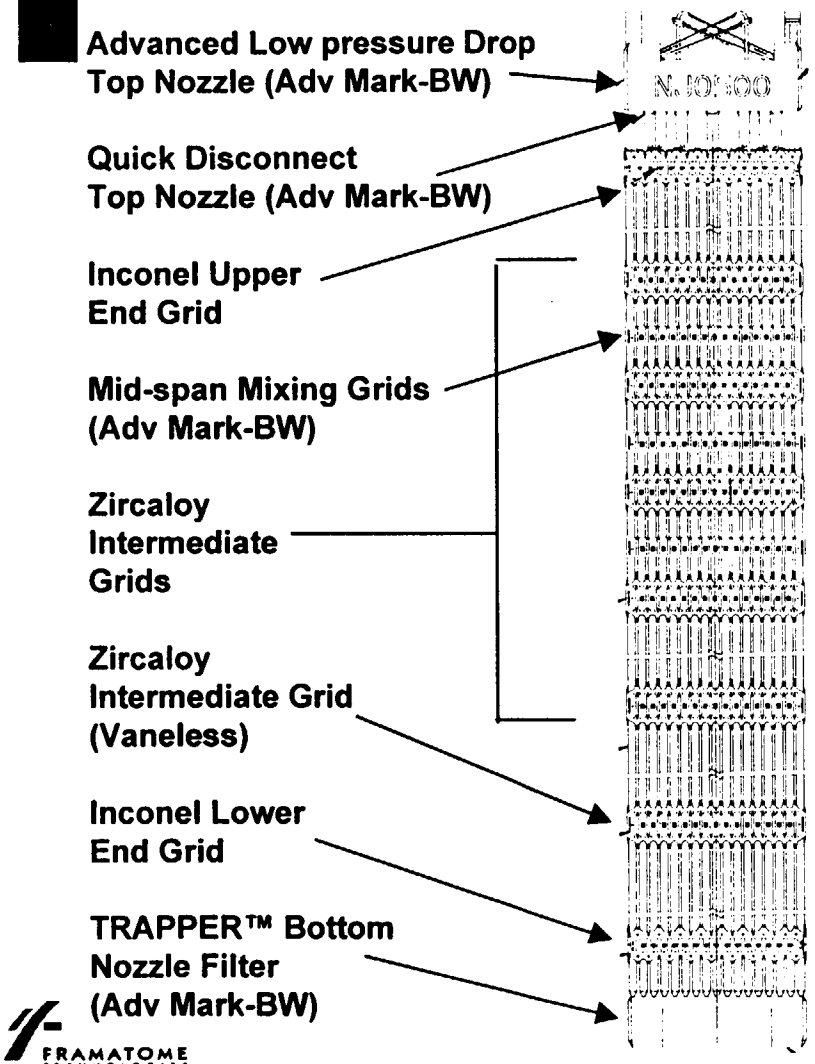
Mark-B 15x15 Design Features



- **Mark-B9**
  - Helical holddown spring
- **Mark-B10**
  - **Cruciform leaf holddown spring**
- **Mark-B10K**
  - Cruciform leaf holddown spring
  - **TRAPPER™ debris filter lower end fitting**
  - **Heavy loaded fuel rod**
  - **M5™ advanced alloy cladding**
  - **Optional quick disconnect upper end fitting**

FRAMATOME TECHNOLOGIES

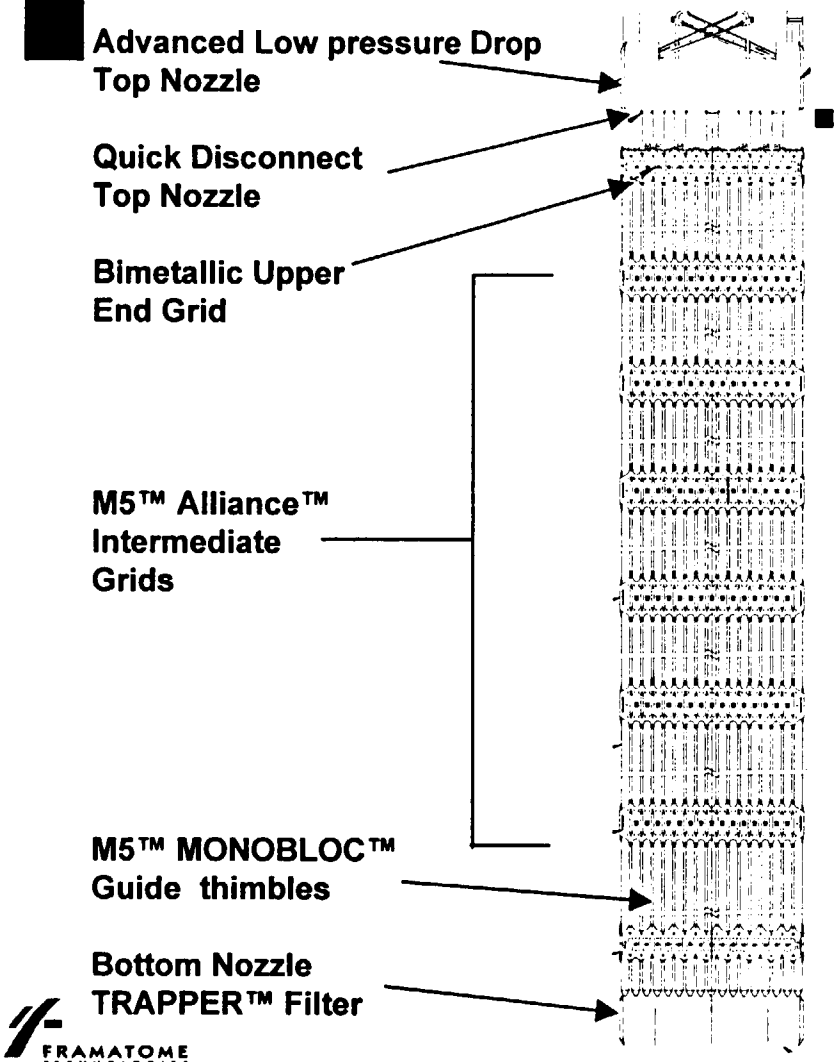
Mark-BW 17x17 Design Features



- **Mark-BW**
  - Leaf spring top nozzle
  - Cloverleaf bottom nozzle
  - High performance Zircaloy mixing grid
  - Inconel end grid
- **Adv Mark-BW**
  - **Advanced low pressure-drop top nozzle**
  - **TRAPPER™ debris filter bottom nozzle**
  - **Heavy loaded fuel rod**
  - **M5™ advanced alloy cladding and guide thimbles**
  - **Quick disconnect upper end fitting**
  - **Mid-span mixing grids (optional)**

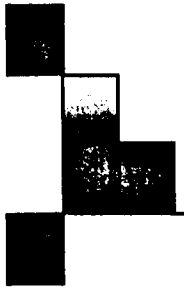
FRAMATOME TECHNOLOGIES

Alliance™ 17x17 Design Features



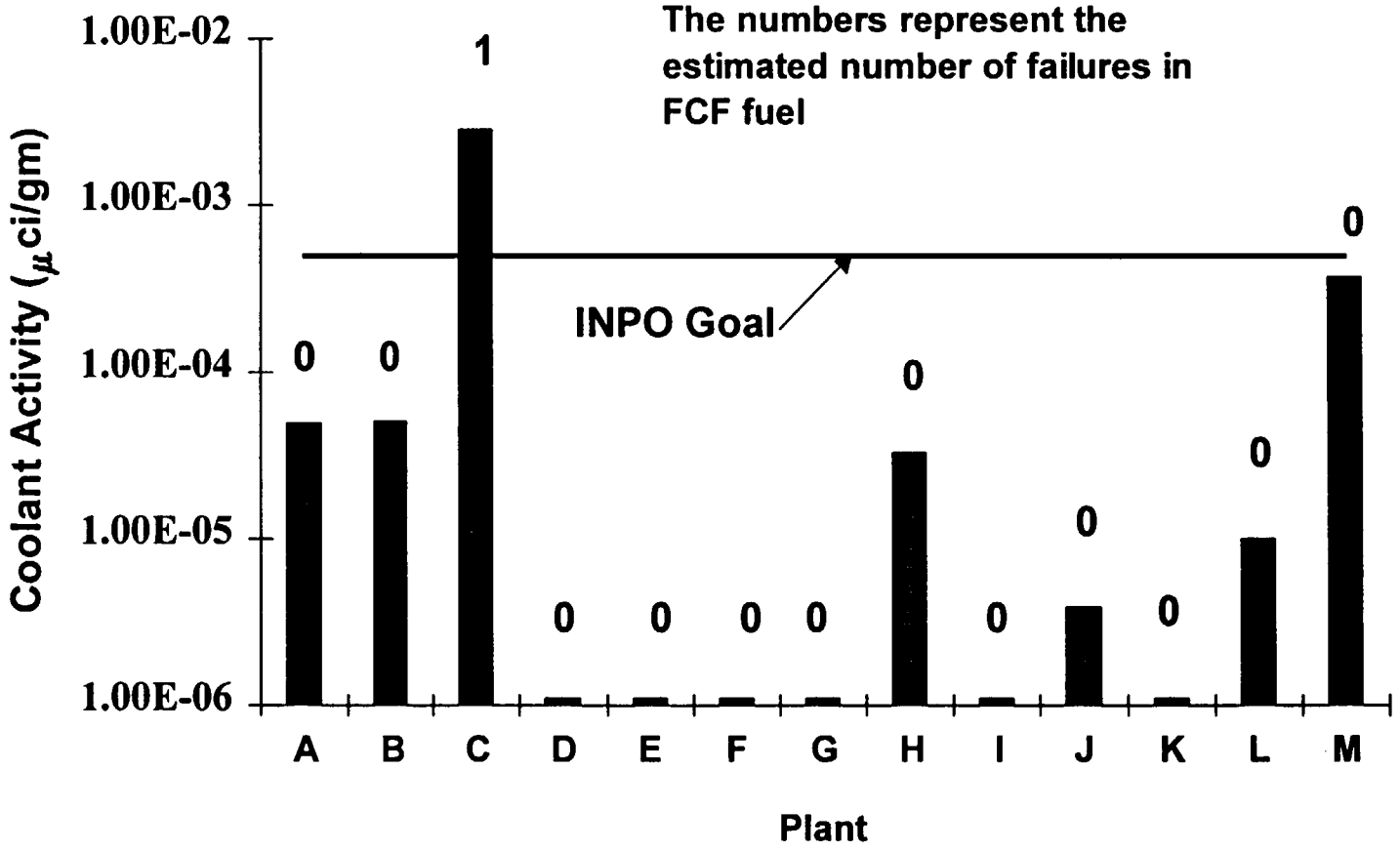
- **Alliance™**
  - Advanced low pressure-drop top nozzle
  - TRAPPER™ debris filter bottom nozzle
  - Heavy loaded fuel rod
  - M5™ advanced alloy cladding, guide thimbles, and **intermediate grids**
  - **High performance Alliance™ intermediate grids**
  - Quick disconnect upper end fitting
  - Mid-span mixing grids (optional)
  - **MONOBLOC™ Guide Thimbles**
  - **Bimetallic end grids**

FRAMATOME TECHNOLOGIES



- Fuel assembly designs
- **Fuel reliability**
- Spacer grid performance
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- Shoulder gap
- Control rod drop performance
- PIE plans

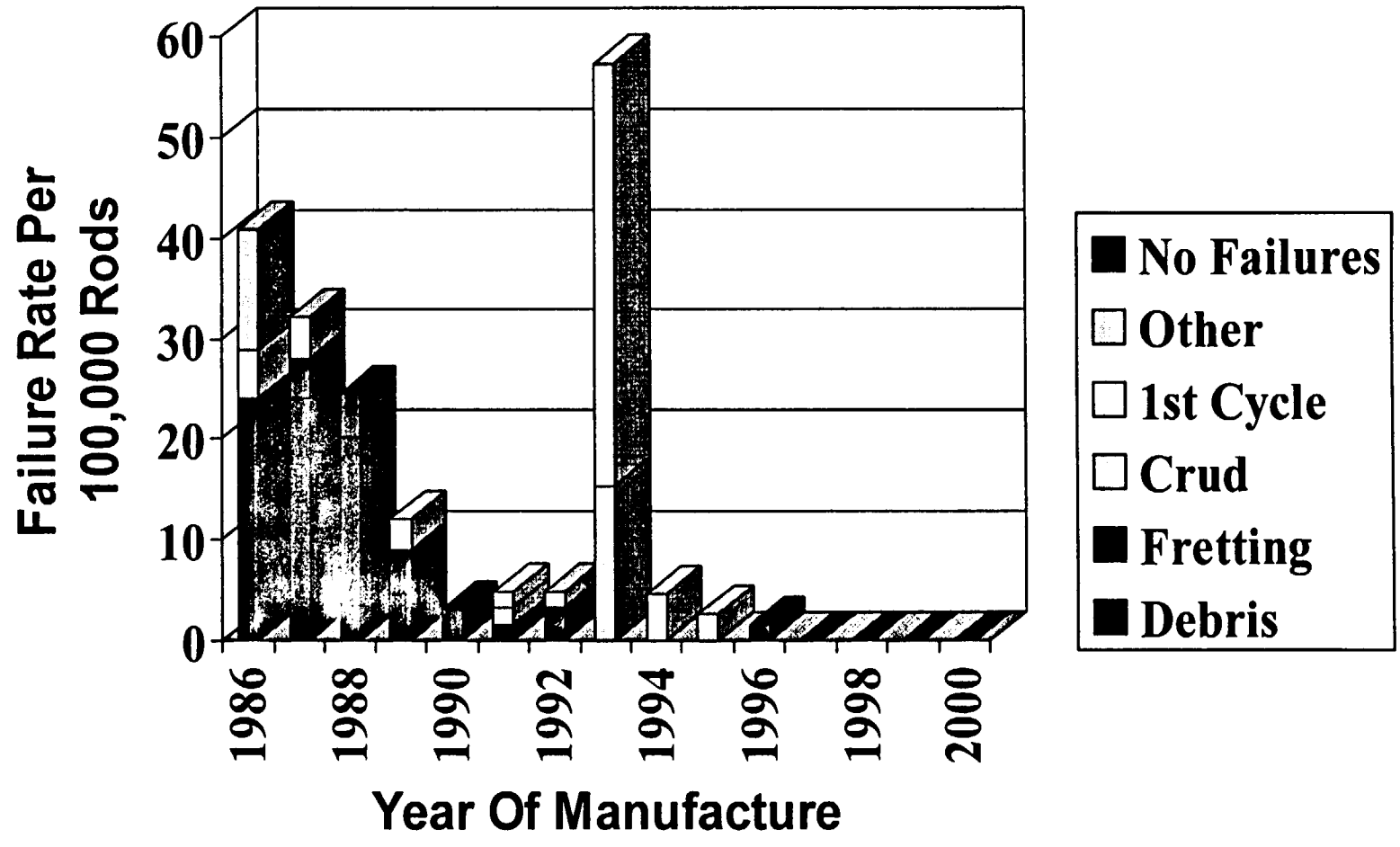
Fuel Performance Status: Failure-Free Except for One Plant



June 2000

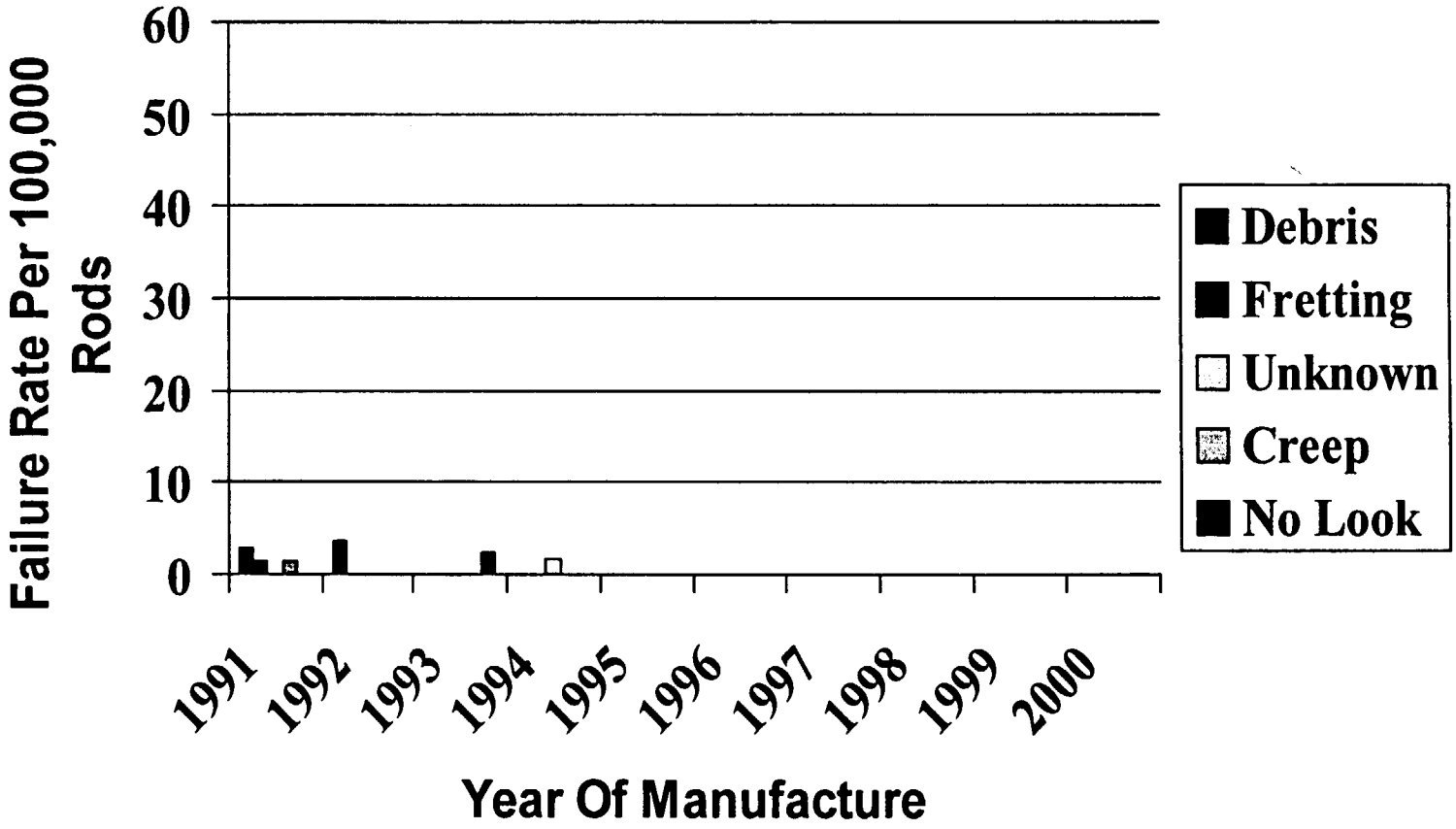
FRAMATOME TECHNOLOGIES

Mark-B Fuel is Failure-Free for Fuel Manufactured after 1996



FRAMATOME TECHNOLOGIES

Mark-BW Fuel is Failure-Free for Fuel Manufactured after 1994



FRAMATOME TECHNOLOGIES

Fuel Reliability Summary

- Fuel reliability remains "best-in-class"
- Reasons for excellent fuel reliability:
  - Fretting-resistant grids
  - Debris resistant features
    - (17x17) TRAPPER™ bottom nozzle
    - (15x15) Long lower end plug and TRAPPER™ lower end fitting
  - Fuel Integrity Quality Improvement Team results
  - Water chemistry control by operating utilities

- Fuel assembly designs
- Fuel reliability
- **Spacer grid performance**
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- Shoulder gap
- Control rod drop performance
- PIE plans

Slipped Spacer Grids

- Except for the next outage for one plant, the redesigned restraint system will be present for all new fuel
- Techniques for repositioning grids and core reloading have been implemented

➢ **No new occurrences of slipped grids seen for fuel with redesigned restraint system**

Damaged Spacer Grids

- Damage continues to occur at some Mark-B reactors
- Increased lead-in on the upper end fitting to be implemented this fall
- Spacer grid changes will begin this fall with the implementation of the Mark-B11 and in 2001 with changes to the other Mark-B corner design

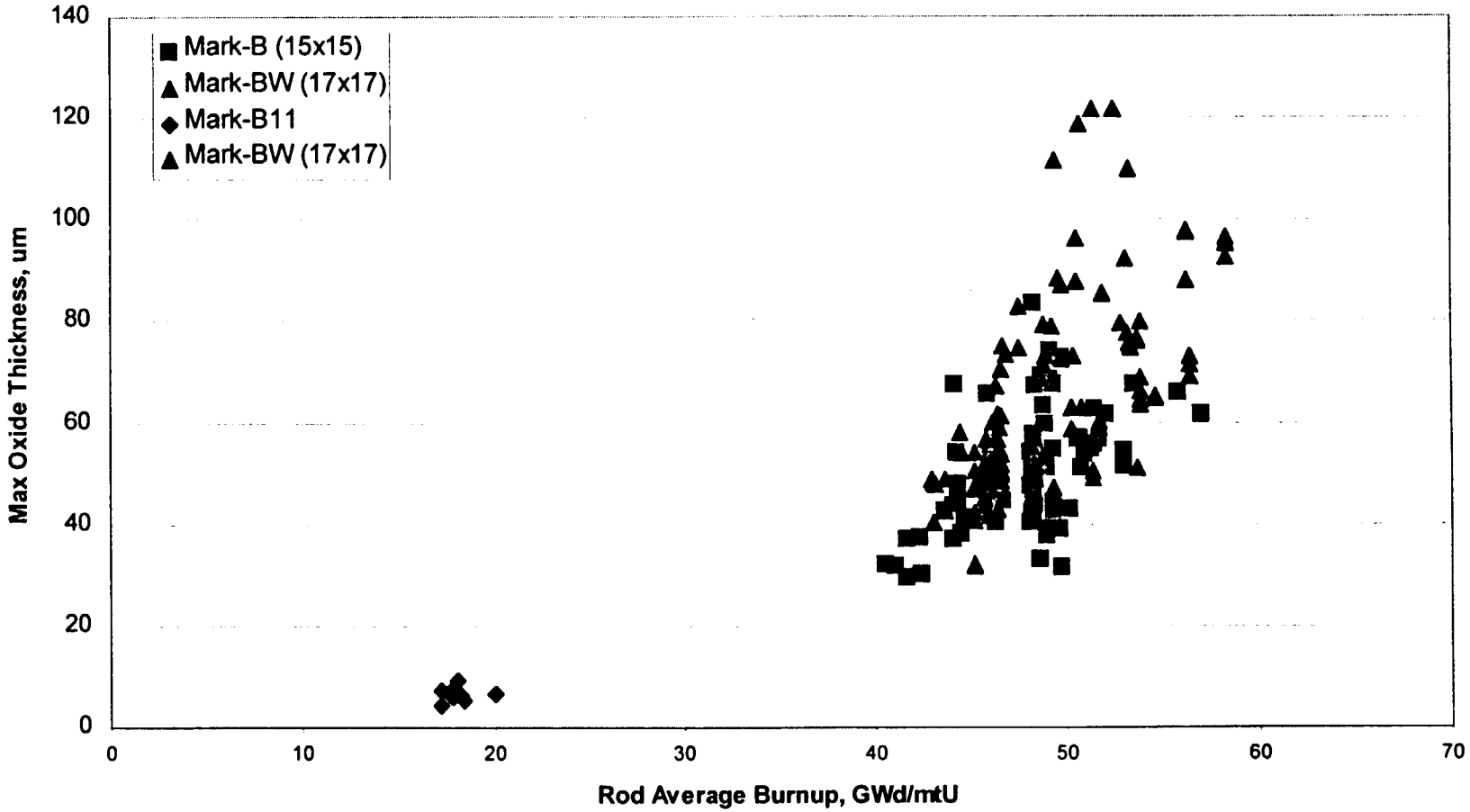
➢ **FCF and utilities will continue to monitor grid damage to assure no operating problems**

Spacer Grid Performance Summary

- Redesigned restraint system and improved handling techniques appear to have mitigated slipped grid problem
- Redesign to reduced grid damage:
  - Lead-in on the upper end fitting
  - Mark-B corner redesign on spacer grid
- Mark-BW has had no grid damage or hang-up problems

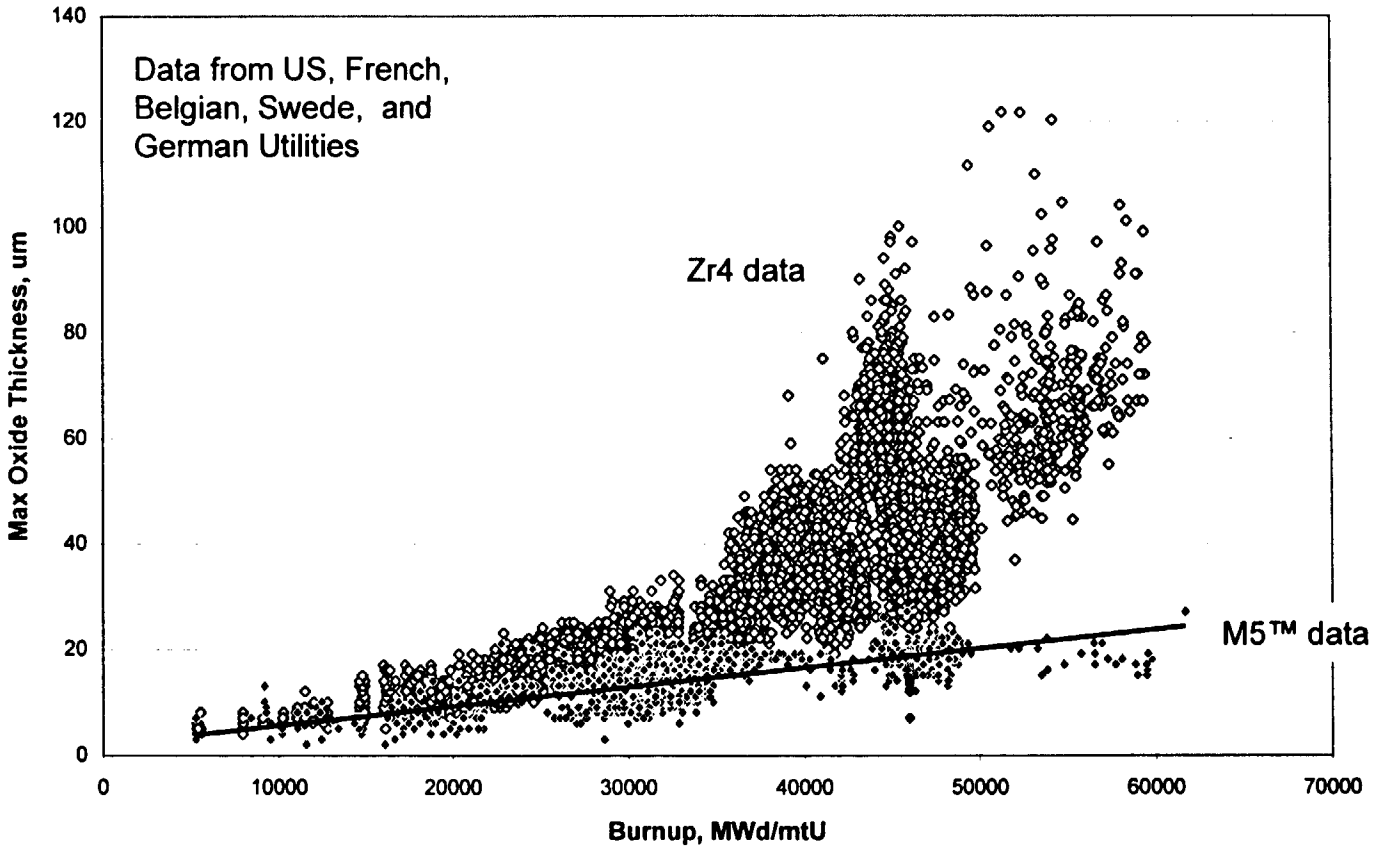
- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- **Fuel rod oxide**
- Fuel assembly and fuel rod growth
- Shoulder gap
- Control rod drop performance
- PIE plans

Mark-B and Mark-BW Zr4 Maximum Oxide Thickness Supports Model



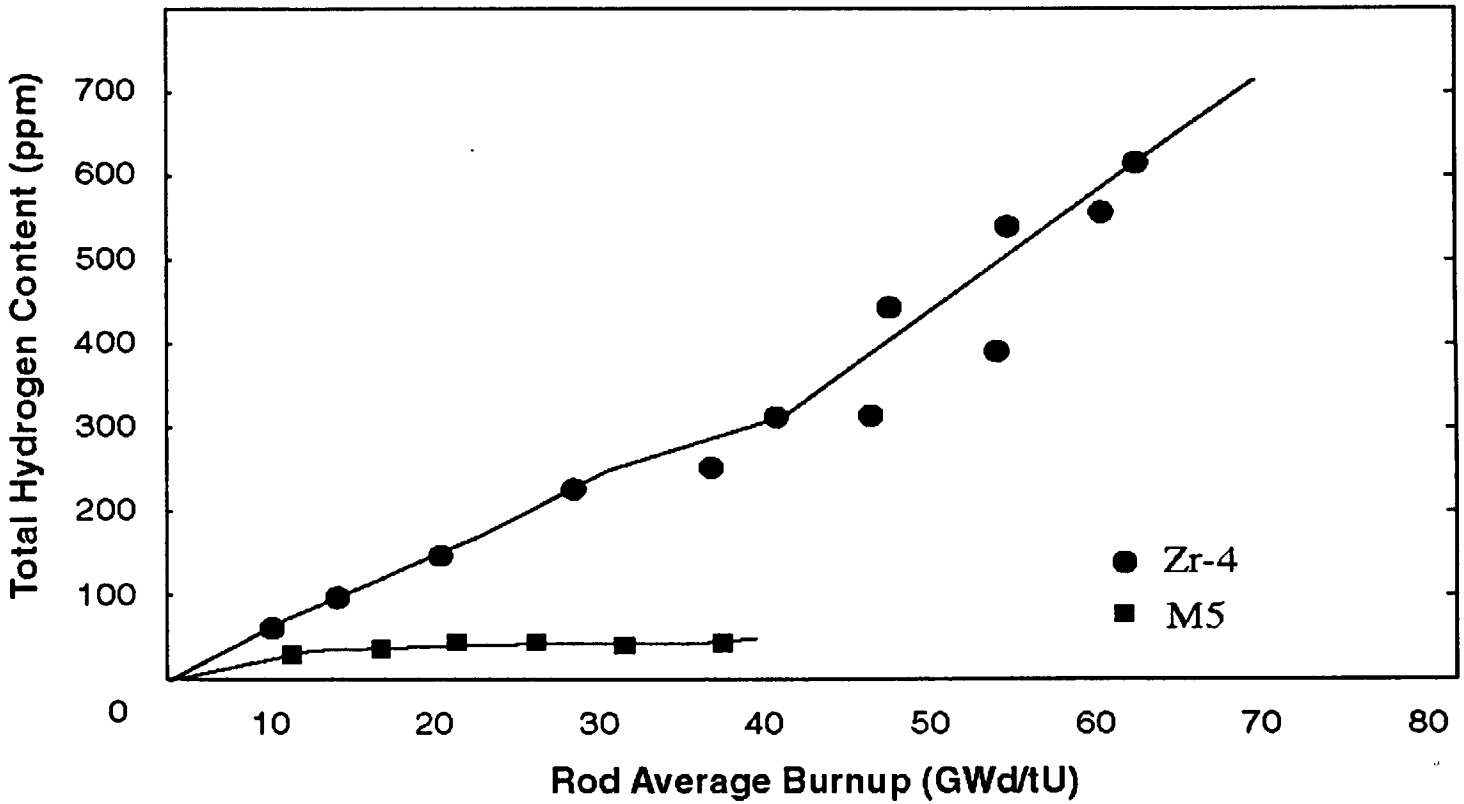
FRAMATOME TECHNOLOGIES

M5™ Maximum Oxide Thickness is Significantly Less Than Zr4

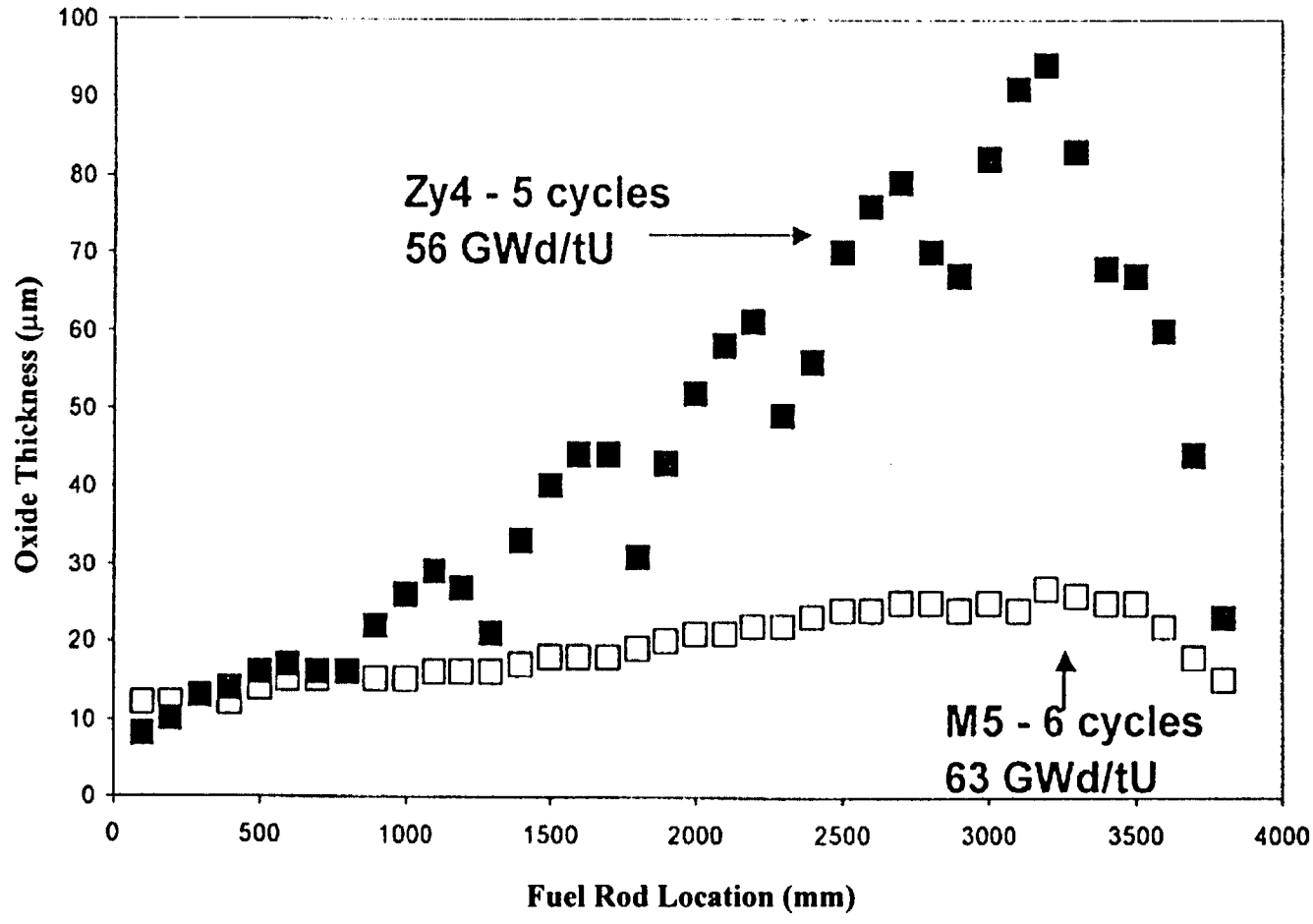


FRAMATOME TECHNOLOGIES

M5™ Hydrogen Content is Significantly Less Than Zr4



M5™ has a Low Sensitivity to Temperature



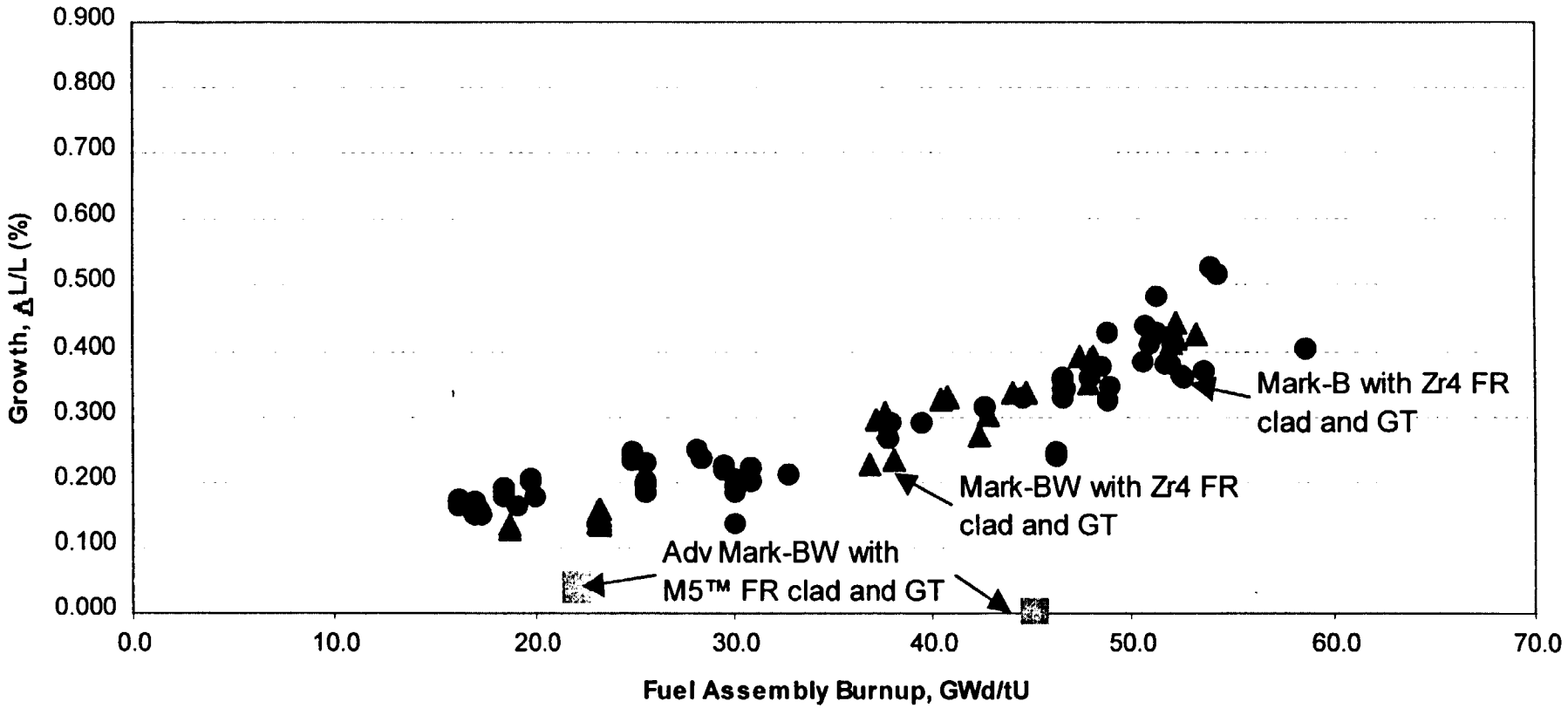
FRAMATOME TECHNOLOGIES

Fuel Rod Oxide Summary

- Zr4 fuel rod oxide models are validated by measurement
- M5™ fuel rod oxide continues to be significantly lower than Zr4
- M5™ fuel rod hydrogen content continues to be significantly lower than Zr4
- M5™ fuel rod oxide does not have a sensitivity with temperature

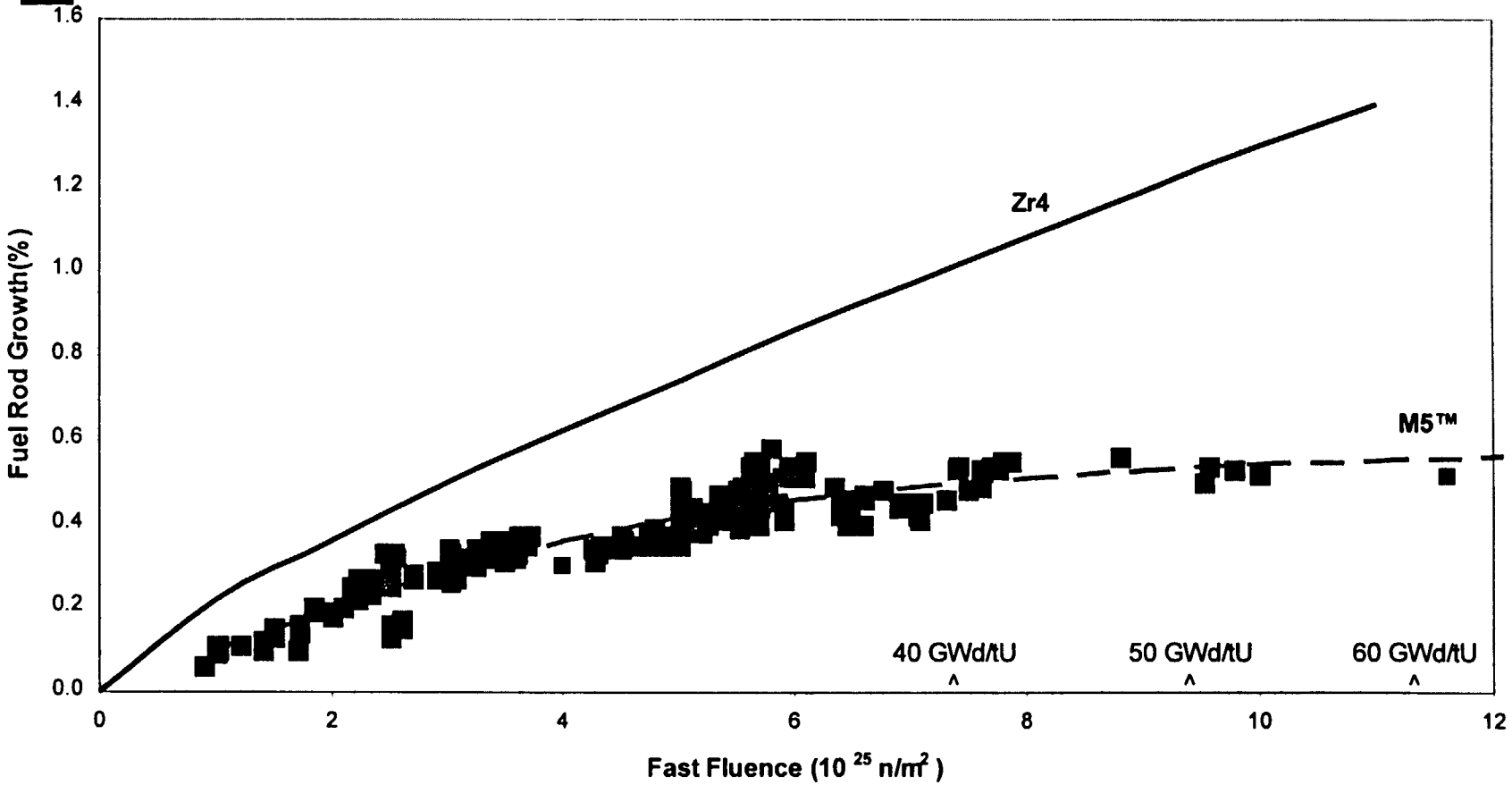
- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- Fuel rod oxide
- **Fuel assembly and fuel rod growth**
- Shoulder gap
- Control rod drop performance
- PIE plans

Fuel Assembly Growth: Zr4 Supports Model, M5™ is Low



FRAMATOME TECHNOLOGIES

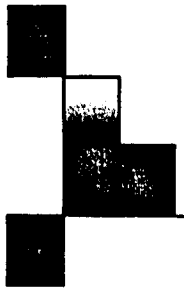
Mark-BW Fuel Rod Growth: Zr4 Supports Models, M5™ is Low



FRAMATOME TECHNOLOGIES

Fuel Assembly and Fuel Rod Growth Summary

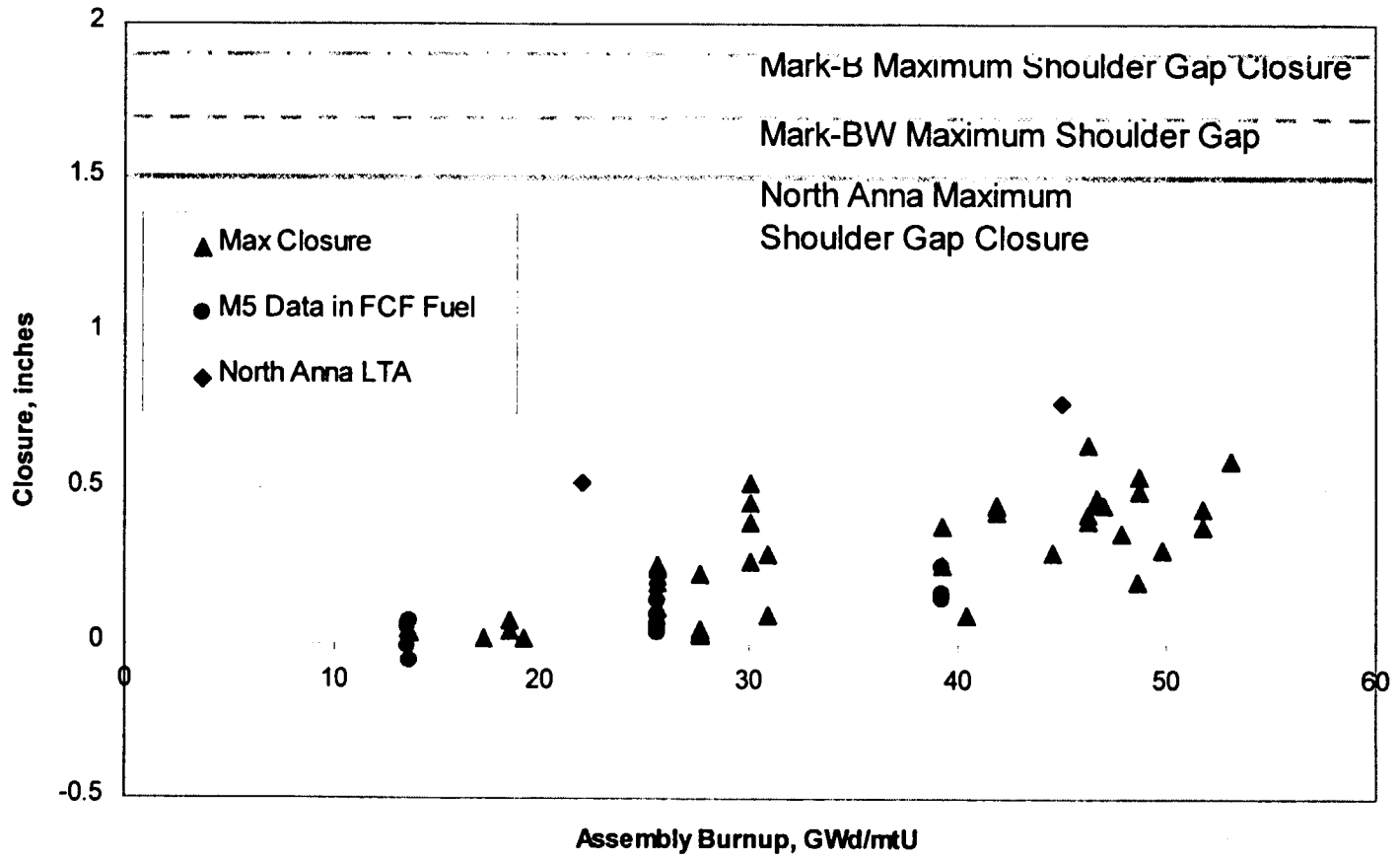
- Mark-BW and Mark-B Zr4 fuel assembly growth supports existing model
- Adv. Mark-BW M5™ fuel assembly growth is low
- Zr4 fuel rod growth supports existing Zr4 model
- M5™ fuel rod growth supports existing M5™ model
- Lower M5™ fuel rod and fuel assembly growth allows an increase in plenum and/or pellet stack length



- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- **Shoulder gap**
- Control rod drop performance
- PIE plans

FRAMATOME TECHNOLOGIES

Mark-B and Mark-BW Maximum Closure Shoulder Gap



FRAMATOME TECHNOLOGIES

Shoulder Gap Summary

- Sufficient margin is available for shoulder gap closure for Mark-B, Mark-BW, and Adv. Mark-BW
- Adv. Mark-BW has higher gap closure than the Zr4 fuel assemblies due to M5™fuel rods and guide thimbles
  - Sufficient margin to full closure exists

- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- Shoulder gap
- **Control rod drop performance**
- PIE plans

FRAMATOME TECHNOLOGIES

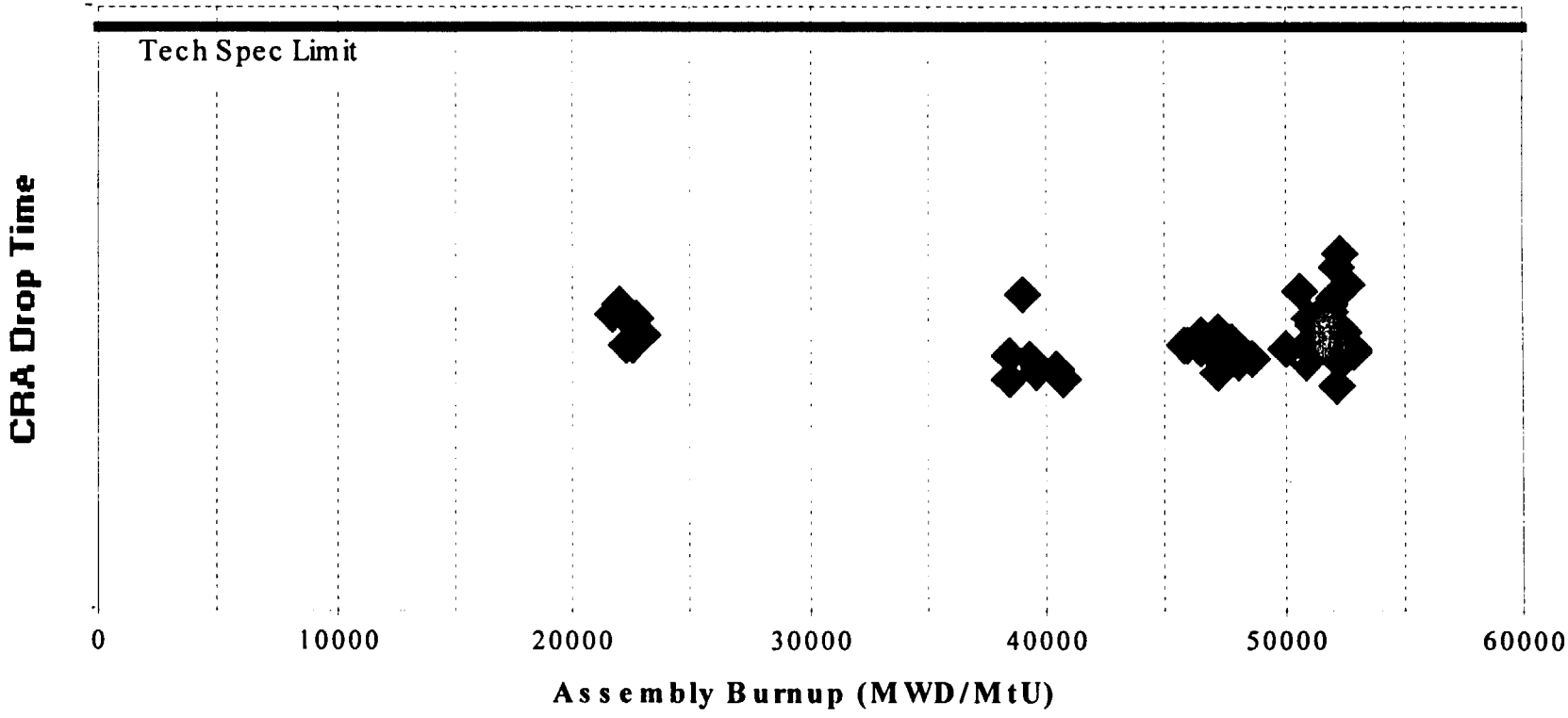
Review of Previous Control Rod Drop Times Meetings with NRC

- Meetings with the NRC held October 1999 and February 2000
- Data was collected and analyzed for Mark-B plants
- Spring set and shuffle-improvements were made to the cycles
- Analysis will be performed when additional drop time data is available
- Only plants with 24-month cycles, Mark-B10 Upper End Fitting, and long, continuous operations have observed IRI

Latest Mark-B Plant Shutdown Following 24-month Cycle

- All control rod drop times met tech specs
- 2 control rod slowed down at 99% inserted and slowly finished last 1%
- 5 control rods had BOC-to-EOC increase greater than 0.1 sec
- In-pool drag data was taken and confirmed drop time model (drop time vs drag force)
- All control rod drop times after refueling are acceptable
- Spring set and shuffle-improvements were made

Latest Mark-B Plant Shutdown Control Rod Drop Times

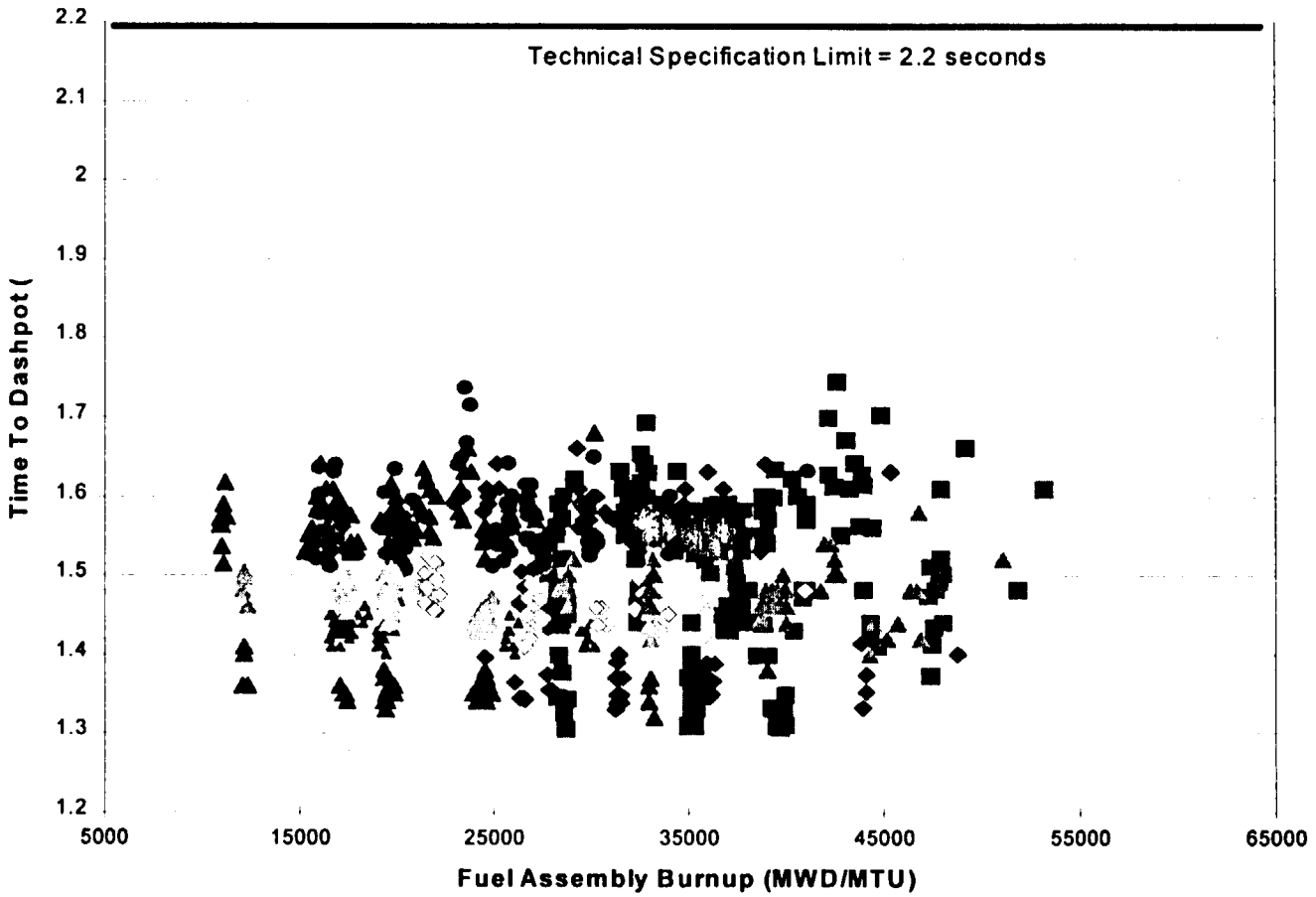


FRAMATOME TECHNOLOGIES

Mark-BW Control Rod Drop Times

- No Mark-BW fuel has had IRI
- Mark-BW fuel has lower loads per guide tube
- Mark-BW fuel has 18-month cycles
- FCF is continuing to monitor Mark-BW control rod drop time data

Rod Drop Times In Mark-BW are Constant Over Burnup Range



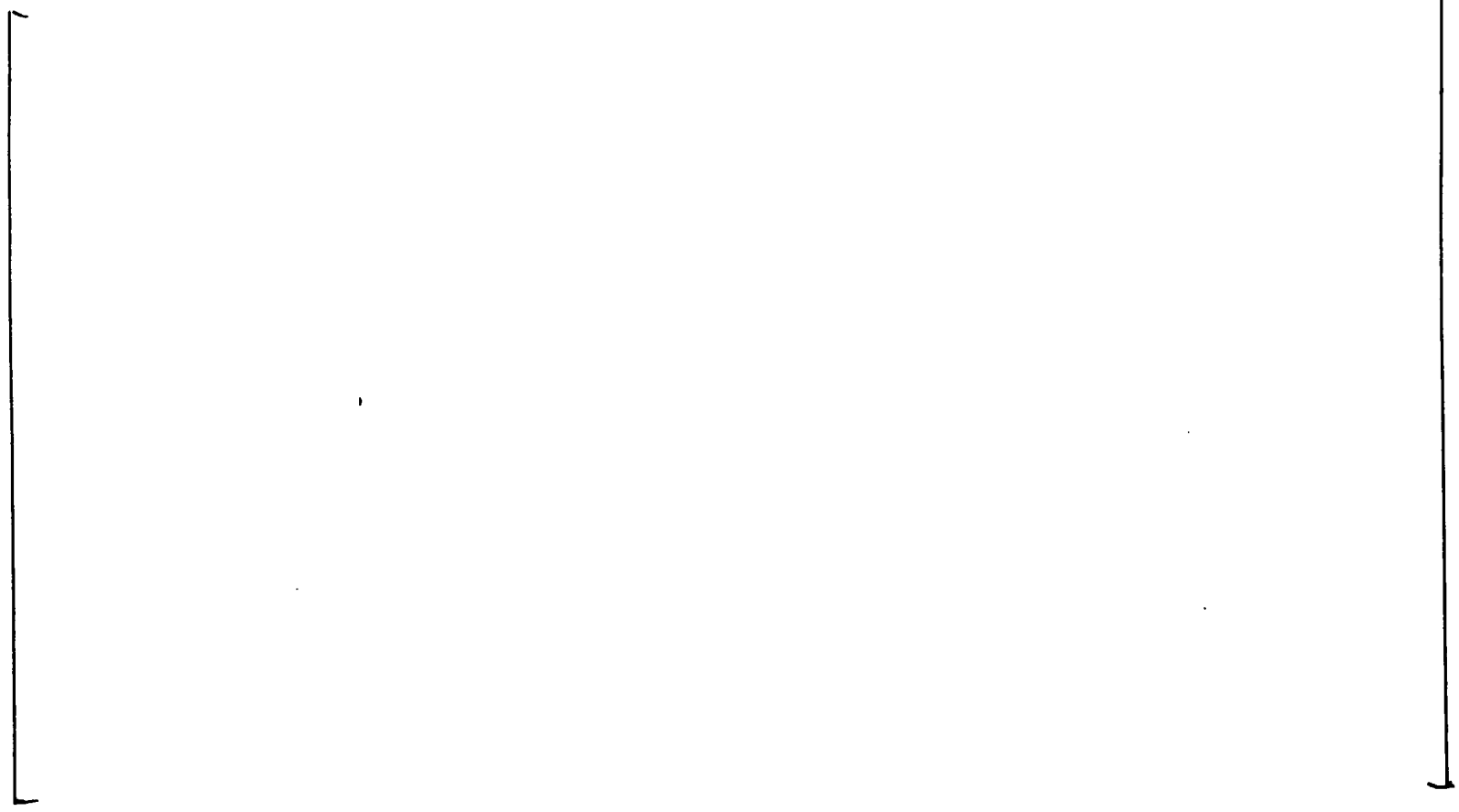
FRAMATOME TECHNOLOGIES

Control Rod Drop Time Summary

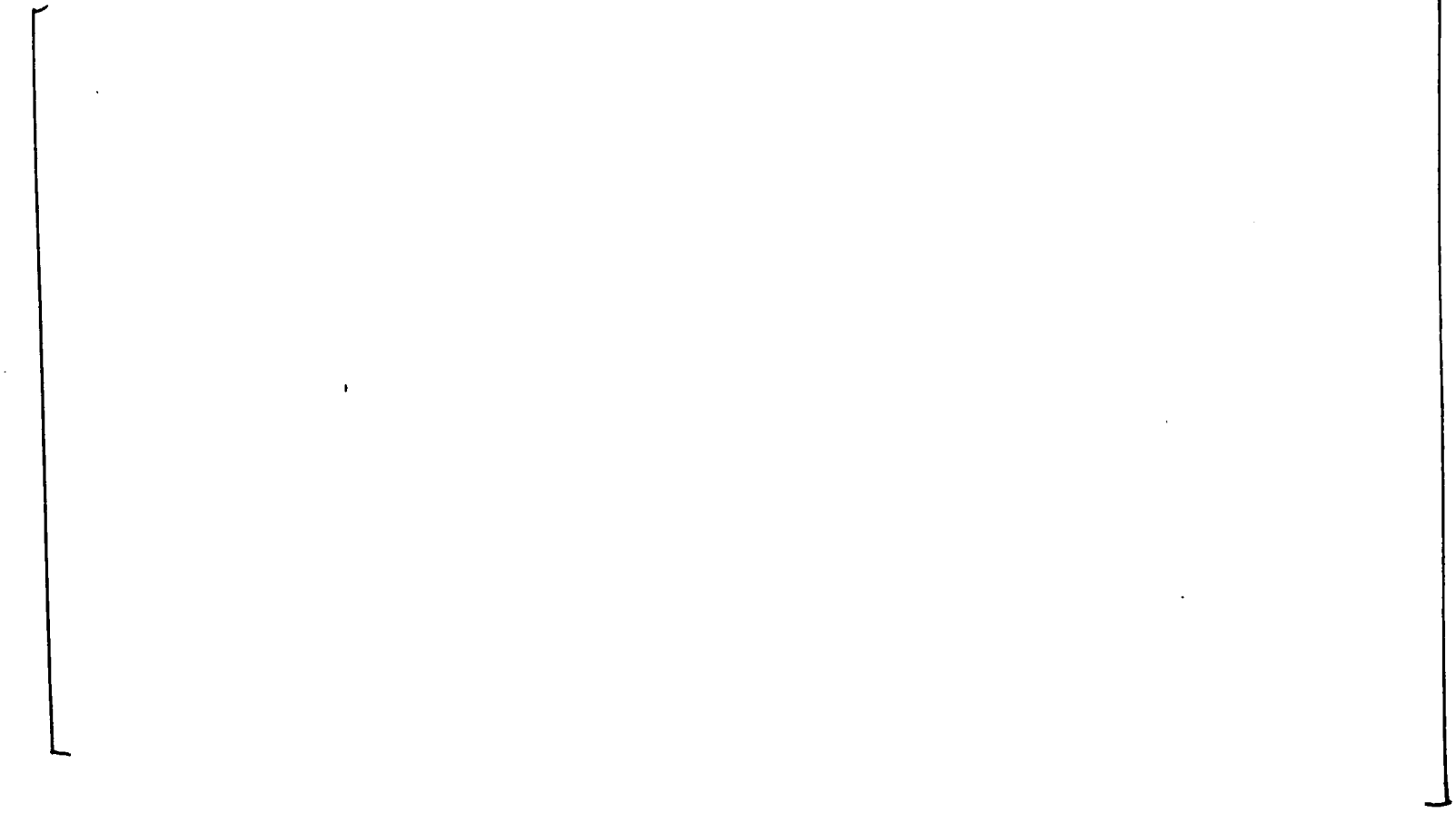
- Mitigative Actions Performed
  - Plastic setting of hold-down springs
  - Shuffle improvements
- Future Actions
  - M5™ guide tube and fuel rod clad material
  - Mark-B10 leaf spring re-design
  - Hydraulic lift methodology
- We are continuing to monitor data and develop analytical tools

- Fuel assembly designs
- Fuel reliability
- Spacer grid performance
- Fuel rod oxide
- Fuel assembly and fuel rod growth
- Shoulder gap
- Control rod drop performance
- **PIE plans**

PIE Summary
1999/2000 PIE's

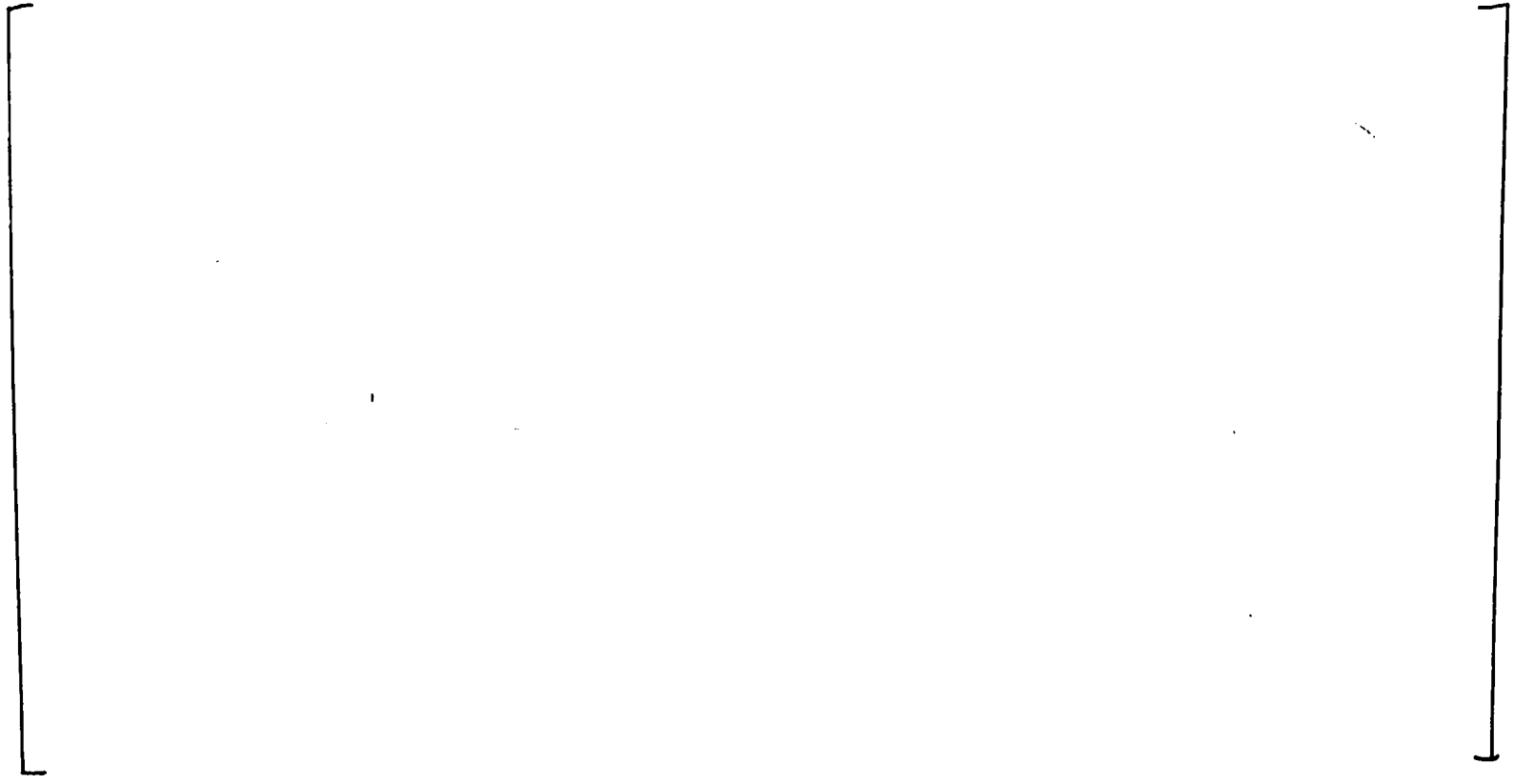


Planned Long-Term PIE's



Planned Long-Term PIE's
continued

Long Term PIE Goals



FRAMATOME TECHNOLOGIES

Planned M5™ Implementation

PIE Plans Summary

Conclusion

- FCF fuel is performing well with in-core performance behaving as expected from design models
- FCF continues to have excellent fuel integrity as burnups increase
- Preventive actions have been taken for fuel handling issues
- M5™ performance is excellent
- Control rod drop times
  - Mitigative actions have been performed
  - We are continuing to monitor data and develop analytical tools

Licensing Activity
Frank McPhatter

- Topical Reports
- Extended Burnup
- Mixed Oxide
- Other licensing activity

Approvals Since July 1999

- BAW-10179 - Reload Methodology
- BAW-10229 - Mark-B11 Fuel Assembly
- BAW-10228 - SCIENCE
- BAW-10227 - M5 Cladding and Structural
- BAW-10199 - Mark-B11 CHF

Topicals in Review

- BAW-10133 Addenda 1 and 2 - Faulted Condition Methodology - RAI submitted on July 21, 2000.

- BAW-10231 - COPERNIC - MOX addendum to be submitted August 2000

Future Submittals

- BAW-10231 - COPERNIC MOX Addendum
- BAW-10186, Rev. 2 - Extended Burnup
- BAW-10227, Rev. 1 - M5 Topical (For Extended Burnup)
- BAW-10179, Rev. 4 - Methodology
- BAW-10199, Addendum 2 - Mark-BW CHF Testing and Correlation
- BAW-10172, Rev. 2 - Mark-BW Fuel
- BAW-10XXX - Alliance Design Report

Topical Report Submittal Schedule

■BAW-10231	8/2000
■BAW-10186, Rev. 2	12/2000
■BAW-10227, Rev. 1	12/2000
■BAW-10179, Rev. 4	12/2000
■BAW-10199, Addendum 2	12/2000
■BAW-10172, Rev. 1	9/2001
■BAW-10XXX	9/2002

Lead Test Assembly Licensing Criteria for Extended Burnup

Corrosion LTA Licensing Criteria

- Max Predicted Oxide is 100 microns
- Eight Fuel Assemblies may have predicted oxide >100 microns and will be designated as Lead Corrosion Assemblies
- Total number of LTAs shall not exceed twelve

Proposed Licensing Criteria for High Burnup LTAs

- Up to twelve fuel assemblies may have predicted burnups > current limits
- These assemblies will be designated as LTAs at BOC in cycle where BU limit will be exceeded.
- PIEs of the LTAs will be conducted and results provided to NRC

M5 High Burnup Rods

- M5 High Burnup Rods in TMI-1 Cycle 14
- Four M5 rods will be inserted in core location H8
- BOC M5 rod burnups in mid forties
- Target EOC M5 rod burnups will be in mid sixties

Mixed Oxide Schedule

■ Fuel Qualification Plan	7/2000
■ COPERNIC MOX Addendum	8/2000
■ Mechanical Design Topical	8/2001
■ LOCA EM Topical	8/2001

Other Licensing Activity

- Petition for rulemaking change to 10 CFR 50.46 and 10 CFR 50.44 to delete specific material references and to include "approved zirconium alloys"