FRAMATOME COGEMA FUELS

October 21, 1999
GR99-214.doc

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Subject: Meeting to Discuss Recent Control Rod Performance Issues at TMI-1

Gentlemen:

Enclosed is a copy of the material to be presented to the NRC staff on October 27, 1999. In accordance with 10 CFR 2.790 FCF requests that the enclosed information be considered proprietary and withheld from public disclosure. Attachment 1 is the proprietary version of the material. Attachment 2 is an affidavit supporting the proprietary classification of the information. Attachment 3 is the non-proprietary version.

Very truly yours,

T A Coleman

T. A. Coleman, Vice President
Government Relations

cc: T. G. Colburn, NRC
M. S. Chatterton, NRC
M. A. Schoppman

FRAMATOME TECHNOLOGIES

Framatome Cogema Fuels
3315 Old Forest Road, P.O. Box 10935, Lynchburg, VA 24506-0935
Telephone: 804-832-3000 Fax: 804-832-3663

Attachment 2

AFFIDAVIT OF THOMAS A. COLEMAN

A. My name is Thomas A. Coleman. I am Vice President of Government Relations for Framatome Cogema Fuels (FCF). Therefore, I am authorized to execute this Affidavit.

B. I am familiar with the criteria applied by FCF to determine whether certain information of FCF is proprietary and I am familiar with the procedures established within FCF to ensure the proper application of these criteria.

C. In determining whether an FCF document is to be classified as proprietary information, an initial determination is made by the Unit Manager, who is responsible for originating the document, as to whether it falls within the criteria set forth in Paragraph D hereof. If the information falls within any one of these criteria, it is classified as proprietary by the originating Unit Manager. This initial determination is reviewed by the cognizant Section Manager. If the document is designated as proprietary, it is reviewed again by personnel and other management within FCF as designated by the Vice President of Government Relations to assure that the regulatory requirements of 10 CFR Section 2.790 are met.

D. The following information is provided to demonstrate that the provisions of 10 CFR Section 2.790 of the Commission's regulations have been considered:

(i) The information has been held in confidence by FCF. Copies of the document are clearly identified as proprietary. In addition, whenever FCF transmits the information to a customer, customer's agent, potential customer or regulatory agency, the transmittal requests the recipient to hold the information as proprietary. Also, in order to strictly limit any potential or actual customer's use of proprietary information, the substance of the following provision is included in all agreements entered into by FCF, and an equivalent version of the proprietary provision is included in all of FCF's proposals:

"Any proprietary information concerning Company's or its Supplier's products or manufacturing processes which is so designated by Company or its Suppliers and disclosed to Purchaser incident to the performance of such contract shall remain the property of Company or its Suppliers and is disclosed in confidence, and Purchaser shall not publish or otherwise disclose it to others without the written approval of Company, and no rights, implied or otherwise, are granted to produce or have produced any products or to practice or cause to be practiced any manufacturing processes covered thereby.

Notwithstanding the above, Purchaser may provide the NRC or any other regulatory agency with any such proprietary information as the NRC or such other agency may require; provided, however, that Purchaser shall first give Company written notice of such proposed disclosure and Company shall have the right to amend such proprietary information so as to make it non-proprietary. In the event that Company cannot amend such proprietary information, Purchaser shall, prior to disclosing such information, use its best efforts to obtain a commitment from NRC or such other agency to have such information withheld from public inspection.

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(ii) The following criteria are customarily applied by FCF in a rational decision process to determine whether the information should be classified as proprietary. Information may be classified as proprietary if one or more of the following criteria are met:

a. Information reveals cost or price information, commercial strategies, production capabilities, or budget levels of FCF, its customers or suppliers.

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d. The information consists of test data or other similar data concerning a process, method or component, the application of which results in a competitive advantage to FCF.

e. The information reveals special aspects of a process, method, component or the like, the exclusive use of which results in a competitive advantage to FCF.

f. The information contains ideas for which patent protection may be sought.

The document(s) listed on Exhibit "A", which is attached hereto and made a part hereof, has been evaluated in accordance with normal FCF procedures with respect to classification and has been found to contain information which falls within one or more of the criteria enumerated above. Exhibit "B", which is attached hereto and made a part hereof, specifically identifies the criteria applicable to the document(s) listed in Exhibit "A".

(iii) The document(s) listed in Exhibit "A", which has been made available to the United States Nuclear Regulatory Commission was made available in confidence with a request that the document(s) and the information contained therein be withheld from public disclosure.

(iv) The information is not available in the open literature and to the best of our knowledge is not known by Combustion Engineering, Siemens, General Electric, Westinghouse or other current or potential domestic or foreign competitors of Framatome Cogema Fuels.

(v) Specific information with regard to whether public disclosure of the information is likely to cause harm to the competitive position of FCF, taking into account the value of the information to FCF; the amount of effort or money expended by FCF developing the information; and the ease or difficulty with which the information could be properly duplicated by others is given in Exhibit "B".

I have personally reviewed the document(s) listed on Exhibit "A" and have found that it is considered proprietary by FCF because it contains information which falls within one or more of the criteria enumerated in Paragraph D, and it is information which is customarily held in confidence and protected as proprietary information by FCF. This report comprises information utilized by FCF in its business which afford FCF an opportunity to obtain a competitive advantage over those who may wish to know or use the information contained in the document(s).

THOMAS A. COLEMAN

State of Virginia)
) SS. Lynchburg
City of Lynchburg)

Thomas A. Coleman, being duly sworn, on his oath deposes and says that he is the person who subscribed his name to the foregoing statement, and that the matters and facts set forth in the statement are true.

THOMAS A. COLEMAN

Subscribed and sworn before me
this 21st day of October 1999.

Notary Public in and for the City
of Lynchburg, State of Virginia.

My Commission Expires 12-31-2000

EXHIBITS A & B

EXHIBIT A

Framatome Cogema Fuels Material on Control Rod Performance Issues a TMI-1, Presented to NRC on October 27, 1999.

EXHIBIT B

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Attachment 3

GPU NUCLEAR

FCF FRAMATOME

Presentation to the NRC
October 27, 1999

Three Mile Island Nuclear Station

Unit 1 - Incomplete Rod Insertion (IRI)
Event of September 11, 1999

Agenda

- Introduction
- Event Description
- Fuel Assembly Design
- Safety Significance
- Root Cause Efforts
- Data Collection Presentations

Agenda

- The French Experience
- Short Term Corrective Actions
- Future Analysis and Method Development for IRI
- Summary
- Cycle 13 Actions
- B&W Owners Group Response

Introduction

- The purpose of this meeting is:
  - Describe the Incomplete Rod Insertion that occurred at TMI
  - Explain the data taken, analysis performed and actions completed to mitigate the problem
  - Demonstrate that there was no Safety Significance
  - Discuss the GPUN plans for future actions

Event Description

- Incomplete Rod Insertion occurred after shutdown for 13R refueling outage
- Trip Time Testing was performed for Maintenance Rule Monitoring
- Two Control Rods failed to fully insert
  - Group 5 Rod 2 at 26% withdrawn (declared inoperable)
  - Group 2 Rod 2 at 7% withdrawn

Event Description

- All rods except 5-2 met the Technical Specification requirement of 1.66 seconds to 3/4 insertion.
- Longest time to 3/4 insertion was 1.46 seconds.
- Nine other CRAs had increased trip insertion times of > 0.1 sec from BOC to EOC tests.
- Both rods 5-2 and 2-2 were latched and driven to the fully inserted position.

Fuel Assembly Designs

FCF Design Comparison
Mark-B8/B9 vs Mark-B10

	Mark-B8/B9	Mark-B10
Rod Array	15x15	15x15
Guide Tubes	16	16
Holddown Spring Type	Single Helical	Eight Leaf Cruciform
Cladding & Structural Material	Zircaloy-4	Zircaloy-4
Fuel Rod Position	Seated	Seated

Fuel Design Notes

- 16 guide tubes per fuel assembly for control components
  - No dashpot region
  - Slowing of control component accomplished through hydraulic snubbing built into drive mechanism
- 8 spacer grids per assembly
  - 2 Inconel 718 end grids
  - 6 Zircaloy-4 (non-mixing) intermediate grids
- Fuel rods seated on lower end fitting
- Gadolinia integral burnable absorber used in some fuel rods -- configuration varies by cycle design

TMI-1 Control Components

- 61 Control Rod Assemblies (CRAs)
  - 16 pins containing Ag-In-Cd absorber
  - Coupled to roller nut drive mechanism by leadscrew
- 8 Axial Power Shaping Rod Assemblies (APSRAs)
  - 16 pins containing a short length of gray absorber
  - Coupled to non-Scramming roller nut drive mechanisms by leadscrew
- Burnable Poison Rod Assemblies (BPRAs)
  - 16 pin configuration

Safety Significance

Safety Significance

- Safety Analysis Bases are assured by Technical Specifications
  - Control Rod Insertion Time Surveillance
    - 75% Insertion in 1.66 Seconds
  - Maintaining 1% Shutdown Margin
    - Most Reactive Rod Stuck Out
  - No More Than One Inoperable Control Rod

Shutdown Margin

- Cycle 12 End of Cycle
  - Required Shutdown Margin
    - 1.0 %
  - As Designed with Most Reactive Rod Stuck Out
    - 1.9 %
  - As Found Insertions
    - 3.8 %

Safety Significance Conclusion

- IRI Condition at End of Cycle 12 was within Licensing Bases
- Actual Shutdown Reactivity Provides Substantial Margin Compared to Safety Analysis Assumptions

Root Cause Investigation Efforts

GPUN - G. Bond

Root Cause Investigation

- Two Meetings, 9/23/99 and 10/1/99
- Multidisciplinary Team
- External Representatives from:
  - Framatome
  - EPRI
  - Duke Power
  - PECO-Nuclear
  - Wolf Creek
- Kepner-Tregoe Problem Analysis Approach
- Certified K-T Facilitator

Root Cause Investigation

- Reviewed Results of Surveillance and Diagnostic Activities
- Reviewed Fuel Inspection Plans and Results
- Reviewed Other TMI Inspection Results
- Discussed Domestic and Foreign Industry Experience
- Discussed Framatome (France) Bow Measurement Program
- Reviewed FCF Design Differences

Root Cause Investigation

- **Most Probable Cause of IRI**
  - Excessive guide tube distortion (Guide Tube or Fuel Assembly Bow)
- **Potential Causes with Low Probability**
  - Defective Control Rod
  - Plenum/Core Plate/CRA Misalignment
  - Guide Tube Collapse/Ovalization
  - Material Process Defects/Properties

Root Cause Investigation

- **Potential Causes which were Eliminated**
  - Control Rod Drive Mechanism
  - Upper Plenum Interference
  - Slipped Grid
  - Internal Guide Tube Blockage
  - Broken Hold-Down Spring
  - Foreign Object
  - RCS Chemistry

Root Cause Investigation

- **Potential Contributors to Fuel Assembly Distortion (Bow)**
  - Excessive Hold-Down Spring Force
  - Core Flow Patterns
  - Flux Gradients
  - Accelerated Guide Tube Growth
  - Differential Guide Tube Growth
  - Accelerated Corrosion
  - Material Creep

Other Root Cause Team Actions

- **Root Cause Team**
  - Recommended Additional Data Acquisition Activities
  - Reviewed Proposed Interim Corrective Actions

Data Collection

- End of Cycle (EOC) 12
- Post Irradiation Examinations (PIE)

EOC 12 Data Collection

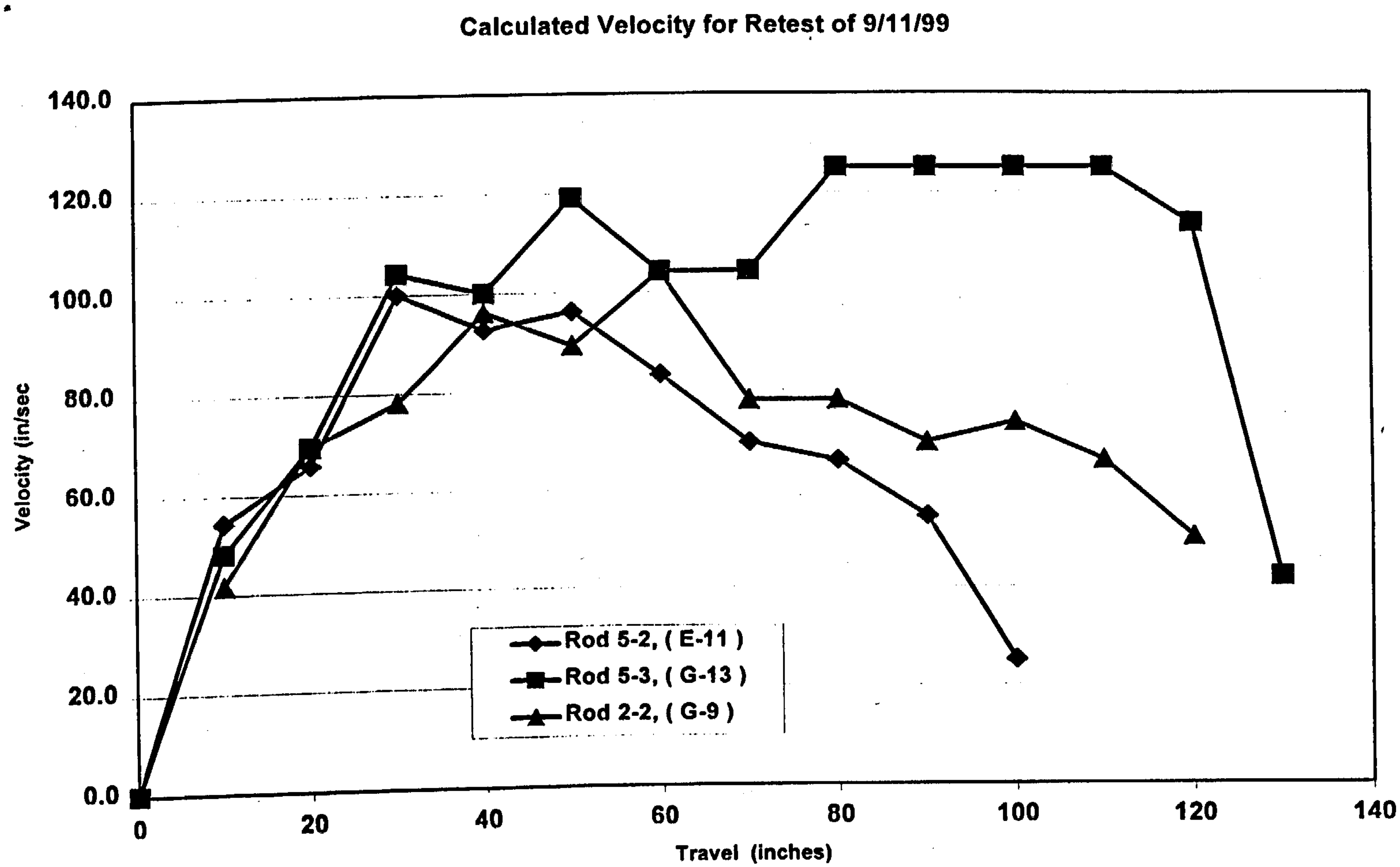
- Control Rod Drop Times
- Velocity Profiles (3 CRAs)
- In Vessel Drag Tests - Head On (4 CRAs)
  - With CRA Attached
  - With Leadscrew only
- Under Plenum & Core Video Inspections
- SFP Drag Force Tests (61 CRAs)
- Visual Inspections (6 Selected CRAs)
- Cycle 12 Visual Bow Profiles (117 FAs)

PIE Data Collection

- Guide Tube (GT) Plug Gauge
- GT Oxide Measurements
- Fuel Assembly (FA) Growth
- FA Bow (6 Assemblies)
- FA Spacer Grid Oxide & Growth
- Fuel Rod Corrosion & Growth
- Fuel Rod Diameter
- Spring Force Verification

EOC 12 Data Collection

As-Found Velocity Profiles



SFP Drag Force Data

CYCLE 12 DRAG FORCE

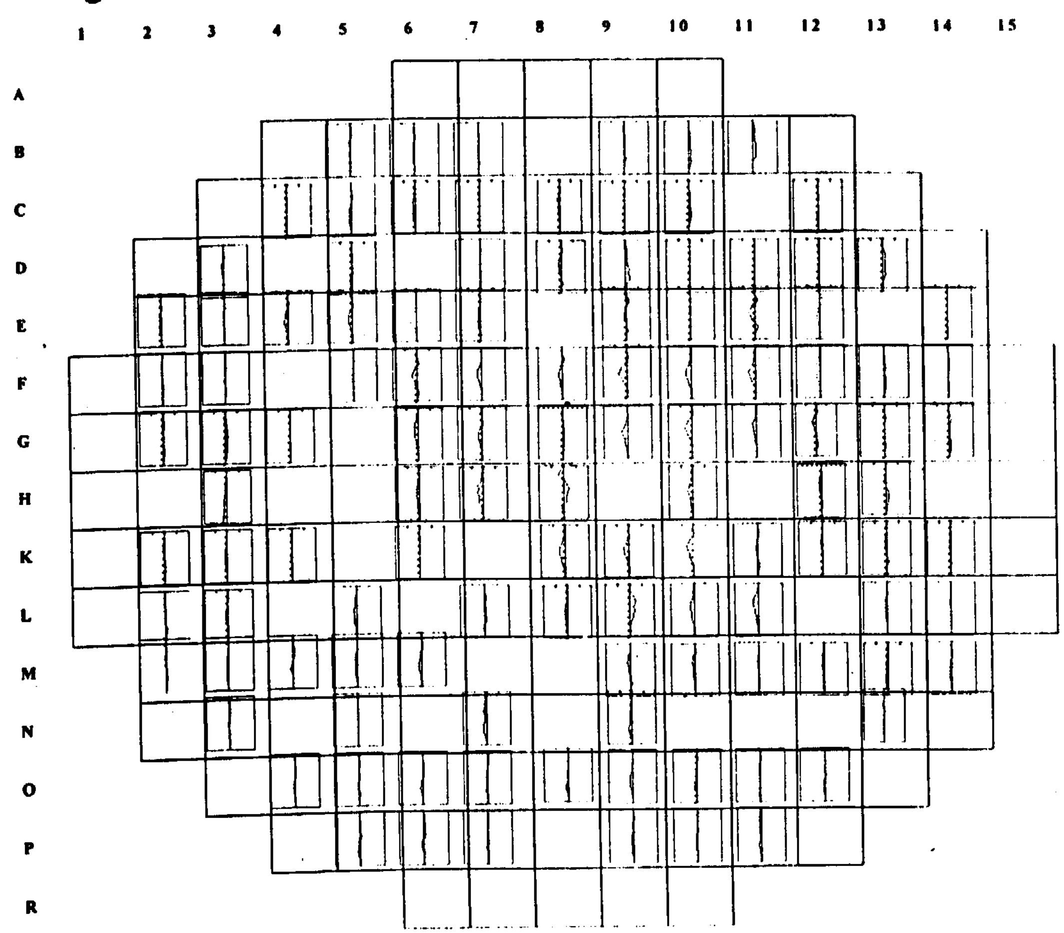
X

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
A																A
B																B
C									60							C
D						APS		90		APS						D
E					70		50		110		>130					E
F				APS		103				90		APSR				F
G					50		90		118		50					G
W H								70				90				H Y
K			70						70		70					K
L				APS						48		APSR				L
M							50		70		70					M
N						APS		50		APS						N
O																O
P																P
R																R
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

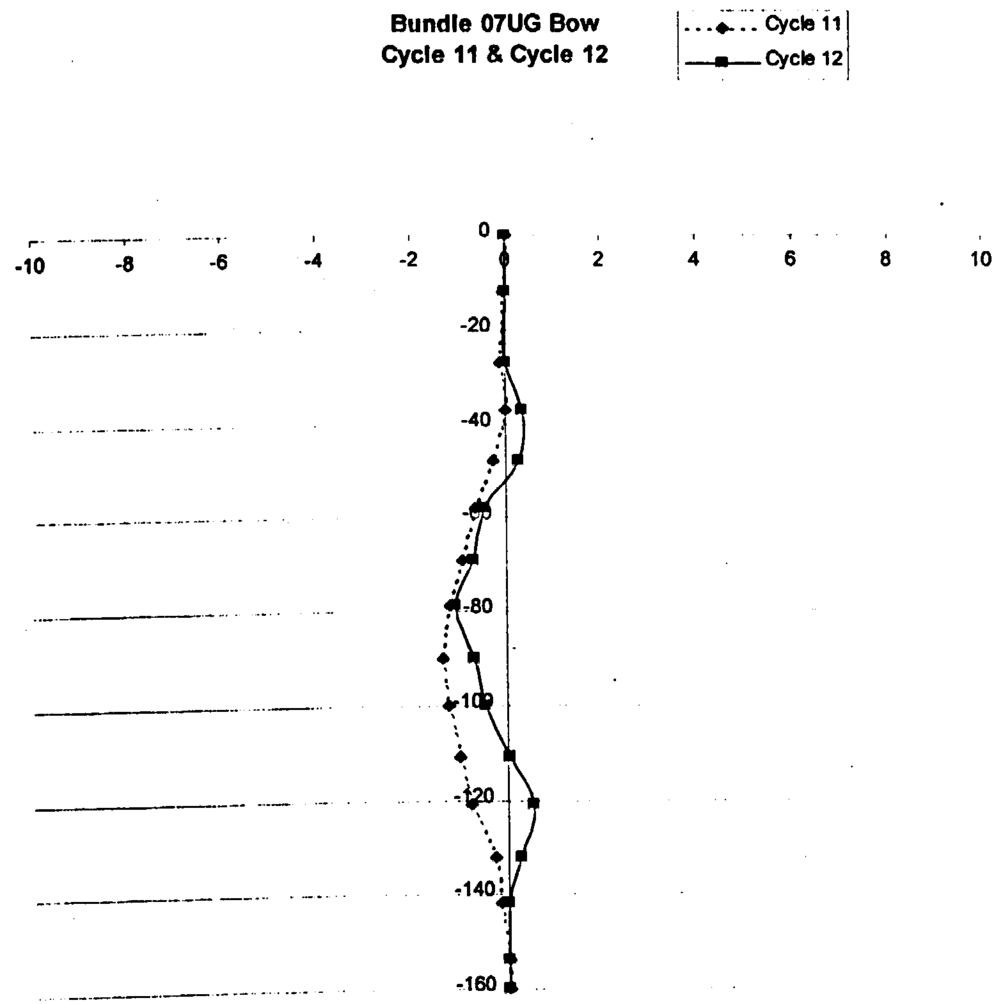
Z

SLOWER

Cycle 12 Bow Profiles

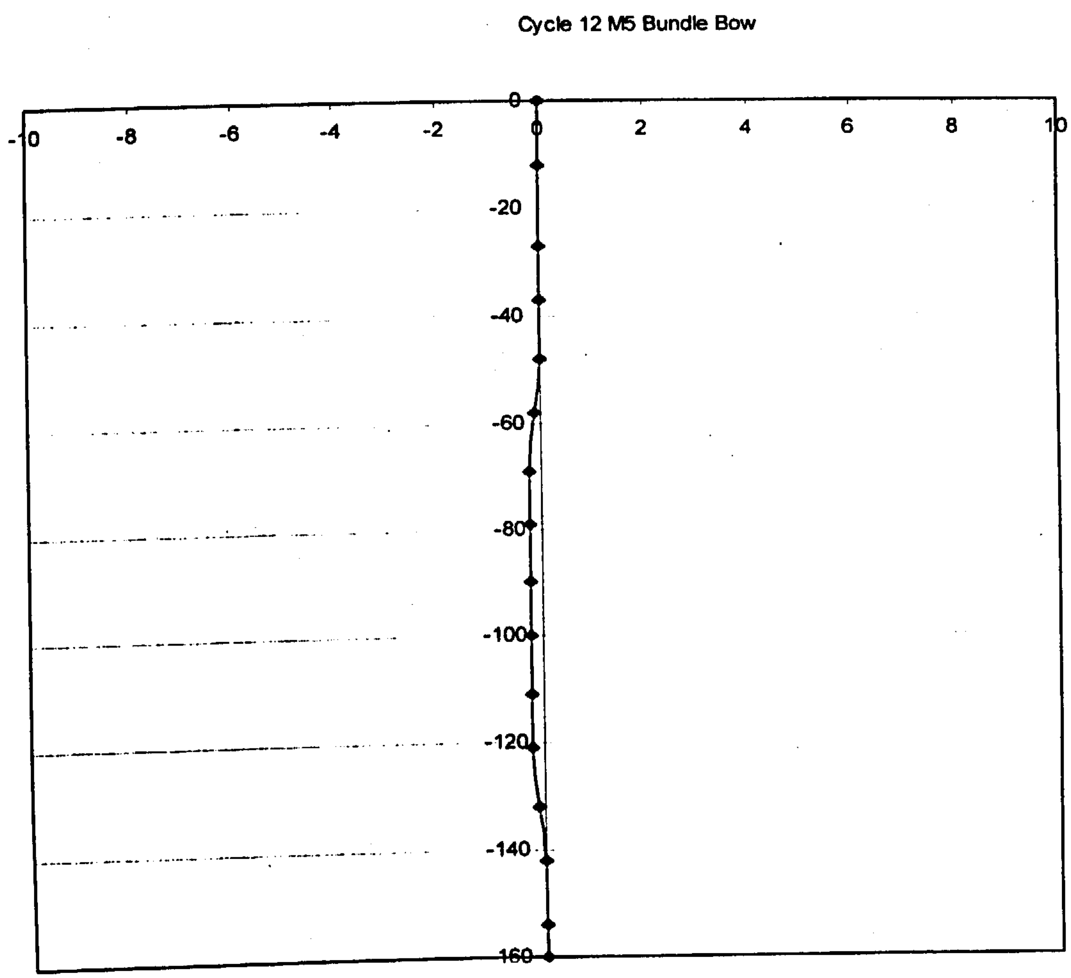


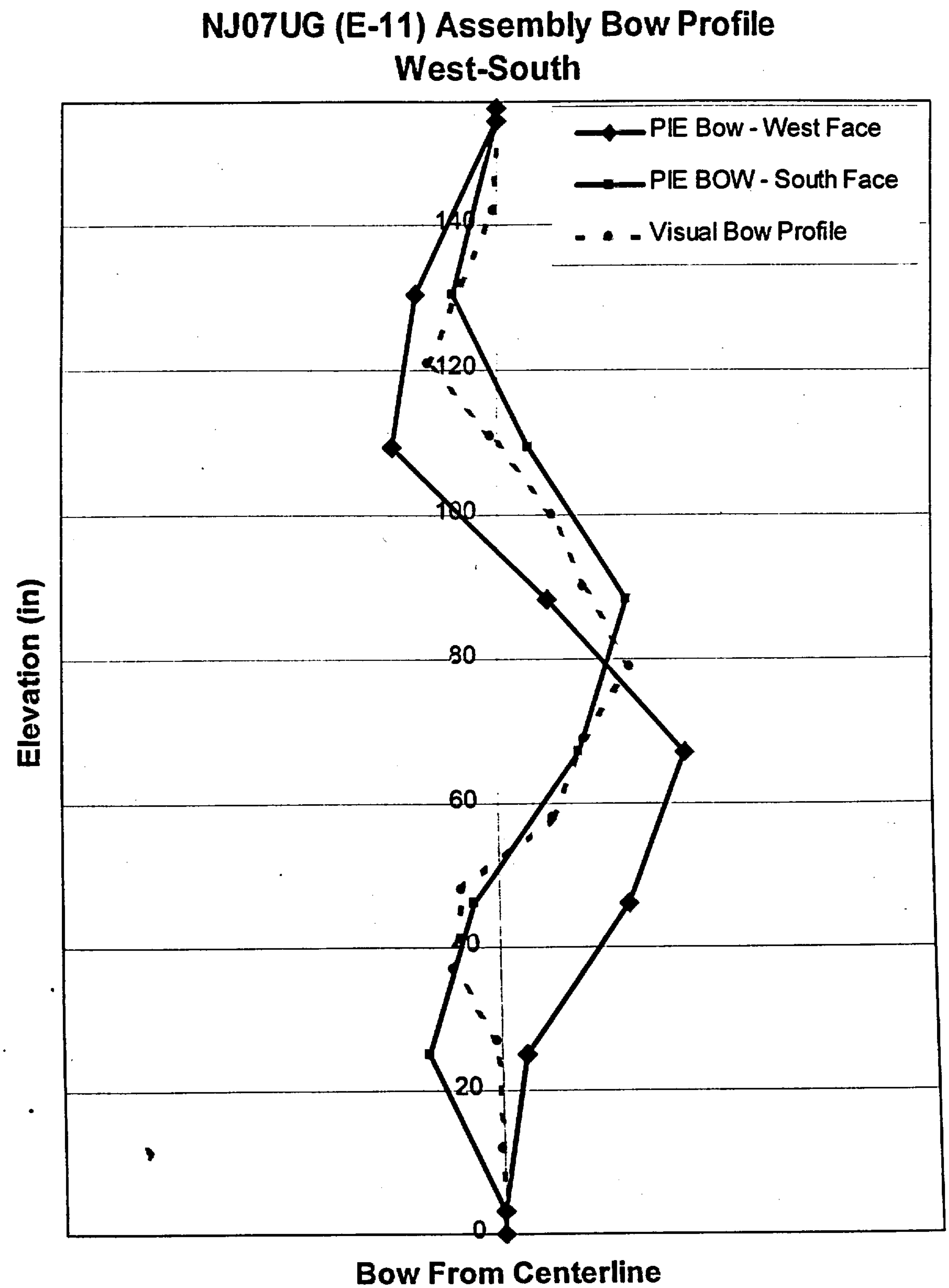
IRI Fuel Assembly Bow



Core Location E-11 in Cycle 12

Core Location M-05 Bow




NJ07UG (E-11) Assembly Bow Profile
West-South
PIE Bow - West Face
PIE BOW - South Face
Visual Bow Profile
Elevation (in)
140
120
100
80
60
40
20
0
Bow From Centerline

PIE Data Collection

FCF -- David Mitchell

FCF Fuel Surveillance

- FCF response to NRC Proposed Bulletin 96-01 Supplement
  - Periodic post irradiation exams (PIEs) to evaluate fuel performance control rod insertability
- FCF has added new inspections since 1997 to provide data for evaluation of IRI potential:
  - CRA Drag Force
  - Guide Tube Oxide
  - Spacer Grid Width
  - Spacer Grid Oxide

IRI and High Burnup Inspections

FCF IRI Program and Actions

Year

Inspection	1996												1997												1998												1999											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
FA Growth												X											O					O					X	O										X	O			
FA Bow												X											O					O						O										X	O			
CRA/RCCA Drag																																		O											O			
Plug Gaging												X											O					O						O										X	O			
GT Oxide																							O					O						O										X	O			
SG Width																							O					O						O										X	O			
SG Oxide																							O					O						O										X	O			
FR Growth												X											O					O						O										X	O			
FR Oxide												X											O					O						O														
Actions																																																
Letter 96-01			L																																													
FCF/NRC Meeting on IRI												M																																				
FCF Submittals on IRI															S				S		S																											

X Mark-BW (17x17) Inspection   Mark-B (15x15) Inspection

Summary of FCF Fuel Exams Conducted Prior to TMI Cycle 12

- Fuel Exams prior to TMI Cycle 12 confirmed BWOG's 1997 response
  - Linear fuel assembly growth with burnup
  - No increase of bow magnitude with burnup
  - Coupled fuel rod and fuel assembly growth
  - Guide tube/thimble corrosion within design limits
  - Limited increase in drag with burnup -- drag work too small to significantly increase drop times

TMI Cycle 12 Fuel Inspections

- Hi-Res Visual
- Fuel assembly length
- Guide tube plug gauging
- Guide tube oxide thickness
- Holddown spring force-deflection
- Spacer grid width
- Spacer grid oxide thickness
- Fuel rod length - shoulder gap
- Fuel rod oxide thickness
- Fuel rod diameter

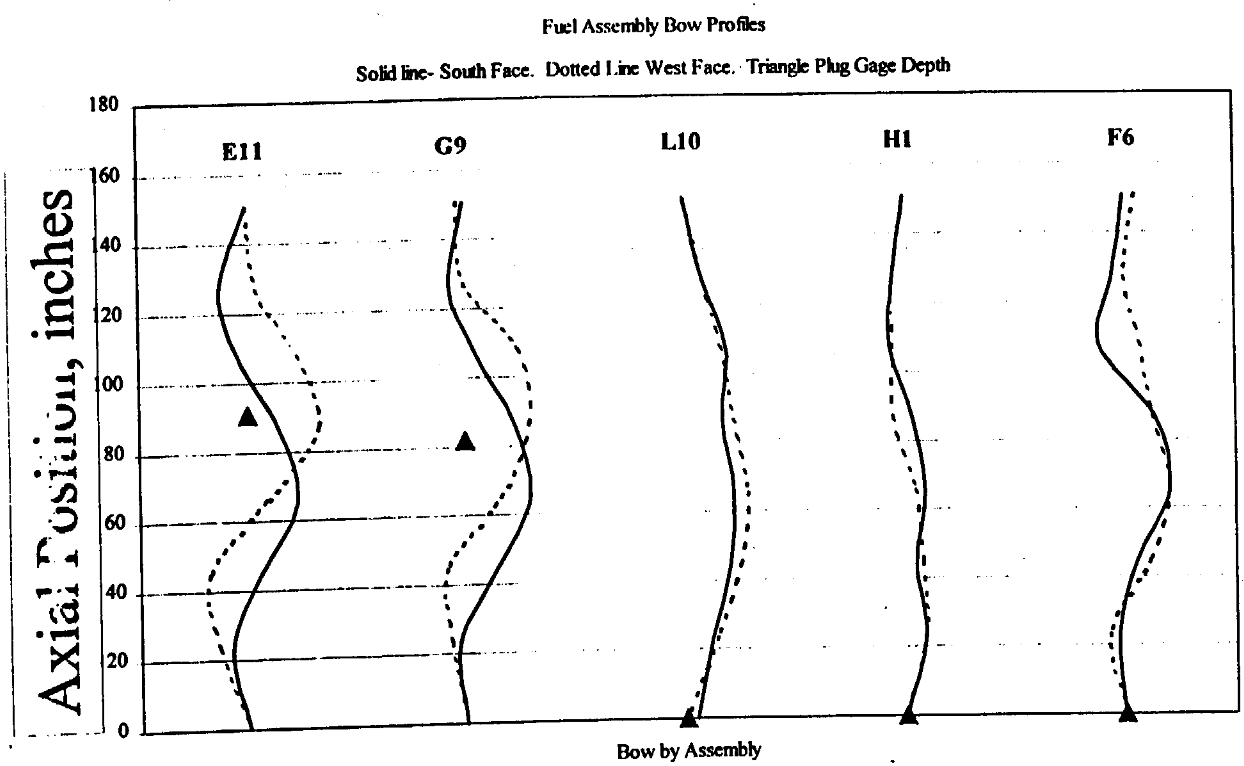
TMI Cycle 12 PIE Data
General Observations

- Fuel in Cycle 12 performed within design limits
- Compared to previous TMI cycles, Cycle 12 (IRI affected & non-affected FA's) experienced:
  - Higher fuel assembly growth
  - Higher fuel rod corrosion
  - Within design limits
- Hold down springs performed as designed

TMI Cycle 12 PIE Data
IRI Evaluation

- IRI correlates to:
  - Complex fuel assembly bow
  - Guide tube distortion (by plug gauging)
- IRI does not correlate to:
  - Fuel assembly growth
  - Guide tube corrosion
  - Spacer grid corrosion
  - Fuel rod corrosion
- Highest growth assembly did not experience IRI

Fuel Assembly Bow



FA Bow by Cycle 12 Core Location

Summary of PIE Data Results

- Cause of IRI is excessive guide tube deformation
- While fuel assemblies in Cycle 12 had higher fuel assembly growth and higher fuel rod oxide thickness than previously observed at TMI, these factors did not directly correlate with IRI

Guide Tube Deformation Conclusions

- Guide tube deformation is correlated to
  - A specific core region for more than one cycle
- Excessive guide tube deformation is not directly or solely caused by
  - Burnup
  - Fast fluence
  - Residence time

Framatome-France Experience with Incomplete Rod Insertion

Framatome -- Etienne Morel

Ringhals

- In 1994 and 1995 Framatome observed slow rod drop and incomplete rod insertion (IRI) in Ringhals 3 and 4 (12-foot 17x17)
- Similar design as Wolf Creek
- Fueled with Framatome AFA-2G
  - Raised fuel rods
  - Dashpot GT
  - Low coolant flow
  - High holddown spring force
- IRI for assembly burnup between 34 and 42 GWd/t
- Cycle length was 1 year

Framatome-Ringhals Experience With IRI

- The cause was determined to be GT deformation
- S-shaped deformation was determined to cause excessive binding with the CRA during insertion
- Excessive FA compression contributed to GT deformation

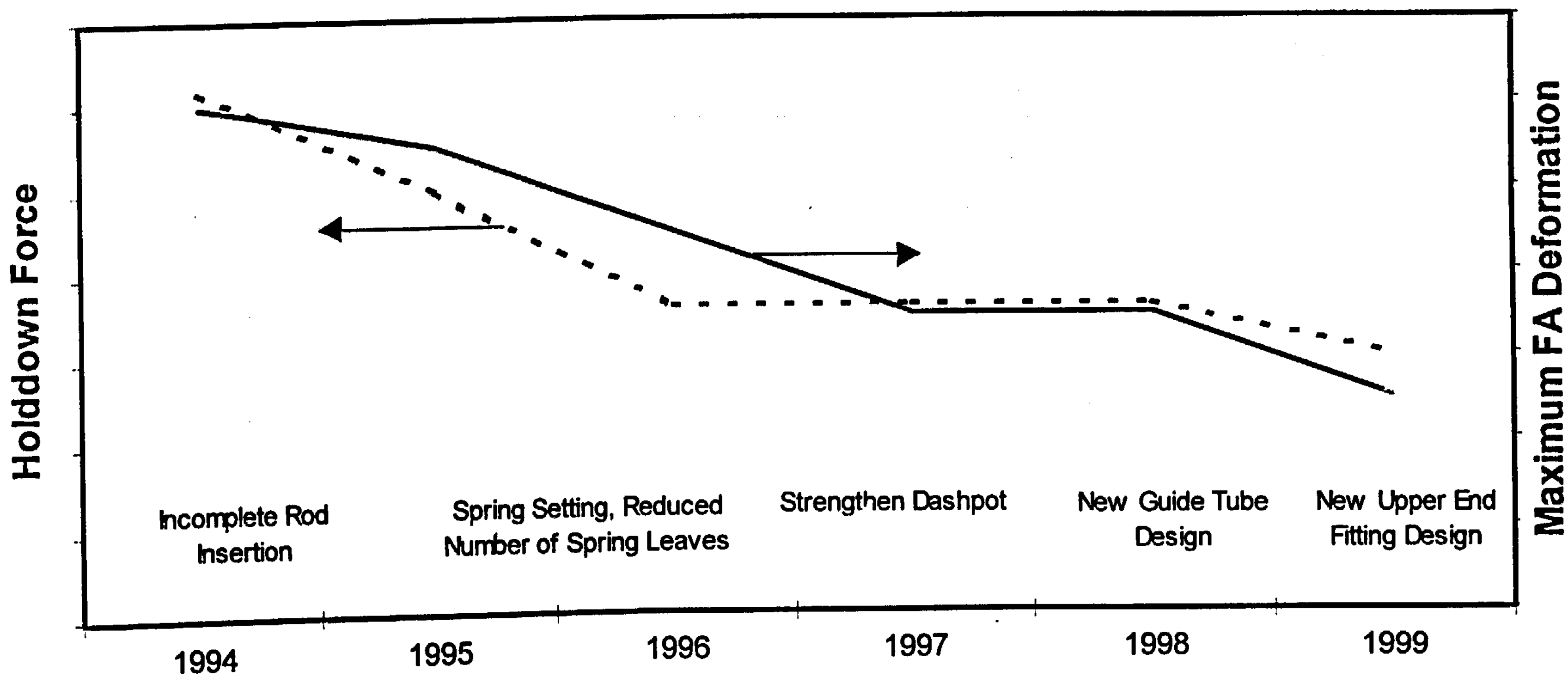
Framatome Solutions for IRI

- Reduced holddown spring force
  - on-site yielding in 1995
  - since, optimized holddown load
- Reinforcement of the dashpot zone (MONOBLOC™ guide thimble)
- Increasing the stiffness of the GT by increasing the GT thickness and width
- Low growth, low corrosion material for the GT (M5™ alloy)

Results of Actions Implemented at Ringhals

- Level of core-wide GT deformation is reduced
- This was verified by a significant number of measurements
- Rod drop time evolution has been reduced to typical values

Improvements in FA Deformation at Ringhals



Framatome Conclusions

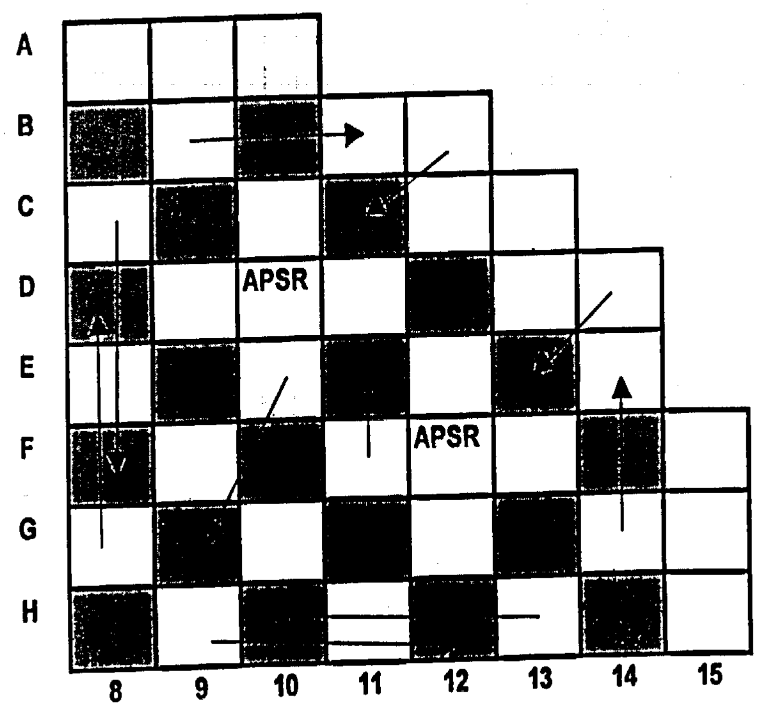
- GT deformation measurements correlate with CRA drop time
- GT deformation strongly depends on core location
- GT global deformation is not a strong effect of assembly burnup
- Local deformation effects are observed primarily in the dashpot and depend on burnup

Short Term Corrective Actions

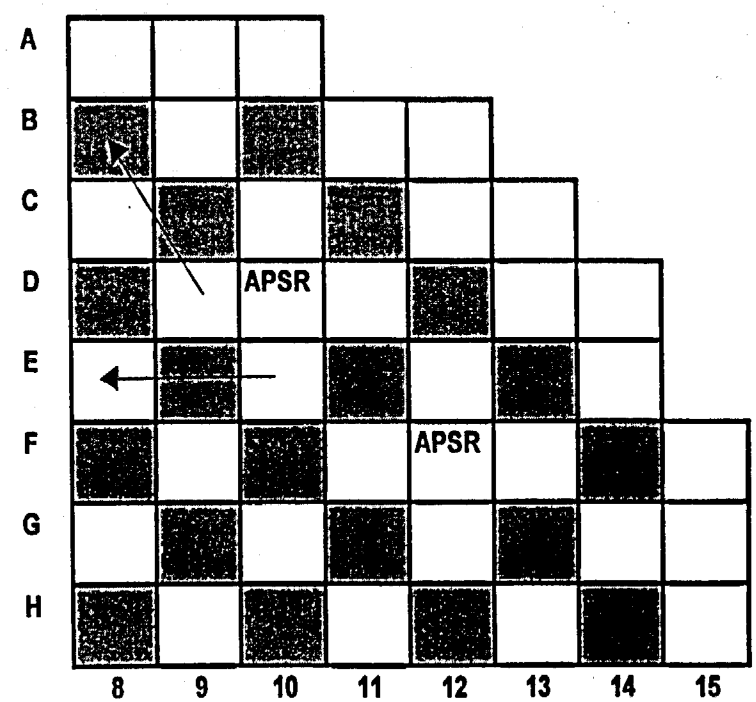
- Redesign Cycle 13 Core
- Reduce Holddown Spring Force

Short Term Corrective Action
Redesign Cycle 13 Core

Cycle 12



Cycle 13 Redesign



Arrows illustrate same-quadrant shuffle

Cycle 13 Shutdown Margin

Sensitivity Studies

- As Designed with Most Reactive Rod Stuck Out:
  - * 1.8 %
- Four Highest Drag CRAs, 30% Out with Most Reactive Rod Stuck Out:
  - * 1.7 %
- Conservative Case with 9 Rods near the Center of the Core at 30% Out and Most Reactive Rod Stuck Out:
  - * 1.0 %
- Technical Specification requirement:
  - * 1.0 %

Short Term Corrective Actions

Reduce Holddown Spring Force

FCF -- Gary Williams

Holddown Spring Force Reduction

- Objective
  - To reduce holddown force on fuel assembly structure while maintaining spring performance
    - Sufficient holddown to prevent lift
    - Spring structural/material margins maintained
    - Spring/control component interfaces maintained
- Reduction in loads are expected to mitigate FA/guide tube distortion for TMI-1 Cycles 13 and 14

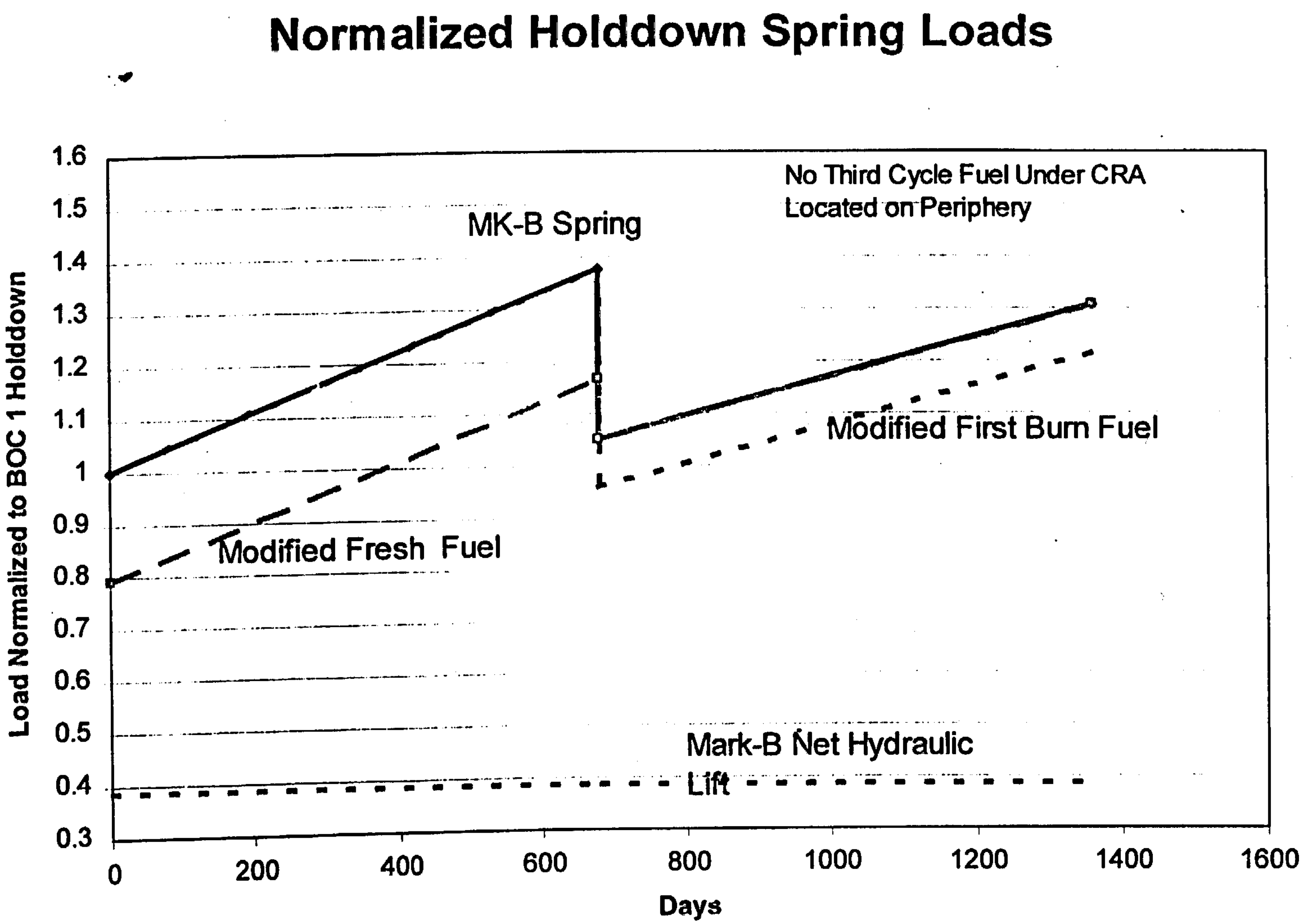
Holddown Spring Set

- Spring Set Operation Prior to Cycle 13
  - Deflection limited to control magnitude of plastic set
  - Discharged and first burn assemblies used for benchmark to existing spring and fuel assembly data prior to operation
    - Load-deflection characteristics shown to be within design
    - Assembly growth verified
    - Preload force verification

Holddown Spring Set

- All First Burn Assemblies with CRAs
  - 8.5% Hot BOC 2 Load Reduction
  - Deflection limited to EOC 2 cold shutdown deflection
- 46 Fresh Fuel Assemblies with BPRAs
  - 21% Hot BOL Load Reduction
  - Deflection limited to EOC 1 cold shutdown deflection

Holddown Spring Force Reduction



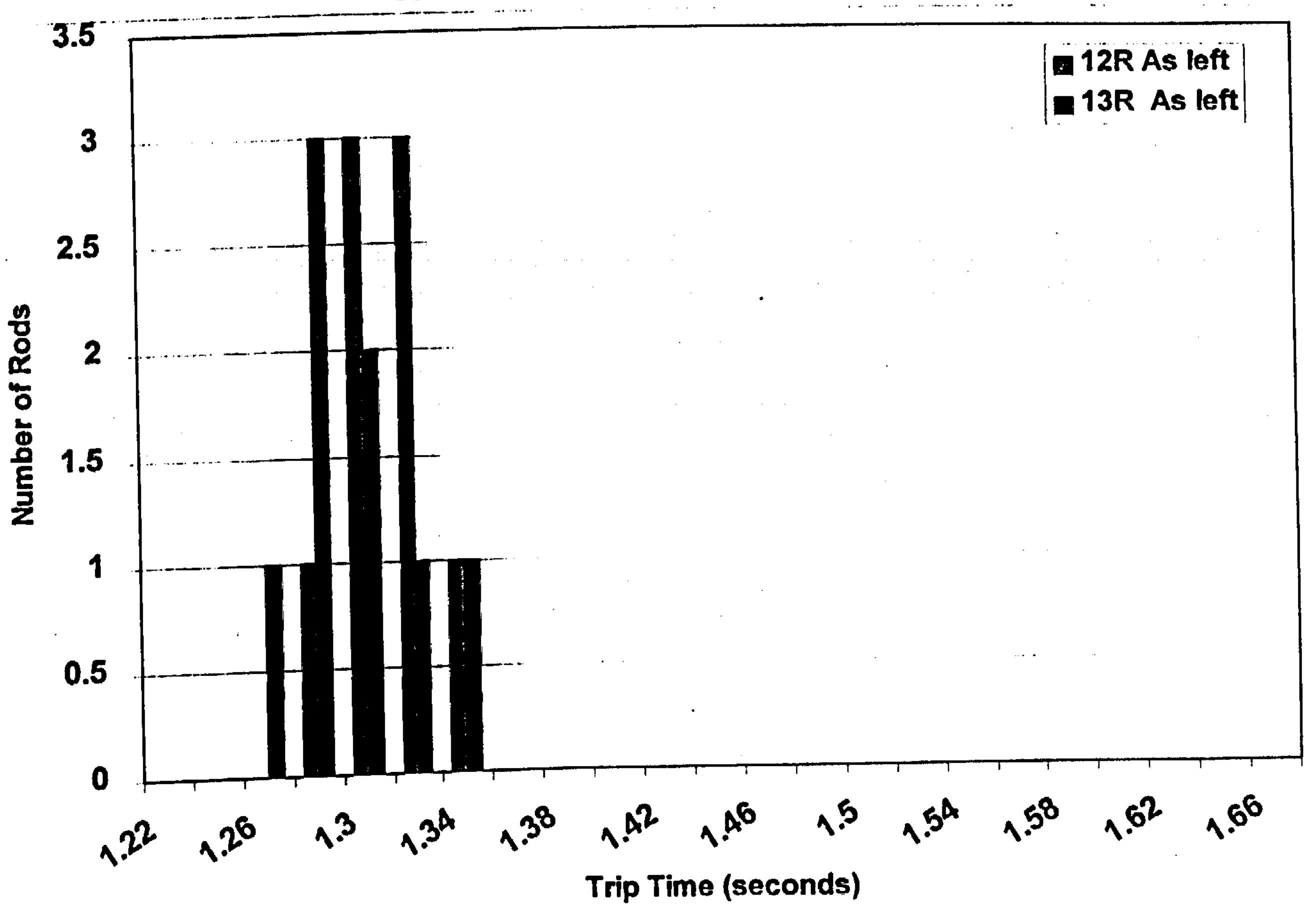
BOC 13 Baseline Data

- Control Rod Drop Times Acceptable
- Drag Data Acceptable

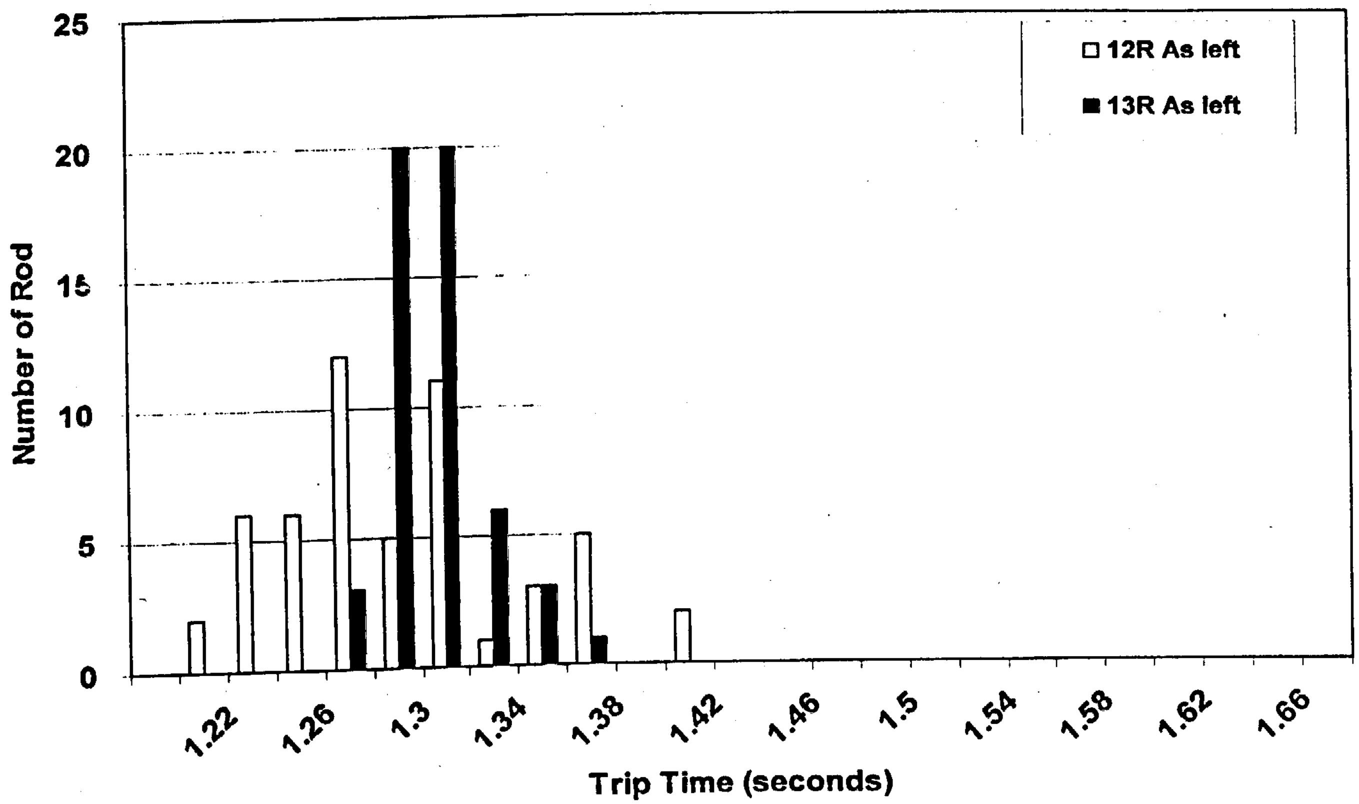
BOC 13 Data Collection

- Tech Spec Control Rod Drop Time Testing
- In Vessel Drag Tests - Head On (33 CRAs)
- Control Rod Velocity Profiles
- Reload Video Examinations:
  - Lower Grid Plate
  - FA Verifications

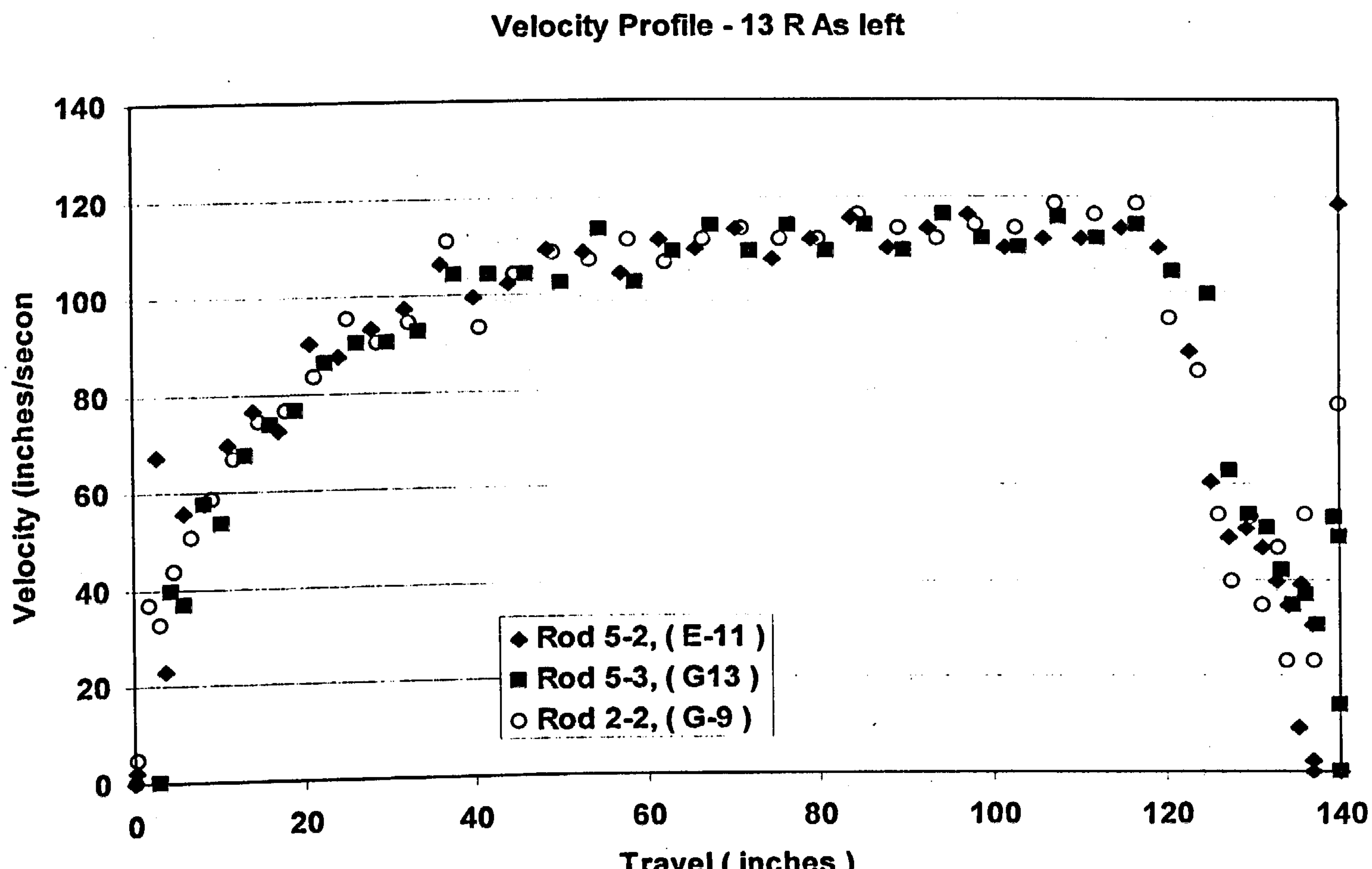
Control Rod Drop Times in Fresh Fuel



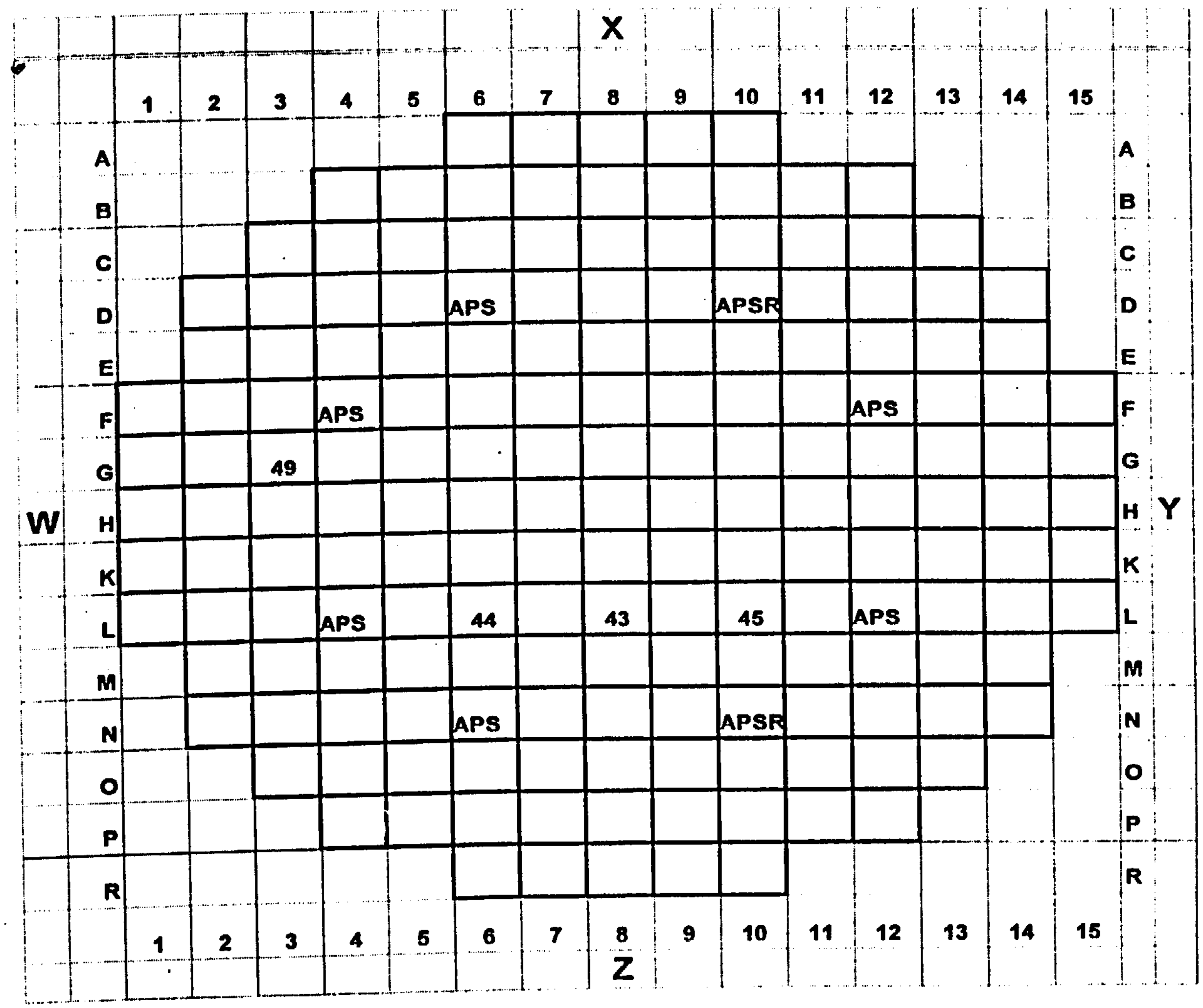
Control Rod Drop Times in Once Burned Fuel



As-Left Velocity Profiles



Drag Force Data - Cycle 13



Future Analysis and Method Development for IRI

FCF -- Bernie Copsey

Future IRI Activities

- Analyze CRA drop and drag data
- Benchmark Framatome-developed analysis tools
- Product development

Analytical Method Development

- Single Fuel Assembly Deformation Model
  - evaluate FA deformation as a function of spring loads, material properties, temperature, etc.
- Core-Wide Fuel Assembly Deformation Model
  - evaluate core-wide deformation as a function of FA characteristics
- Guide Tube Drag Model
  - evaluate CRA drag as a function of GT deformation
- CRA Drop Model
  - evaluate CRA drop time as a function of CRA drag

Product Development

Long-term Plans on Mark-B Product Development:

- Refine hydraulic lift calculations to more realistically model in-core conditions
- Reduce spring force for Mark-B10 design
- Develop fuel shuffle guidelines to minimize IRI
- Low-growth M5™ alloy

Summary and Cycle 13 Actions

GPUN -- P. Walsh

Summary

- A significant amount of data has been collected, analyses performed and actions taken to provide an understanding of the TMI - IRI event.
- The plant operated within design basis in Cycle 12.
- Improvements were made to the Cycle 13 core:
  - Core redesign to minimize same quadrant residence.
  - Spring force reduction to minimize FA distortion.
- Startup data has shown acceptable control rod drop times and drag forces.
- Based on the corrective actions, continuous operation is justified for Cycle 13.

If the basis for withholding this information from public inspection should change in the future such that the information could then be made available for public inspection, you should promptly notify the NRC. You also should understand that the NRC may have cause to review this determination in the future, for example, if the scope of a Freedom of Information Act request includes your information. In all review situations, if the NRC makes a determination adverse to the above, you will be notified in advance of any public disclosure.

If you have any questions regarding this matter, I may be reached at 301-415-1402.

Sincerely,

ORIGINAL SIGNED BY:

Timothy G. Colburn, Sr. Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-289

cc: See next page

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