FRAMATOME
TECHNOLOGIES

December 16, 1996
JHT/96-86

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

Subject: NRC/B&W Owners Group Meeting on Control Rod Insertion Concerns (Project #693)

Gentlemen:

Enclosed is the information to be discussed with the NRC staff on December 18, 1996. FCF requests in accordance with 10CFR2.790 that this information be considered proprietary. An affidavit supporting this request is included as Attachment 1. Attachment 2 is the proprietary version of the material. Attachment 3 is the non-proprietary version.

Very truly yours,

J. H. Taylor

J. H. Taylor, Manager
Licensing Services

cc: J. L. Birmingham, NRC
M. S. Chatterton, NRC
E. W. Weiss, NRC

Change: LTR ENCL
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Proj-693

Attachment 1

Proprietary Affidavit for Framatome Cogema Fuels Material on Control Rod Insertion Problems Presented to NRC on December 18,1996

AFFIDAVIT OF JAMES H. TAYLOR

A. My name is James H. Taylor. I am Manager of Licensing Services for Framatome Technologies, Inc. (FTI). Framatome Cogema Fuels is administratively responsible to Framatome Technologies, Inc. Therefore, I am authorized to execute this Affidavit.

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

C. In determining whether an FTI 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 Licensing personnel and other management within FTI as designated by the Manager of Licensing Services 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 FTI. Copies of the document are clearly identified as proprietary. In addition, whenever FTI 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 FTI, and an equivalent version of the proprietary provision is included in all of FTI'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.

Company shall be given the right to participate in pursuit of such confidential treatment."

(ii) The following criteria are customarily applied by FTI 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 FTI, its customers or suppliers.

b. The information reveals data or material concerning FTI research or development plans or programs of present or potential competitive advantage to FTI.

c. The use of the information by a competitor would decrease his expenditures, in time or resources, in designing, producing or marketing a similar product.

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 FTI.

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 FTI.

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 FTI 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, EXXON, General Electric, Westinghouse or other current or potential domestic or foreign competitors of Framatome Technologies, Inc.

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

E. I have personally reviewed the document(s) listed on Exhibit "A" and have found that it is considered proprietary by FTI because it contains information which falls within one or more of thecriteria enumerated in Paragraph D, and it is information which is customarily held in confidence and protected as proprietary information by FTI. This report comprises information

utilized by FTI in its business which afford FTI an opportunity to obtain a competitive advantage over those who may wish to know or use the information contained in the document(s).

James H. Taylor

JAMES H. TAYLOR

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

James H. Taylor, 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.

James H. Taylor

JAMES H. TAYLOR

Subscribed and sworn before me
this 16th day of December 1996.

Brenda C. Cardona

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

My Commission Expires July 31 1999

EXHIBITS A & B

EXHIBIT A

Framatome Cogema Fuels Material on Control Rod Insertion Problems Presented to NRC on December 18, 1996.

EXHIBIT B

The above listed document contains information which is considered Proprietary in accordance with Criteria c and d of the attached affidavit.

Attachment 3

Non-Proprietary Version of Framatome Cogema Fuels Material on Control Rod Insertion Problems Presented to NRC on December 18, 1996

B&W Owners Group Presentation to NRC on Control Rod Insertion Concerns

December 18, 1996

Agenda

- Introduction
- Technical Presentation
- Discussion

Objective

- Demonstrate with Analyses, Measured Data, and Comparisons that FCF Fuel Does Not Exhibit RCCA/CRA Insertion Problems or Associated Root Causes During Licensed Lifetime.

FCF FUEL CUSTOMERS AND PLANTS

MARK-B (15x15)

- Fuel designed for Babcock & Wilcox 177 fuel assembly reactors
- Duke Power - Oconee Units 1, 2, and 3
- Entergy - Arkansas Nuclear One, Unit 1
- Florida Power Corporation - Crystal River 3
- General Public Utilities Nuclear - TMI-1
- Toledo Edison - Davis-Besse

FCF FUEL CUSTOMERS AND PLANTS

<u>MARK-BW (17x17)</u>

- Fuel designed for Westinghouse 193 and 157 fuel assembly reactors
- Duke Power
  - Catawba Units 1 & 2
  - McGuire Units 1 & 2
- Tennessee Valley Authority
  - Sequoyah Units 1 and 2 (1997)
- Virginia Power
  - North Anna Unit 1 (LTAs 1997)

Incomplete Rod Cluster Control Assembly (RCCA) Insertion Issue

Applicability to FCF Fuel Designs

December 18, 1996

RCCA Insertion

- Problem overview
- Discussion of FCF fuel designs
- Presentation of applicable data
- Conclusions and recommendations

Summary

- FCF fuel designs do not exhibit RCCA insertion problems
  - 100% successful insertion performance
  - RCCA drag data demonstrates continued good performance
  - Consistent and as predicted fuel assembly growth data in high and low temperature plants
  - Fuel designs have significant margin for axial buckling and significantly lower loads than Vantage 5H fuel assemblies throughout most of life
  - Guide thimble measurements show little creep deformation
  - Corrosion data does not correlate with growth data
- No core management restrictions should be placed on FCF fuel designs

MEETING OBJECTIVE

- To review and clarify specific root cause issues pertaining to Westinghouse RCCA insertion problem
- To demonstrate that the FCF designs have not exhibited the RCCA insertion problem or associated root cause symptoms
- To demonstrate that the FCF fuel designs have sufficient design margins to preclude the problem
- To demonstrate that the FCF fuel designs should not have fuel management restrictions regarding fuel assemblies in rodded locations

ROOT CAUSE CONCLUSIONS
WOLF CREEK INCIDENT

Conclusions as presented by Westinghouse via public document to the NRC on 9/9/96

- Incomplete RCCA insertions have been caused by excessive compressive loads on the fuel assembly guide thimble tubes leading to excessive thimble tube distortion
- The increased compressive load was caused by unusual fuel assembly growth over and above what would normally be expected as a result of irradiation exposure
- The unusual growth component is a combination of growth due to oxide accumulation and accelerated growth, both of which are temperature sensitive
- The unusual growth is observed only in high temperature plants on those high burnup fuel assemblies that have certain types of power histories

ROOT CAUSE CONCLUSIONS
RINGHALS INCIDENT

Conclusions as presented by FRAMATOME in the NRC core performance workshop on 10/24/96

- Incomplete RCCA insertions have been caused by excessive axial compression force resulting in S-shaped bowing of the fuel assembly
- The S-shaped bow was a result of axial creep of the fuel assembly
- The excessive axial compressive forces resulted from oversized fuel assembly holddown springs in relation to the coolant flow lifting force

SOLUTIONS IMPLEMENTED
RINGHALS INCIDENT

- Resident fuel design change
  - Plastic setting of existing leaf springs to reduce axial loads
  - After 1 cycle favorable FA bow results have been observed
- New fuel design change
  - Removed fourth leaf spring to reduce axial loads
  - Increased upper guide thimble diameter from 0.443 inch to 0.450 inch to increase clearance with control rod
  - Increased guide thimble wall thickness from 0.016 inch to 0.020 inch to increase strength
- Utility implemented core management restrictions and surveillance
  - Only fresh or once burn fuel can be placed in rodded locations
  - Mid-cycle RCCA trip testing required

MARK-BW AND VANTAGE 5H DESIGN COMPARISON

MARK-BW

- Shorter FA length
- Lower holddown force over FA life
- Larger upper GT diameter (0.450")
- Floating intermediate grids/top end grid unattached to guide thimble
- Fuel rods seated on bottom nozzle (no gap)
- GT/grid rotational constraint set by grid height and saddle interface

VANTAGE 5H

- Longer FA length
- Higher holddown force
- Smaller GT upper diameter (.442")
- All grids attached to guide thimbles
- Fuel rods lifted off bottom nozzle @ BOL
- GT rotational constraint set by swaged sleeve/grid weld interface

MARK-B AND VANTAGE 5H DESIGN COMPARISON

MARK-B

- inch available axial growth gap
- Comparable guide thimble load
- Higher guide thimble buckling strength
- No dashpot diameter
  - Uniform tube diameter
  - GT to control rod clearance -
- Floating intermediate grids/top end grid unattached to guide thimble
- Fuel rods seated on bottom nozzle (no gap)
- GT/grid rotational constraint set by grid height and saddle interface

VANTAGE 5H

- inch available axial growth gap
- Comparable guide thimble load
- Lower guide thimble buckling strength
- Dashpot to control rod clearance - 0.016"
- All grids attached to guide thimbles
- Fuel rods lifted off bottom nozzle @ BOL
- GT rotational constraint set by swaged sleeve/grid weld interface

FUEL ASSEMBLY PARAMETERS AFFECTING RCCA INSERTION

- Fuel Assembly Axial Loads
- Guide Thimble Design
- In-Reactor Effects
  - Fuel Assembly Growth
  - Guide Thimble Corrosion
  - Guide Thimble Creep
  - FA Bow

FUEL ASSEMBLY PARAMETERS AFFECTING RCCA INSERTION

- Fuel Assembly Axial Loads
  - Holddown spring
    - Spring rate
    - Preload
    - In reactor compression (thermal, irradiation)
    - Material modulus
  - Fuel rod slip load (grid spring force)
  - Fuel rod position (seated or lifted)
    - Fuel assembly weight load path
    - Fuel rod slip load distribution
  - Spacer grid fixity (floating or fixed)
    - Fuel rod slip load distribution
    - Grid hydraulic lift load path

FUEL ASSEMBLY HOLDDOWN COMPARISON

HOLDDOWN LOAD (LBS)

- BW HOLDDOWN IS LESS OVER THE FUEL ASSEMBLY LIFE

FCF MARK-B VERSUS VANTAGE 5H FUEL ASSEMBLY HOLDDOWN

- Mark-B leaf spring holddown (per tube) is comparable to V5H for EOL conditions

- Load is offset by critical buckling strength of Mark-B guide tube
  - Mark-B guide tube strength is greater than V5H guide thimble

- Mark-B helical spring holddown is less than V5H for all conditions

MARK-B VERSUS V5H GUIDE TUBE LOADS

FUEL ASSEMBLY PARAMETERS AFFECTING RCCA INSERTION

- Guide Thimble Design
  - Strength
    - Thickness
    - Diameter
    - Span length
    - Span end fixity
    - Material
    - Initial deflection
  - Control rod clearance

GUIDE THIMBLE COMPARISON

Guide Thimble	Mark-B	Mark-BW	Vantage-5H
Material	Fully Recrystallized Annealed Zircaloy 4	Fully Recrystallized Annealed Zircaloy 4	Fully Recrystallized Annealed Zircaloy 4
Outer Diameter, in. (Upper) (Lower)	 0.530 N/A	 0.482 0.429	 0.474 0.430
Inner Diameter, in. (Upper) (Lower)	 0.498 N/A	 0.450 0.397	 0.442 0.398
Wall Thickness, in.	0.016	0.016	0.016
Nominal Diametral Control Rod Clearance, in. (Upper) (Lower)	 0.058 0.058	 0.069 0.016	 0.061 0.017

SUFFICIENT BUCKLING MARGIN EXISTS

- Allowable buckling load (hot) based on deflection criteria
  - Mark- BW - lbs per tube (lbs total)
    - margin
  - Mark-B - lbs per tube (lbs total)
    - margin
- Allowable load based on:
  - Maximum EOL corrosion
  - Maximum tube eccentricity
  - Worst case tolerances
  - Maximum span deflection of inch
    - Deflection corresponding to functional gage
- Allowable buckling load per tube based on stress:
  - BW - lbs (lbs total)
  - Mark-B - lbs (lbs total)

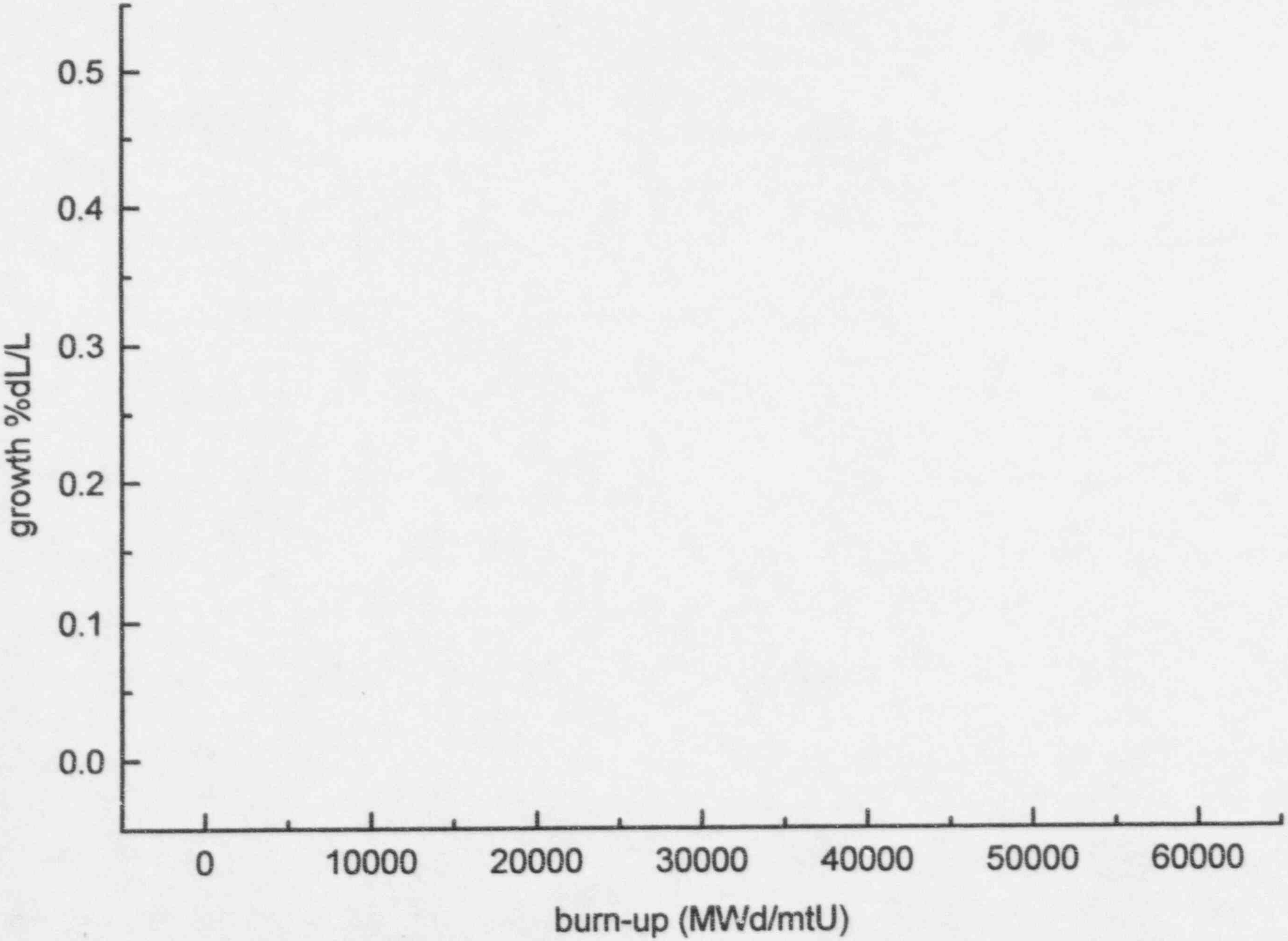
FUEL ASSEMBLY PARAMETERS AFFECTING RCCA INSERTION

- In-Reactor Effects
  - Fuel assembly irradiation growth
  - Guide thimble corrosion
  - Irradiation creep
  - Fuel assembly/guide thimble bow
- Fuel Assembly Design
  - Margin for axial growth

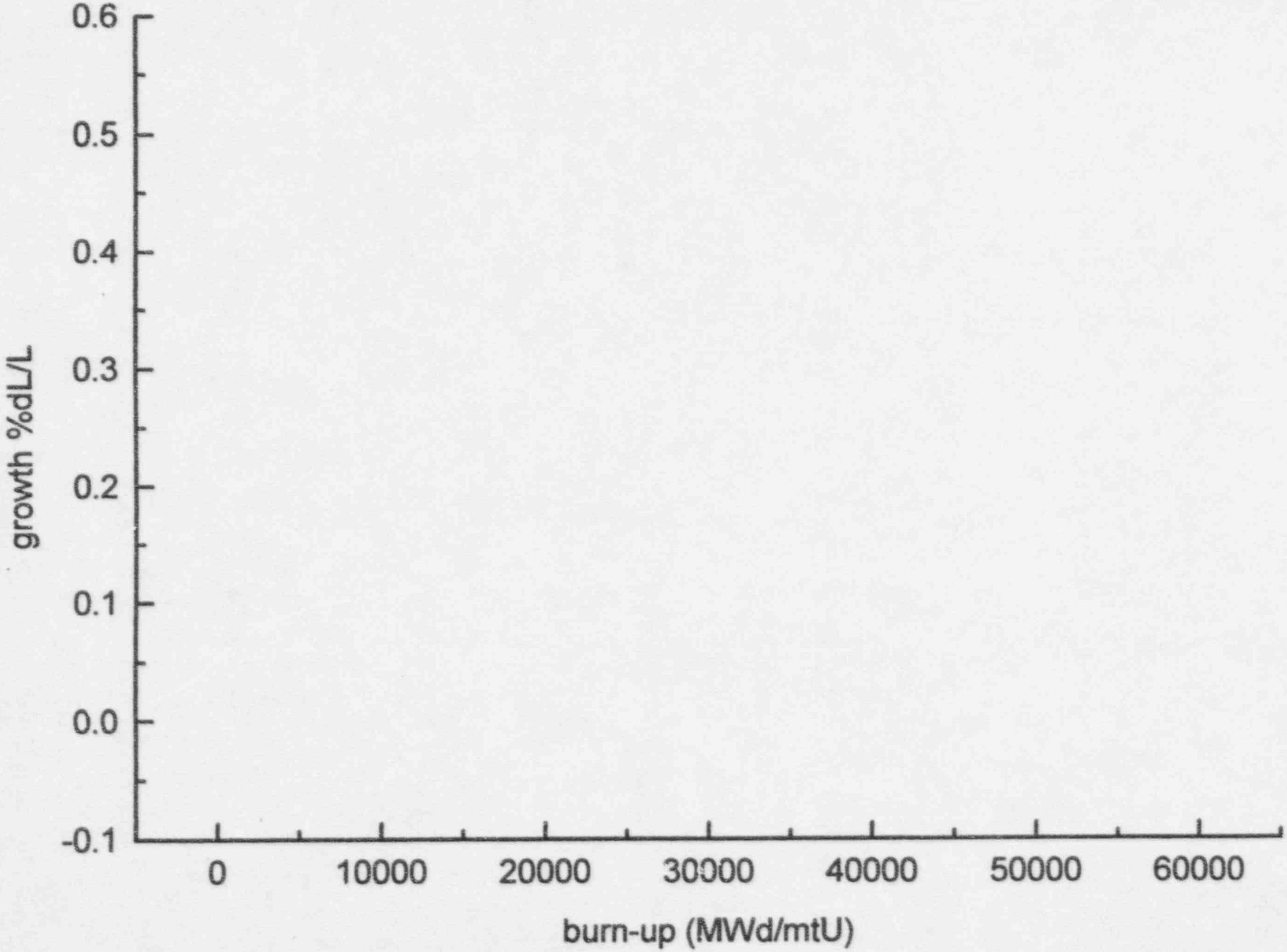
FCF Fuel Assembly Growth

- Mark-BW growth model alone is more conservative than combined Mark-B and Mark-BW data growth model
- Burnup to close fuel assembly to core plate gap calculated conservatively (minimum gap at cold conditions)

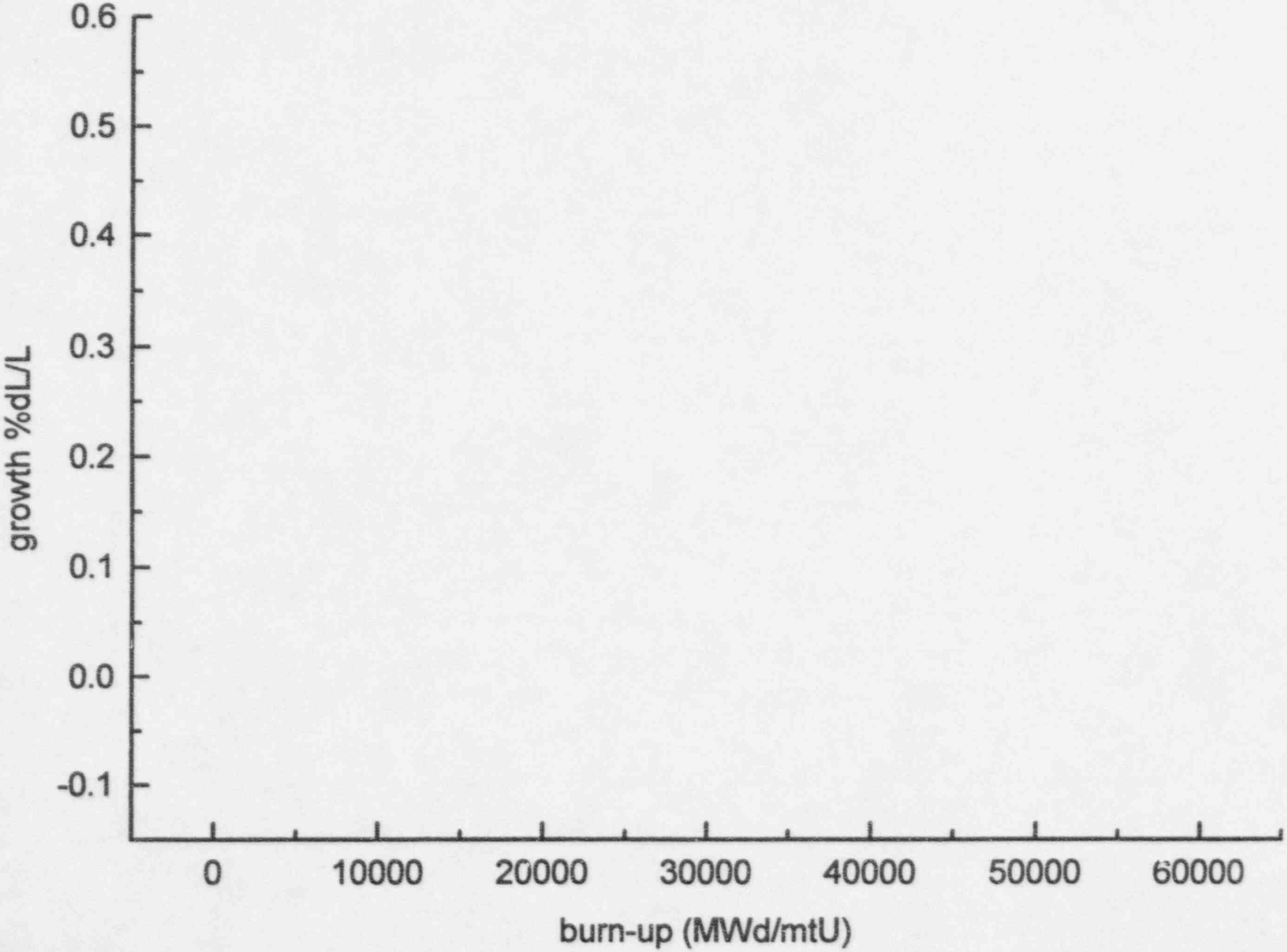
FCF Fuel Assembly Growth Combined Data Model



FCF MK-BW Fuel Assembly Growth Model and MK-BW Database



Fuel Assembly Growth plotted against MK-BW model



FUEL ASSEMBLY GROWTH COMPARISON

Reactor Parameters

PARAMETER	MARK-BW	MARK-BW	MARK-BW	MARK-BW	VANTAGE 5H
Plant	McGuire 1 / 2	Catawba 1 / 2	Sequoyah 1 / 2	North Anna 1	Wolf Creek
Plant Type	W 4 Loop	W 4 Loop	W 4 Loop	W 3 Loop	W 4 Loop
Core Power	3411	3411	3411	2893	3411/3565
# FAs	193	193	193	157	193
System Pressure	2265	2265	2265	2265	2265
Core Outlet Temperature (F)	622.2 / 622.1 #	621.6 / 617.8 #	614.5	621.9	621.4/618.4
Avg LGHR (kw/ft)	5.43	5.43	5.43	5.67	5.45/5.68

For steam generator changeout outlet temperatures are as follows::
Catawba 1, McGuire 1 and 2 - 616.6 F

Reactor Parameters

PARAMETER	MARK-B	MARK-B	VANTAGE 5H
Plant	Oconee	Davis-Besse	Wolf Creek
Plant Type	B&W	B&W	W 4 Loop
Core Power	2568	2772	3411/3565
# FAs	177	177	193
System Pressure	2215	2215	2265
Core Outlet Temperature (F)	601.5	606	621.4/618.4
Avg LGHR (kw/ft)	5.80	6.21	5.45/5.68

GUIDE THIMBLE CORROSION

- Guide thimble corrosion as expected
- Corrosion comparable to the lower range of that reported at Ringhals
- Mark-B corrosion expected to be lower than Mark-BW due to lower core temperature

Mark-BW Corrosion Data

- Guide thimble corrosion increases non-linearly with fluid temperature
- Upper two grid spans see the highest corrosion

Mark-BW Corrosion Data

- Guide thimble corrosion and hydrogen pickup increases non-linearly with fluid temperature

- Upper two grid spans see the highest corrosion and hydrogen pickup

Framatome Corrosion Data

- No correlation observed between FA growth and guide thimble corrosion
- Data is from plants with outlet temperatures comparable to Wolf Creek and McGuire and Catawba

Guide Thimble Corrosion Summary

- FCF has accounted for Guide thimble corrosion in calculations.
- Measured data is well within design limits for :
  - Buckling strength at EOL
  - Ductility at EOL
- Corrosion data is well behaved
- No correlation observed between oxide thickness and growth
- Corrosion performance meets design requirements

MCGUIRE 2 PIE PLUG GAGE INSPECTION

GUIDE THIMBLE PLUG GAGE RESULTS

Guide Thimble Distortion Summary

- Minimal creep deformation is observed in Guide Thimbles for burnups to
  - Guide Thimble dimensions are nearly identical to as built structures.
- Free hanging bow of FCF fuel assemblies of up to have been measured.
  - No impact on RCCA insertion path has been observed.
- No burnup dependency on guide thimble dimensions has been observed.
  - No change is expected for the small increment in burnup projected for the future.

RCCA Insertion-Data

Mark-BW

- MNS/CNS Data
- Drop Time Data
- Drag Data

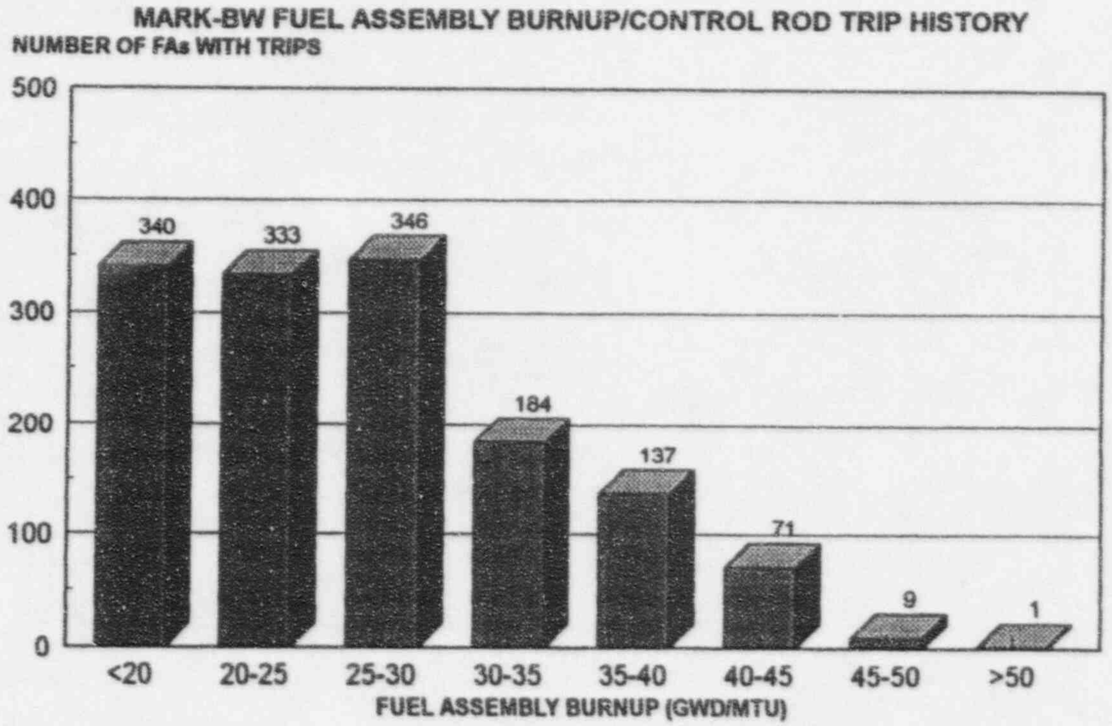
Mark-B

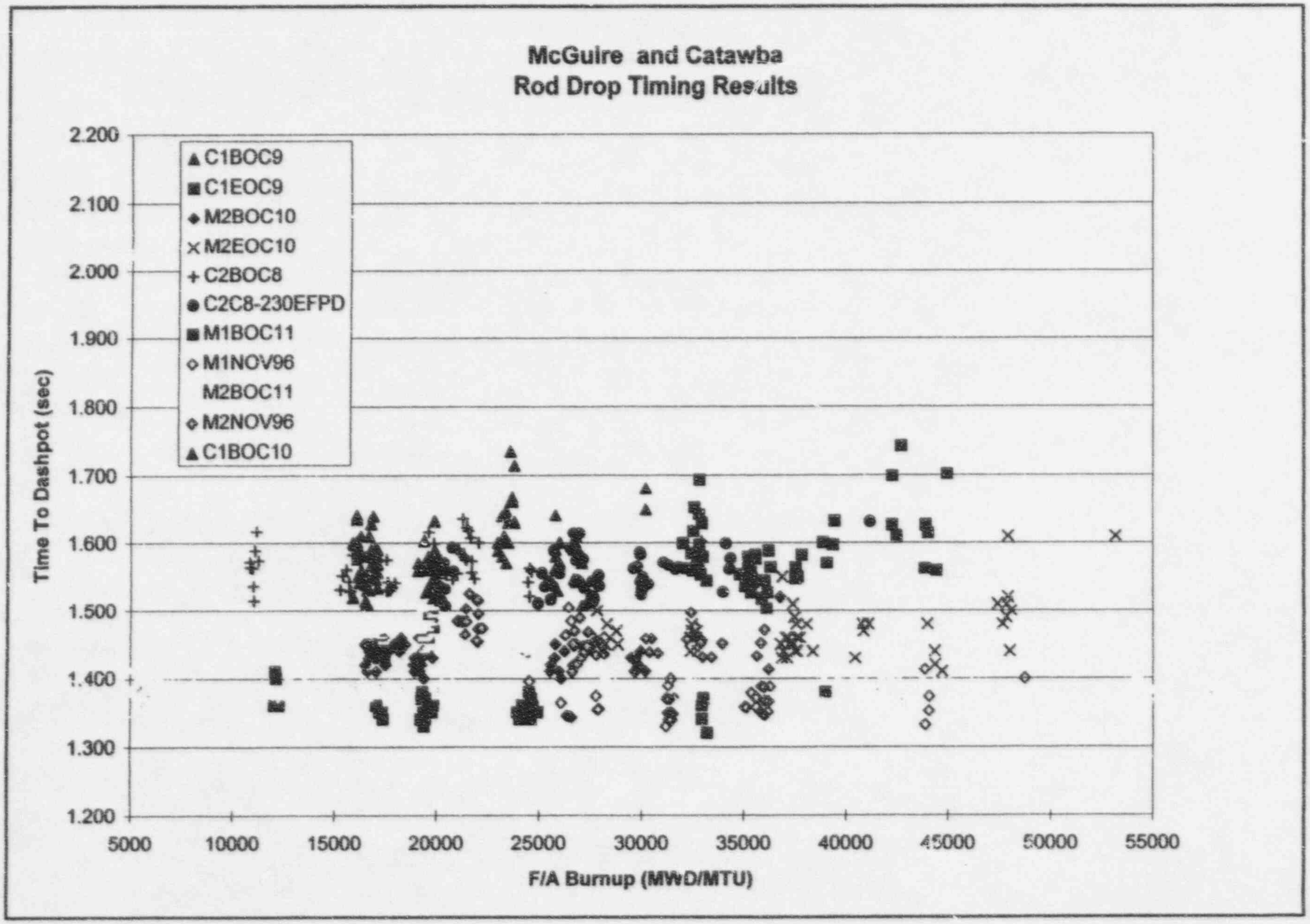
- Oconee 3 and ANO-1
- Drop Time Data

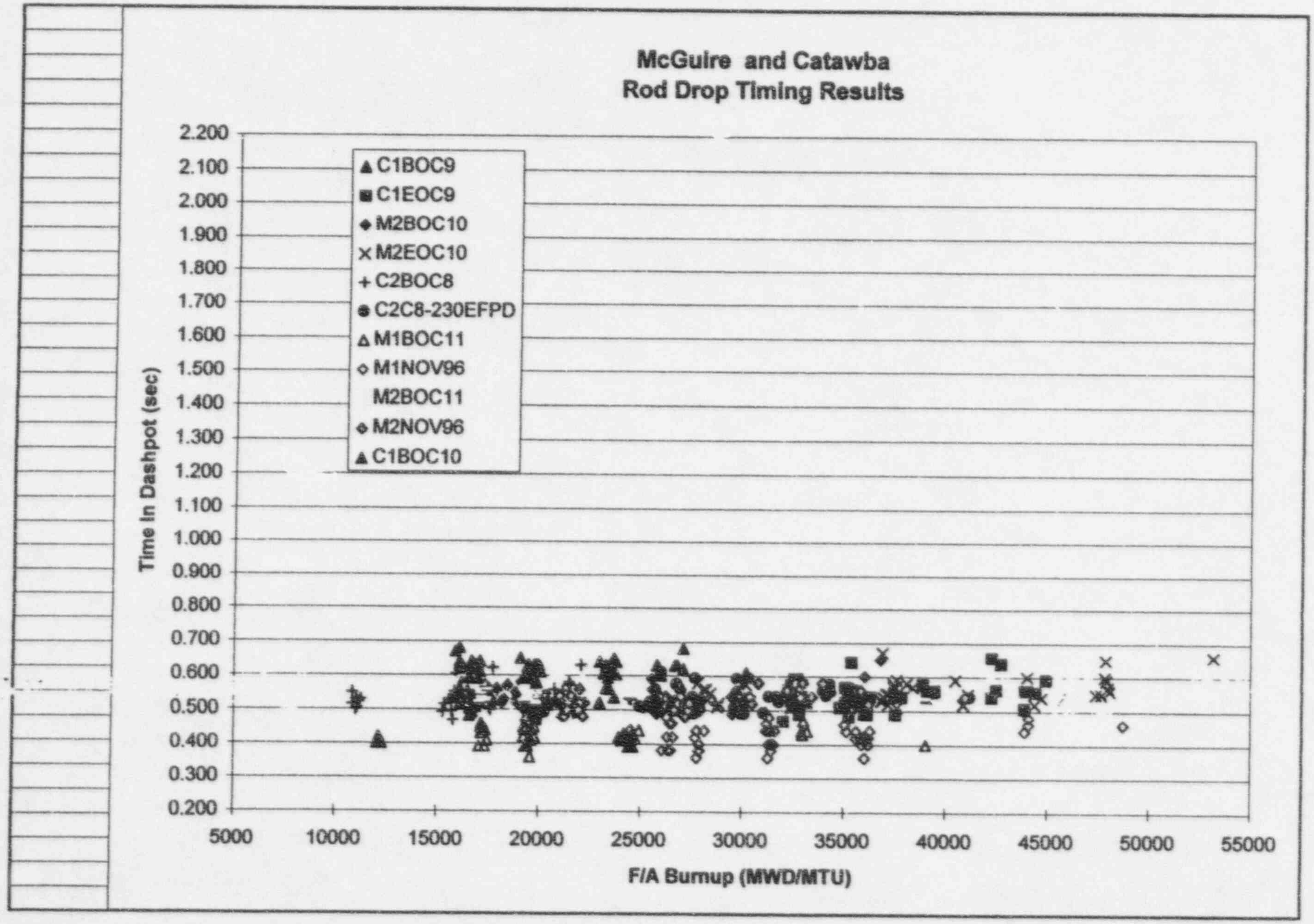
FCF HAS EXPERIENCED NO RCCA INSERTION PROBLEMS

MARK-BW FUEL

- 1421 total successful insertions
- 81 successful insertions for burnups greater than 40 GWD/MTU
- Maximum burnup with successful insertions - 53145 MWD/MTU

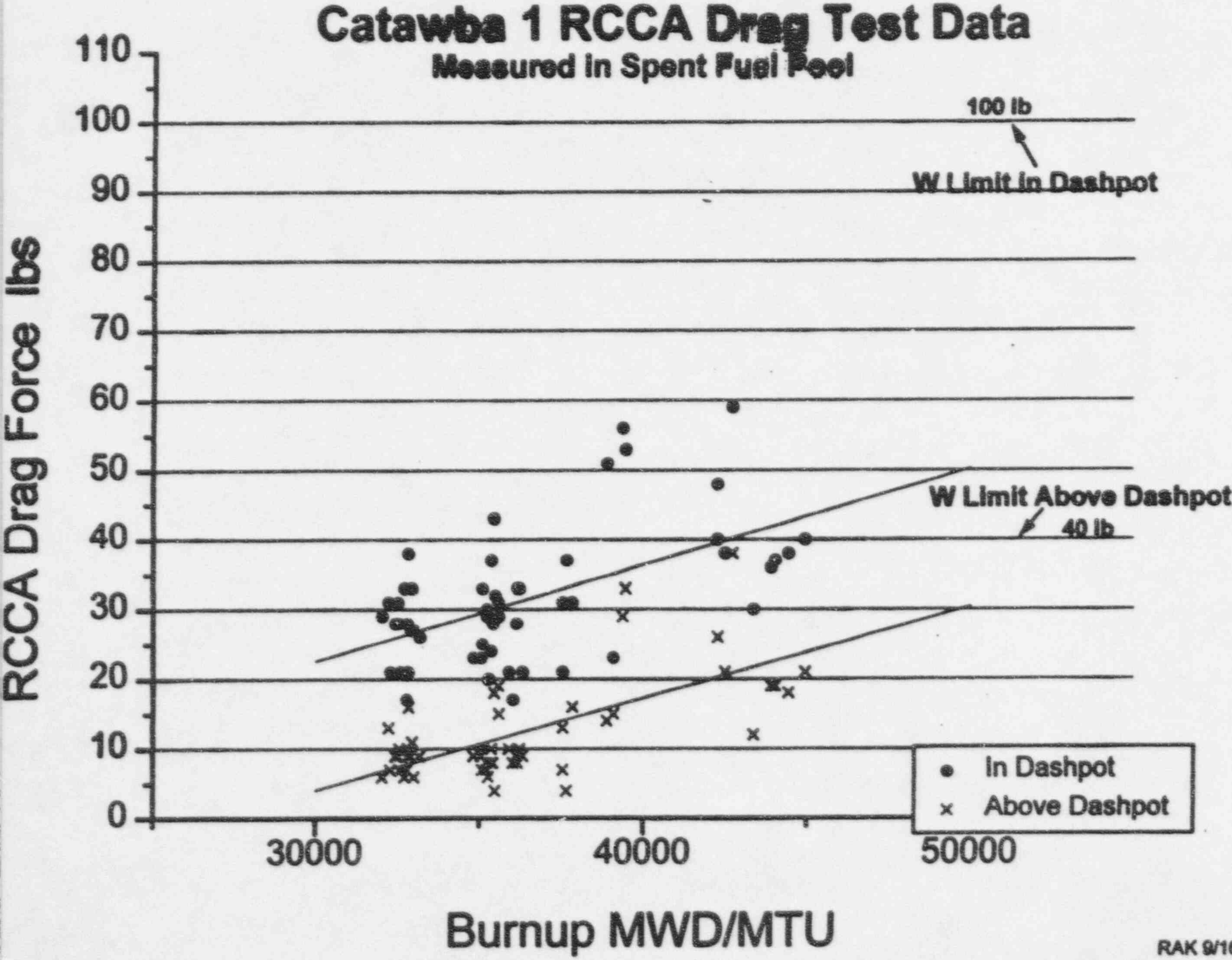



McGuire and Catawba
Rod Drop Timing Results
Time To Dashpot (sec)
2.200
2.100
2.000
1.900
1.800
1.700
1.600
1.500
1.400
1.300
1.200
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000
F/A Burnup (MWD/MTU)
C1BOC9
C1EOC9
M2BOC10
M2EOC10
C2BOC8
C2C8-230EFPD
M1BOC11
M1NOV96
M2BOC11
M2NOV96
C1BOC10



McGuire and Catawba
Rod Drop Timing Results
Time In Dashpot (sec)
F/A Burnup (MWD/MTU)
C1BOC9
C1EOC9
M2BOC10
M2EOC10
C2BOC8
C2C8-230EFPD
M1BOC11
M1NOV96
M2BOC11
M2NOV96
C1BOC10
2.200
2.100
2.000
1.900
1.800
1.700
1.600
1.500
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000

FIGURE 20



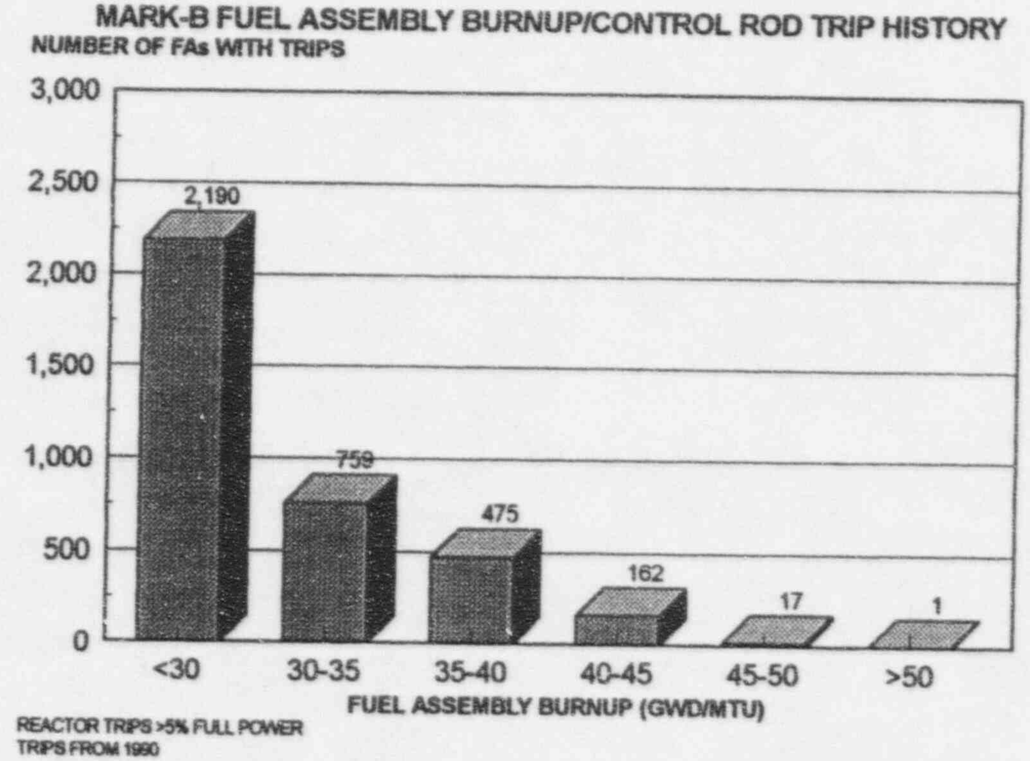
RAK 9/16/96
RCCDROP Plot 7

v19/96

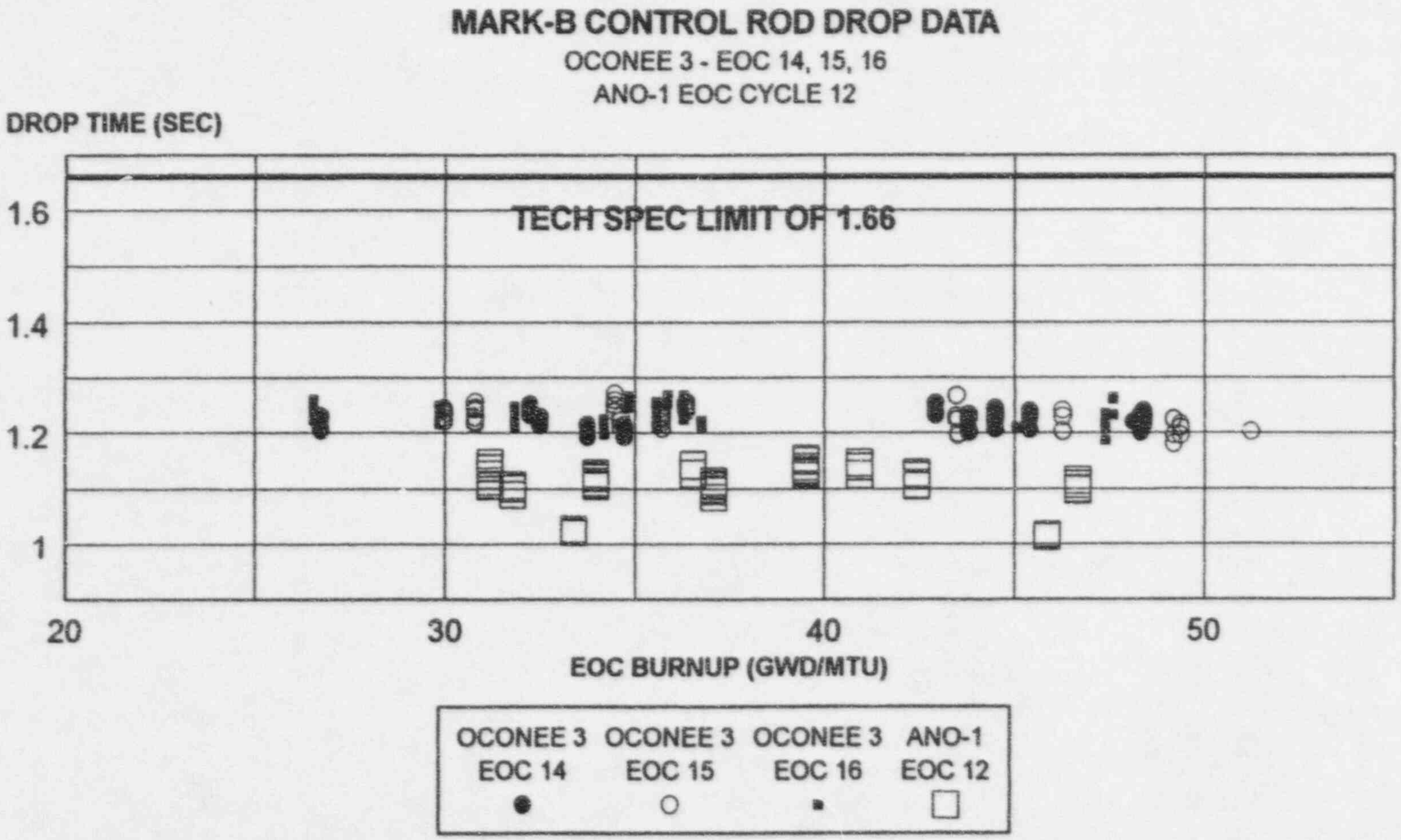
FCF HAS EXPERIENCED NO RCCA INSERTION PROBLEMS

MARK-B FUEL

- 3604 total successful insertions (since 1990)
- 180 successful insertions for burnups greater than 40 GWD/MTU
- Maximum burnup with successful insertion - 58.4 GWD/MTU



MARK-B TRIP DATA SHOW NO ADVERSE TREND



Power History Comparisons Summary

- FCF has compared the following rodded assembly power histories to Wolf Creek cycles 7 and 8:
  - Oconee 1 and 3
  - ANO, Unit 1
  - Catawba 1 and 2
  - McGuire 1 and 2
- Current FCF power histories are similar to those of Wolf Creek where problems have been observed.
- No accelerated growth, guide thimble distortion or RCCA/CRA insertion problems have been observed in FCF fuel.

Mark-BW PIE Program

- Fuel assembly growth
- Guide thimble distortion/creep
- Fuel assembly bow
- Fuel rod oxide
- Fuel rod growth

Mark-BW PIE Program

- Assembly selection based on:
  - Burnup
  - RPD
  - Core Location
  - RCCA Trip time
  - RCCA Drag force

Mark-B PIE Program

- Planned for Fall 1997
- Fuel assembly length
- Fuel assembly bow
- Guide tube oxide
- Fuel rod growth - shoulder gap

FCF FUEL DESIGN PERFORMANCE SUMMARY

FCF'S MARK-BW AND MARK-B FUEL

- Have exhibited no growth anomalies
  - Burnups as high as and MWD/MTU respectively
- No temperature / corrosion related phenomena observed in Mark-B and Mark-BW growth data
- Have higher margin for growth
  - Mark-BW has BOL margin than Vantage 5H
  - Mark-B has BOL margin than Vantage 5H
- Have lower relative axial loads over life of fuel
  - Mark-BW holddown loads are than Vantage 5H at BOL
  - Mark-BW holddown loads are than Ringhals at BOL

FCF FUEL DESIGN PERFORMANCE SUMMARY

FCF'S MARK-BW AND MARK-B FUEL

- Mark-BW has larger guide thimble upper diameter than that of the problem fuel
- Mark-BW has shown little guide thimble creep deformation
- Mark-BW guide thimble corrosion is as expected
- Mark-B has stronger guide thimble which also does not have dashpot (reduced) diameter
- Mark-B guide thimble corrosion is expected to be even lower due to lower core temperatures

RCCA Insertion Mark-BW Conclusions

- FA growth data was taken under representative high burnup conditions.
- Testing has shown acceptable RCCA insertion and drag up to 53.2 MWD/MTU.
- Growth is as predicted and designed for.
- Guide thimble plug gage measurements show minimal change in guide thimble free path.
- Fuel assembly axial loads are lower.
- Steam Generator Replacement and Catawba 2 temperature reductions will help to reduce guide thimble corrosion.
- PIE program is in progress for Mark-BW fuel to measure fuel assembly growth, guide thimble distortion, fuel assembly bow, and fuel rod oxide and growth.

RCCA Insertion
Mark-B Conclusions

- FA growth data was taken at representative high burnup conditions.
  - Growth is as predicted and designed for.
  - No temperature effect is observed in Mark-B and Mark-BW growth data.
- Testing has shown acceptable RCCA insertion up to 58400 MWD/MTU.
- Lower core outlet temperature (<610F) will help reduce guide tube corrosion
- Stronger guide thimble design increases structural margin
- Large continuous length guide tube (no dashpot) improves control rod interface
- PIE program is planned for Fall 1997 to measure fuel assembly growth and bow, guide tube corrosion, and fuel rod growth.

Final Recommendation

- Proceed to burnups consistent with the methods established in the Mark-B and Mark-BW topicals, BAW-10172 and 10179.
  - Small increment from existing burnups
  - Additional axial load less than 5% of total load experienced
  - Data is well behaved compared to licensed models
- No new core management restrictions are merited for Mark-B and Mark-BW fuel outside NRC approved topicals

FIGURE 1
MARK-BW FUEL ASSEMBLY

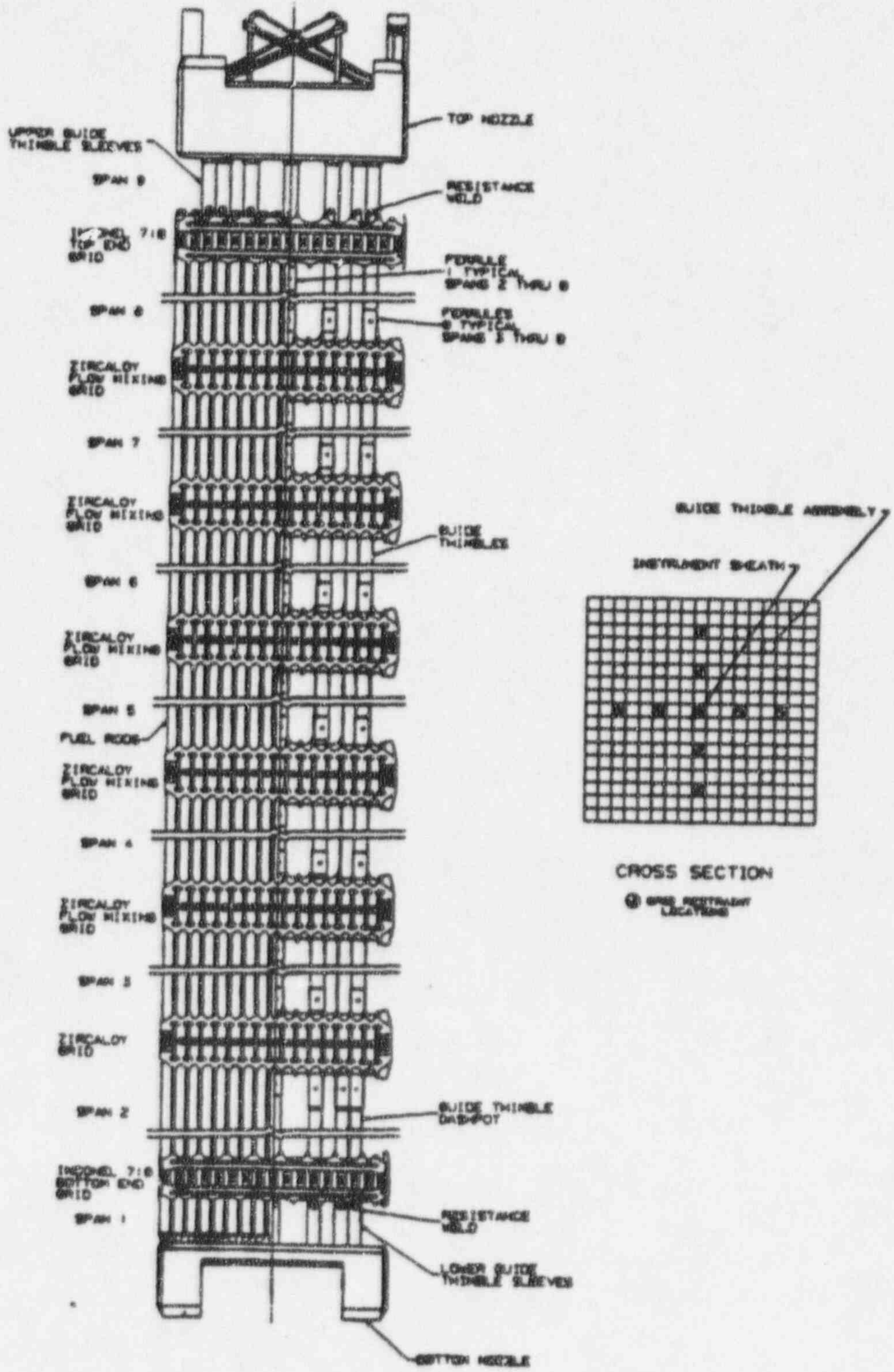


FIGURE 3

Top End Grid Restraint

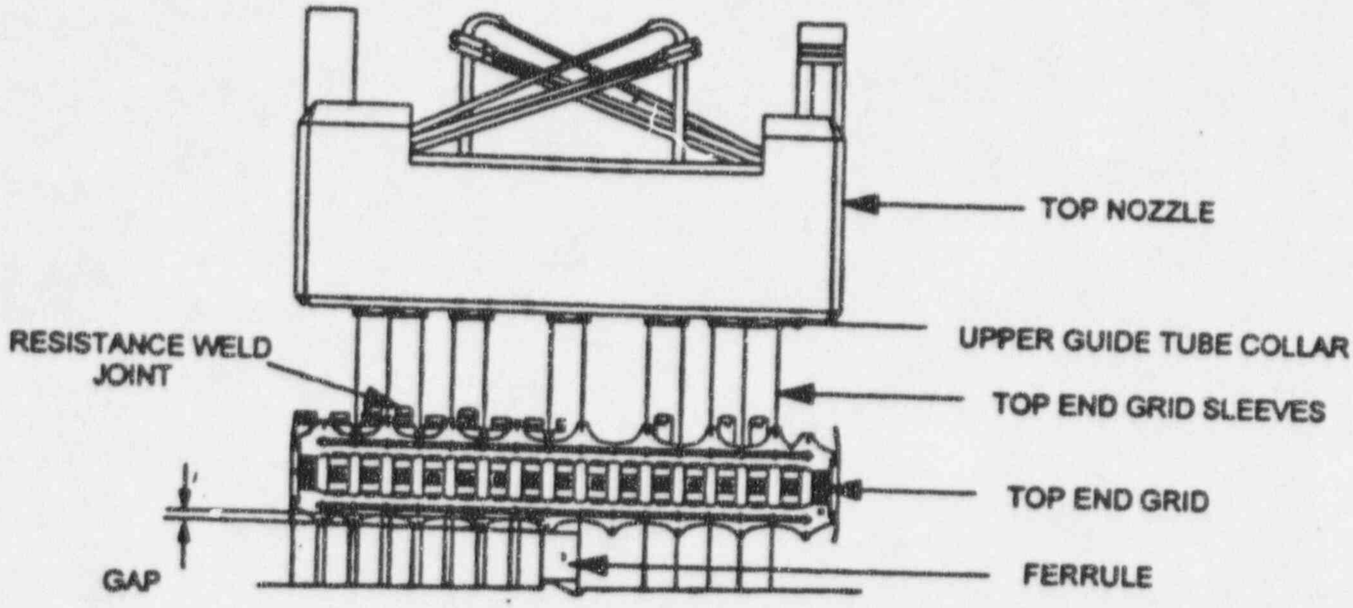


FIGURE 4

Bottom End Grid Restraint

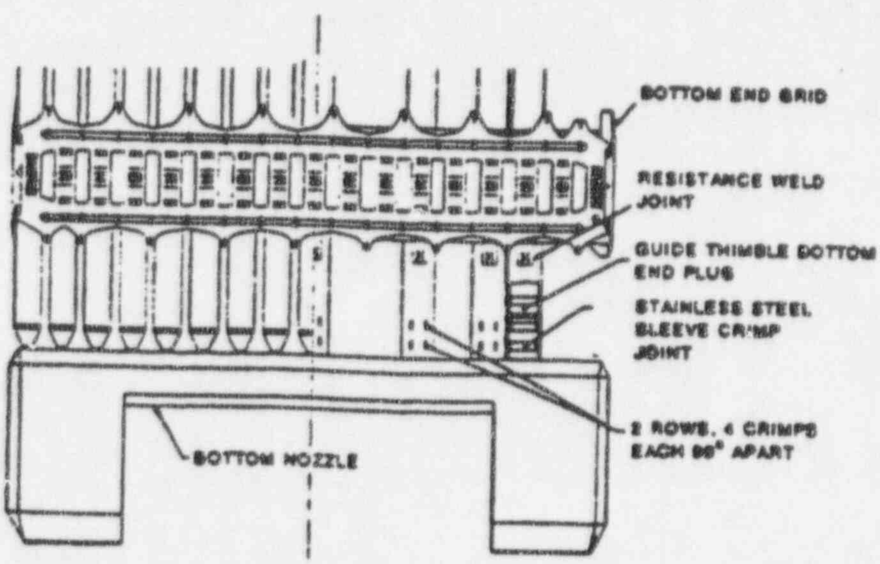


FIGURE 2a

MARK-BW Intermediate Spacer Grid Features

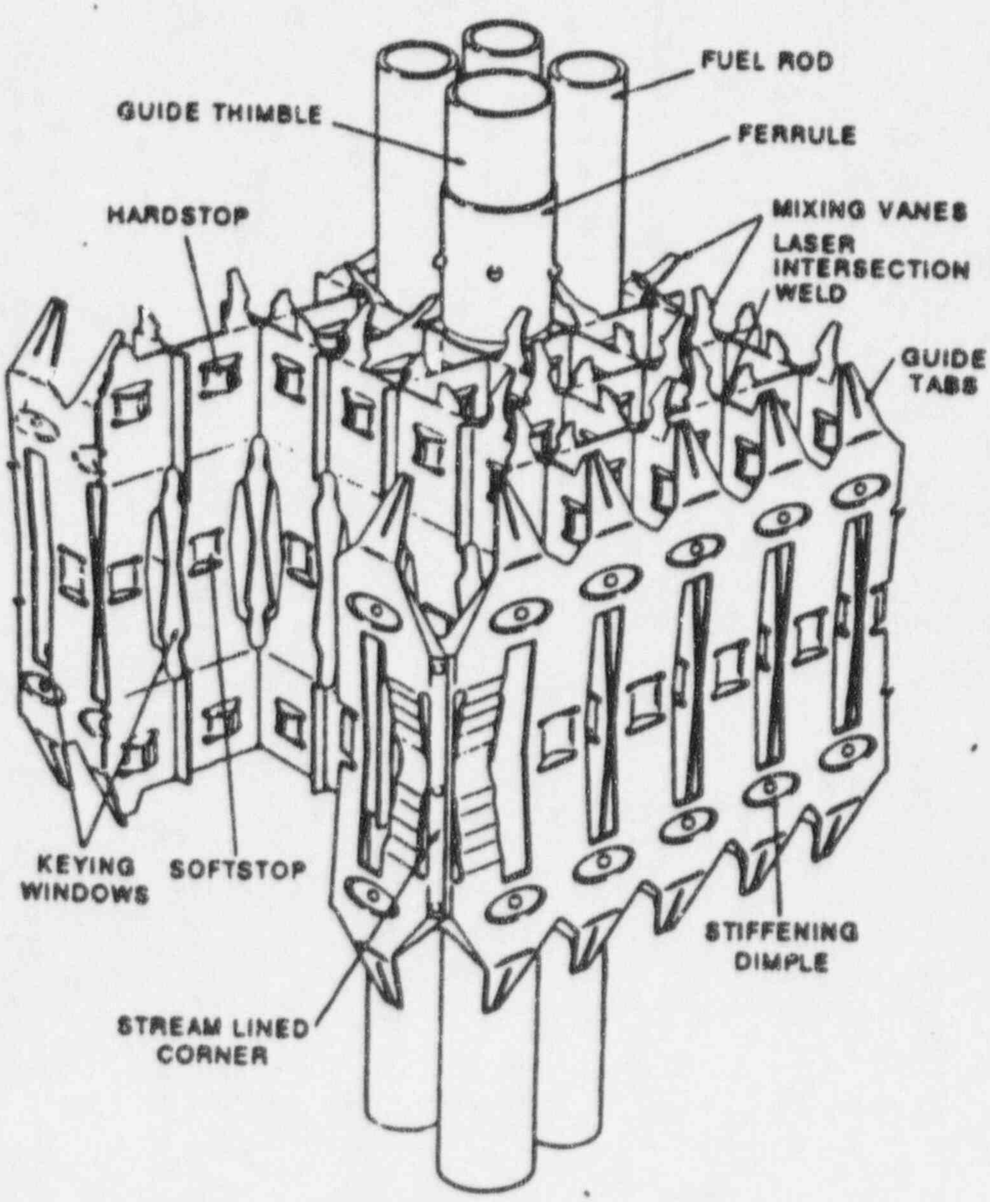
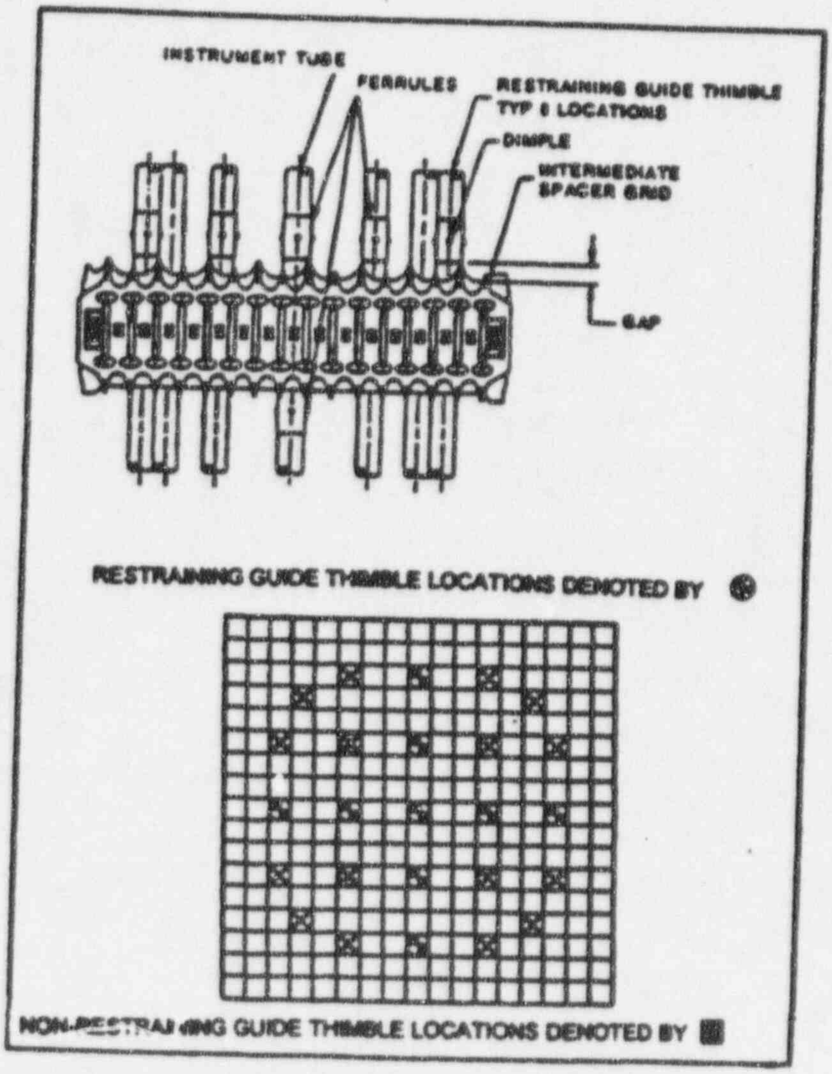
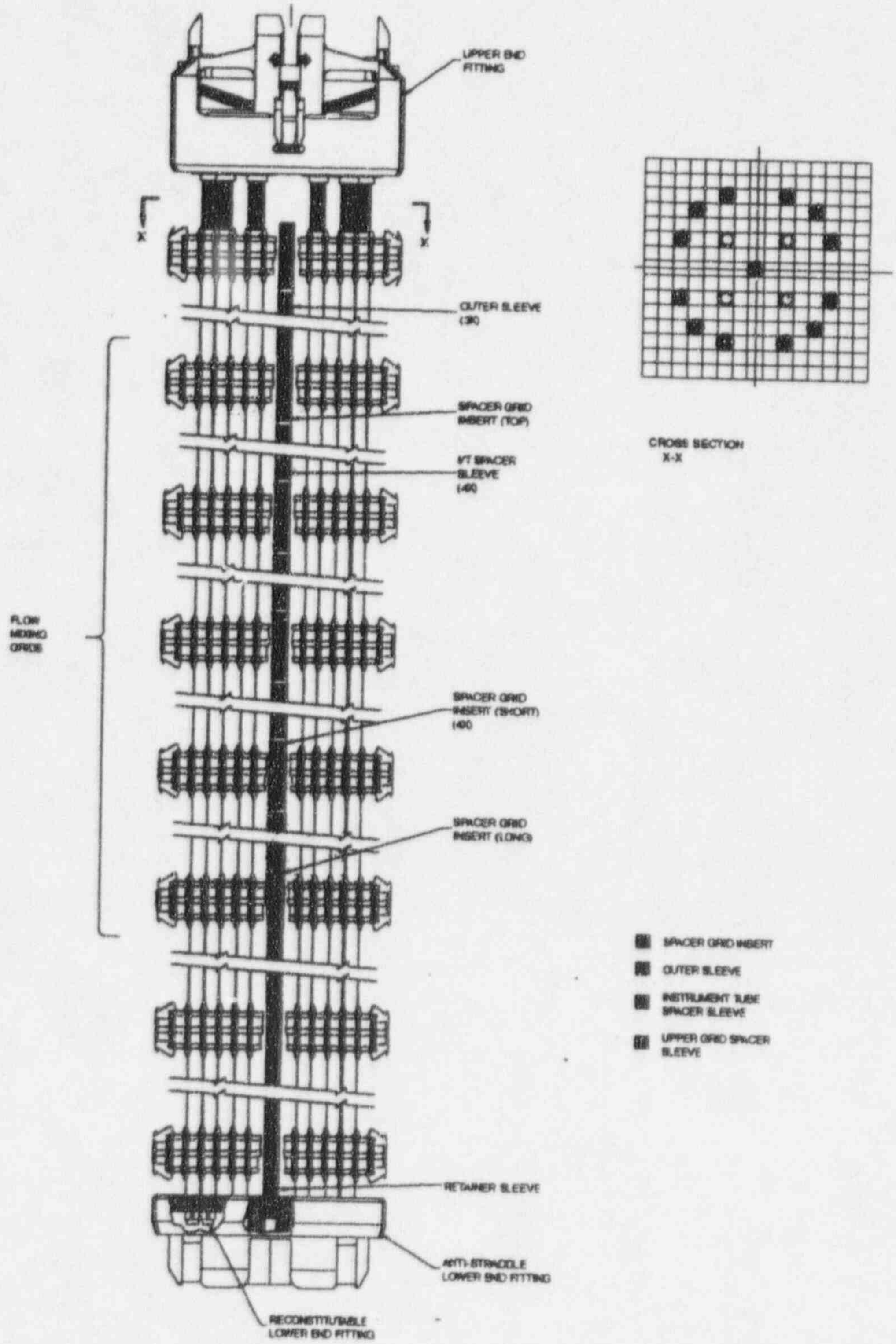


FIGURE 2b

Mark-BW Intermediate Spacer Grid Restraint System



MARK-B11 GRID RESTRAINT SYSTEM



FUEL ASSEMBLY COMPARISON			
	Mk-B10/B11	Mk-BW	VANTAGE 5H
Fuel Rod Array	15 x 15	17 x 17	17 x 17
Overall Assembly Length (in)			
FA Length Bottom Nozzle to Top Nozzle			
Allowable Axial Growth Gap (in)			
End Grid Envelope (in) Intermediate Grid Envelope (in)			
FA Incore Gap Cold (in) Outer Inner			
Number of Fuel Rods	208	264	264
Number of Guide Tubes	16	24	24
Number of Instrument Tubes	1	1	1
Number of Spacer Grids	8 ==> 2 Inconel End Grids; 6 Zircaloy Intermediate	8 ==> 2 Inconel Vaneless End Grids; 6 Zircaloy Intermediate	8 ==> 2 Inconel End Grids; 6 Zircaloy Intermediate

FUEL ASSEMBLY COMPARISON			
	Mk-B10/B11	Mk-BW	VANTAGE 5H
Fuel Rod Growth Clearance (in)			
Fuel Rod Overall Length (in)			
Fuel Rod O.D. (in)			
Holddown Springs	1 set of stacked (8) cruciform springs	4 sets of 3-leaf springs	4 sets of 3-leaf springs
Spring Constant (lbs/in)			
Preload (lbs)			
Guide Tube Material	Fully recrystallized Zircaloy-4	Fully recrystallized Zircaloy-4	Fully recrystallized Zircaloy-4
Guide Tube Length (in)			
Guide Tube O.D. (in)	0.530	0.482 (upper) 0.429 (lower)	0.474 (upper) 0.430 (lower)
Guide Tube I.D. (in)	0.498	0.450 (upper) 0.397 (lower)	0.442 (upper) 0.398 (lower)

GRID SPAN COMPARISON

Span	MARK-B	MARK-BW	VANTAGE- 5H
Top End Grid - ISG6			
ISG5 - ISG6			
ISG4 - ISG5			
ISG3 - ISG4			
ISG2 - ISG3			
ISG1 - ISG2			
ISG1 - Bottom End Grid			

ISG - Intermediate Spacer Grid

Dimensions in inches

FIGURE 6.6: Fuel Assembly G71 Bow, North and South

FIGURE 6-7: Fuel Assembly G71 Bow, East and West

FIGURE 6-4: Fuel Assembly G70 Bow, East and West

FIGURE 6-5: Fuel Assembly G70 Bow, North and South

FIGURE 6-2: Fuel Assembly G69 Bow, East and West

FIGURE 6-3: Fuel Assembly G69 Bow, North and South

Figure 4-3. LA RPD vs. EFPD

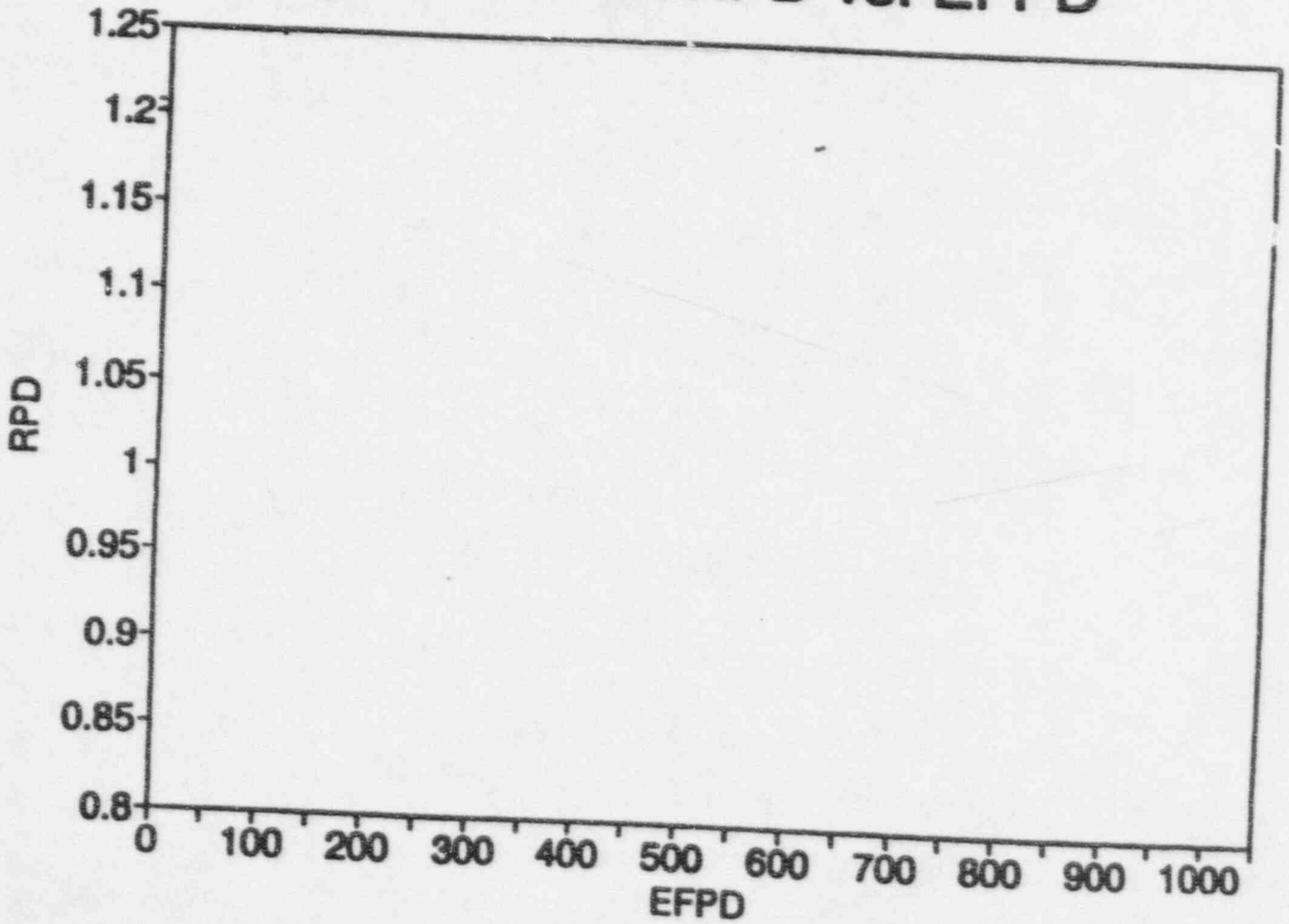


Figure 4-3. LA RPD vs. EFPD

McGuire 2 PIE Scope															
FA ID	Core Loc	Drop Time (sec)		Drag Force (lbs)		Power			3rd Cycle Burnup (GWD)	Inspections					
		Dashpot	Total	Dashpot	Above Dashpot	1 Cycle	2 Cycle	3 Cycle		FA Length	GT Dimen	FA Bow	FR Oxide	FR Growth
V37	H08	0.65	2.28	71	67	1.289	1.0253	0.971						
V44	H06	0.51	2.05	25	<40	1.258	0.659	1.085						
V68	H10	0.54	2.20	69	65	1.290	0.660	1.069						
V15	F10	0.54	2.16	51	<40	1.245	0.6663	1.077						
V01	K10	0.49	2.07	51	<40	1.251	0.659	1.068						
V54	J09					1.274	0.3967	1.082						
V24	H12	0.56	2.08	27	<40	1.187	0.4703	1.108						
V33	E09					0.826	0.6457	1.176						
V72	J11					0.806	0.6623	1.148						
V67	H02	0.49	2.00	15	<40	1.158	0.4870	0.920						
W68	C09	0.58	2.06	59	<40	na	1.2673	1.125						
V19	R09					1.132	.7293	0.525						
V35	J01					1.137	.7403	0.519						
V18	J15					1.139	.7157	0.525						
W29	N09	0.57	2.22	71	<40	na	1.202	1.071						
								Total						

Power History Comparison for RCCA Host FAs Mark-BW			
Plant	Cycle	EOC Burnup GWd/mtU	RPD
Wolf Creek	8 7	51.3 32.7	1.02 1.12
	8 7	49.5 35.3	0.81 1.00
	8 7	47.6 36.8	0.79 1.21
McGuire 1	10 9 8	47.1 31.5 18.3	0.99 1.02 1.28
	10 9 8	45.5 29.9 16.1	1.00 1.05 1.13
McGuire 2	10 9 8	53.1 36.8 20.6	0.97 1.03 1.29
	10 9 8	48.0 30.2 19.8	1.05 0.67 1.28
Catawba 1	9 8 7	44.9 30.2 14.2	0.86 1.05 1.06
Catawba 2	7 6 5	46.4 27.2 20.1	1.05 0.50 1.32
	6 5	45.9 31.9	0.92 1.03

Power History Comparison for RCCA Host FAs Mark-B			
Plant	Cycle	EOC Burnup GWd/mtU	RPD
Wolf Creek	8	51.3	1.02
	7	32.7	1.12
	8	49.5	0.81
	7	35.3	1.00
	8	47.6	0.79
	7	36.8	1.21
Oconee 1	15	47.6	1.00
	14	33.4	1.30
	13	18.0	1.31
	14	47.3	1.03
	13	34.1	1.37
	12	17.7	1.34
Oconee 3	16	47.6	1.04
	15	33.7	1.09
	14	18.1	1.35
ANO-1	14	51.7	1.09
	13	34.4	1.26
	13	48.2	1.03
	12	30.9	1.13
	11	14.6	1.06