April 16, 1997

MEMORANDUM TO: David B. Matthews, Chief
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

FROM: Claudia M. Craig, Senior Project Manager Original Signed By:
Generic Issues and Environmental
Projects Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MEETING WITH WESTINGHOUSE TO DISCUSS INCOMPLETE ROD CLUSTER CONTROL ASSEMBLIES (RCCA) INSERTIONS

The subject meeting was held at the Nuclear Regulatory Commission (NRC) offices in Rockville, Maryland on January 10, 1997, between representatives of Westinghouse and the NRC staff. The purpose of the meeting was for Westinghouse to provide an update of the RCCA insertion test data, provide a comparison of 14 foot fuel versus 12 foot fuel and their susceptibility to incomplete RCCA insertions, discuss the impact of intermediate flow mixing grids (IFMs) and ZIRLO, provide burnup guidance developed by Westinghouse, and provide preliminary design changes. Attachment 1 is a list of meeting participants. By letter dated January 16, 1997, the proprietary and non-proprietary versions of the presentation material were submitted. Attachment 2 is a copy of the non-proprietary version of the presentation material.

Westinghouse provided a summary of the testing performed to date and the different parameters that were examined, in addition to testing results which led them to develop the root cause. Westinghouse discussed their short term corrective action, but recognizes that long-term solutions are needed. Westinghouse outlined their draft process to address acceptability when plants exceed the recommended values. The process includes a two prong approach: first, a safety evaluation needs to be performed to determine shutdown margin and second, a prediction of the acceptability of the future fuel assembly bowing needs to be determined. This will be accomplished using the mechanical model which has been developed. Westinghouse requested a meeting be set up in the future to discuss the mechanical model and the acceptability process.

The final RCCA insertion issue root cause report is scheduled to be submitted to the staff in mid to late February 1997.

Attachments: As stated

cc w/atts: See next page
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DF03 1/1

210087

97-74 RD-8-2 Westinghouse

X-Ofm-6 meeting

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

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WESTINGHOUSE / NRC MEETING

INCOMPLETE RCCA INSERTION UPDATE

JANUARY 10, 1997

MEETING PARTICIPANTS

NAME	ORGANIZATION
Claudia Craig	NRC/NRR/PGEB
Harold H. Scott	NRC/RES
Kenneth Turnage	Southern Nuclear
Ernie Kee	HL&P - South Texas
Satoshi Azumi	Kansai Electric Power
Lynn Connor	for STS
J. Rajan	NRC/NRR/EMEB
Robert Hinkle	Northeast Utilities
Gerald Canavan	New York Power Authority
H. Oley Nelson	Northern States Power
Kris Thomas	NRC/NRR PDIV-2
Vance VanderBurg	AEP and WOG
Roger Newton	WEPCo/WOG
Jim Sparrow	Westinghouse CNFD
Howard Menke	Westinghouse CNFD
Sumit Ray	Westinghouse CNFD
Nick Liparulo	Westinghouse NFD
Brian Sheron	NRC/NRR/ADT
Jim Lyons	NRC/NRR/SRXB
Muffet Chatterton	NRC/NRR/SRXB
Dick Wessman	NRC/NRR/EMEB
Henry Sepp	Westinghouse
Vincent J. Esposito	Westinghouse CNFD

ATTACHMENT 1

DISTRIBUTION w/attachments: Summary of January 10, 1997, with Westinghouse dated April 16, 1997

Central File
PUBLIC
PGEB R/F
RArchitzel
CCraig

E-Mail
SCollins/FMiraglia
TMartin
RZimmerman
GHolahan
BSheron
EWeiss
MChatterton
RScott
JRajan
DTessman
KThomas
HOrnstein
JLyons

Incornplete RCCA Insertion Summary Update

NRC Meeting

1/10/97

Attachment 2

Incomplete RCCA Insertion

- Purpose of Meeting

Provide update of recent data, focus on why 14 ft. fuel behaves differently than 12 ft. fuel, impact of IFM/ZIRLO, burnup guideline and design changes to increase margins for extended burnup

Incomplete RCCA Insertion Agenda

- Accumulated Test Data
- Summary of Wolf Creek Root Cause
- 14 Ft. Fuel versus 12 Ft. Fuel
- Special Featured Fuel Assemblies
- Safety Significance
- Core Loading Pattern Process
- Potential Design Changes
- Conclusions/Summary

Accumulated Test Data - Significant Amount of Data Obtained in 1996

96-01 Testing

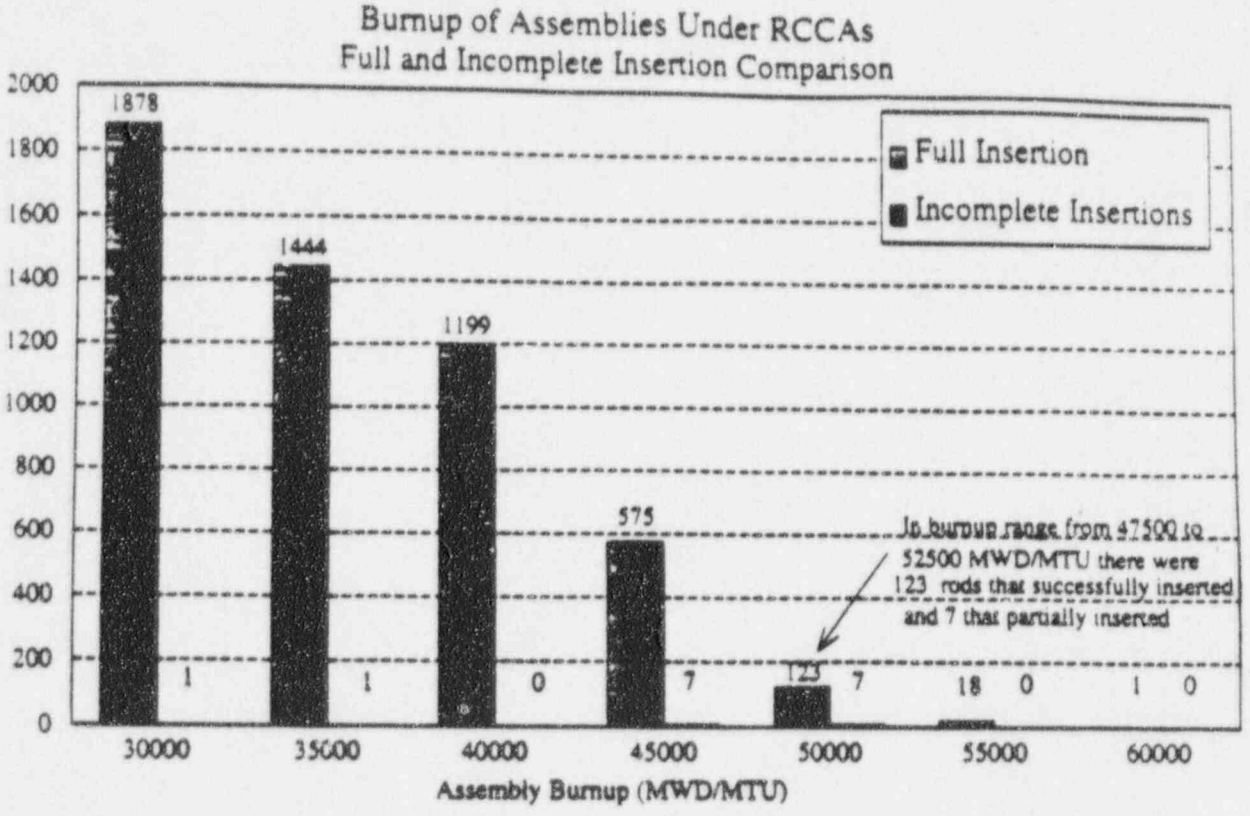
- # FA Rod Drop Tests (Total) - 2175
- # FA Rod Drop Tests (IFM) - 1031
- # Drag Tests (Total) - - 1356
- # Drag Tests (IFM) - 586

Root Cause

- # FA Inspections - 174
- # Plant Sites - 10
- # FA Growth Measurements - 137
- # Drag Tests - 147
- # Single Tube Probe Tests - 37
- # FA in Hot Cell - 2

SUMMARY OF PLANT TRIP INFORMATION

- Data From 50 Plants (Westinghouse & Non-Westinghouse Fuel)



BU (GWD/MTU) Range Under RCCAs	Number FAs Showing Full Insertion	Number FAs Showing Incomplete Insertion	
		Wolf Creek	So. Texas 1
27.5 - 32.5	1878	0	1
32.5 - 37.5	1444	0	1
37.5 - 42.5	1199	0	0
42.5 - 47.5	575	0	7
47.5 - 52.5	123	5	2
52.5 - 57.5	18	0	0
57.5 - 62.5	1	0	0
TOTAL	5238	5	11

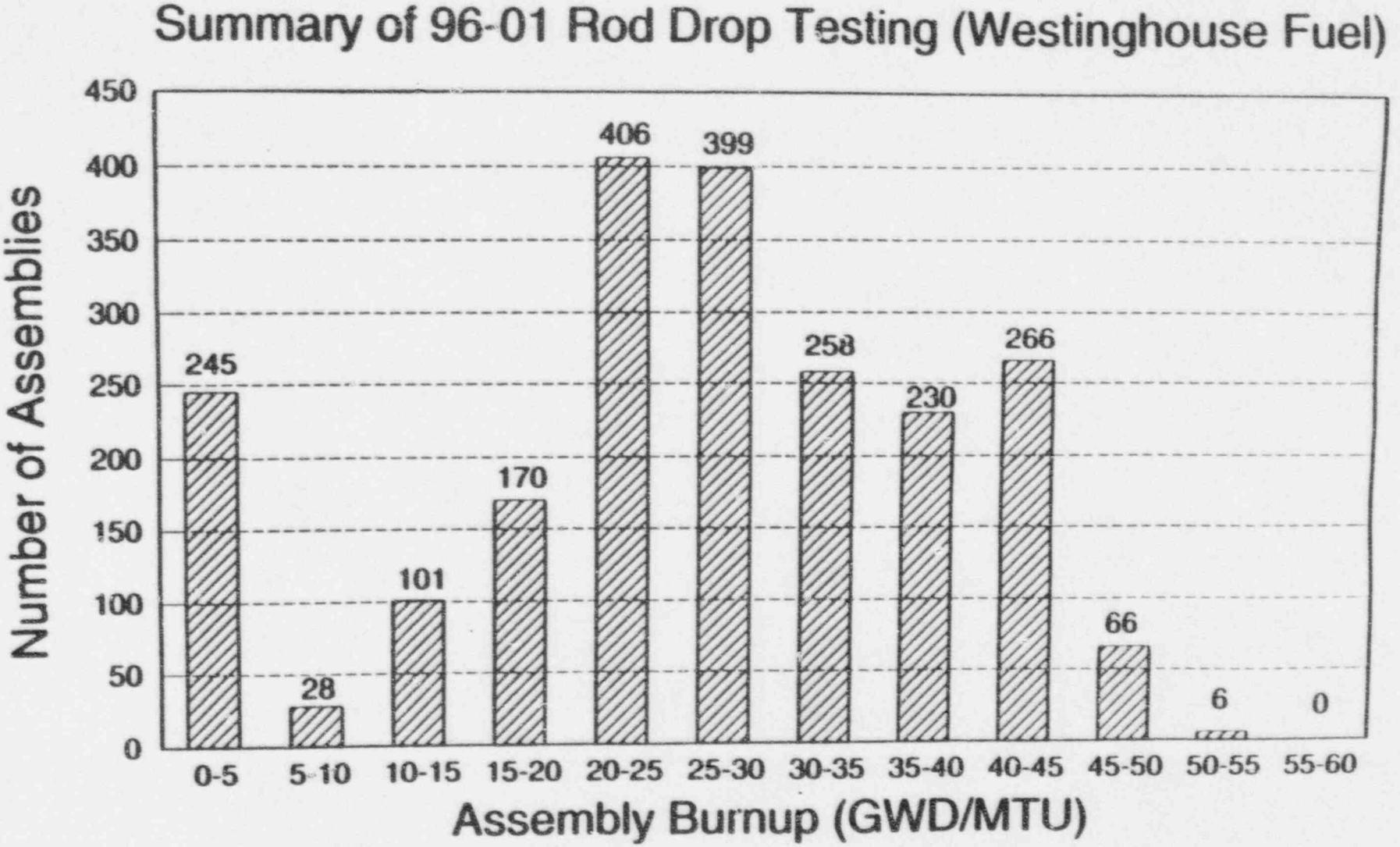

Summary of 96-01 Rod Drop Testing (Westinghouse Fuel)
Number of Assemblies
450
400
350
300
250
200
150
100
50
0
245
28
101
170
406
399
258
230
266
66
6
0
0-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
Assembly Burnup (GWD/MTU)

Figure 5.1.1: Dashpot and Upper Guide Thimble Drag Data
(Drag Measured after Reactor Trip)

a,b,c

[

]

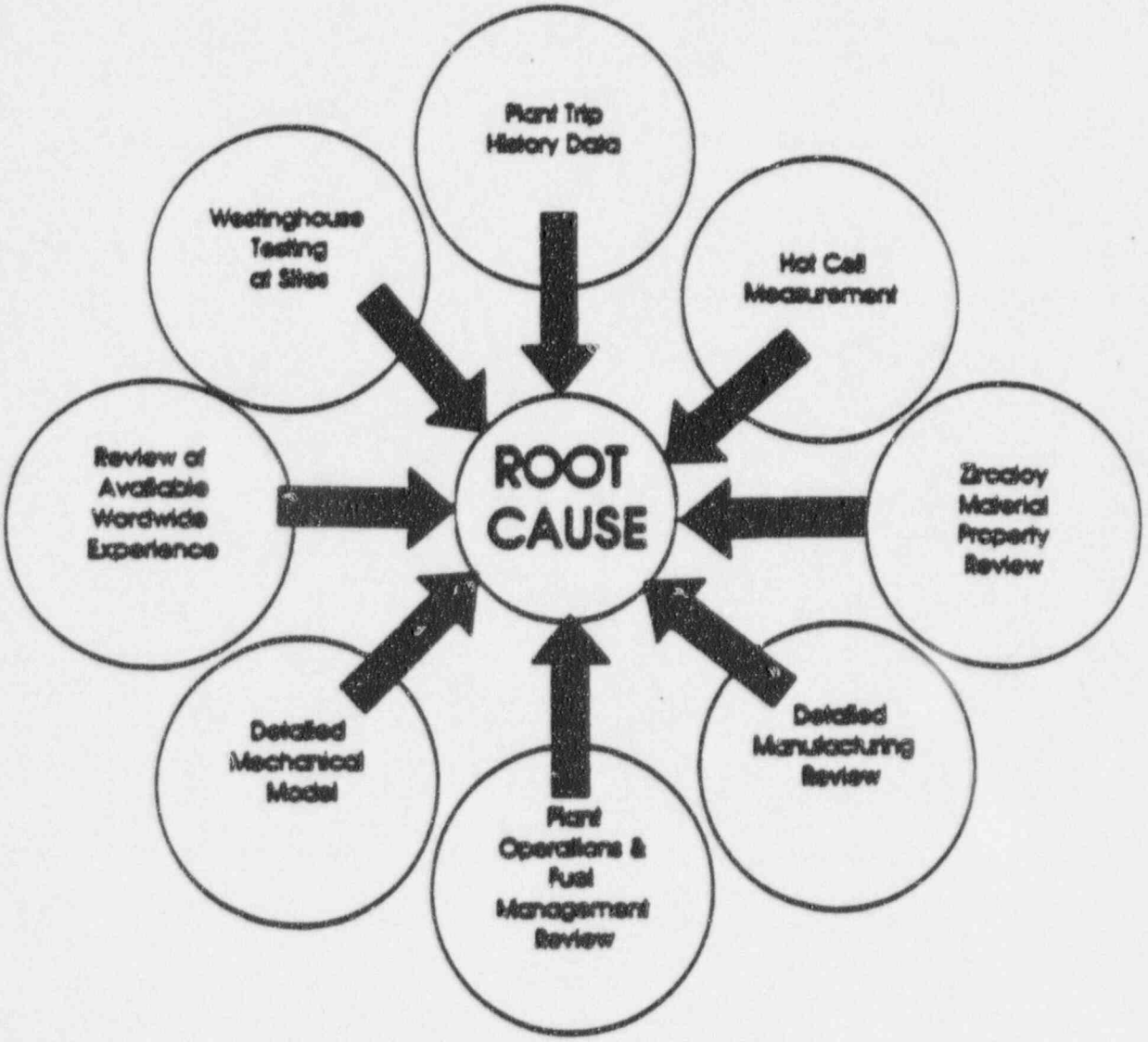
Accumulated Test Data: Key Observations

- No unusual FA growth for 12 ft. W fuel except Wolf Creek
- Normal FA growth noted for 14 ft. W fuel
- No incomplete insertion without unusual growth in 12 ft. fuel
- Incomplete insertion for 12 ft. W fuel shows high drag in both dashpot and thimble tube
- Many FAs operating at high burnup levels without insertion problems

Accumulated Test Data Major Parameters

- FA Parameters
  - Holddown spring force
  - Skeleton material
  - Dashpot design
  - IFMs
- Operational Parameters
  - Burnup
  - Core temperature
  - Power history
  - Residence time

ROOT CAUSE DETERMINATION PROCESS



Summary of Wolf Creek Root Cause

- Incomplete RCCA insertion caused by high compressive loads on FA thimble tubes
- Unusual FA growth contributed to high compressive loads
- Growth due to corrosion and accelerated growth of thimble tubes (temperature sensitive)
- Unusual growth requires high temperature, high burnup with 3 cycle residence time/power histories

14 Ft. vs 12 Ft. Core Differences

- Dashpot Design: Double vs Single
- Key Critical Features:

Assembly Weight

Length

Holddown Force

Hydraulic Lift Force

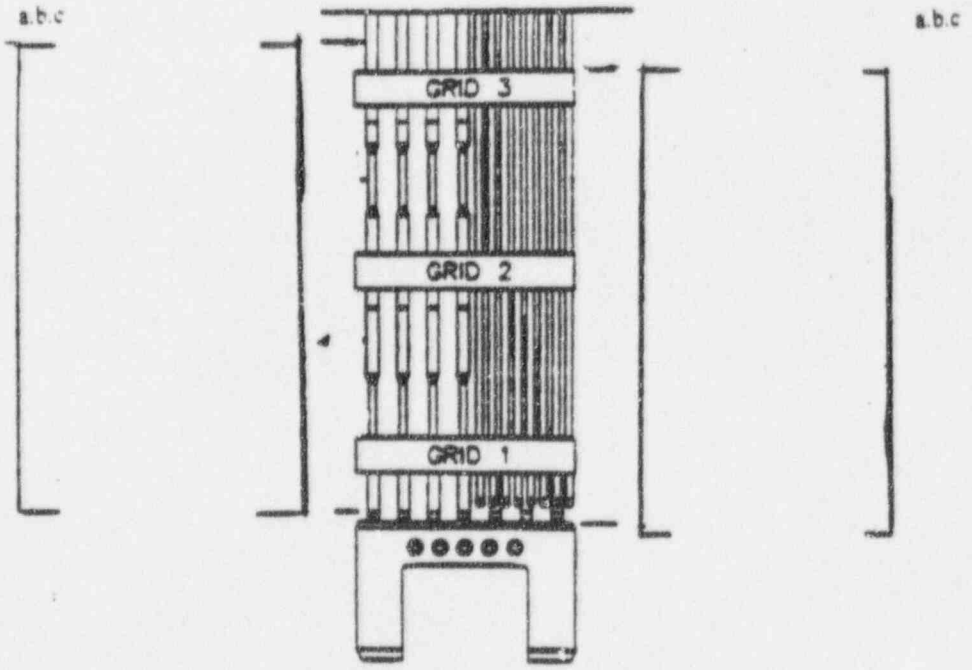
Typical Span Length

Dashpot Length

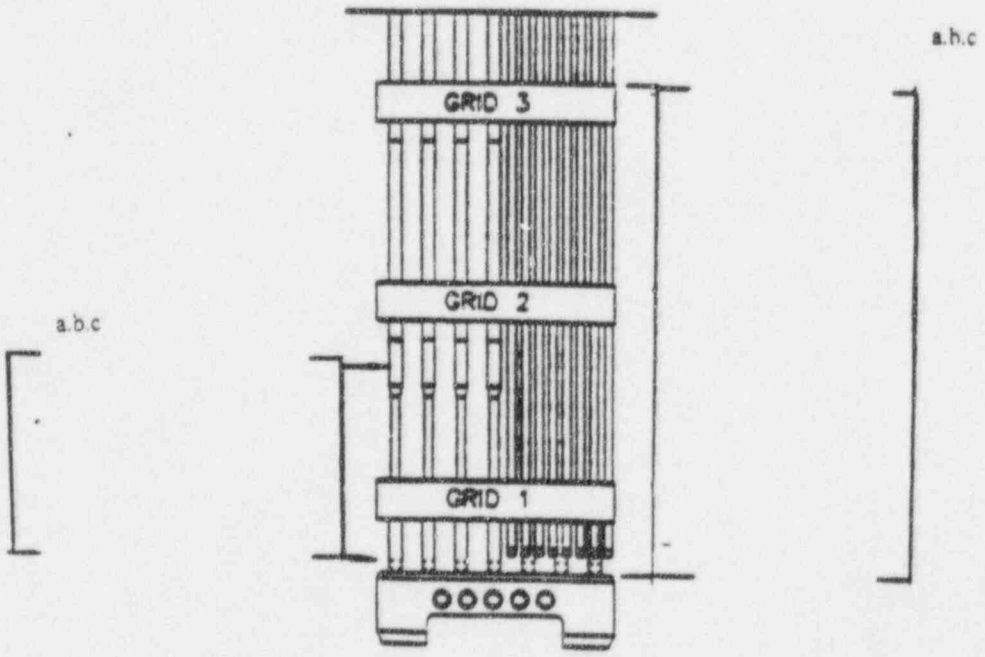
Number of Transitions (1 vs 3)

Compressive loads in dashpot region approximately twice those of 12 ft. core

17X17 XL FUEL ASSEMBLY



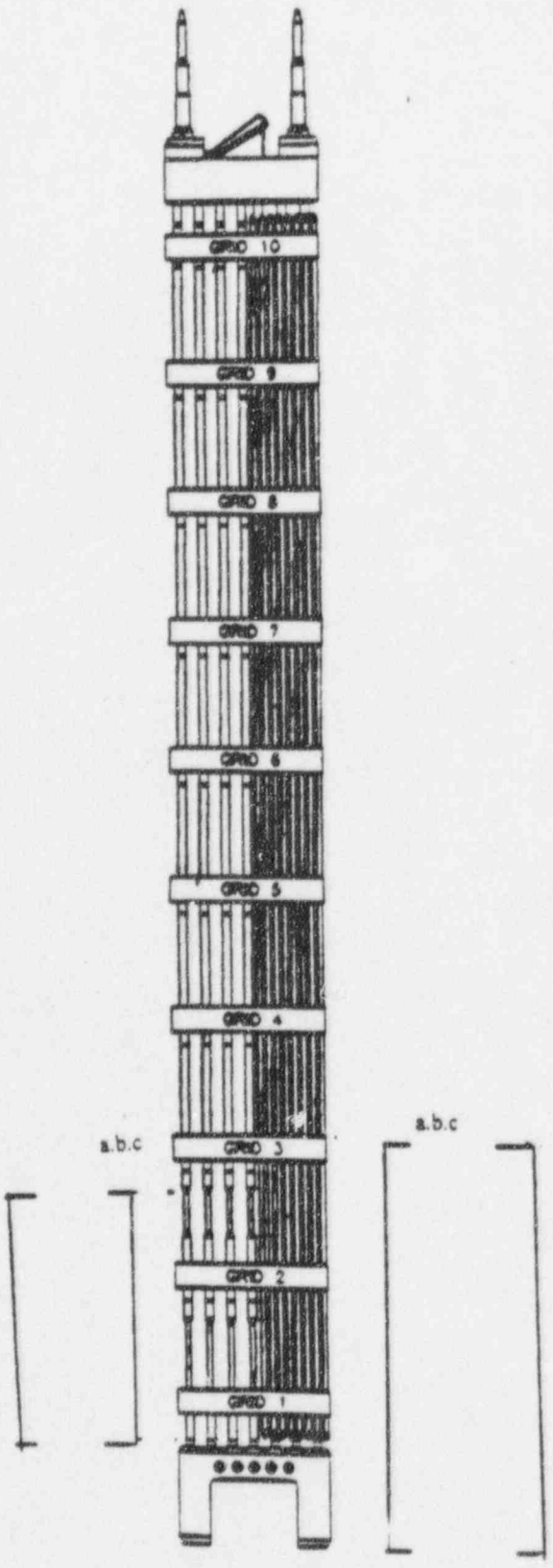
17X17 V5H FUEL ASSEMBLY



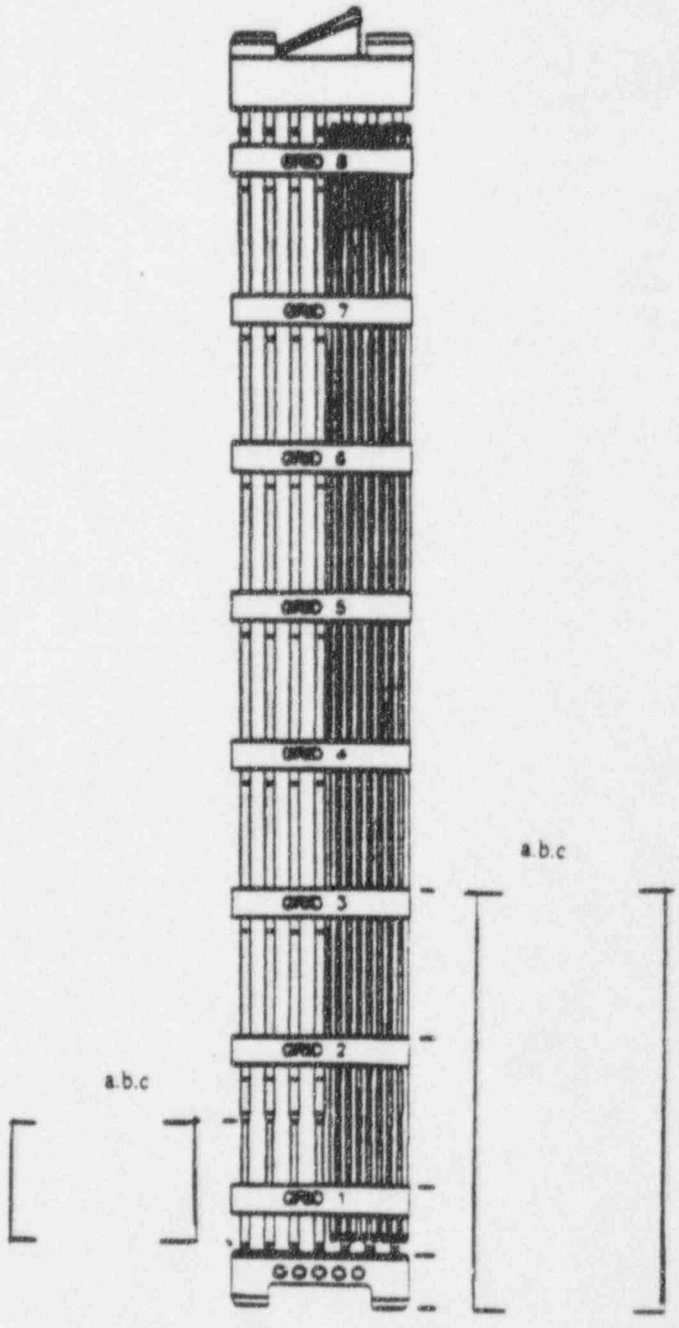
14 Ft. FUEL ASSEMBLY vs 12 Ft. FUEL ASSEMBLY

LOWER GUIDE TUBE GEOMETRY

DIMENSIONS ARE IN INCHES (NOMINAL)



17X17 VSH FUEL ASSEMBLY



14 Ft. FUEL ASSEMBLY vs 12 Ft. FUEL ASSEMBLY

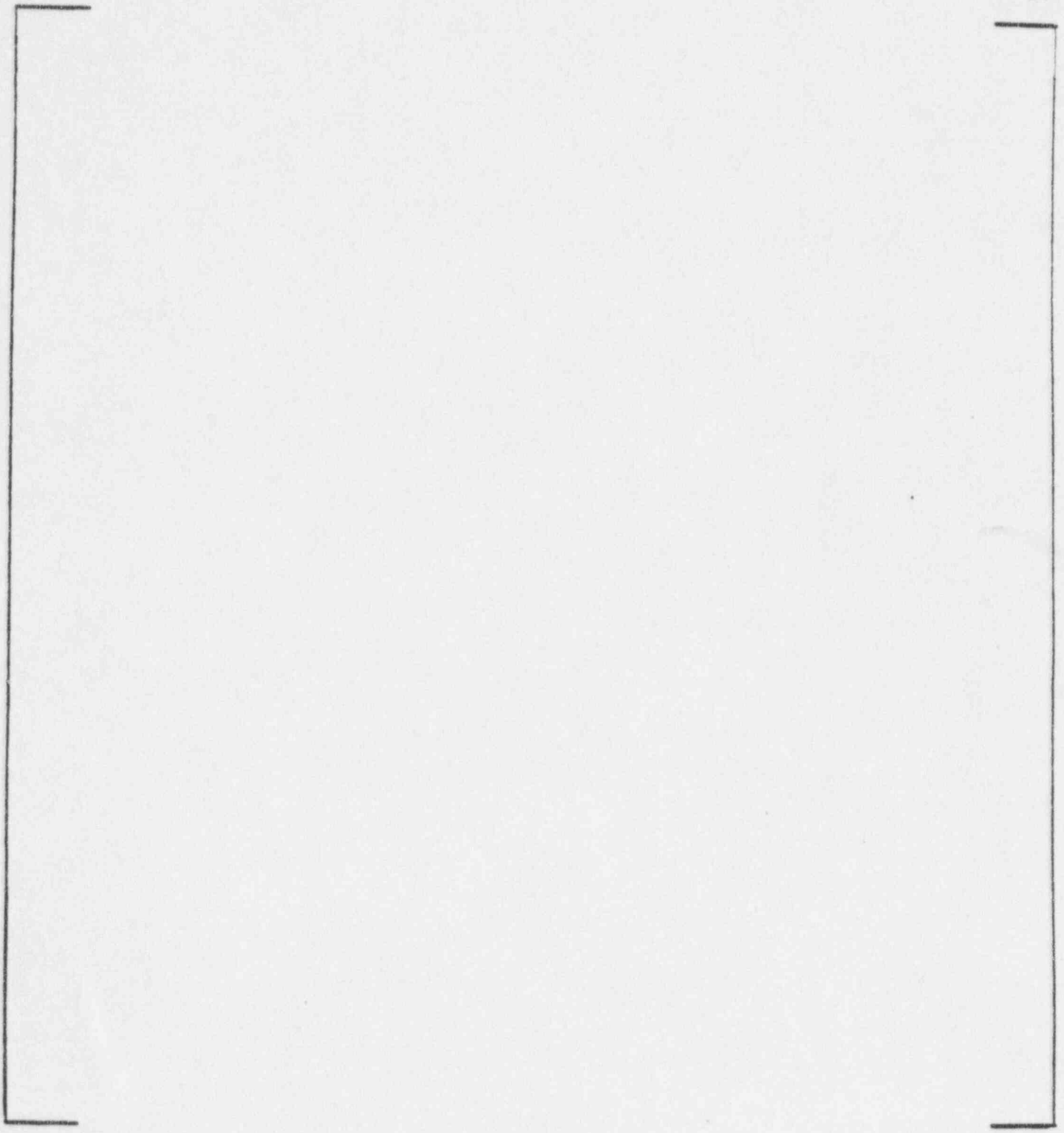
DIMENSIONS ARE IN INCHES (NOMINAL)

14 Ft. vs 12 Ft. Core Differences
(continued)

- **14 ft. Behavior**
  - Dashpot bow is [ ]$^{a, b, c}$ larger for 14 ft. vs. 12 ft at [ ]$^{a, b, c}$ by analysis
  - Field data for incomplete insertion shows FA growth is not excessive or unusual
  - Distortion in dashpot region can be [ ]$^{a, b, c}$

TYPICAL DISTORTION IN DASHPOT REGION

a,b,c



14 Ft. Core vs 12 Ft. Core Differences (continued)

- **Basic reasons why 14 ft. fuel is more susceptible than 12 ft. core:**
  - Dashpot design enhances distortion due to [ ]a, b, c
  - Higher compressive loads in dashpot
- **Root cause: High compressive loads and dashpot design**
- **Exceeding F-spec criteria and tie to unusual growth does not hold for 14 ft. due to dashpot design**

Special W Fuel Assembly Features

- IFMs
  - Data shows lower drag in upper guide tube which ensures entry of control rod into dashpot (no safety issue)
  - Some data shows high dashpot drag but insertion still achieved
  - In no case are both F-spec criteria exceeded, no insertion problem

Figure 1 - Summary of RCCA Insertion Information - IFM Fuel

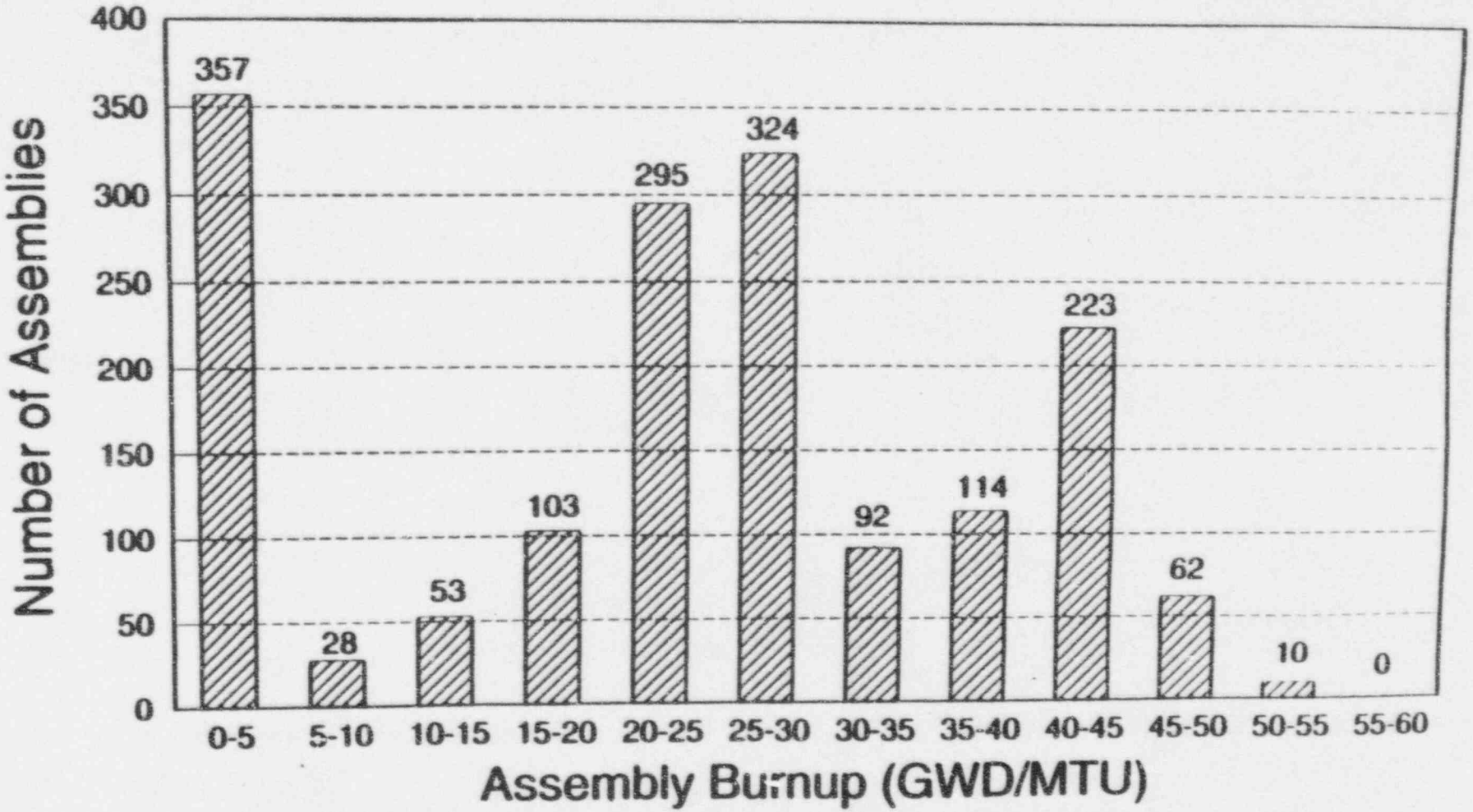


Figure 4 - Upper Guide Thimble Drag vs. Burnup - Westinghouse Fuel

Figure 3 - Dashpot Drag vs. Burnup - Westinghouse Fuel

Figure 2 - Upper Guide Thimble Drag vs. Dashpot Drag - Westinghouse Fuel

abc

Special W Fuel Assembly Features

- IFMs
  - IFM FAs are less susceptible than non-IFM FAs
    - Reduced drag in upper guide tube region due to increased stiffness
    - Reduced compressive loads due to increased ΔP from IFM grids

Special W Fuel Assembly Features

IFM

Conclusions

- No reported incomplete insertion for IFMs
- Drag tests with IFM do not exceed F-Spec
- Mechanical model predicts lower thimble tube bow for IFM FA than Wolf Creek H50

<u>No Restrictions on IFMs up to Current Burnup Limit</u>

Special W Fuel Assembly Features

- **ZIRLO**
  - **Basic material property differences between ZIRLO and Zirc-4 are significant relative to RCCAs**
    - Growth rate vs burnup
    - Fuel rod growth vs burnup
    - Creep rate[ ]$^{a, b, c}$
    - Oxide data
  - **Comparison of Wolf Creek 50H FA with and w/o ZIRLO**
    - Span bow [ ]$^{a, b, c}$ with ZIRLO
    - FA growth is [ ]$^{a, b, c}$ with ZIRLO

FIGURE 1 ASSEMBLY GROWTH (ZR-4 VS ZIRLO THIMBLE)

a,b,c

NORTH ANNA DEMO ROD GROWTH

a b c

1814P51

10/27/95

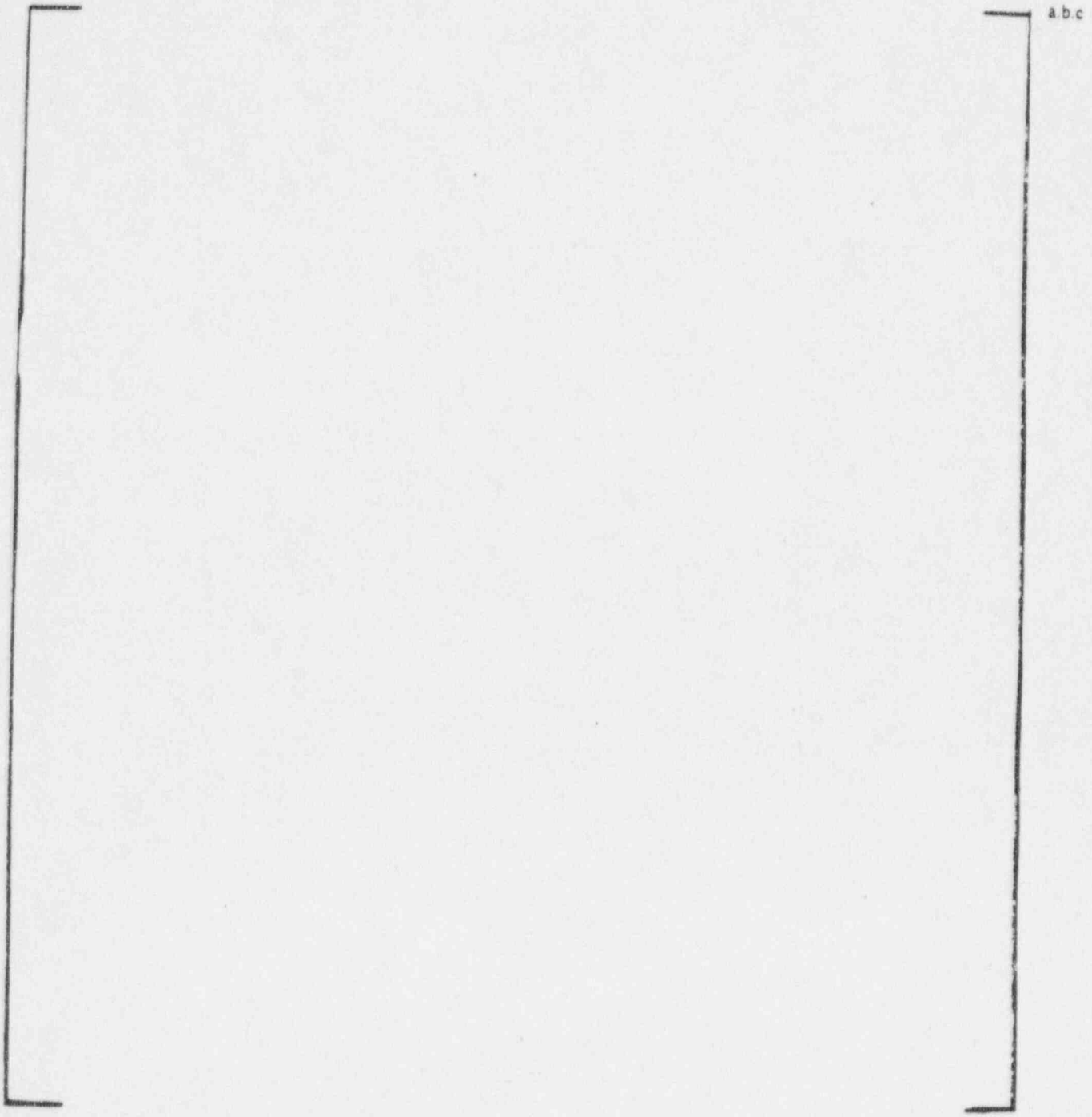
Scherpereel/Slaughter

North Anna Creep Measurements

[a b c]

North Anna Corrosion Measurements

WC H50 ROD & ASSEMBLY GROWTH
(ZIRLO-1650 HYD LIFT)



a,b,c

Special W Fuel Assembly Features: IFMs and ZIRLO (continued)

- **ZIRLO skeletons are significantly less susceptible than Zirc-4 skeletons due to material properties such as [ ]$^{a, b, c}$**
- **Additional high burnup data will be available from demos**
- **ZIRLO skeletons require no burnup restrictions given current burnup license limit**

Recommendation for Current Operating W Cores

- **No restriction for IFM or ZIRLO skeleton FAs**
- **No restriction for low temperature plant or 2 cycle FAs**
- **Temperature > 615°F and 3 cycle FA (18 months)**
  - 12 Foot - 40,000 MWD/MWT
  - 14 Foot - 30,000 MWD/MWT
- **Temperature < 615°F**
  - 12 Foot - no restrictions
- **Process to assess acceptability should the above values be exceeded**

Process to Address Acceptability for Operating Plant above W Recommended Values

[a,b,c]

Potential Design Changes to Provide Additional Margin for Extended Burnup

[ ]

abc

Conclusions

- Significant amount of data obtained and used to understand behavior
- A mechanical model has been developed to predict span bow/growth
- A process under development to assess incomplete insertion
- No restrictions required for IFM and /or ZIRLO FAs based on current burnup licensing limit
- Design changes being pursued to eliminate issue and provide additional margin for the future

SUMMARY

Bottom Line

We will make this issue go away.

Schedule of Near-Term Actions

• Response to NRC Questions	1/17
• IFM Report to NRC	1/18
• Final Root Cause Report	2/17
• Detail Technical Meeting	TBD
• Identify Design Changes for 17 XL	4/97
• Ship Modified 17 XL Assemblies	8/97

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