Slides for Pre-Planning PAD Update Meeting (Non-Proprietary)

Westinghouse Electric Company
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Cranberry Township, Pennsylvania 16066

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Pre-Planning PAD Update Meeting

NRC / Westinghouse

March 30, 2011

Westinghouse

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Introduction and Meeting Purpose

Pre-Planning PAD Update Meeting

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Introduction

- Westinghouse has a schedule driven project to extend their codes and methods [

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- Schedule is driven by a window of opportunity for plant implementation.

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Meeting Purpose

- Present ongoing scope of work and schedule for NRC planning purposes
- Conduct open dialogue with NRC staff with respect to [ ]^{a,c}
- Receive NRC feedback on approaches, technical considerations, effect of ongoing rulemakings and testing.
- Extension of PAD code is primary subject of meeting.

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Agenda

- **PAD Update: Program Definition**
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- **Licensing Plan**
- **Customer Perspective**
- **PAD Development**
  - Materials Data
  - Approach
  - Milestones and Status
- **Summary**

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PAD Update Program

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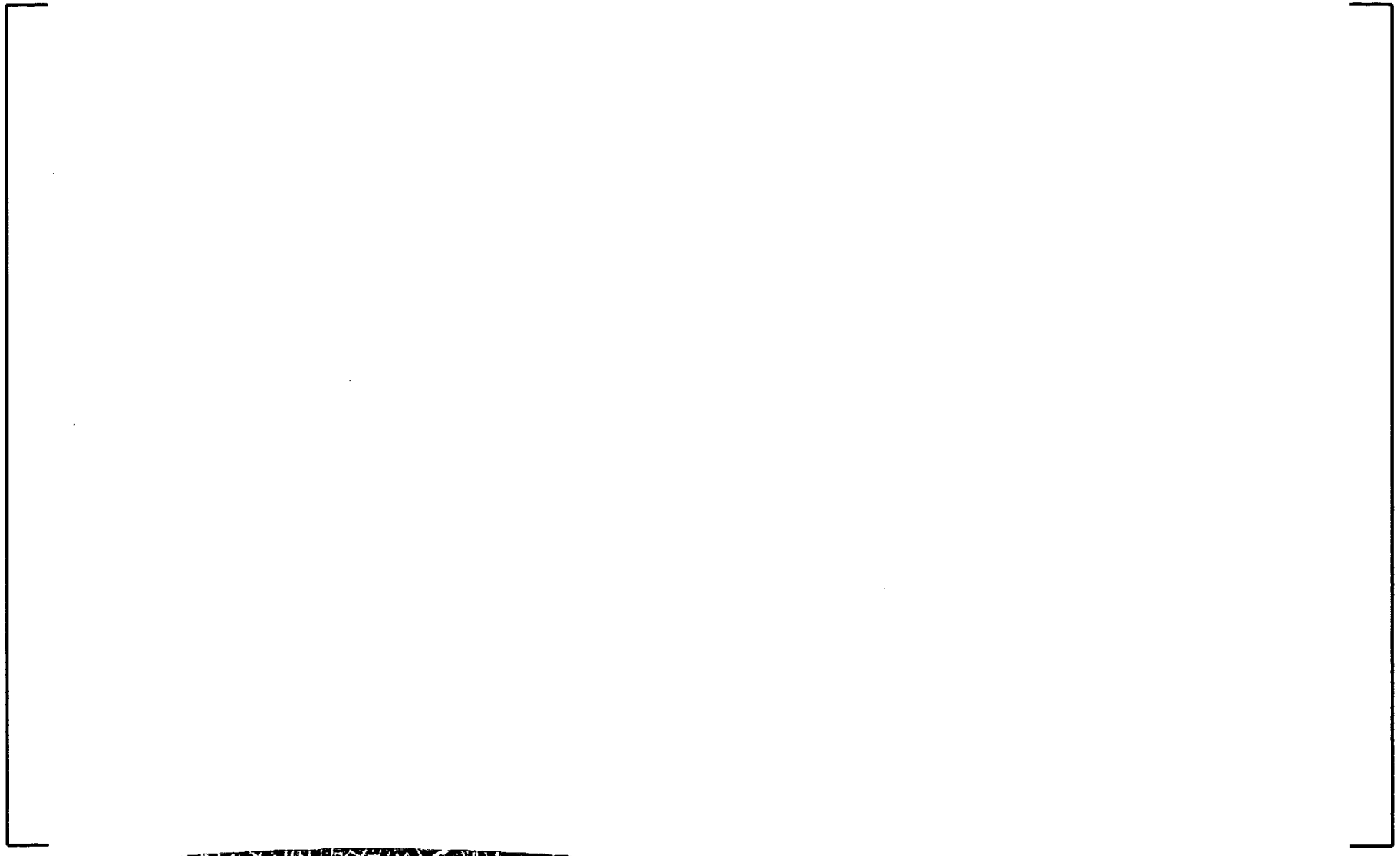

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Licensing Plan

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Content of PAD 5.0 Topical Report

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Fuel Materials and Performance Codes

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Addressing Regulatory Changes

- Westinghouse participation in NEI and EPRI task force/working groups
- Attendance/Participation in PWROG programs
- Response to NRC requests for information and comment on guidance documents and rulemaking efforts.
- Updating materials/methods as needed to address these ongoing issues.

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Westinghouse Licensing Schedule

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Customer Perspective

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Tentative Timeline for Implementation

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Tentative Plant Implementation

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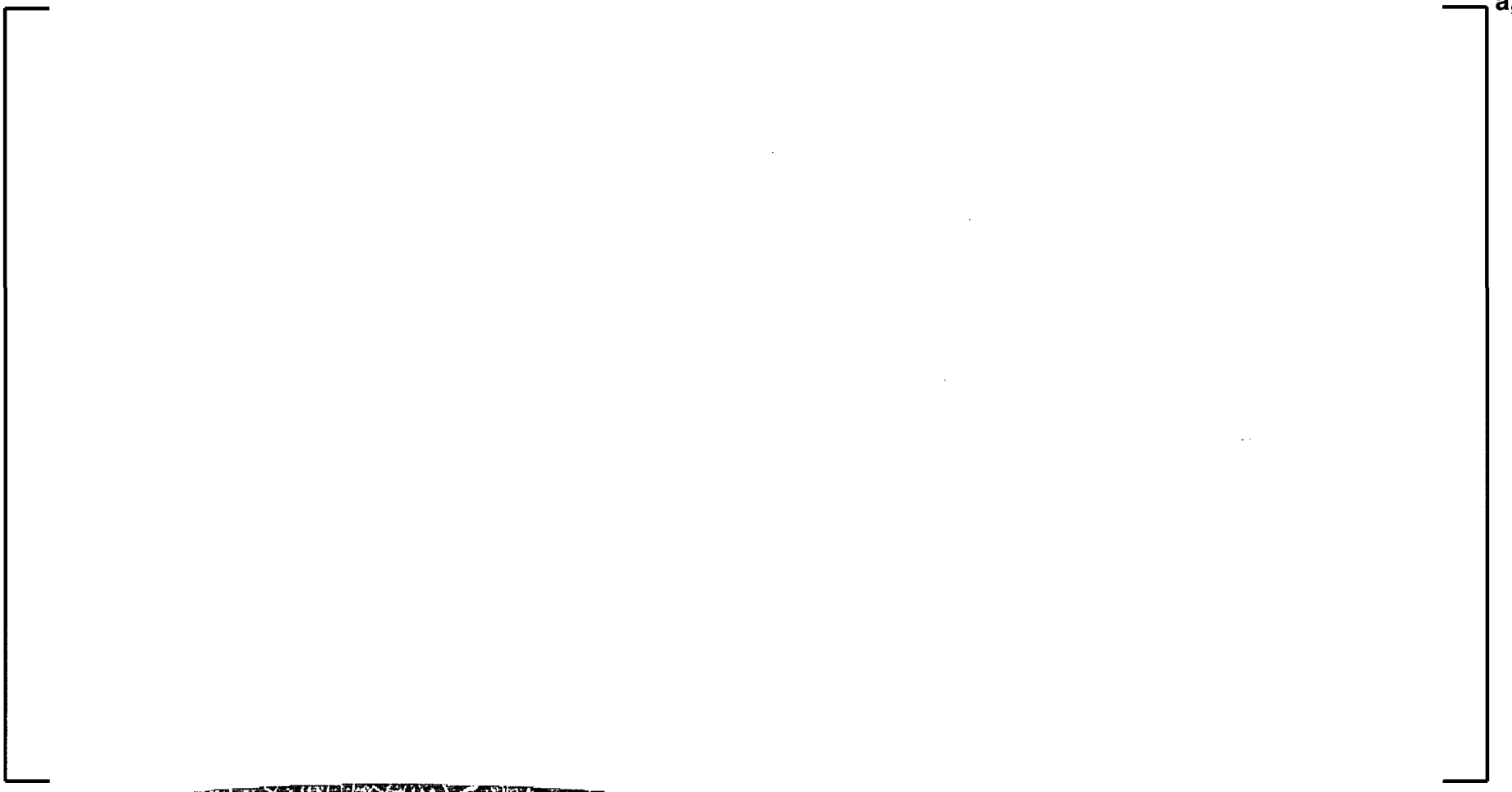

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Impacts on [ ]a,c Power Plant

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Material Performance

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Agenda

- [ ]a,c
- Westinghouse Alloy Development
- **Optimized ZIRLO**™ Properties and Experience
- **Optimized ZIRLO** Irradiation Programs
- **Optimized ZIRLO** Performance

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Material Evolution with Burnup

- ZIRLO® Cladding and Structural components have demonstrated robust performance at current burnup limits and in Lead Test Assembly (LTA) high burnup programs reaching 70 GWD/MTU.
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Westinghouse Alloy Development

Zircaloy-4

ZIRLO

Reduced corrosion and growth.

Optimized ZIRLO

Evolutionary improvement to ZIRLO, [ ]^{a,c} corrosion reduction.

	Zircaloy-4	ZIRLO	**Optimized ZIRLO**
Niobium	[		] **a,b,c**
Tin			
Iron			
Chromium			
Microstructure			

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Optimized ZIRLO Properties

- Creep properties designed to be similar to ZIRLO material
  - The lower tin results in [ ]a,c
  - Countered by [ ]a,c
- Use of [ ]a,c means also that **Optimized ZIRLO** unirradiated mechanical properties are affected, i.e., [ ]a,c
- [ ]a,c
  - Hot cell exam was performed to obtain data. The report is being finalized.
  - [ ]a,c

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Optimized ZIRLO Material

- Developed based on vast ZIRLO material experience
  - [

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but with

- Significantly improved corrosion properties

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Optimized ZIRLO Cladding Experience

- Used in 16 units, worldwide
- More than 105,000 fuel rods
- High burn-up experience to above 70 GWD/MTU
- Significant improvement to ZIRLO cladding experience with regard to corrosion
- Licensed in the USA
- First full reloads in 2008

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Optimized ZIRLO LTA Programs

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Opt. ZIRLO™ LTA Programs

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High Burnup ZIRLO Accident Testing

- LOCA Testing
  - PQD Testing – ANL
  - Integral LOCA testing
    - JAEA
    - Studsvik (Ongoing)
- RIA testing
  - Cabri
  - NSRR
  - RIA Mechanical Testing
    - Studsvik – EDC tests
    - Studsvik – EPRI sponsored Modified Burst Test

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Optimized ZIRLO Performance

- Reached burnups of ~74 GWD/MTU
- Reached Fuel Duty (MFDI) > 1000
- **Optimized ZIRLO** cladding has:
  - 40% lower fuel rod corrosion.
  - Similar fuel rod cladding creep.
  - Similar PCI failure threshold.
  - Similar high temperature oxidation kinetics and post quench ductility (PQD) behavior.

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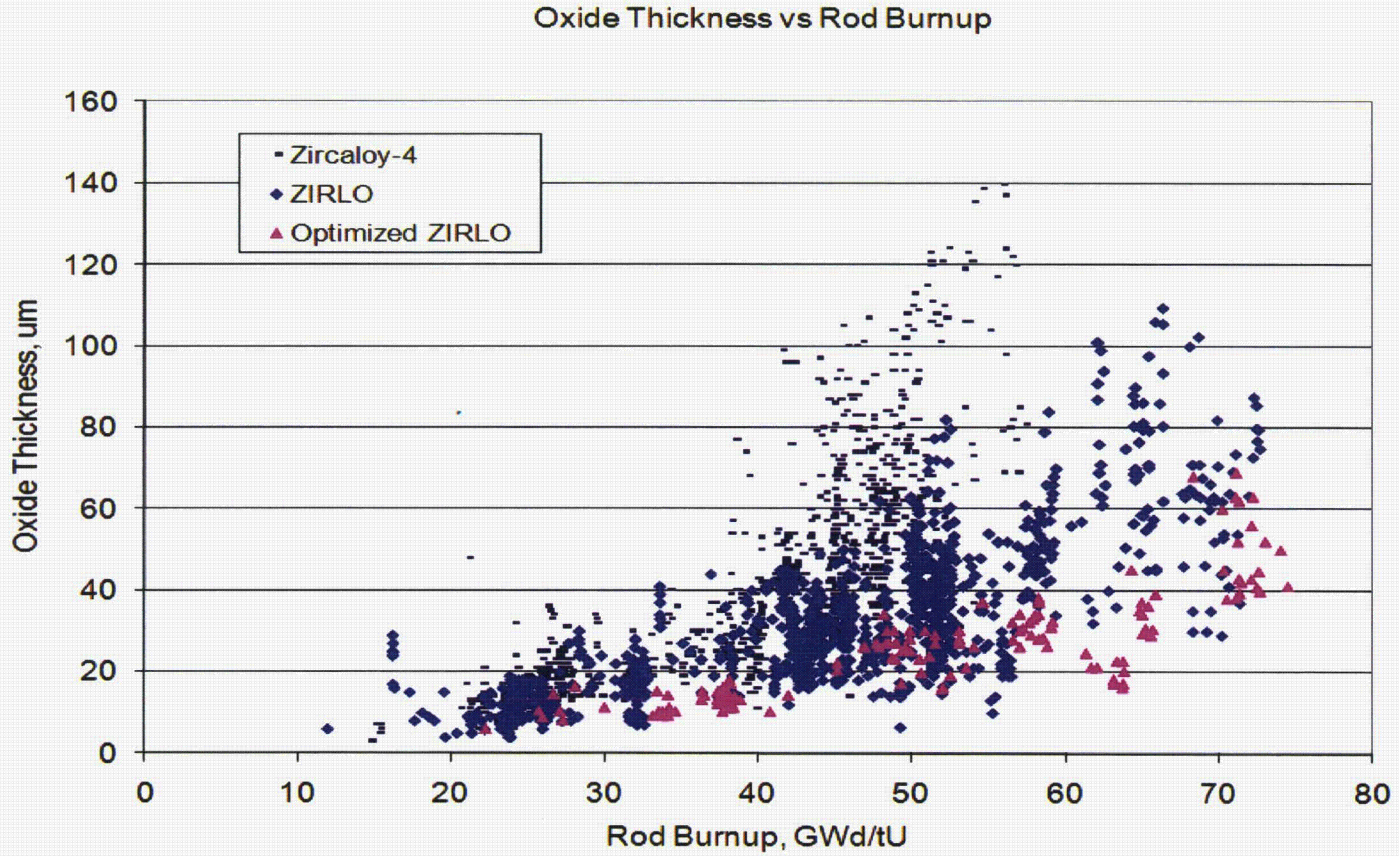
Zircaloy-4, ZIRLO and **Optimized ZIRLO** Cladding Corrosion Trends



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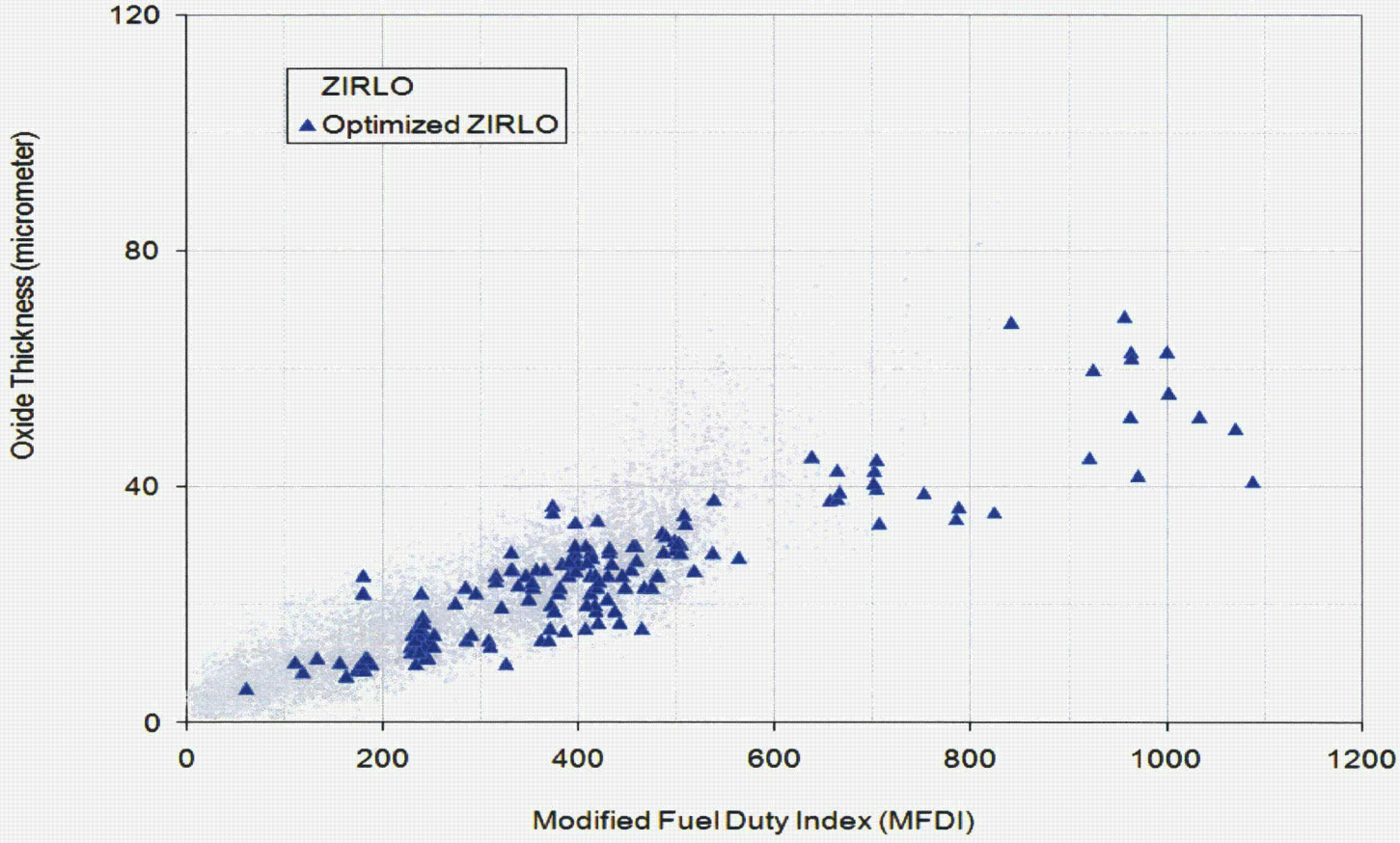
Corrosion Trend with Respect to MFDI



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Major Milestones

- Plant A Optimized ZIRLO clad fuel rods reached a peak rod burn-up level of ~74 GWD/MTU
  - Shipped rods to hot cell
  - Hot Cell Exam Report: March 2012.
- April 2011: Approval of WCAP-12610-P-A & CENPD-404-P-A, Addendum 2-P, ZIRLO and Optimized ZIRLO Corrosion Model.
- April 2011: Provide updated Vogtle data and 63 GWD/MTU LUA data in final Optimized ZIRLO data package to NRC. Westinghouse would like the NRC to formally acknowledge that Conditions 6 and 7 have been satisfied.
- June 2011: Submit ZIRLO and Optimized ZIRLO PQD data to NRC.

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Vogtle Creep & Growth Test

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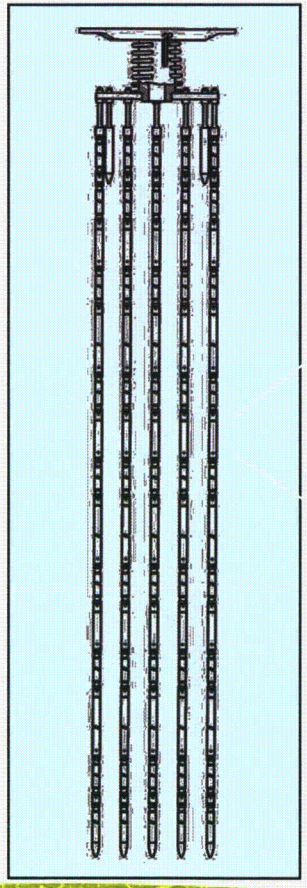
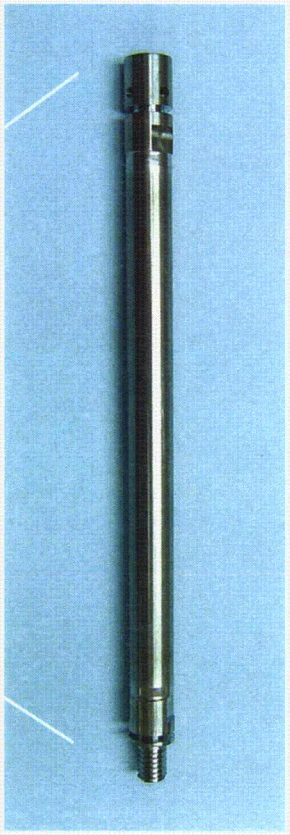
Vogtle Creep & Growth Test - Setup





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Vogtle Creep Capsule Key Results

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Milestones

- Completed inspections and evaluation of results for 1 to 3 cycles.
- Initiated PIE of Four Cycle Test Assemblies A6 and A4
- Initial results for **Optimized ZIRLO** material:
  - Irradiation creep and growth is consistent with previous material.
- **Optimized ZIRLO** material has demonstrated consistent and robust performance under various operating conditions.

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Conclusions

- **Optimized ZIRLO** material is a robust alloy that has demonstrated very good performance at burnups > 70 GWD/MTU under a variety of operating conditions.

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PAD Development

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PAD5.0 Development Approach

- Update Fuel Performance database
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- Integrate fuel performance expertise
  - Experts from several sites (Cranberry, Columbia, and Sweden)
  - Input from Westinghouse partners and external consultants

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Key Model Updates

Area	Models	Data
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Model Update Plan

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PAD5.0 Project - Milestones

Milestone	Status
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