

Fuel Performance Update Meeting with NRC May 16, 2001

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Westinghouse Electric Company



Westinghouse Non-Proprietary Class 3



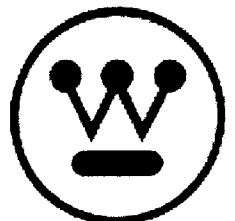
Agenda

- Introduction - Sumit Ray (Non-Proprietary)
- Update/closeout of 17% ECR for ZIRLO™ - Dave Mitchell (Non-Proprietary)
- Discussion on ZIRLO™ topical for CE Plant Application - Tom Rodack or Chuck Molnar (Non-Proprietary)
- Fuel Performance Update (COLA) - Rod Grimoldby (Proprietary)
 - General Update
 - Top Nozzle Screw Update/Integral Clamp Top Nozzle
 - North Anna Top Nozzle Issue Update



Agenda

- Fuel Performance Update (Windsor) - Tom Rodack (Proprietary)
 - Grid-to-Rod Fretting
 - Oxide Spallation
 - Palo Verde 2 Fuel Failures
 - Palo Verde 1 CEA Issue
- Next Generation Fuel - Dave Mitchell (Proprietary)
 - Standard update on LTA programs/other testing
 - Next Gen Fuel Program



Introduction

- Westinghouse Electric Re-organization
 - Columbia, Pittsburgh and Windsor Second Level Management
 - Sumit Ray, Product Engineering
 - Tim Collier, Core Engineering
 - Tom Rodack, Windsor Fuel Engineering
 - Licensing Manager
 - Jay Akers, Core Engineering (Primary Licensing Responsibility)



LOCA Basis Testing of ZIRLO™ Cladding

David Mitchell
Westinghouse Electric Company
May 16, 2001



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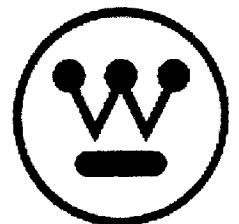
Items for Discussion

- Background on Current issue
- Description of Testing
- Specimen Evaluations
- Results of Testing
- Conclusions



Background on Current issue

- Question of applicability of current LOCA criteria to claddings containing Niobium.
- Work by Böhmert on E110 (Zr1Nb) showed.
 - Complete embrittlement is about 1/3 the value for Zircaloy-4
 - Higher hydrogen pickup for some cases compared to Zircaloy-4
- Westinghouse met with NRC on February 26, 2001 to discuss concerns and to present initial test results.
- Westinghouse also met with ACRS committee on April 4, 2001 to present findings to date.



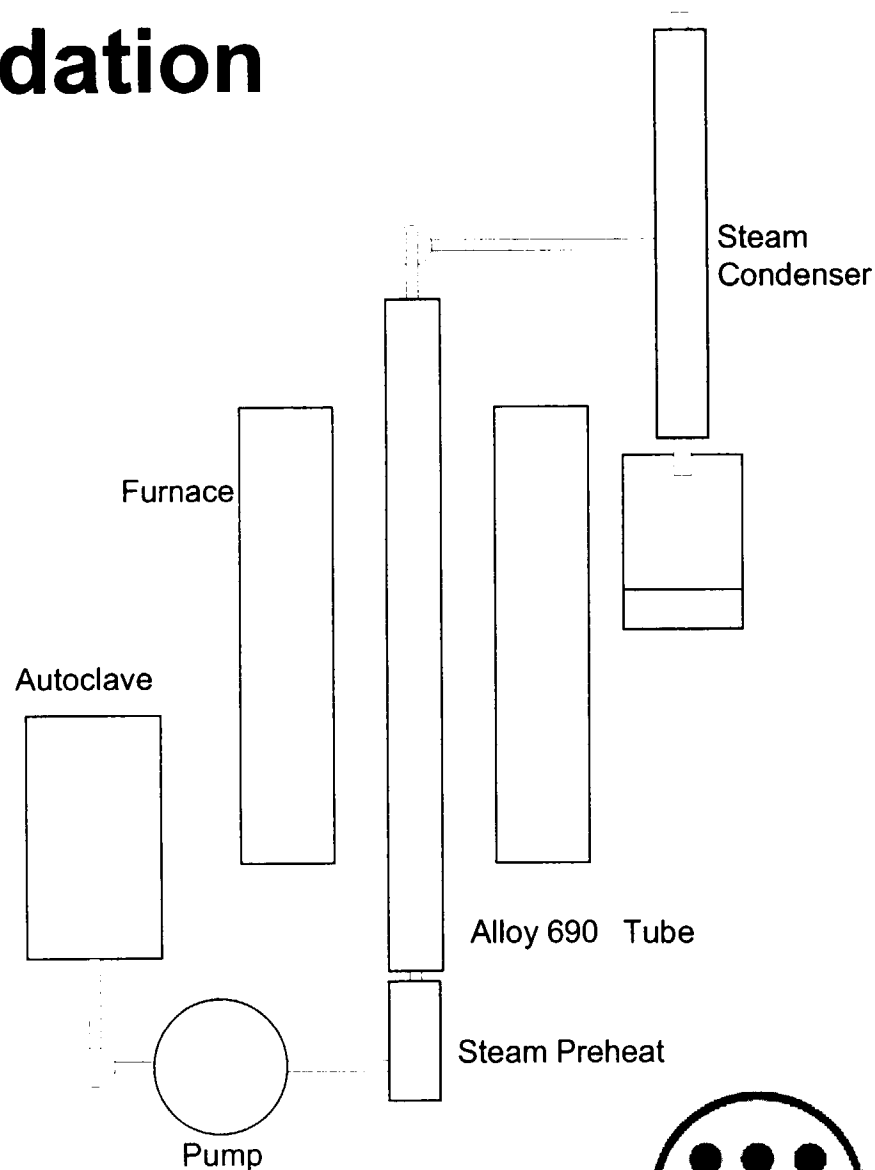
Description of Testing

- 30 Tests of ZIRLO™ and 31 Tests of Zircaloy-4 (61 Samples)
- Temperature Range
 - 1500 °F (815.6 °C)
 - 2300 °F (1260 °C)
- Measured Equivalent Cladding Reacted (ECR) Fraction
 - 0.03
 - 0.36
- Time
 - 3-60 Minutes



Steam Oxidation

- Clam shell resistance furnace.
- Specimens placed in Alloy 690 tube.
- Deaerated water from autoclave pumped into Alloy 690 tube.
- Exit steam condensed by water cooling jacket.

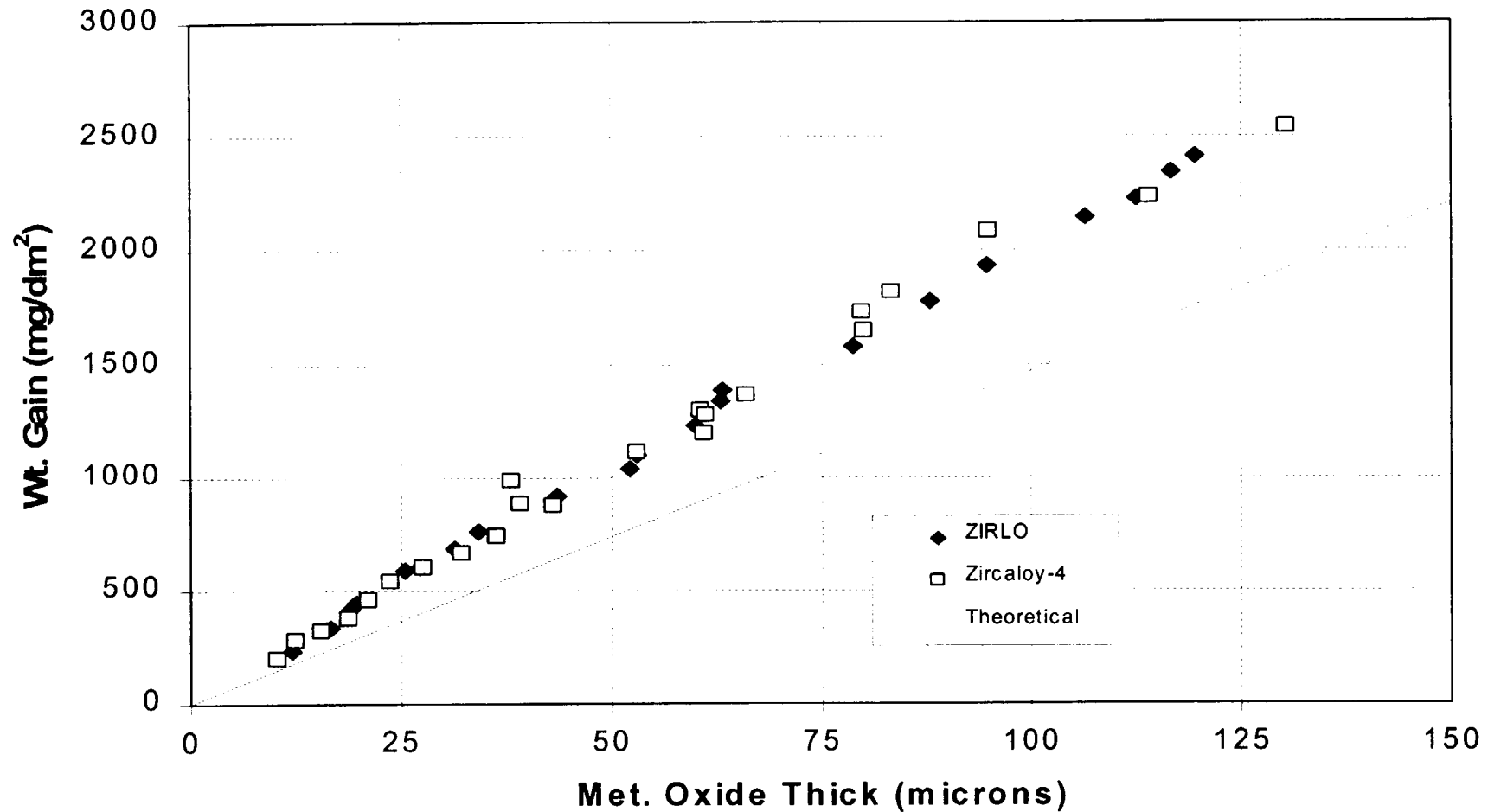


Specimen Evaluations

- Specimen Evaluations
 - Oxide Layer Characteristics
 - Ring compression tests
 - Assess cladding ductility.
 - Room temperature and 275°F.
 - Test performed similar to Hobson & Rittenhouse (ORNL Report 4758) and Böhmert.
 - Optical metallography
 - Oxide thickness, α -stabilized layer, transformed- β layer.
 - Microhardness to assess oxygen penetration.
 - Hydrogen concentrations, oxygen uptake

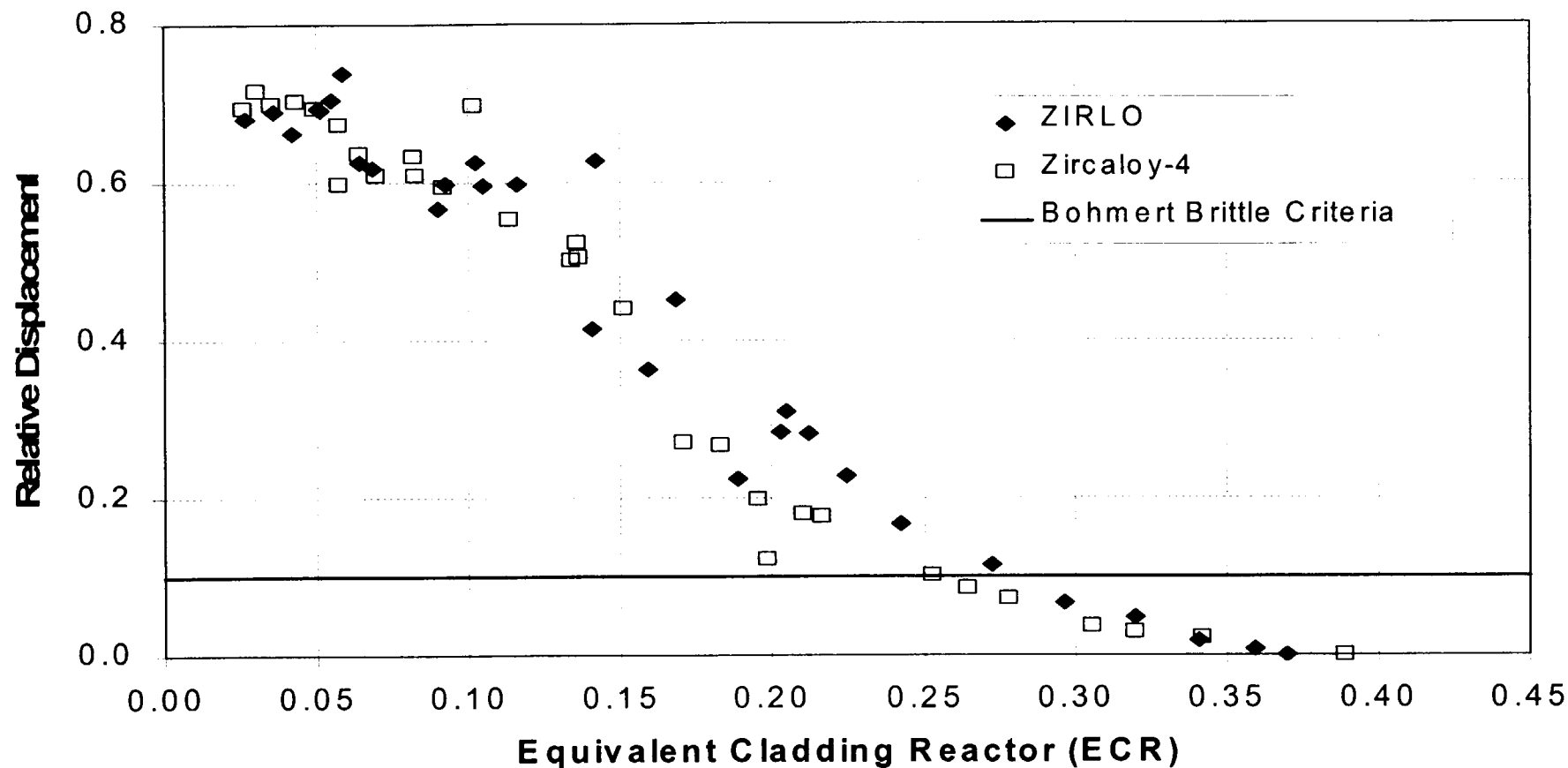
Weight Gain vs Measured Oxide Thickness

Theoretical: $14.7 \text{ mg/dm}^2 = 1 \text{ } \mu\text{m}$ Oxide Thickness



ZIRLO™ and Zircaloy-4 behave the same

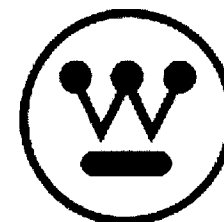
Relative Displacement vs ECR 275°F Ring Compression Test



ZIRLO™ and Zircaloy-4 behave the same

Hydrogen Analysis of Samples

Alloy	Temp °F	Time (min.)	Hydrogen (ppm)
ZIRLO™	1800	30	18
	1950	30	22
	2000	30	24
	2100	30	36
	2200	5	31
	2200	20	31
Zircaloy-4	1800	30	68
	1950	30	32
	2000	30	36
	2100	30	36
	2200	5	34
	2200	20	45



Results of Testing

- Both oxide layers were dark, adherent, and with no laminations
- Hydrogen uptake is low for both ZIRLO™ and Zircaloy-4 with <100 ppm and values ranging from 18 to 68 ppm from 1800 to 2200 °F
- ZIRLO™ and Zircaloy-4 are effectively identical in response and performance to high temperature oxidizing conditions.
 - Fractions of Oxygen in Oxide Layer and Metal
 - Microhardness of
 - α -stabilized layer
 - transformed- β
 - Post Test Ductility using Ring Compression Tests.

Conclusions

- ZIRLO™ and Zircaloy-4 show the same trends as a function of measured Equivalent Cladding Reacted (ECR).
- Tests are completed, Engineering review conducted and results accepted.
- ZIRLO™ and Zircaloy-4 perform the same after exposure to LOCA conditions. Therefore the same criteria are applicable to both alloys.

Implementation of ZIRLO™ in CE Plants

Tom Rodack
Meeting at NRC
May 16, 2001



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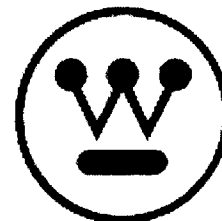
Topical Report Review Status

- ZIRLO™ properties and models have been added to CE codes and methods
- ZIRLO™ Topical was submitted January 22, 2001
- One month acceptance review states target to complete review is August 15, 2001
- Westinghouse issued letter on cause of OPPD fuel rod fretting failures
 - Cause related to grid design
- Expect first set of RAIs by May 16
- Meeting set at NRC on May 21 to discuss RAIs



Implementation of ZIRLO™ Cladding

- Calvert Cliffs Nuclear Power Plant and Arizona Public Service have ordered ZIRLO™ cladding
 - Calvert Cliffs Unit 1 fuel delivery in November 2001
 - Palo Verde Unit 2 Cycle 1 fuel delivery in February 2002
- OPTIN clad is no longer an option for next batch of Calvert Cliffs fuel
- Engineering analysis initiated to support reloads
- Draft license amendments for utilities to reference ZIRLO™ & new LOCA Topical Reports



Summary

- ZIRLO™ will provide real margin to oxidation and spallation fuel performance limits for CE reactors
- Topical report addressing application of ZIRLO™ cladding in CE fuel designs has been submitted
- APS and Calvert Cliffs have ordered ZIRLO™ cladding in next batches of fuel - analysis and ordering of material are in progress