



Fuel Performance Meeting

***September 13-14, 2006
Lynchburg, VA***

AREVA NP, Inc. Proprietary

Fuel Performance Meeting September 14, 2006

- **8:00 Welcome – Gardner**
 - *Introduction and Purpose*
 - *Description of AREVA NP Inc.*
- **8:30 BWR Fuel Designs and Methods – N. Garner**
 - *Description of Current Fuel Designs*
 - *New Fuel Designs and Methods*
 - *Update on Fuel Channel Performance*
- **10:30 PWR Fuel Designs and Methods – Wiltz/Brown**
 - *Description of Current Fuel Designs*
 - *New Fuel Designs*
 - *New Methods*
- **12:00 Lunch**
- **1:00 Recent Fuel Performance Experience – Willse**
 - *Fuel Services Capabilities*
 - *PWR*
 - *BWR*
- **2:30 Irradiation Experience – Strumpell/G. Garner**
 - *Lead Test Assembly Programs*
 - *Post Irradiation Exams*
 - *Extended Burnup Experience*
- **4:30 Conclusion - Gardner**
- **4:45 Adjourn**

Introduction and Purpose

Ronnie L. Gardner
Manager, Site Operations and Regulatory Affairs

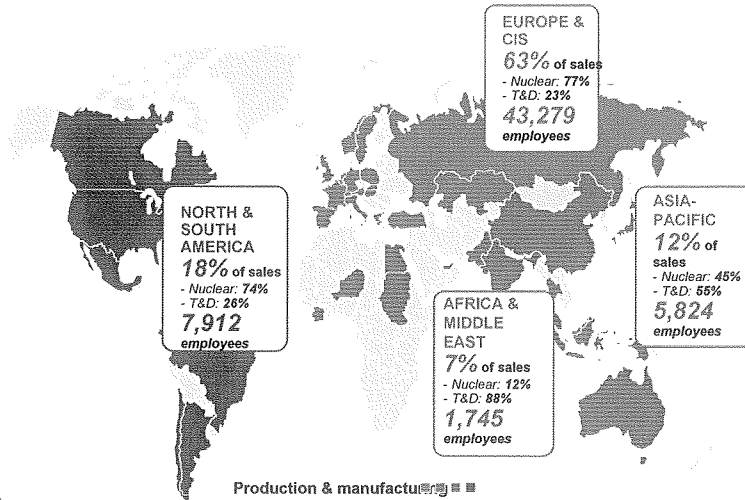
Introduction

- ▶ *Introduction of participants*
- ▶ *Outline of discussion*
 - ♦ *Current fuel designs*
 - ♦ *New fuel designs and methods*
 - ♦ *Recent experience*
 - ♦ *Fuel development*
- ▶ *Objectives*
 - ♦ *Understanding AREVA NP Inc.'s fuel design*
 - ♦ *Exchanging ideas and expectations on fuel issues*
 - ♦ *Open communication; ask questions*

Description of AREVA NP Inc.

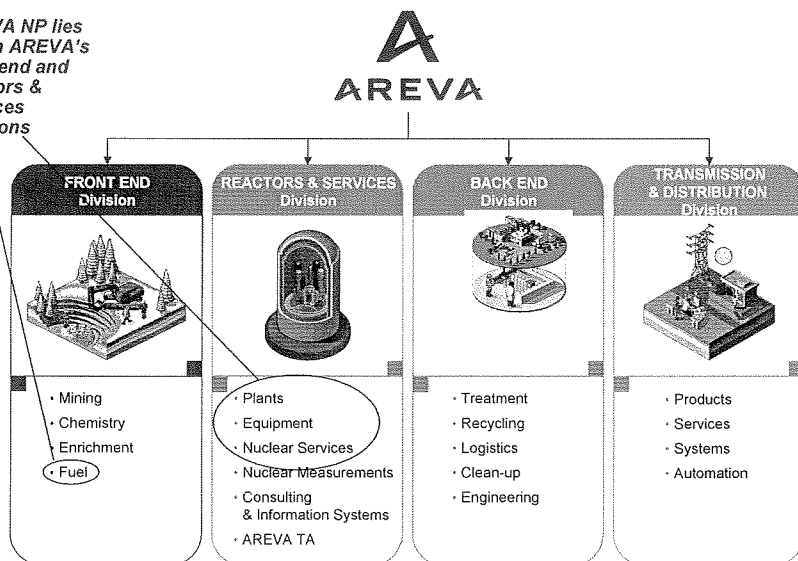
AREVA around the globe

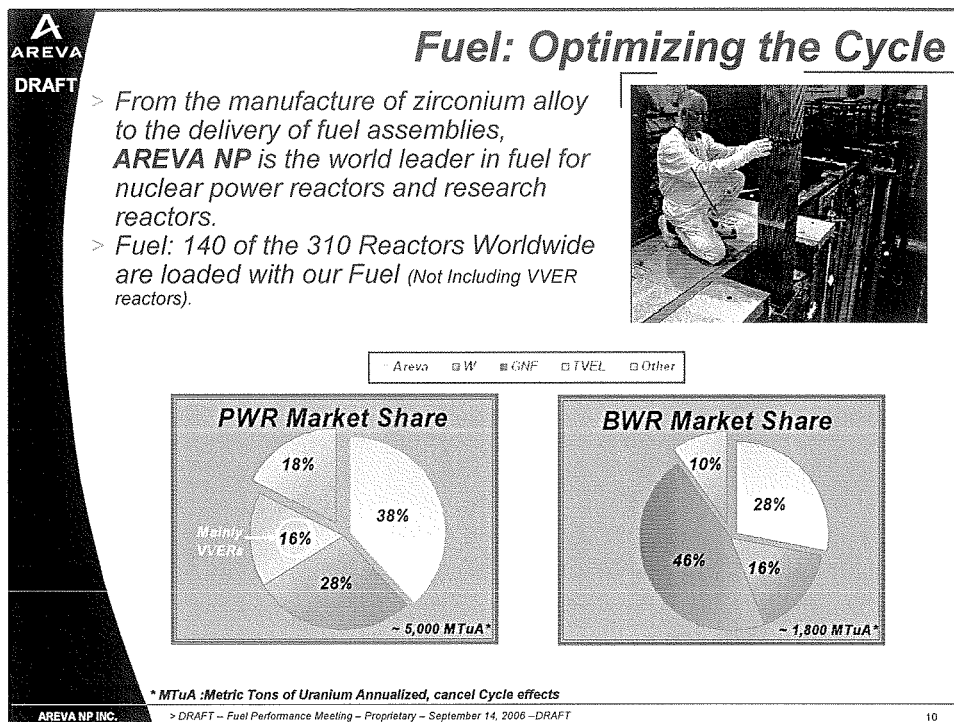
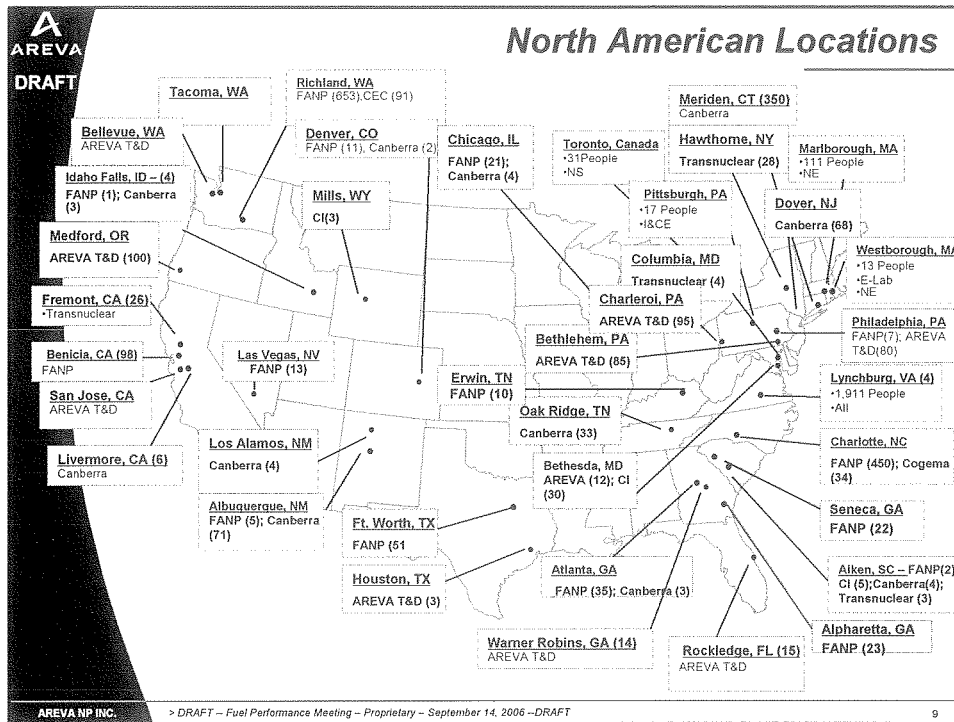
40 countries Production & Manufacturing | **100 countries** Marketing & Sales | **€6,754M: 67%** of all sales come from outside France



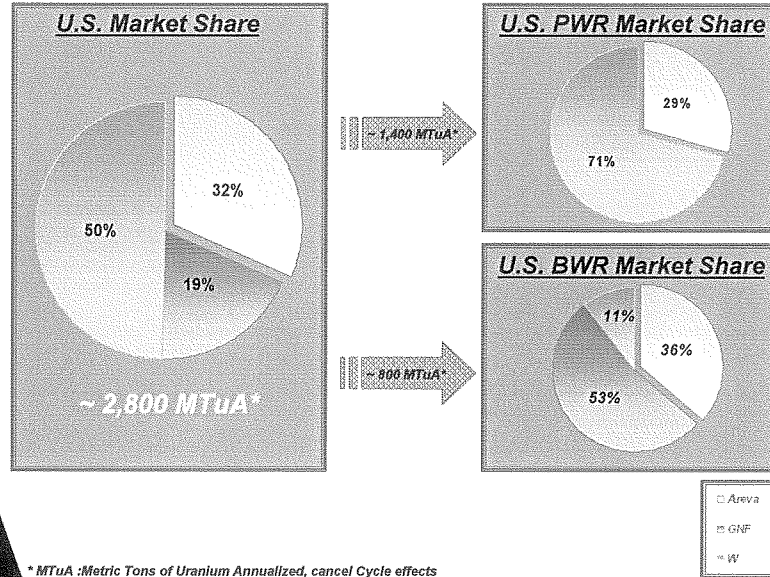
Organization of the group

AREVA NP lies within AREVA's front end and reactors & services divisions

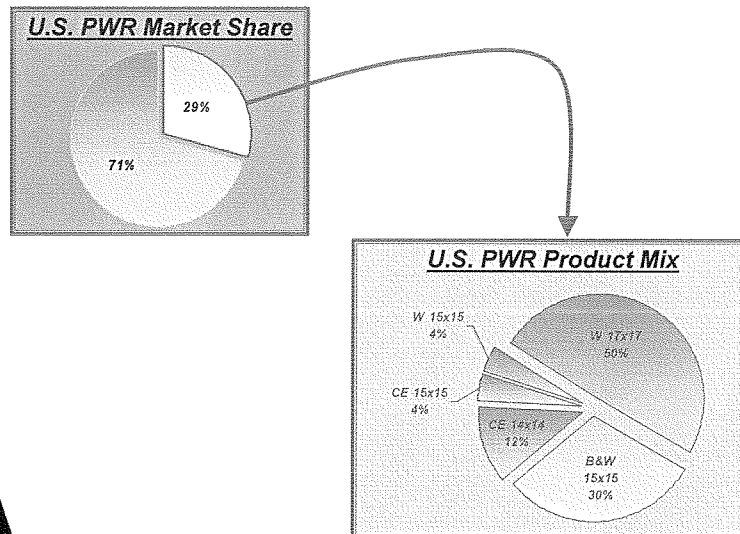


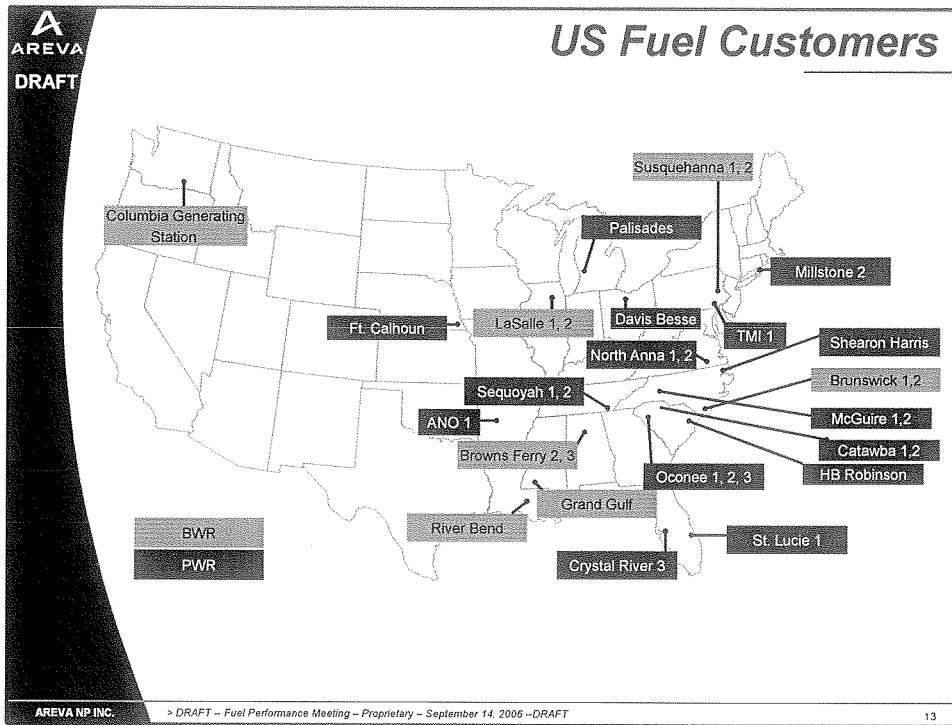


U.S. Market Share



U.S. Market Share: PWR Product Mix





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Operations Mt. Athos Road Facility

- > Constructed in 1968
- > Facility size: 68,000 square feet
- > Shipped 14,000 fuel assemblies since 1971
- > Shipped 1,600 incore detectors since 1983
- > Average workforce experience: 17 years
- > INS SERF facilities on site
- > Pump and motor services building

AREVA NP INC. AREVA NP General Capabilities



Operations Horn Rapids Road Facility

- > Constructed in 1971
- > Facility size: 400,000 square feet
- > Shipped 46,506 fuel assemblies since 1971
 - BWR: 33,175
 - PWR: 13,331
- > Shipped powder for 174 contracts since 1990
- > Shipped pellets/rods for 293 contracts since 1989
- > Average workforce experience: 13 years
- > Analytical and materials laboratories
- > Advanced fuel design performance testing

AREVA NP INC.

AREVA NP General Capabilities



AREVA NP Inc. Executive Team



President & CEO
Tom Christopher



Senior Vice President Nuclear Services
George Beam



Senior Vice President Nuclear Fuel
John Matheson



Acting Manager Nuclear Eng. & New Plants Eng.
Bill Fox



Senior Vice President Projects & Mechanical Components
Tony Granda



Senior Vice President Sales & Marketing
Andrew Cook



Senior Vice President Federal Group
Tom Stevens



Senior Vice President New Plants Deployment
Ray Ganthner



Acting Manager Instrumentation & Controls Engineering
Don Janacek



Vice President and Chief Financial Officer
Kathy Williams



Chief Counsel Legal
Dave Guza



Vice President Business Integration
Jim Hicks



Vice President AREVA NP CN, Ltd.
Steve Hamilton



Vice President Human Resources & Facilities
Steve Blickenstaff



Vice President Information Systems
Bob Kibler



Vice President Region Quality
Emily Mayhew

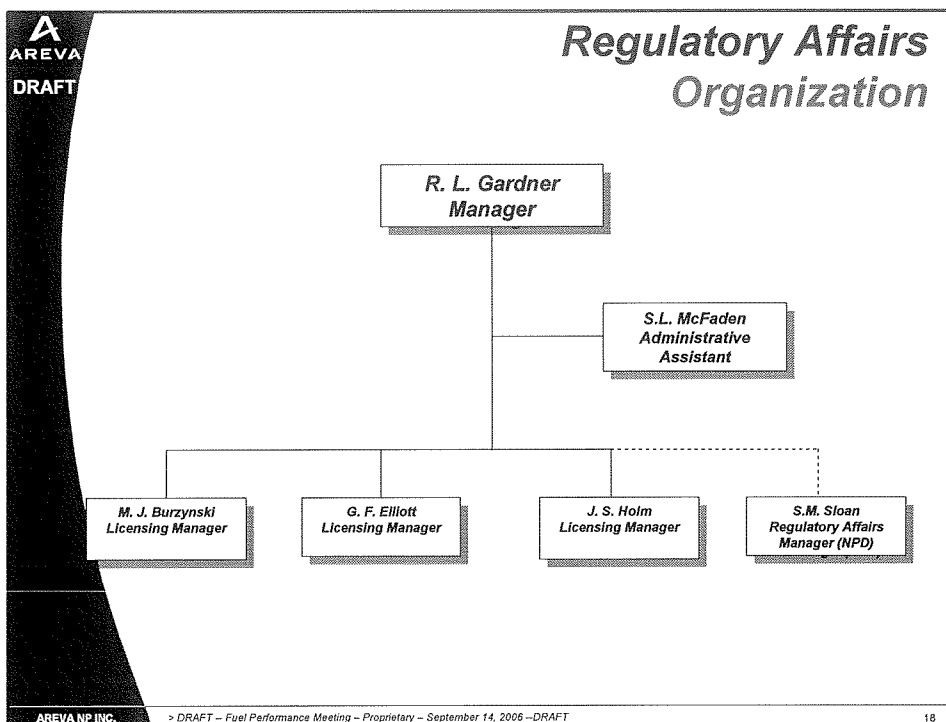
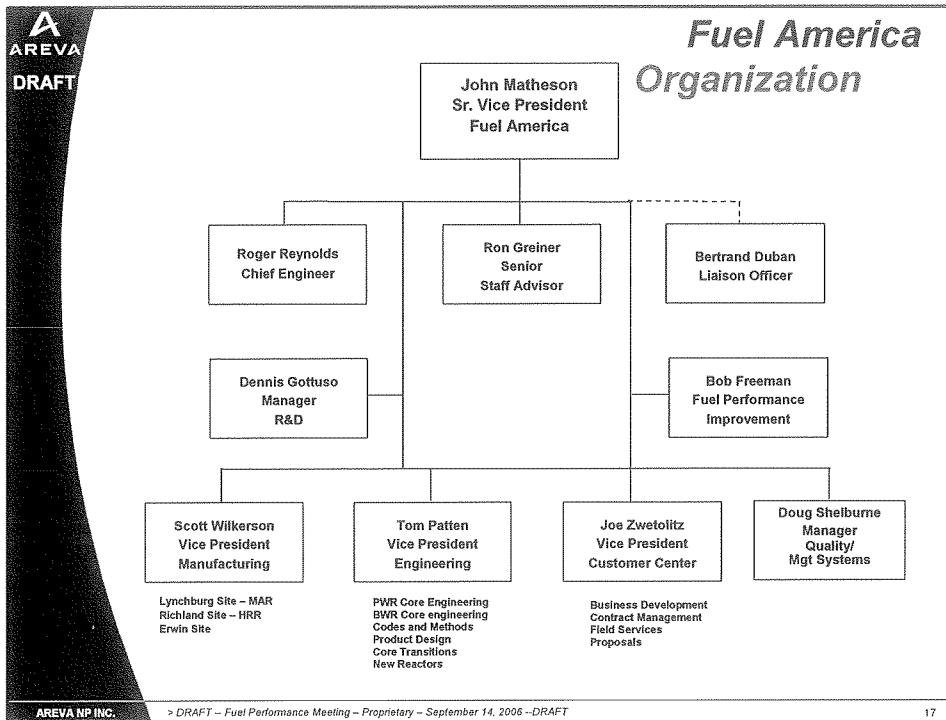


Vice President Charlotte Site Office and U.S. Region Safety
Bill Fox

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Ground Rules

- > **If evacuation is necessary, go to nearest EXIT and then to the assembly area**
- > **Turn off all telephones and pagers or set them to vibrate**
- > **Breaks will be established as needed**
- > **Ask questions; dialogue is welcome**

BWR Fuel Designs and Methods

Norm Garner
Product Manager, BWR Fuel

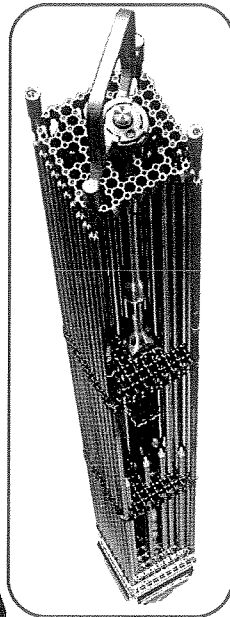
BWR Overview for USNRC

- > *Current AREVA BWR Fuel Designs***
- > *Advanced BWR Development***
- > *Advanced Methods Development***
- > *Fuel Channel Performance Update***

ATRIUM 10 Family of Fuel Designs

- > *High Performance***
- > *Proven Reliability***
- > *Refined Manufacturing***

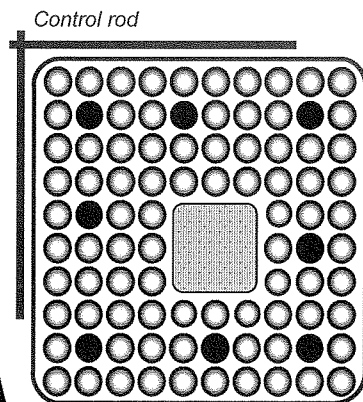
Current BWR Fuel Products



ATRIUM™ 10 Family

- ATRIUM 10
- ATRIUM 10XP
- ATRIUM 10XM

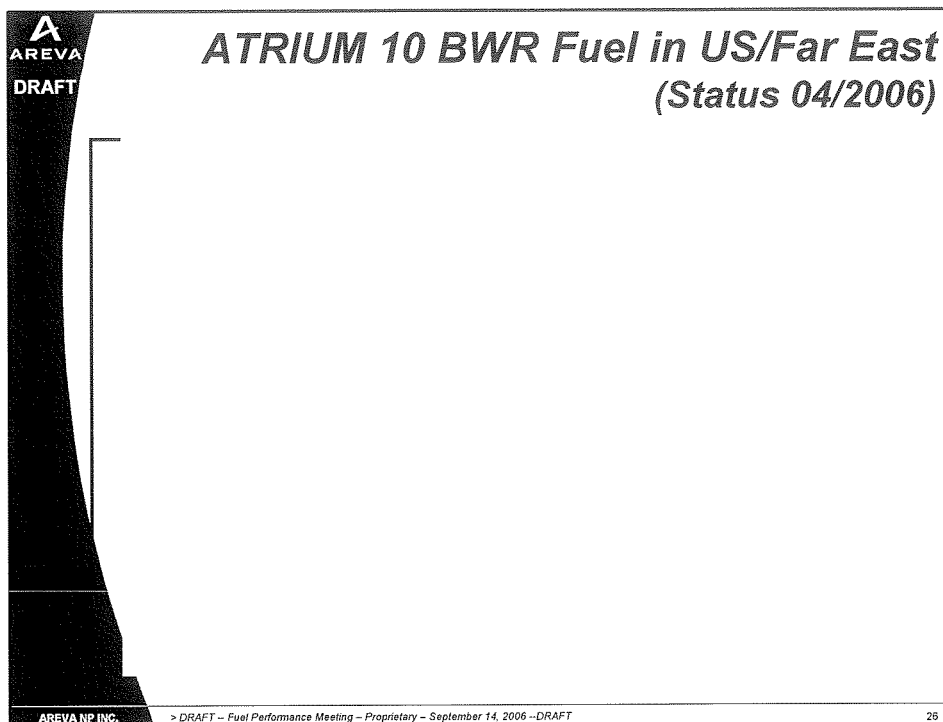
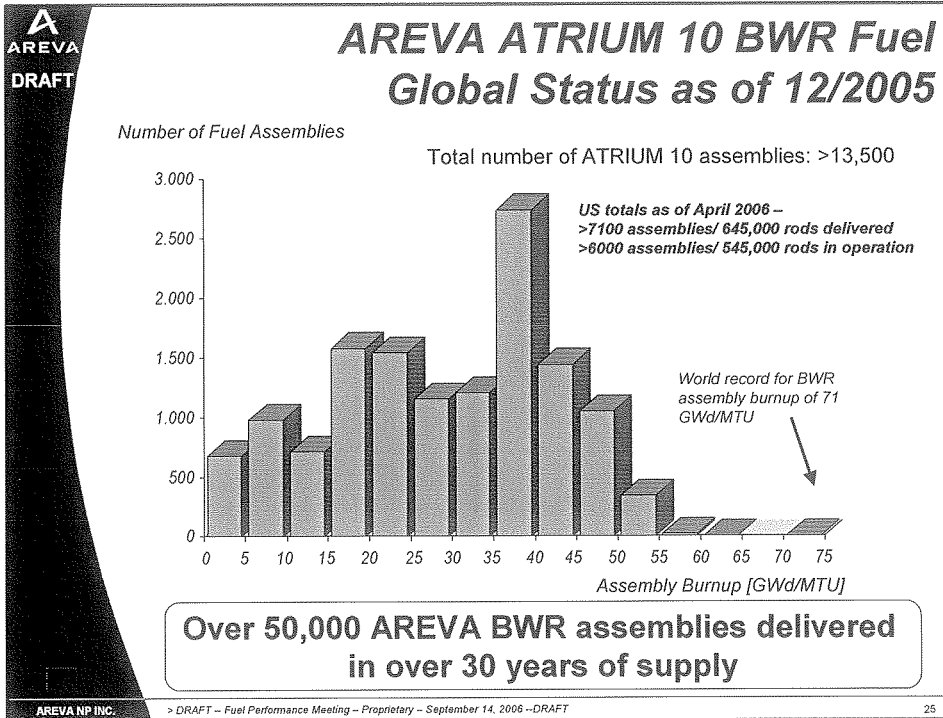
ATRIUM 10




ATRIUM 10 represents a proven and reliable high performing, well-balanced fuel design

● Part-length fuel rod

US Reload Operation Since 1996






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Upgraded components (ATRIUM 10XP/XM)

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ATRIUM 10XP

ATRIUM 10XP provides
higher fuel weight and
better stability

Operating since 2002

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ATRIUM 10XM

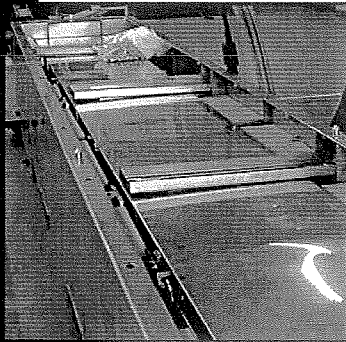
**ATRIUM 10XM provides
superior MCPR capability
and fuel utilization**

Operating since 2005

ATRIUM 10 Designs

BWR Fuel Shipment & Handling

- > ***ATRIUM 10 fuel is currently handled consistent with past experience with AREVA and GNF fuel:***
 - ♦ ***Fuel bundles and fuel channels received separately at plant site and paired after receipt inspection***




- > ***AREVA is progressively building a fleet of RAJ-II shipping containers***
 - ♦ ***Co-licensed with GNF***


Advanced BWR Fuel Product Development

Key Objectives:


- > ***Responsive to customer needs***
- > ***No compromise of reliability***
- > ***Innovative features backed by rigorous testing***


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Advanced BWR Fuel Assembly
Development




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Advanced BWR Fuel Design



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Advanced BWR Design Introduction Timeline

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KATHY Hydraulic Loop - Rated Conditions and Stability Testing Capability

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This slide is titled "AREVA BWR Fuel Supply Summary". It features the AREVA logo and the word "DRAFT" in the top left corner. The main content is a bullet point: "> AREVA's ATRIUM 10 is a well-proven and highly reliable product that continues to deliver excellent value for today's BWR operations". The footer contains the text "AREVA NP INC." on the left, "> DRAFT – Fuel Performance Meeting – Proprietary – September 14, 2006 –DRAFT" in the center, and the number "38" on the right.

Advanced BWR Methodology Development

Key Objectives:

- > *Improved and extended mechanistic modeling*
- > *Reduced use of empirically-derived algorithms*
- > *Robust V&V processes*

BWR Methodology Development Overview


- > ***AREVA is committed to continual improvement of our analytical methodology***
 - ♦ *Global development teams integrating diverse experience in both PWR and BWR technology*
 - ♦ *Expanded validation base including operational regimes that are not currently practiced in the US*
 - ♦ *Strong backing by AREVA NP experimental test facilities located throughout the world*
- > ***Migration to best-estimate methods provides:***
 - ♦ *Better understanding of the physical phenomena*
 - ♦ *Better quantification of uncertainties*
 - ♦ *Clearer understanding of operational safety margins*

BWR Methodology Development Overview (cont.)

- > ***Recent methodology advances provide a strong foundation for continual improvement:***
 - ♦ ***CASMO-4/MICROBURN-B2 neutronics methodology***
 - *Reliable predictions of core reactivity and power distributions*
 - ♦ ***STAIF stability methodology***
 - *Direct computation of channel, global and regional stability margins with the lowest uncertainties in the industry*
 - ♦ ***S-RELAP5 RLBLOCA methodology***
 - *Best-estimate capability following CSAU development methodology*
 - ♦ ***RAMONA5-FA DIVOM methodology***
 - *Provided cycle specific safety evaluations to address Part 21 issues on BWROG LTS methodology*

Recent Submittals

- > ***RODEX-BWR mechanical analysis – August 2004***




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Recent Submittals (cont.)

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Recent Submittals (cont.)

- > **ACE/ATRIUM-10 critical power correlation – May 2006**

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Current Development Programs


- > ***MICROBURN-B2 enhancements based on continual feedback from operating reactor***
 - ◆ *Central to all BWR methods*
- > ***SAFLIM2 upgrade to incorporate ACE/ATRIUM-10 correlation***

Current Development Projects (cont.)

Current Development Projects (cont.)



BWR Fuel Channel Performance Update



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Channel Measurement Campaigns

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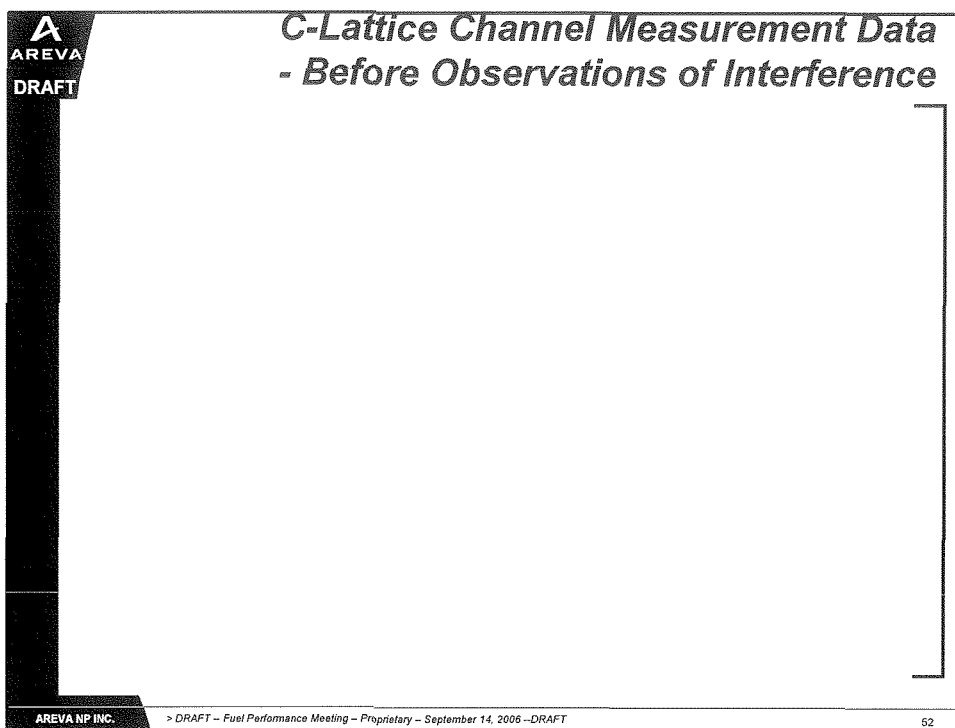
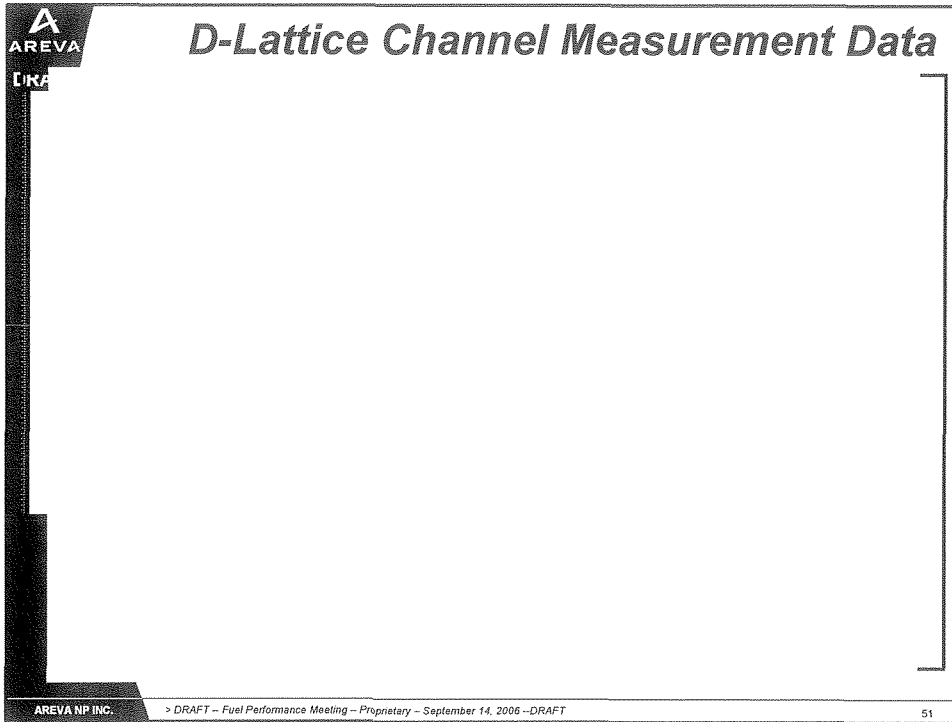

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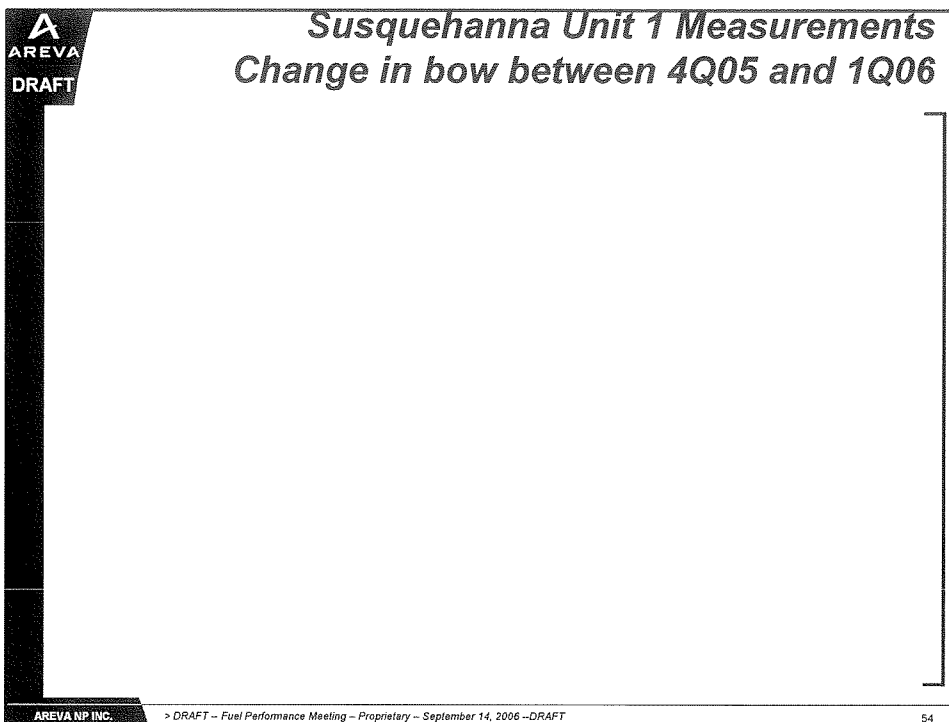
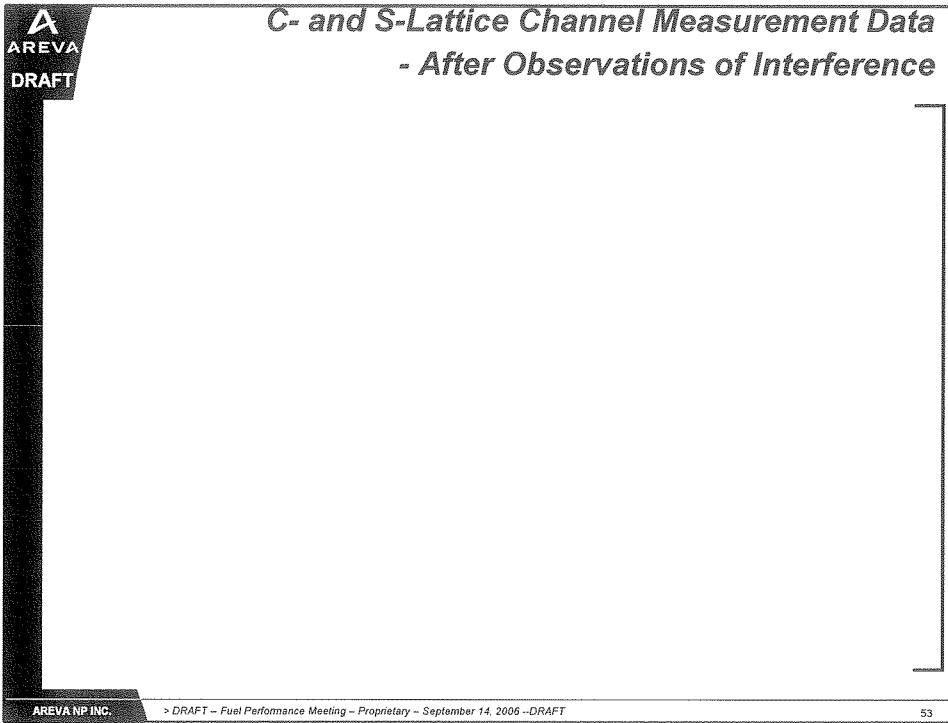
AREVA Fuel Channel Designs for US Market

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Observations Based on Measurements to Date



Root Cause Evaluation Important Action Status

- > ***Expand data collection***
 - ♦ ***Channel coupons for examination of hydrogen content and oxide layers***
 - ♦ ***Crud scraping for constituent and morphology analyses***
 - ♦ ***Poolside oxide measurements to assess normal and shadow corrosion magnitudes on large population of channels***
 - ♦ ***Channel measurement campaigns to support quantifying growth and bow***
- > ***An agreement between GNF and AREVA has been arranged via EPRI to exchange channel coupon data***
 - ♦ ***Lessons learned from GNF coupon campaign applied to improve sampling and evaluation of AREVA coupons***

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Fuel Channel Coupon Sampling

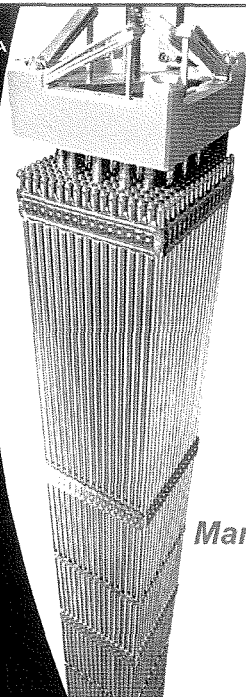
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AREVA Fuel Channel Performance Experience Summary Comments

- > *AREVA is responding to this issue as a major challenge to plant operations*
- > *Understanding the abnormal bow phenomenon requires extensive data collection at plant sites*
- > *Cooperative pursuit of the root cause is underway among operators, fuel vendors, and EPRI to most effectively reach closure of this issue*
- > *AREVA is not stopping at the first answer and will follow through to the extent practicable to identify the actual mechanism and key causal factors*

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Description of Current and New PWR Fuel Designs

Prepared by: Joel R. Hartman
PWR Product Manager

Presented by: Chris Wiltz
Manager, Mechanical Design & Engineering

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PWR Product Overview

- > **Advanced Mark-BW Design**
 - ♦ Used in Westinghouse 17x17 Plants
 - ♦ Design Variants: Mark-BW, Advanced Mark-BW, and Advanced Mark-BW(A)
 - ♦ Design Utilized for MOX Program
- > **Mark-B Design**
 - ♦ Used in Babcock & Wilcox 15x15 Plants
 - ♦ Current Design Variants: Mark-B11, Mark-B12 and Mark-B-HTP
- > **HTP Design**
 - ♦ Design concept applicable to B&W, CE, Framatome ANP, Siemens KWU and Westinghouse Plants (14x14 to 18x18 Arrays)
 - ♦ EPR Reactor will utilize a 14' HTP design

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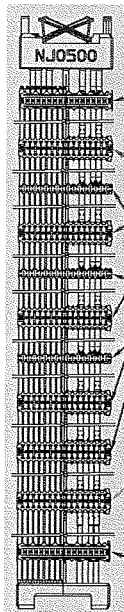
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Outline of Presentation

- > **Advanced Mark-BW Design Overview** ✓
 - ♦ *Design Features*
 - ♦ *Operating Experience*
 - ♦ *Planned Enhancements*
- > *Mark-B Design Overview*
- > *HTP Design Overview*
- > *New PWR Fuel Design Development*

Overview of Advanced Mark-BW Assembly

- ♦ **Removable Upper End Fitting**
 - Alloy 718 Leaf Springs
 - Quick Disconnect Feature
 - ♦ **M5 Fuel Rods**
 - ♦ **M5 Guide Tubes (offered with MONOBLOC™)**
 - ♦ **M5 Instrument Tubes**
 - ♦ **TRAPPER™ Lower End Fitting (offered with FUELGUARD™)**
- 
- The diagram shows a vertical cross-section of the fuel assembly. At the top is the 'NJ0500' upper end fitting. Below it is the 'Alloy 718 Top Grid'. Several 'M5 Mixing Grids' are shown in the upper section. Below these are 'M5 Mid-Span Mixing Grids (optional)'. Further down is an 'M5 Non-Vaned Grid (offered with vane version)'. At the bottom is the 'Alloy 718 Lower Grid' and the 'TRAPPER™ Lower End Fitting'.
- Alloy 718 Top Grid
 - M5 Mixing Grids
 - M5 Mid-Span Mixing Grids (optional)
 - M5 Non-Vaned Grid (offered with vane version)
 - Alloy 718 Lower Grid

Design Features – Utilizes Alloy M5

► Applicable Components:

- ♦ Fuel Rods
- ♦ Guide Tubes / Instrument Tubes
- ♦ Intermediate Grids and Mid-Span Mixing Grids

► Performance with M5 (vs. Zircaloy-4)

- ♦ 3 to 4x Lower Corrosion at High Burnup
 - Greater Margin at Higher Burnups
- ♦ 2x Improvement in Growth Performance
 - Design Optimization
 - Reduce Integrated Fuel Assembly Axial Loads over life
- ♦ Very low sensitivity to reactor duty factors (i.e., heat flux, temperatures and power)
- ♦ Licensed by the USNRC (December 1999)

Design Features – Spacer Grids

> End Grids – Alloy 718 (Low Cobalt)

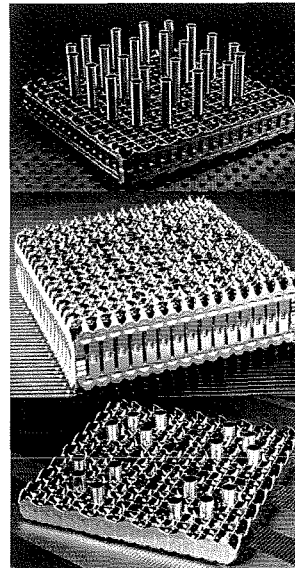
- ♦ Utilized at bottom and top positions
- ♦ Non-vaned

> Intermediate Grids – M5

- ♦ Optimized mixing vanes
- ♦ Non-vaned version available for lower region
- ♦ Wide support – fretting resistance
- ♦ Handling robustness

> Mid-Span Mixing Grid – M5

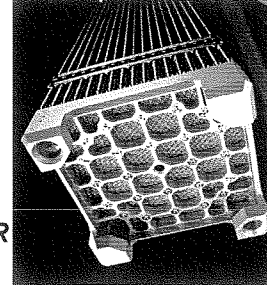
- ♦ Added thermal performance



Design Features – Lower End Fitting

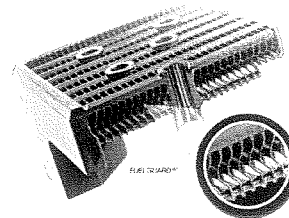
> TRAPPER™ Plate

- ♦ **Cast Frame and Web**
 - Provides structural support
 - Accommodates attachment of guide tubes with secured cap screws
- ♦ **No debris passing through TRAPPER has caused failures since introduction (over 2,500)**
- ♦ **Two Mesh sizes offered**




> FUELGUARD™ Offered with Advanced Mark-BW(A)

- ♦ **No debris passing through FUELGUARD has caused failures since introduction (over 6,300)**




Operating Experience – Mark-BW Fuel Assembly



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Operating Experience – Mark-BW Fuel Assemblies



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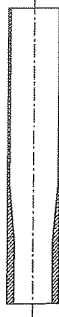
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Planned Enhancements – Structure

- > **MONOBLOC™ Guide Tubes**
 - ◆ Increased Wall Thickness and Reinforced Dashpot
 - ◆ Increase Assembly Stiffness (Reduce Bow & Twist)
 - ◆ Extensive experience (>15,000 Assemblies)
 - ◆ Implementation: Begins Fall 2007
- > **Welded Structure – Advanced Mark-BW(A)**
 - ◆ Based on other AREVA designs (HTP, AFA, ...)
 - ◆ Improves lateral and torsional stiffness
 - ◆ Related Design Features:
 - FUELGUARD™ lower end fitting
 - Replace Vaneless grid with Vaned Mixing ISG
 - Adjust grid springs for automated “Non-Keyed” rod loading
 - Alloy 718 end grid design proven with HTP designs
 - ◆ Implementation: Fall 2007





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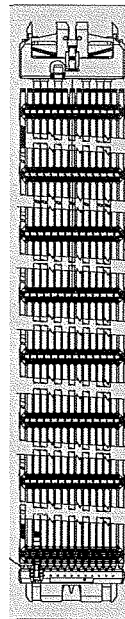
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Outline of Presentation

- ▶ **Advanced Mark-BW Design Overview** ✓
- ▶ **Mark-B Design Overview** ✓
 - ♦ *Design Features*
 - ♦ *Operating Experience*
 - ♦ *Planned Enhancements*
- ▶ **HTP Design Overview**
- ▶ **New PWR Fuel Design Development**

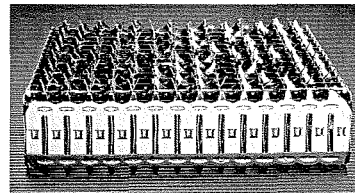
Overview of Current Mark-B Fuel Assemblies

- ♦ **Removable Upper End Fitting**
 - Alloy 718 Cruciform Springs
 - “Quick Disconnect” on Mark-B11
- ♦ **M5 Fuel Rods**
- ♦ **M5 Guide Tube**
- ♦ **M5 Instrument Tube**
- ♦ **Lower End Fitting**
 - Mark-B11: Plug-in-Grid
 - Mark-B12: TRAPPER™



♦ **Alloy 718 Top Grid**

♦ **Zirc-4 Intermediate Grids (Mark-B11 Utilizes Mixing Vanes)**

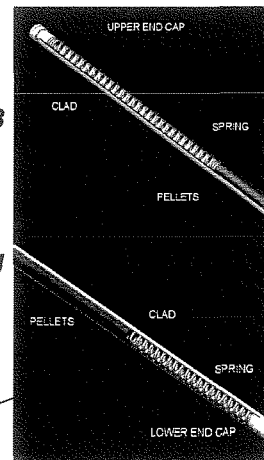


♦ **Zirc-4 Vaneless Grid**

♦ **Alloy 718 Lower Grid**

Design Features – Fuel Rods

- > **Application of M5**
 - ♦ Increased Corrosion Protection
 - ♦ Reduced Hydrogen Pickup
 - ♦ Improved Growth Behavior
- > **Mark-B11**
 - ♦ Reduced Diameter (0.416 inch) for 18 Month Cycle Operation
 - ♦ Long Lower End Cap in Lower Grid for Debris Protection
 - ♦ Stainless Steel Upper Plenum Spring
- > **Mark-B12 / Mark-B-HTP**
 - ♦ Heavier Loaded Fuel Rod (0.430 Inch) for 24 Month Cycle Operation
 - ♦ Stainless Steel Upper and Lower Plenum Springs



Operating Experience – Mark-B Fuel Assemblies

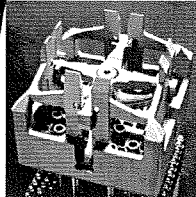
- > **9,840 Mark-B Fuel Assemblies delivered since 1972**
- > **Proven Experience in eight US Reactors (Typically 18 and 24-Month Cycles)**

| <u>Unit</u> | <u>Batches</u> | <u>Fuel Assemblies</u> |
|-----------------------|----------------|------------------------|
| ♦ Oconee-1 | 25 | 1,487 |
| ♦ Oconee-2 | 24 | 1,441 |
| ♦ Oconee-3 | 25 | 1,465 |
| ♦ Crystal River-3 | 15+2* | 997 + 169* |
| ♦ ANO-1 | 21+1* | 1,277 + 56* |
| ♦ Davis-Besse | 16+1* | 997 + 76* |
| ♦ Three Mile Island-1 | 18 | 1,205 |
| ♦ Three Mile Island-2 | 3 | 177 |
| ♦ Rancho Seco | 9 | 493 |
| TOTAL | 160 | 9,840 |

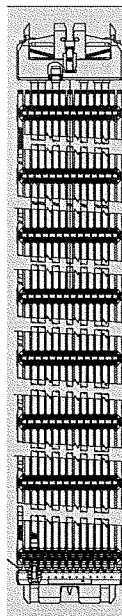
* Mark-B-HTP Product

Planned Mark-B Enhancements – Mark-B-HTP

Overview of Mark-B-HTP Fuel Assembly

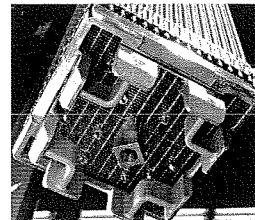


- ♦ **Removable Upper End Fitting**
 - ♦ Alloy 718
 - ♦ Cruciform Springs
- ♦ **M5 Fuel Rods**
- ♦ **M5 Guide Tube**
- ♦ **M5 Instrument Tube**
- ♦ **FUELGUARD™ Lower End Fitting**



M5® HTP Grids (7x)

Alloy 718 Lower HMP Grid



Outline of Presentation

- > *Advanced Mark-BW Design Overview* ✓
- > *Mark-B Design Overview* ✓
- > *HTP Design Overview* ✓
 - ♦ *Design Features*
 - ♦ *Operating Experience*
 - ♦ *Planned Enhancements*
- > *New PWR Fuel Design Development*

Overview of Current HTP Fuel Assemblies

(W15x15 Shown)

♦ Hold-down Springs

- *W – Leaf Springs*
- *CE – 5 Coil Springs with Reaction Plate*
- *B&W – Cruciform*

♦ Removable Upper End Fitting

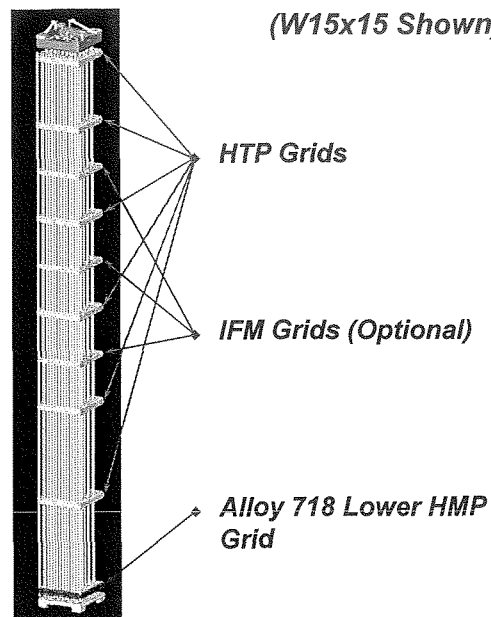
- *“Quick Disconnect”*

♦ Fuel Rods

♦ Guide Tube

♦ Instrument Tube

♦ FUELGUARD™ Lower End Fitting



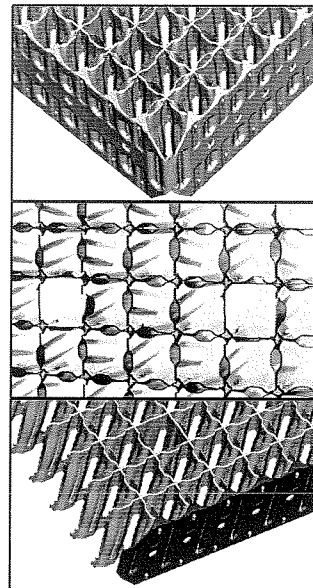
HTP Spacer Grid Design Concept



- ♦ *Balanced Stiffness and Damping Characteristics*
- ♦ *Highly Effective Energy Dissipation*
- ♦ *"Dual Line Contact" Rod Support System*
- ♦ *Robust Construction*
- ♦ *Low Flow Resistance*
- ♦ *Curved Flow Channels for Flow Mixing*

Design Features – Spacer Grids

- > **HTP Grid**
 - ♦ *M5 (Zirc-4) Material*
 - ♦ *Curved Flow Channels*
 - ♦ *Welded to Guide Tubes*
- > **IFM Grid**
 - ♦ *Added Thermal Performance*
 - ♦ *M5 (Zirc-4) Material*
 - ♦ *Angled Flow Channels*
 - ♦ *Welded to Guide Tubes*
- > **HMP End Grid**
 - ♦ *Lower Grid Location*
 - ♦ *Alloy 718 Material*
 - ♦ *Straight Flow Channels*
 - ♦ *Capture Rings*



Design Features – FUELGUARD™

> FUELGUARD™ Design

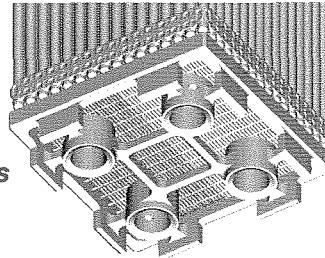
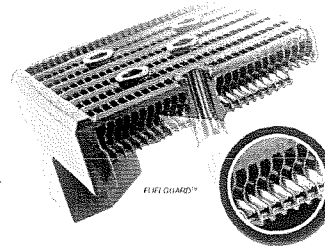
- ♦ No direct line of sight
- ♦ Effectively filters debris
- ♦ Low pressure drop
- ♦ Reduction of inlet turbulence

> FUELGUARD™ Effectiveness

- ♦ No debris passing through
FUELGUARD has caused failures
- ♦ Over 6,300 PWR assemblies
delivered with FUELGUARD
debris protection

> Design Versatility

- ♦ Same concept applied to various
PWR Designs and BWRs




Operating Experience – Highlights of HTP Assemblies

- > Over 6,800 HTP Fuel Assemblies loaded into 41 plants
- > Maximum achieved fuel assembly burn-up of 65 GWd/mtU
- > Worldwide – Zero known Fretting Failures at HTP Spacer Positions
 - ♦ 18 Years of flawless operation (1,594,379 Fuel Rods)
- > Proven in a wide range of design variants and flow conditions
 - ♦ CE 14x14 and 15x15 (First in 1988)
 - ♦ Siemens KWU 15x15, 16x16 and 18x18 (First in 1989)
 - ♦ Framatome ANP 17x17 (First in 1993)
 - ♦ Westinghouse 14x14, 15x15 and 17x17 (First in 1994)
 - ♦ B&W 15x15 (First in 2003)
 - ♦ Currently Adapting for CE 16x16 HTP Design
 - ♦ Planned for EPR 14' 17x17 Design

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Planned Enhancements – Material and Structure




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Outline of Presentation

- > *Advanced Mark-BW Design Review* ✓
- > *Mark-B Design Review* ✓
- > *HTP Design Review* ✓
- > *New PWR Fuel Design Development* ✓

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Product Evolutionary and Revolutionary Development Process

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The GAIA Project – Innovation for the Future


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The GAIA Project – Innovation Process



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Conclusion

Fuel Product Designs continue to evolve:

- > *Meet operational needs*
- > *Increase fuel performance and reliability*
- > *Increase design margins and safety*

Questions?


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New Methods

Graydon S. Uyeda
Supervisor, Reload Design & Analysis
PWR Engineering

Current Code Systems – Global Diversity

| | <u>Lynchburg</u> | <u>Richland</u> | <u>Paris/Lyon</u> | <u>Erlangen</u> |
|----------------------------|------------------|-----------------|-------------------|-----------------|
| <i>Cross-Section</i> | CASMO-3 | CASMO-3 | APOLLO-2 | CASMO-3 |
| <i>Neutronic Simulator</i> | NEMO | PRISM | SMART | PRISM |
| <i>Kinetic Simulator</i> | NEMO-K | --- | SMART-K | PANBOX |
| <i>Thermal-Hydraulics</i> | LYNXT | XCOBRA-IIIC | FLICA-IIIF | COBRA-3CP |
| <i>Fuel Rod</i> | TACO3 | RODEX2A | COPERNIC | CARO |




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The Future – and Beyond!

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APOLLO / ARTEMIS Development

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APOLLO / ARTEMIS Features

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APOLLO / ARTEMIS Features
(cont.)

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Benefits of APOLLO / ARTEMIS System




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BWR & PWR Fuel Reliability and Performance


John T. Willse
Manager, Fuel Reliability and Performance

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PWR Fuel Performance

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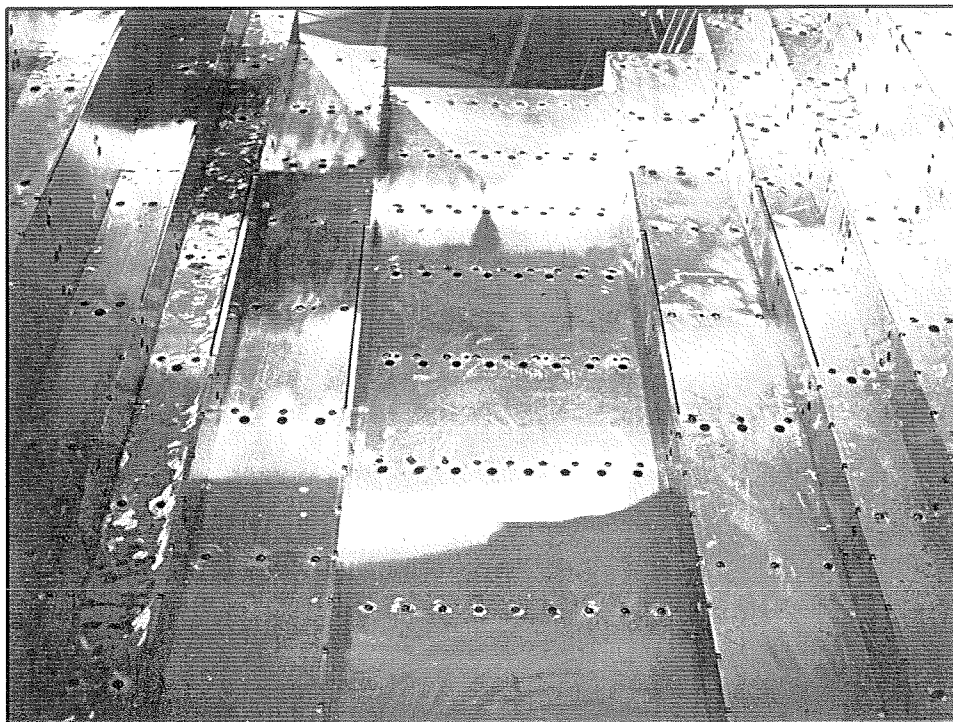
Recent PWR Fuel Reliability


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AREVA NP PWR Fuel Performance Status as of 07/18/06

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Baffle Design

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Status Current PWR Failure Mechanisms

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Status Current PWR Failure Mechanisms (cont.)

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Status Current PWR Failure Mechanisms (cont.)

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Status Current PWR Failure Mechanisms (cont.) Spacer Grid Fretting

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Status Current PWR Failure Mechanisms (cont.)

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Status Current PWR Failure Mechanisms (cont.)

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Status Current PWR Failure Mechanisms (cont.)

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PWR Fuel Performance – Baffle Interaction

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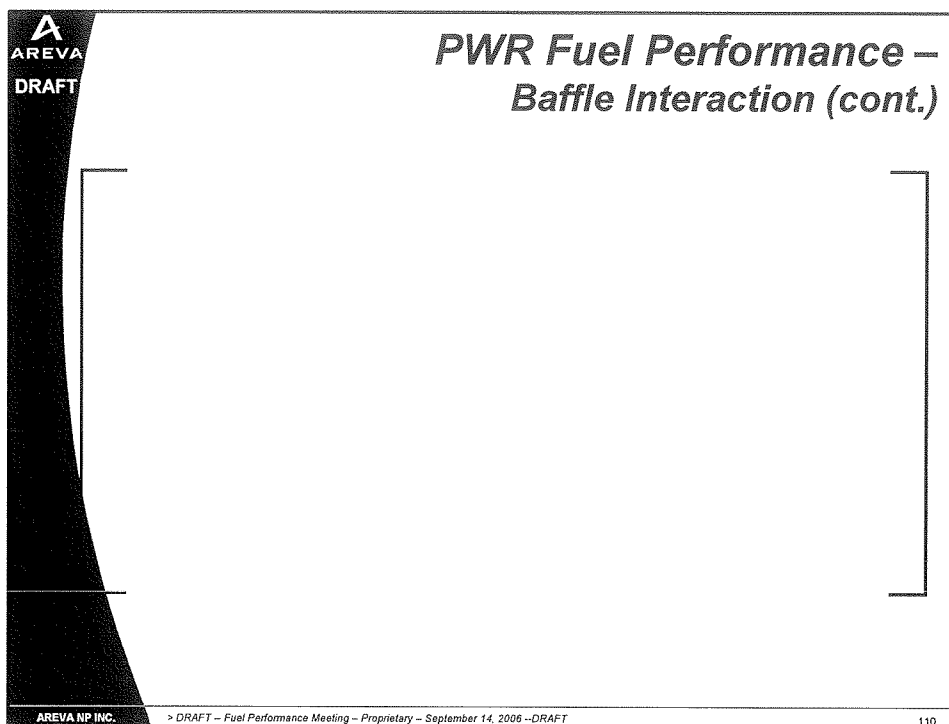
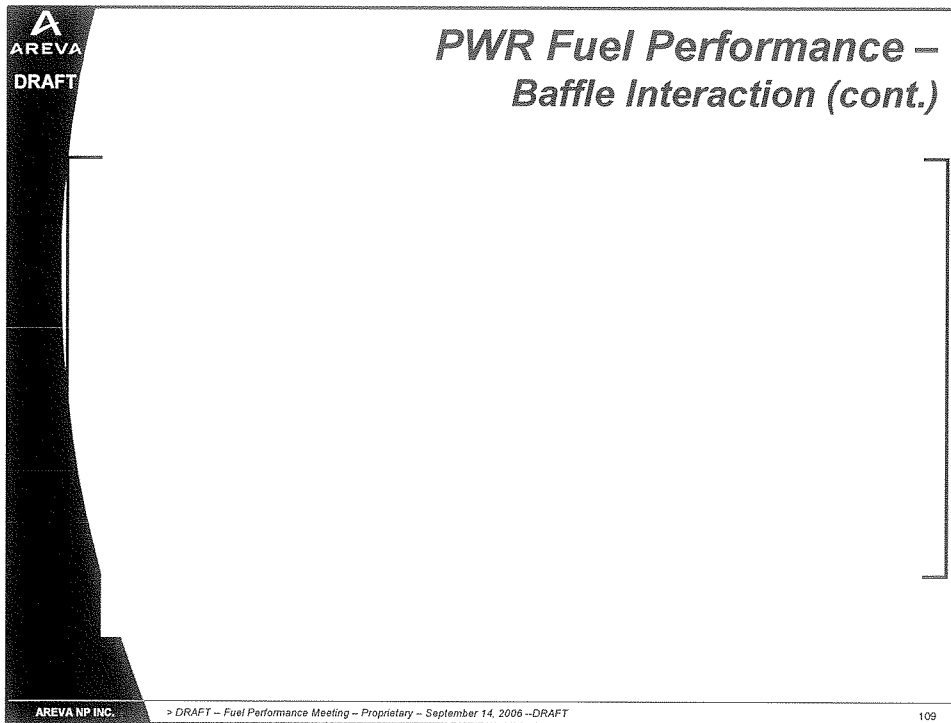

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PWR Fuel Performance – Baffle Interaction (cont.)

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PWR Fuel Performance – Baffle Interaction (cont.)

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PWR Fuel Performance – Baffle Interaction (cont.)

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PWR Fuel Performance – Baffle Interaction (cont.)


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PWR Fuel Performance – Baffle Interaction (cont.)

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PWR Fuel Performance – Baffle Interaction (cont.)

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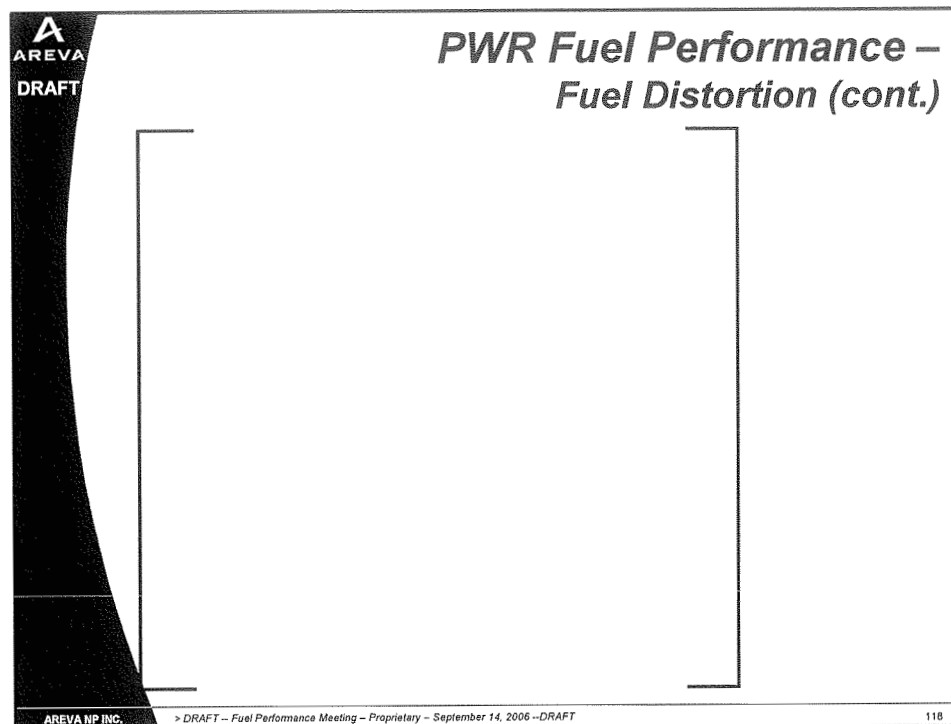
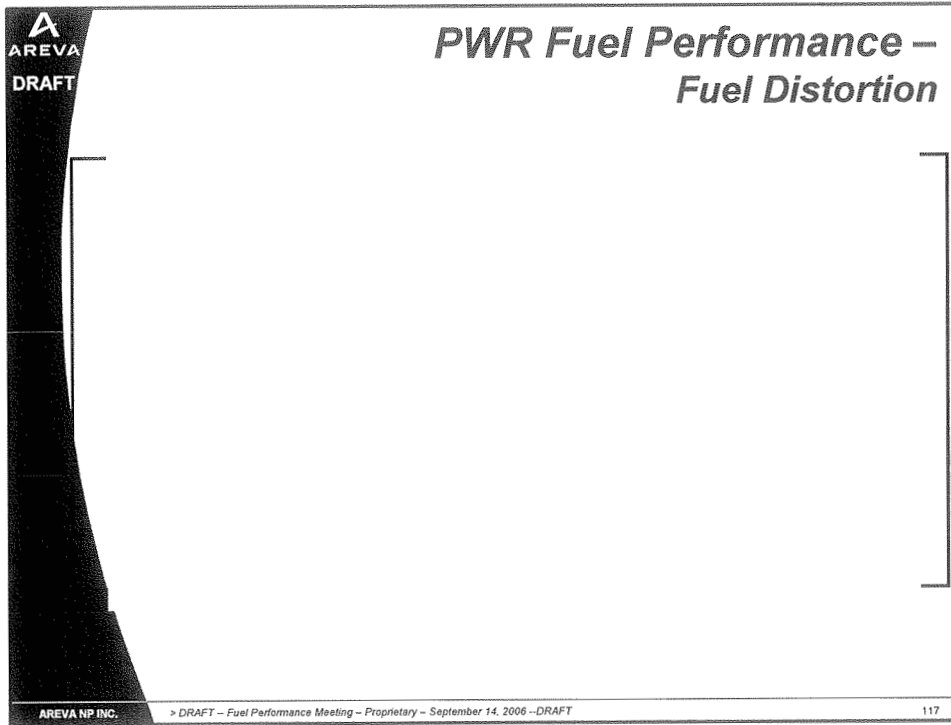

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PWR Fuel Performance – Baffle Interaction (cont.)

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PWR Fuel Performance – Grid Damage

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PWR Fuel Performance – Grid Damage (cont.)

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BWR Fuel Performance

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Recent BWR Fuel Reliability

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AREVA NP BWR Fuel Performance Status as of 07/18/06

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Status Current BWR Failure Mechanisms

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Status Current BWR Failure Mechanisms (cont.)

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Status Current BWR Failure Mechanisms – Assumed PCI

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Fuel Field Services General Capabilities

John T. Willse
Manager, Fuel Reliability and Performance

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Introduction

- > Internationally Experienced Organization
- > General
 - > Fuel Inspection/Repair Capabilities
 - * Listing of PWR Techniques
 - * Listing of BWR Techniques
 - > Primary Inspection Techniques
 - * Sipping
 - * Fuel UT
 - * Fuel Repair
 - * PIE (Post Irradiated Examinations)
 - * CRUD Sampling
 - * Control Inspection
 - * Fuel Cleaning
 - > Specialty Inspections, Tool Design and Fabrication
 - * Visual Characterization
 - * Consolidation – fuel rod transfers and accountability, rod containers, and misc. storage structures
 - * Fuel handling alignment tools
 - * Fuel handling tools
 - * Component handling tools
 - * Specialized storage containers for fuel rods, fuel components and misc. items

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Fuel Field Service Organization

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Fuel Field Service General Capabilities

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Fuel Services Techniques on Fuel Assemblies without Disassembly (PWR)

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Fuel Services Techniques on Fuel Assemblies without Disassembly (PWR) (cont.)

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Fuel Services Techniques on Fuel Assemblies without Disassembly (PWR) (cont.)

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Fuel Services Techniques on Dismantled Fuel Assemblies (PWR)

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Fuel Services Techniques on Dismantled Fuel Assemblies (PWR) (cont.)


Fuel Services Techniques Core Components (PWR)

Conditioning Techniques on Fuel Assemblies and Core Components (PWR)



Fuel Service Techniques on Fuel Assemblies without Dismantling (BWR)






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Fuel Service Techniques on Fuel Assemblies without Dismantling (BWR)(cont.)

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Fuel Service Techniques on Dismantled Fuel Assemblies (BWR)

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Fuel Service Techniques on Dismantled Fuel Assemblies (BWR) (cont.)



Fuel Service Techniques on Core Components (BWR)



Water/Gas Sipping Description (BWR/PWR)

Water/Gas Sipping

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Failed Fuel Detection by Mast Sipping Gas Detection (PWR)

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Failed Fuel Detection by In-Core Sipping (BWR)

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Failed Fuel Detection by Cell Sipping (PWR)

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Vacuum Sipping System (BWR/PWR)


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Vacuum Sipping Dual Canister Requirements

Failed Fuel Detection by Ultrasonic Fuel Inspection



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Failed Fuel Detection by Ultrasonic Fuel Inspection

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Failed Fuel Detection by Ultrasonic Fuel Inspection

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Failed Fuel Detection by Ultrasonic Fuel Inspection

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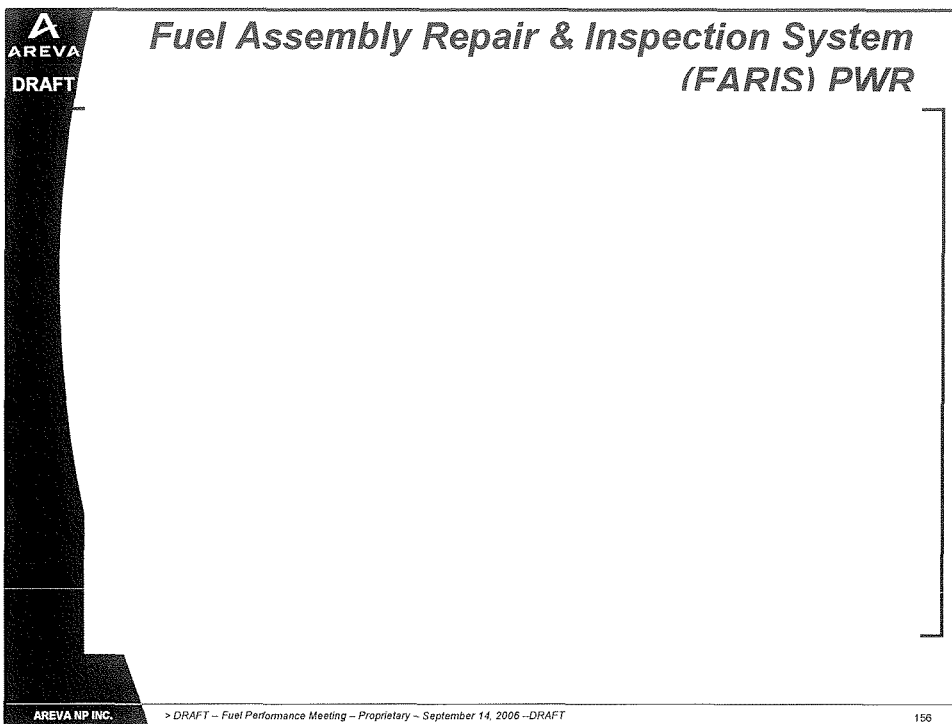
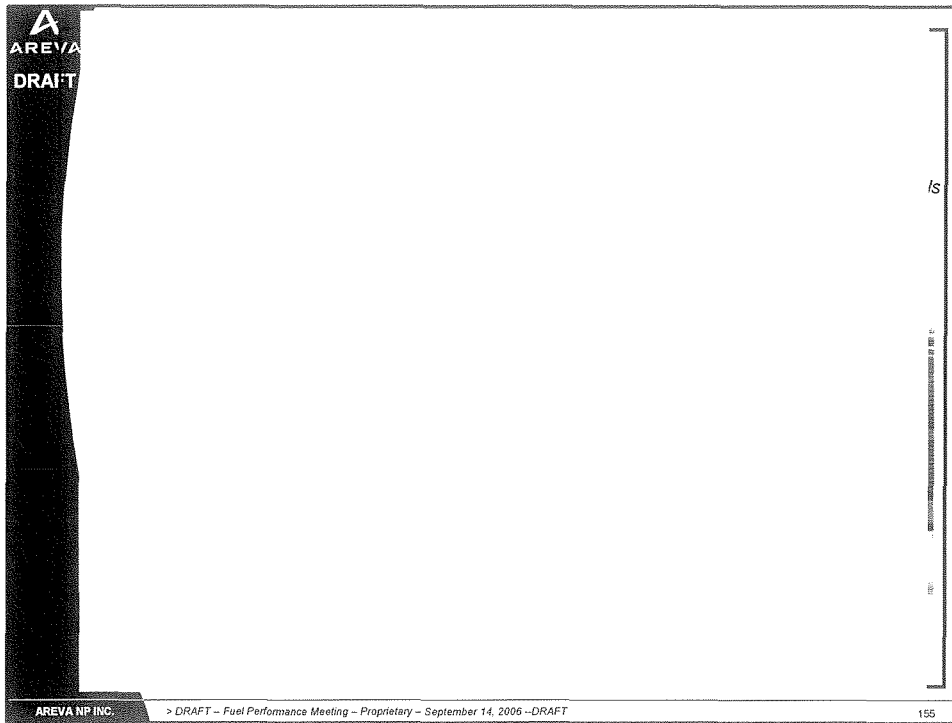

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Fuel Reconstitution and Recage

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Post-Irradiation Examination System

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Post-Irradiation Examination System

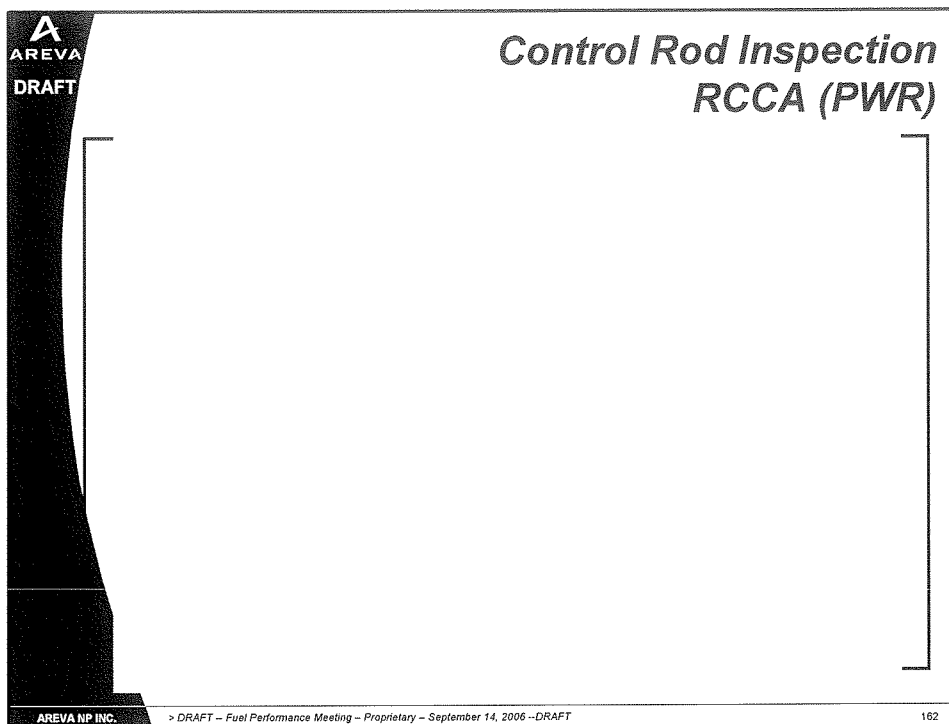
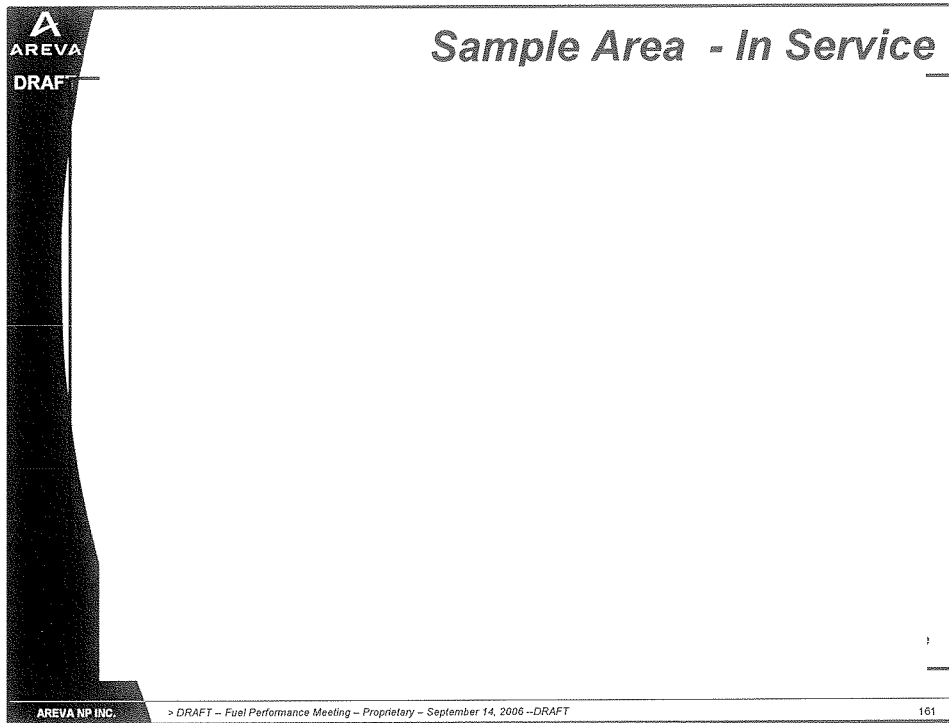
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Fuel Rod Gamma Scan System

Fuel Assembly Crud Sampling/Analysis





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Control Rod Inspection
RCCA (PWR)

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Control Rod Inspection
CRA and CEA (PWR)

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Control Rod Inspection CRA (PWR)

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Ultrasonic Fuel Cleaning (BWR/PWR)

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Specialty Tools Design and Fabrication

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Specialty Tools Visual Characterization – Consolidation/Repair - PWR/BWR


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Specialty Tools
Fuel Handling – In-Core Alignment Tool
Top Nozzle Alignment (PWR)



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Specialty Tools
Fuel Handling – In-Core Alignment Tools
Top Nozzle Alignment – Spreader (PWR)



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Specialty Tools
Fuel Handling – In-Core Alignment Tools
Lower Core Support Alignment (PWR)

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Specialty Tools
Smooth Sided Dummy Fuel Assembly – PWR/BWR

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Specialty Tools

Auxiliary Fuel Handling Tools Fuel Handling Grapple (PWR)

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Specialty Tools

Control Component Handling Tool CRA/APSR/BPRA (PWR)

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Specialty Tools

Top Nozzle Separation (TNS) Fuel Handling Tool (PWR)

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Specialty Tools

Top Nozzle Separation (TNS) Fuel Handling Tool (PWR)

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Specialty Tools

Specialized Containers and Fuel Rod/Pellet Encapsulation (PWR/BWR)

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Summary

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Fuel & Hardware Testing Programs

John Strumpell
Manager, Fuel Mechanical & Structural Design

AREVA NP INC.

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Fuel & Hardware Testing Programs

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PWR LTA & PIE Objectives

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PWR Test Assembly Programs

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PWR Test Assembly Programs (cont.)

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Recently Completed PWR Poolside Post Irradiation Exams

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Recently Completed
PWR Poolside Post Irradiation Exams
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Recently Completed
PWR Poolside Post Irradiation Exams
(cont.)

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Upcoming PWR Poolside Post Irradiation Exams

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Recently Completed PWR Hot Cell Post Irradiation Exams

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Upcoming PWR Hot Cell Post Irradiation Exams

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AREVA PWR Extended Burnup Support Activities

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AREVA PWR Extended Burnup Support Activities (cont.)

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Summary of U.S. M5 Experience

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Summary of U.S. M5 Experience (cont.)

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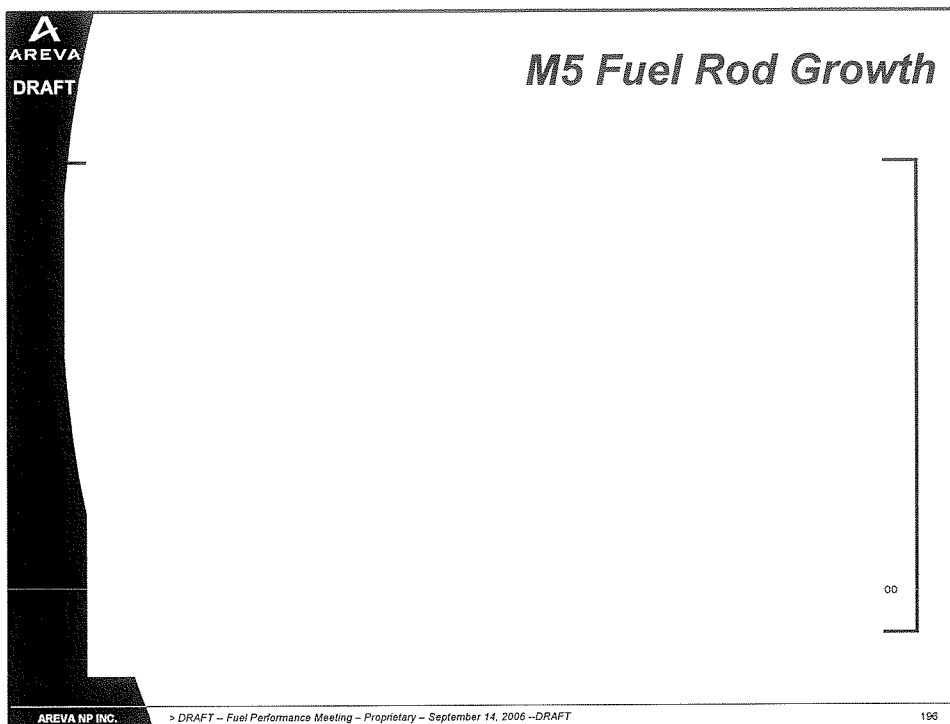
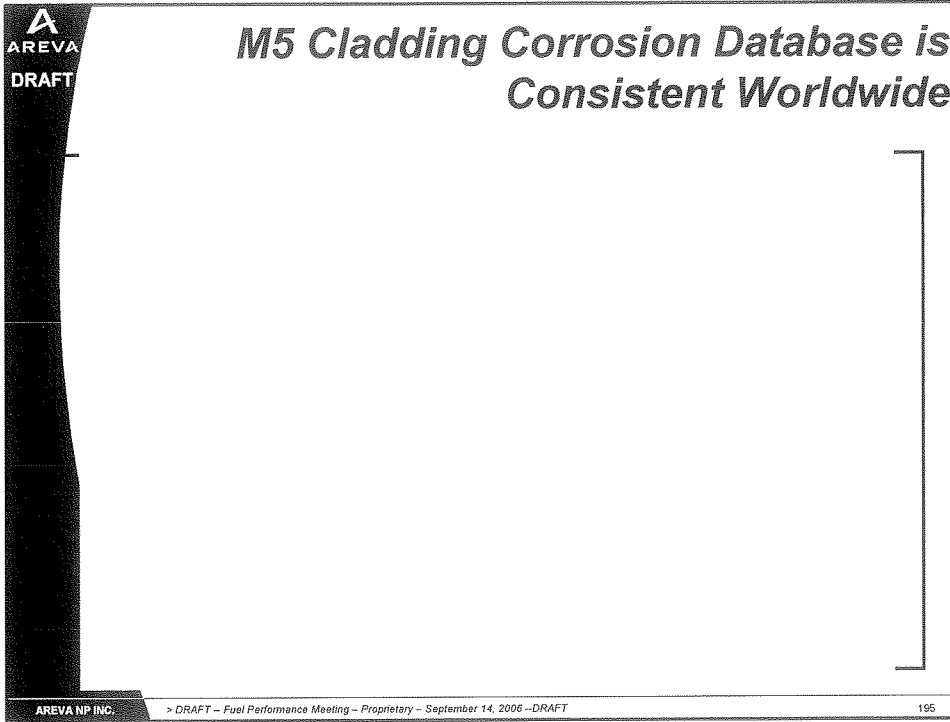
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M5 Cladding Exhibits the Best Corrosion Behavior in PWRs

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AREVA PWR European Research

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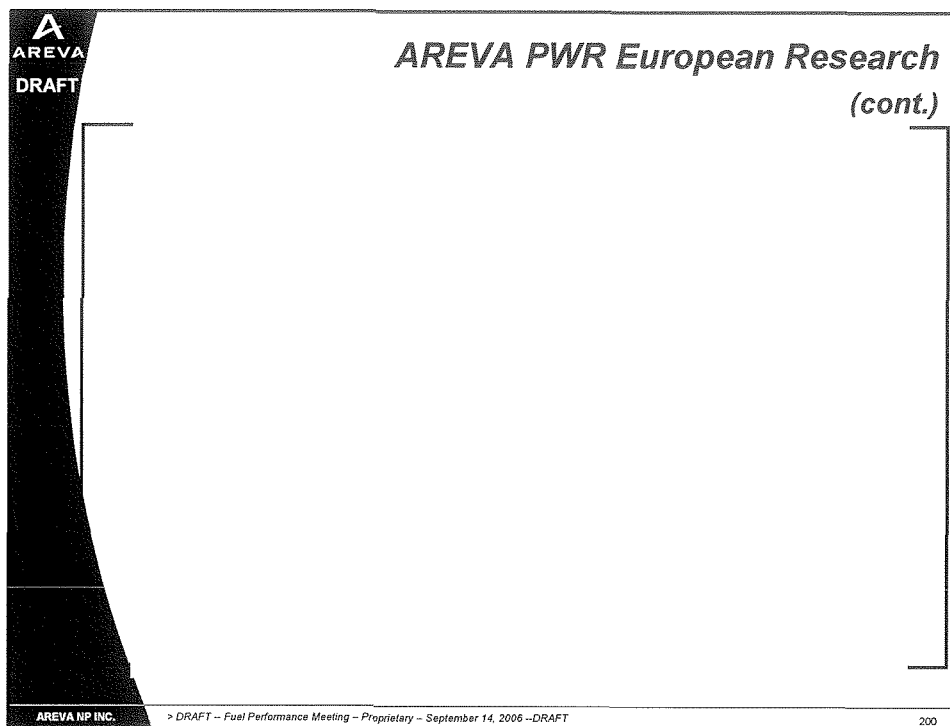
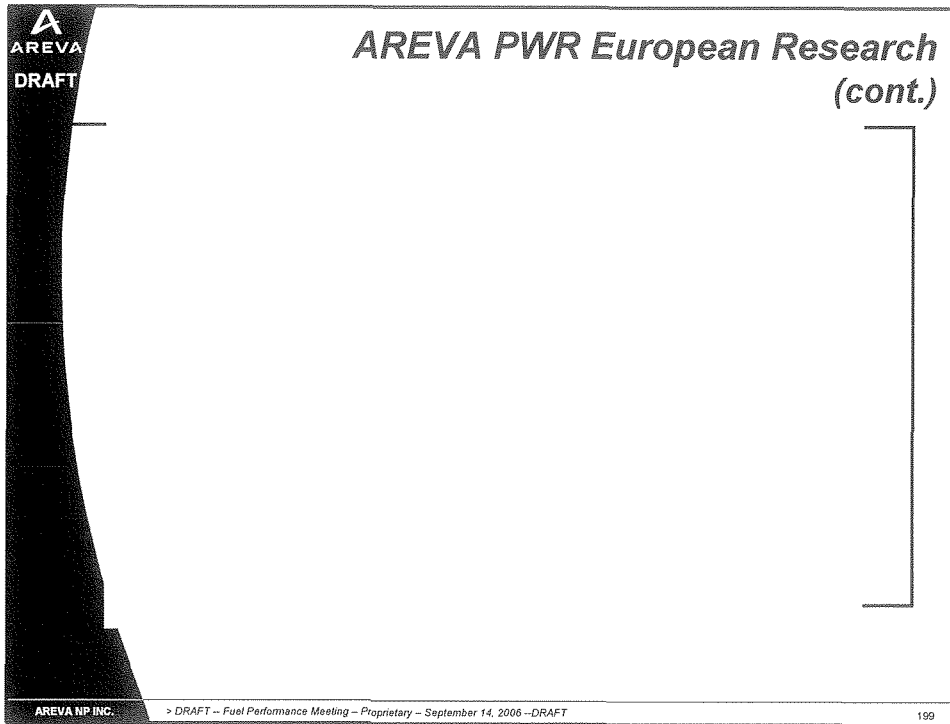

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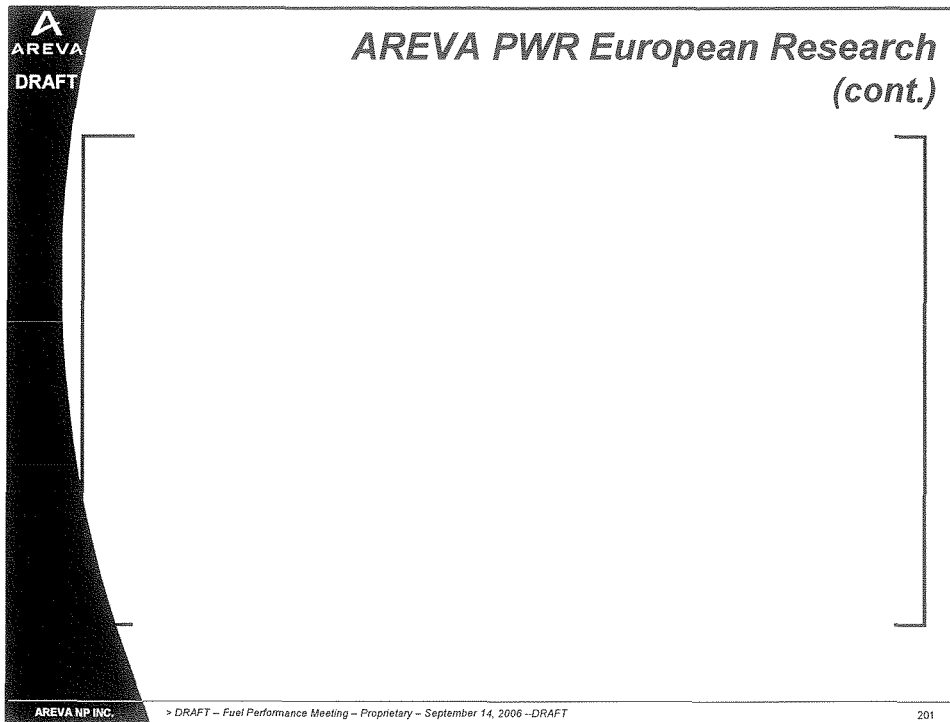
AREVA PWR European Research
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Fuel & Hardware Testing Programs




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Long-Term BWR PIE Goals



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Recently Completed BWR Poolside Post Irradiation Exams

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Recently Completed BWR Poolside Post Irradiation Exams (cont.)

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BWR Hot Cell Post Irradiation Exams

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BWR Hot Cell Post Irradiation Exams (cont.)

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BWR High Burnup Support

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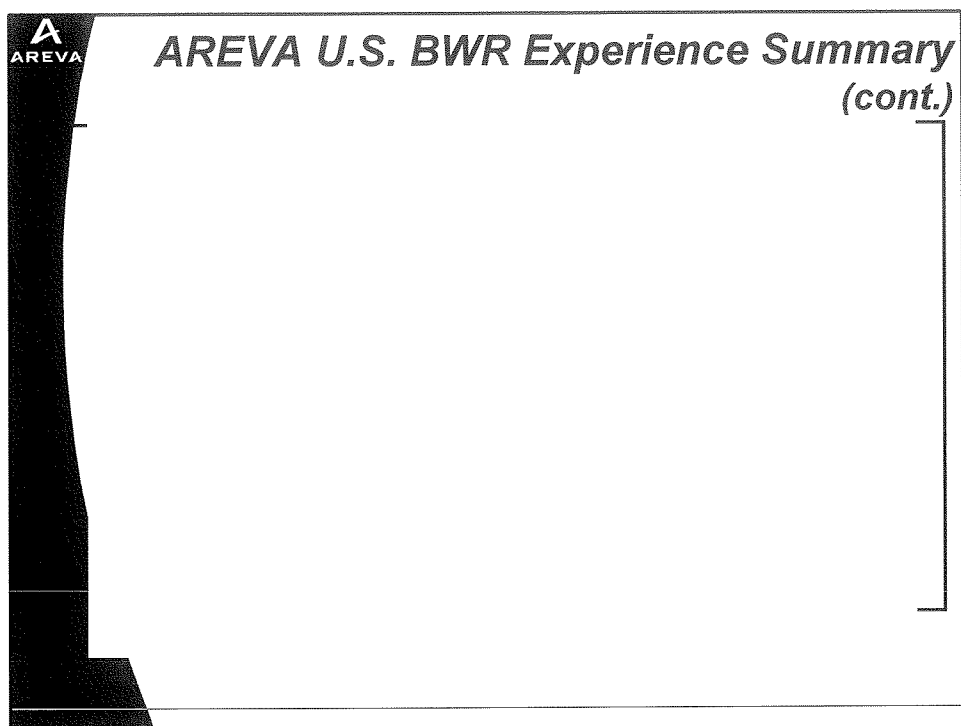
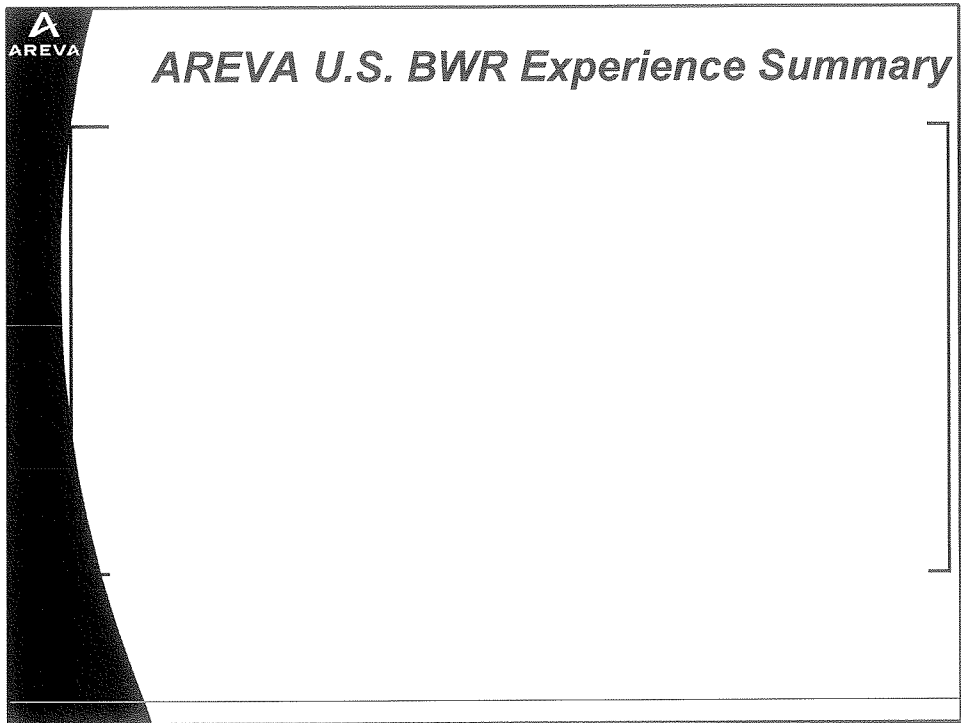

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BWR High Burnup Support (cont.)

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AREVA U.S. BWR Experience Summary (cont.)

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AREVA U.S. BWR Experience Summary (cont.)

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AREVA U.S. BWR Experience Summary (cont.)

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AREVA U.S. BWR Experience Summary (cont.)

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AREVA BWR European Research

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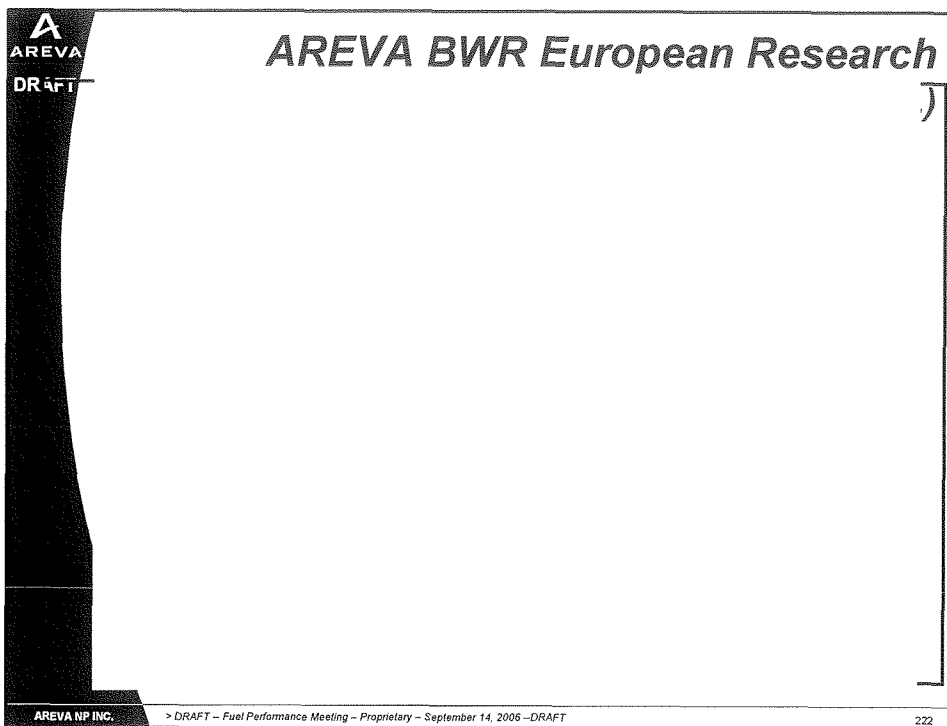
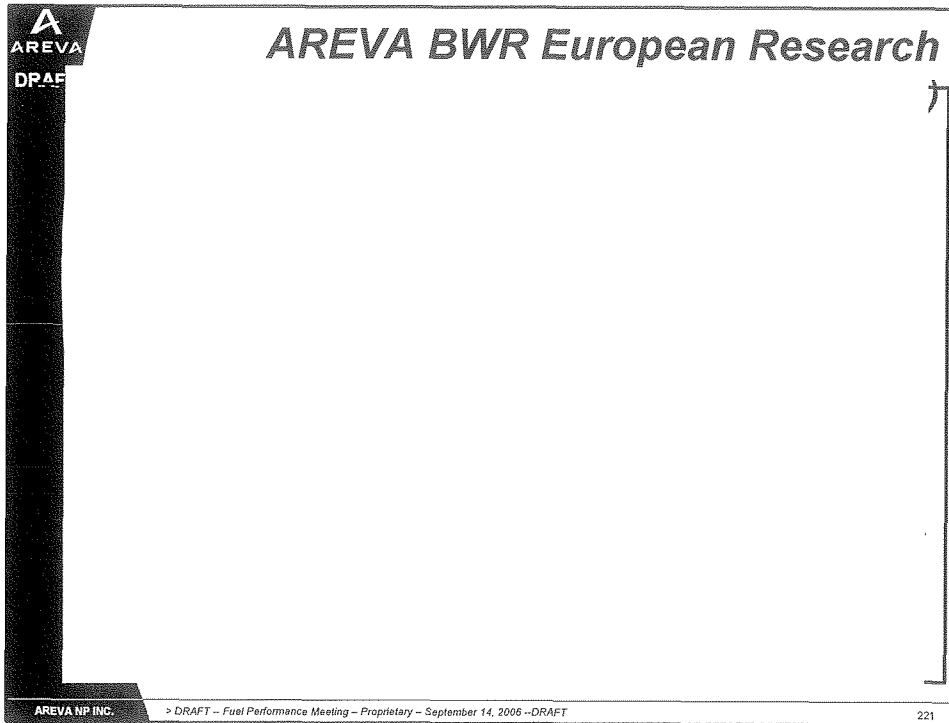
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AREVA BWR European Research (cont.)

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AREVA BWR European Research (cont.)

AREVA BWR European Research (cont.)



AREVA BWR European Research (cont.)