



## ***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**

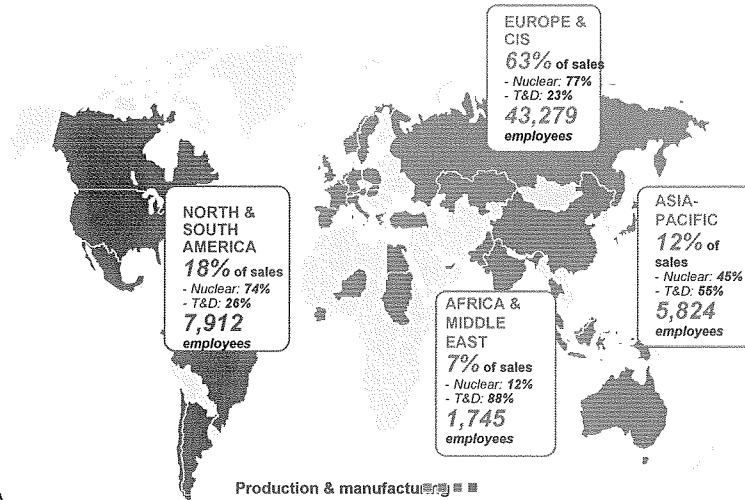
Production & Manufacturing

**100 countries**

Marketing & Sales

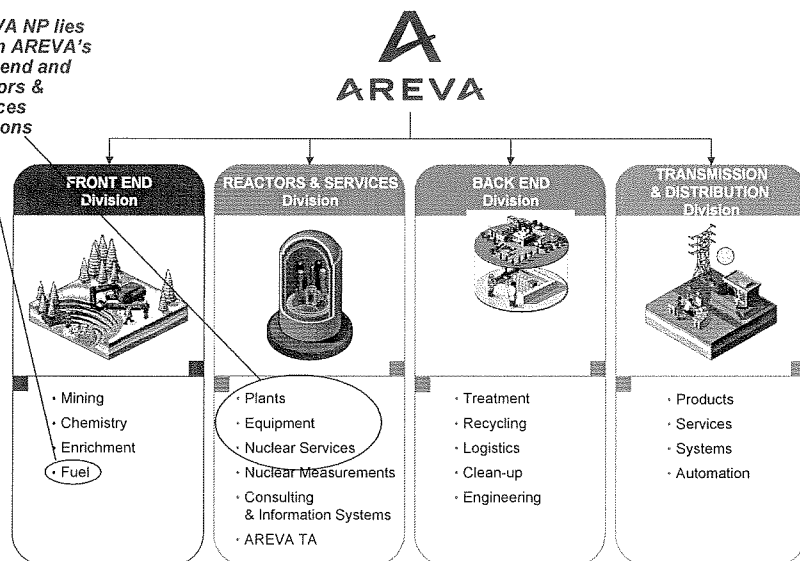
**€6,754M: 67%**

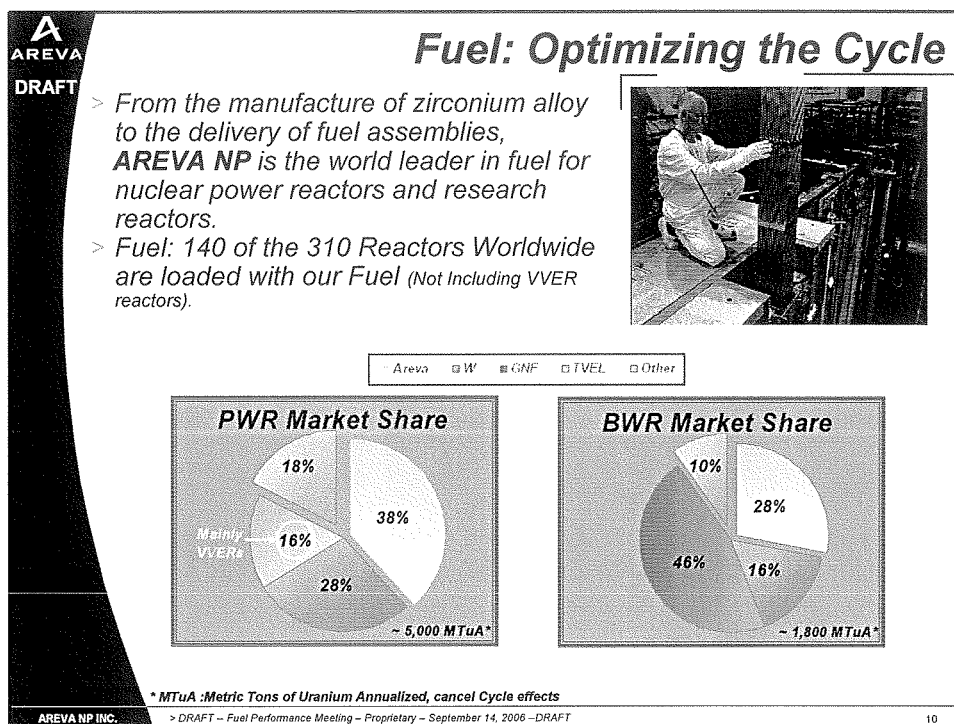
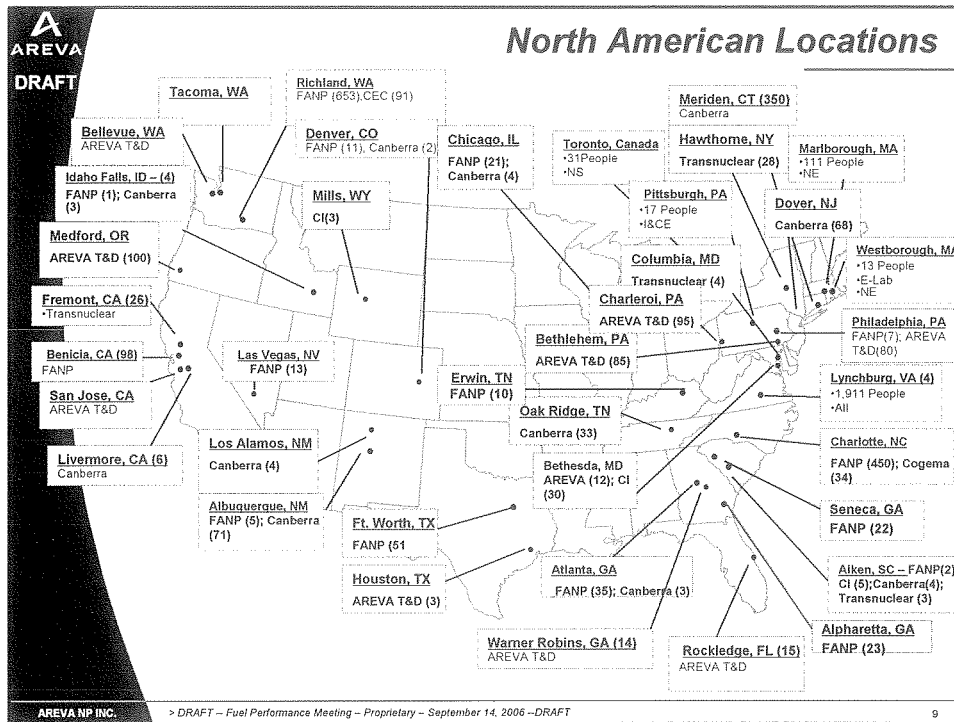
of all sales come from outside France



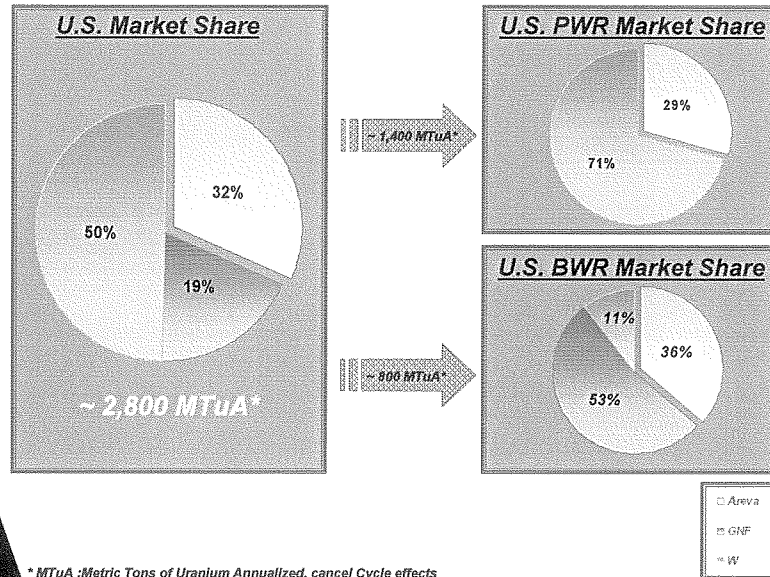
## Organization of the group

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

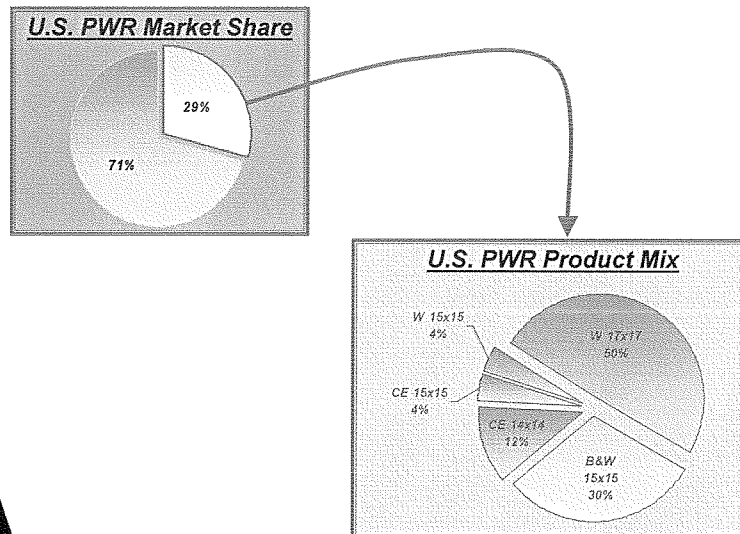


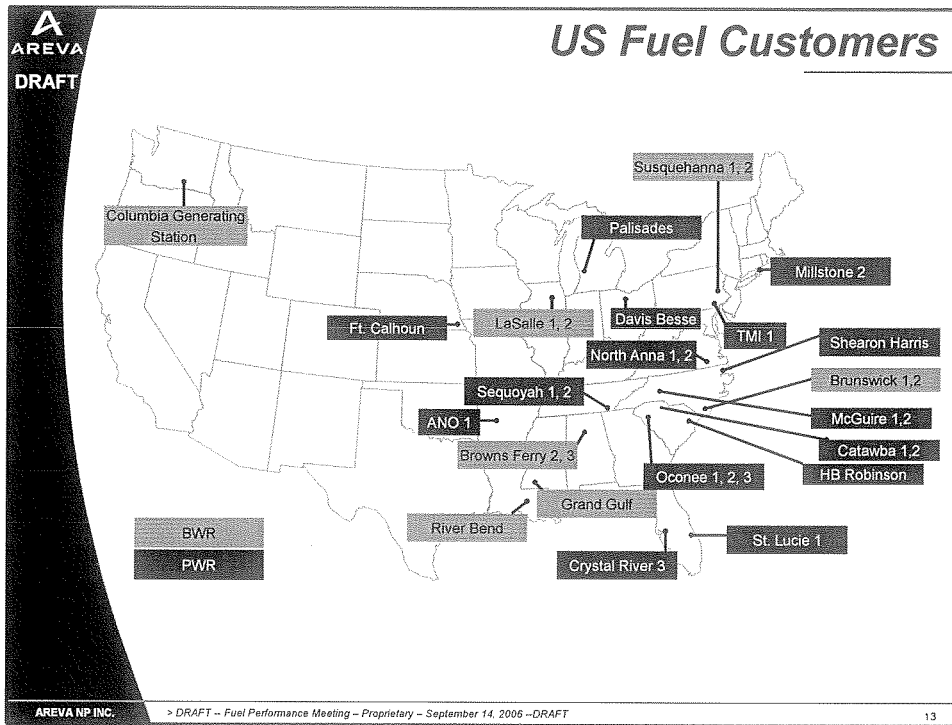


## U.S. Market Share



## U.S. Market Share: PWR Product Mix





**AREVA**

## 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



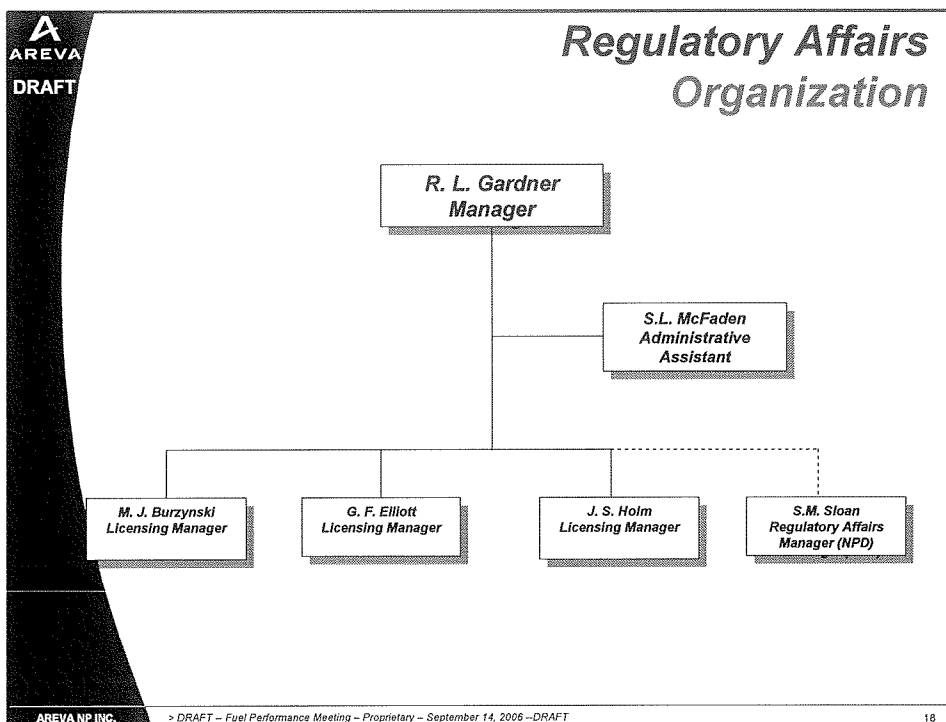
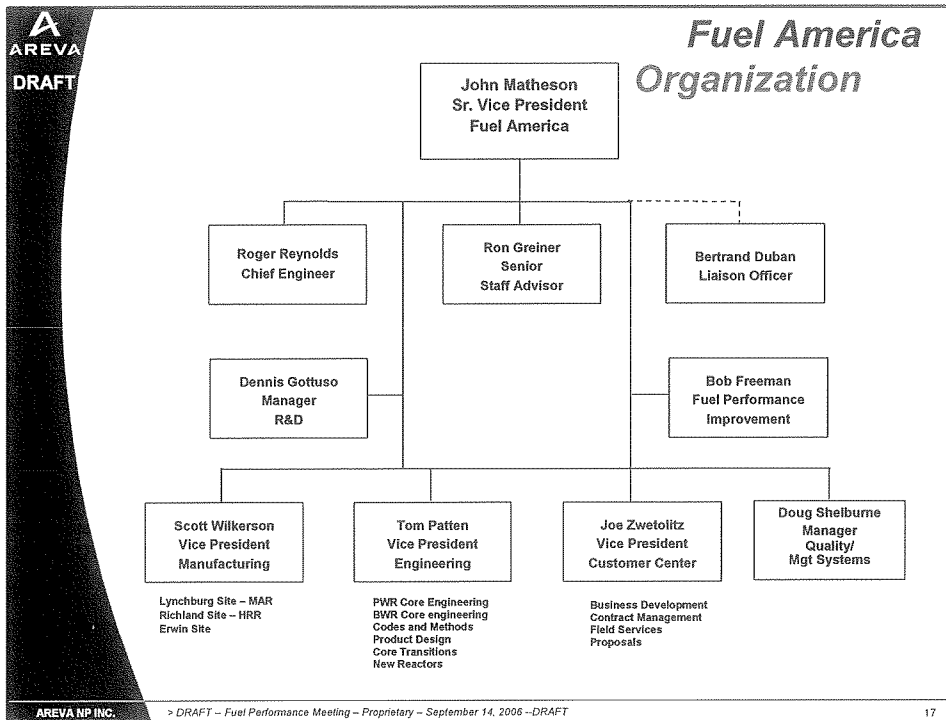
**Vice President Charlotte Site Office and U.S. Region Safety**  
Bill Fox

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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***

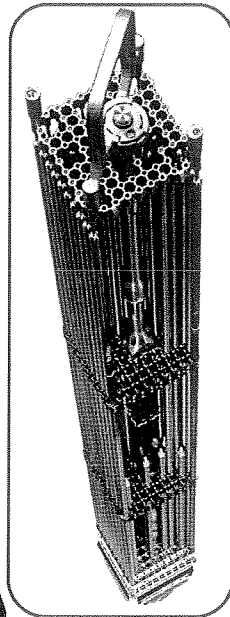
## ***BWR Overview for USNRC***

- > 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***

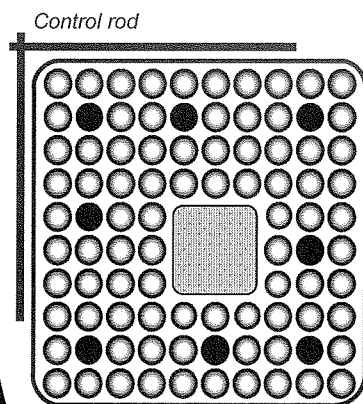
## Current BWR Fuel Products



### ATRIUM™ 10 Family

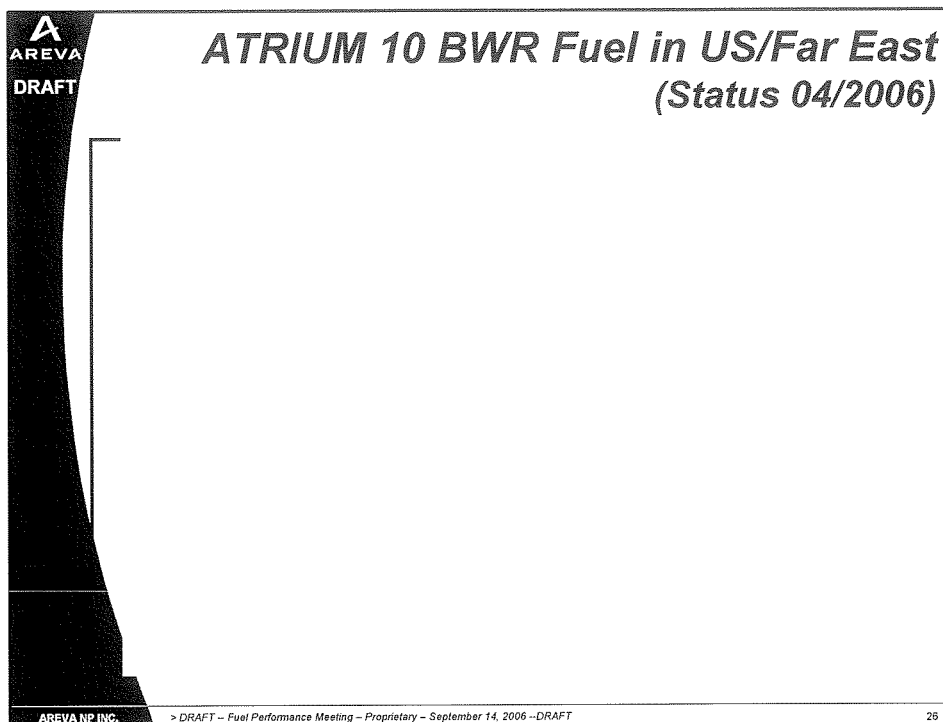
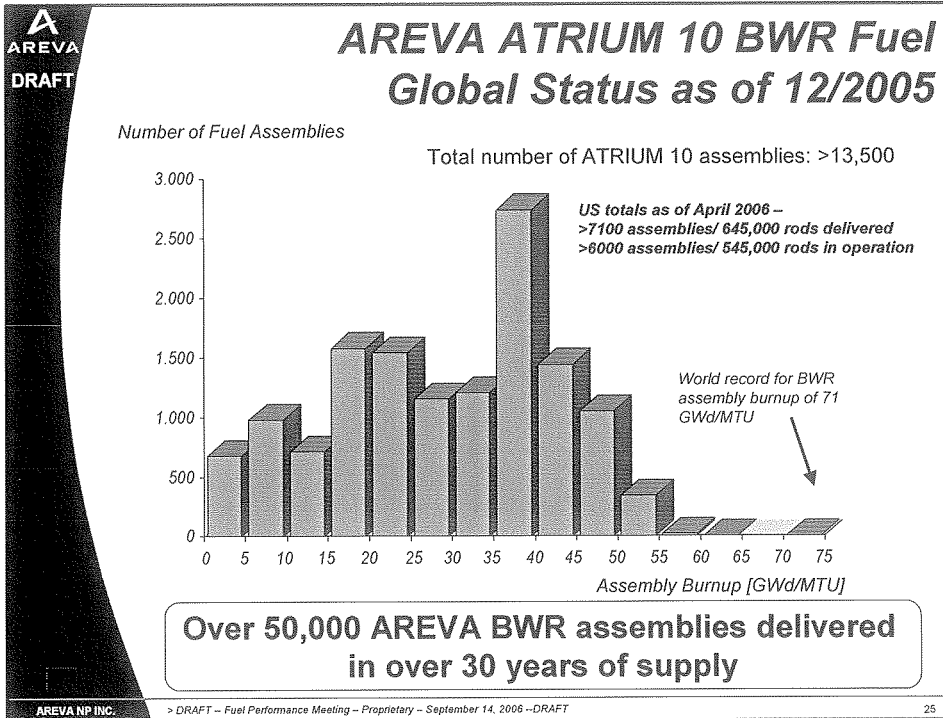
- ATRIUM 10
- ATRIUM 10XP
- ATRIUM 10XM

## ATRIUM 10



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

US Reload Operation Since 1996



## *Upgraded components (ATRIUM 10XP/XM)*

## *ATRIUM 10XP*

**ATRIUM 10XP provides  
higher fuel weight and  
better stability**

**Operating since 2002**

## ***ATRIUM 10XM***

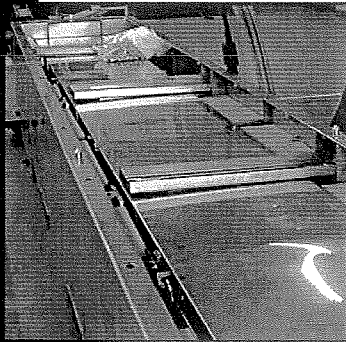
**ATRIUM 10XM provides  
superior MCPR capability  
and fuel utilization**

**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.

## AREVA BWR Fuel Supply Summary

- > AREVA's ATRIUM 10 is a well-proven and highly reliable product that continues to deliver excellent value for today's BWR operations

## ***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.)*

  
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# Current Development Projects (cont.)

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# BWR Fuel Channel Performance Update




  
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# Channel Measurement Campaigns

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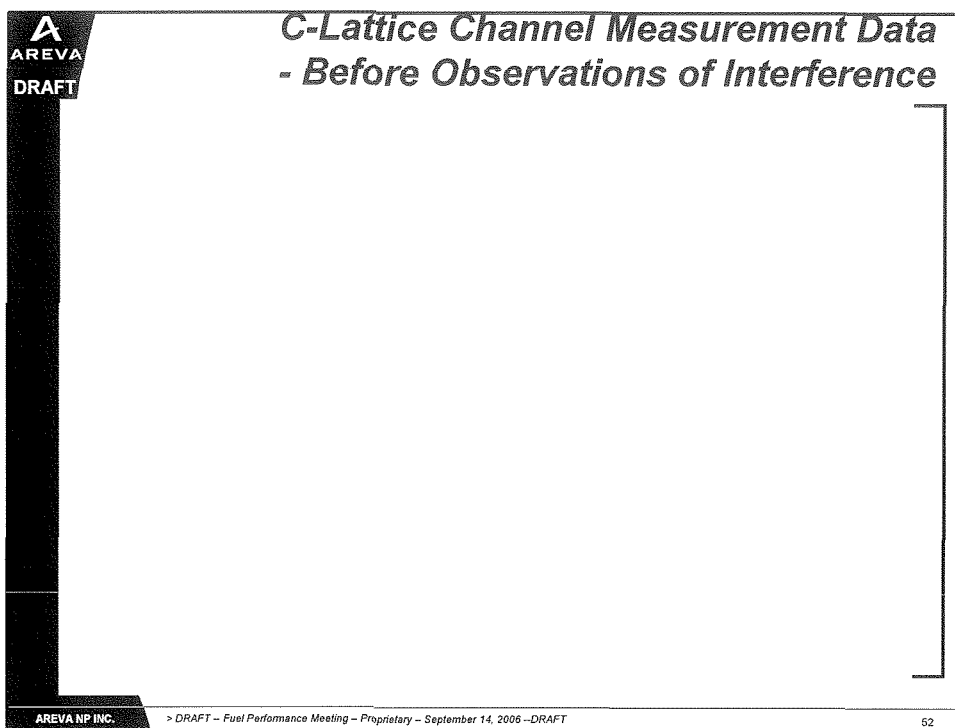
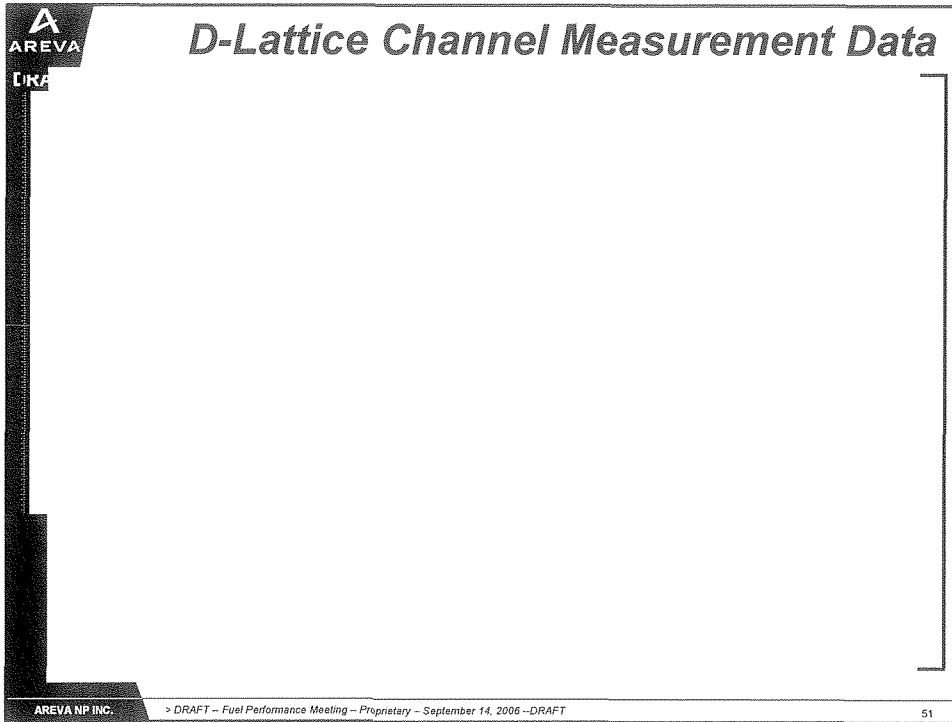
  
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# AREVA Fuel Channel Designs for US Market

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## ***C- and S-Lattice Channel Measurement Data - After Observations of Interference***




## ***Susquehanna Unit 1 Measurements Change in bow between 4Q05 and 1Q06***



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## ***Observations Based on Measurements to Date***



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## ***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***

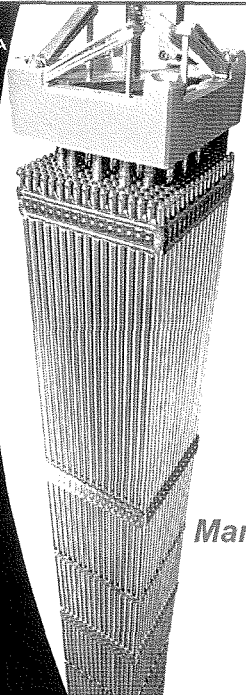
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## ***AREVA Fuel Channel Performance Experience Summary Comments***

- > ***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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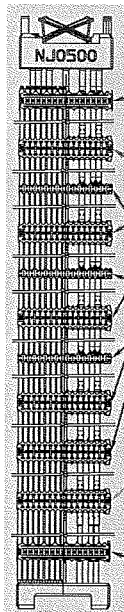
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## Outline of Presentation

- > **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 are the 'Alloy 718 Top Grid', 'M5 Mixing Grids', 'M5 Mid-Span Mixing Grids (optional)', 'M5 Non-Vaned Grid (offered with vane version)', and 'Alloy 718 Lower Grid'. The bottom is 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)

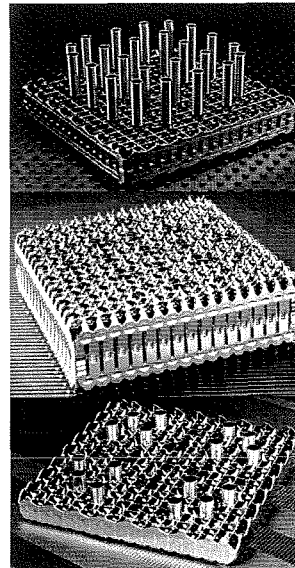
- ♦ Utilized at bottom and top positions
- ♦ Non-vaned

### > 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

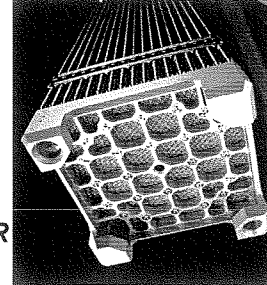




## Design Features – Lower End Fitting

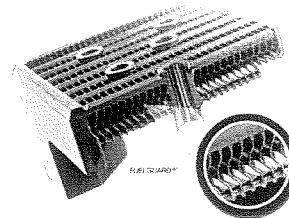
### > TRAPPER™ Plate

- ♦ **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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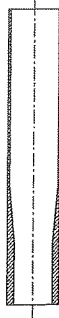
## Planned Enhancements – Structure


> **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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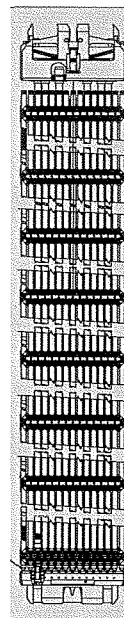
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## Outline of Presentation

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

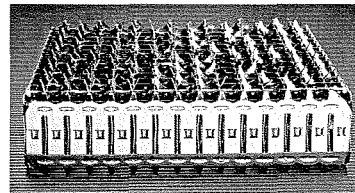
## Overview of Current Mark-B Fuel Assemblies

- ◆ **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)**

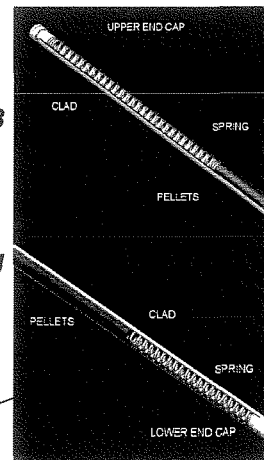


◆ **Zirc-4 Vaneless Grid**

◆ **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

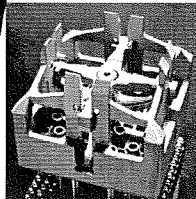
- > **9,840 Mark-B Fuel Assemblies delivered since 1972**
- > **Proven Experience in eight US Reactors (Typically 18 and 24-Month Cycles)**

<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
<b>TOTAL</b>	<b>160</b>	<b>9,840</b>

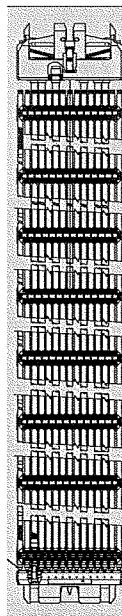
\* Mark-B-HTP Product

## Planned Mark-B Enhancements – Mark-B-HTP

## Overview of Mark-B-HTP Fuel Assembly

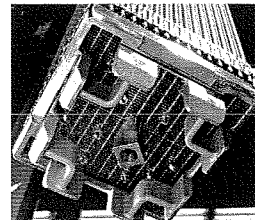


- ♦ **Removable Upper End Fitting**
  - ♦ Alloy 718
  - ♦ Cruciform Springs
- ♦ **M5 Fuel Rods**
- ♦ **M5 Guide Tube**
- ♦ **M5 Instrument Tube**
- ♦ **FUELGUARD™ Lower End Fitting**



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

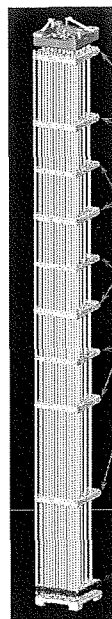
- *“Quick Disconnect”*

### ♦ Fuel Rods

### ♦ Guide Tube

### ♦ Instrument Tube

### ♦ FUELGUARD™ Lower End Fitting



HTP Grids

IFM Grids (Optional)

Alloy 718 Lower HMP Grid

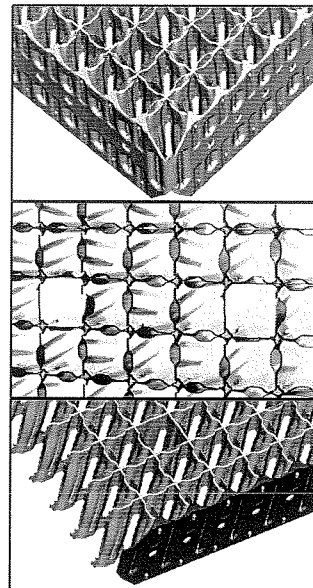
## HTP Spacer Grid Design Concept



- ♦ *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

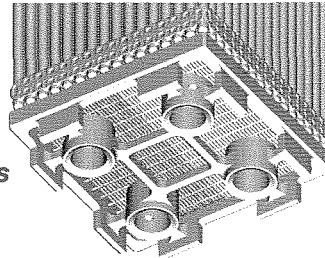
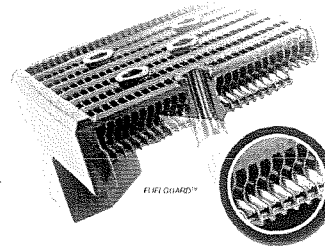
- ♦ No direct line of sight
- ♦ Effectively filters debris
- ♦ Low pressure drop
- ♦ Reduction of inlet turbulence

### > 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***

## ***Conclusion***

***Fuel Product Designs continue to evolve:***

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


***Questions?***

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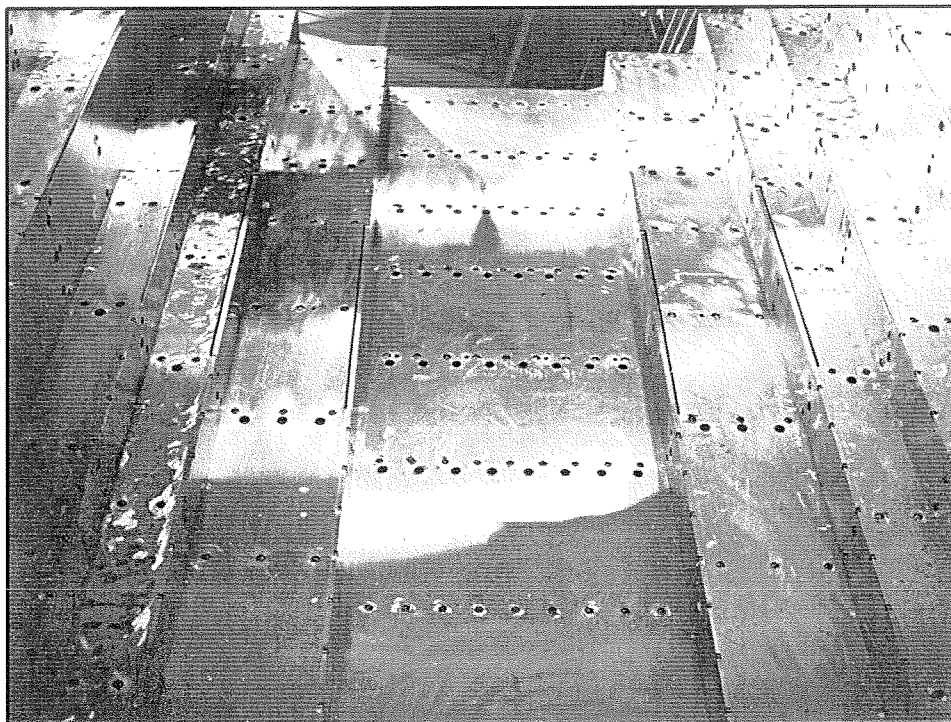
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# ***AREVA NP PWR Fuel Performance Status as of 07/18/06***

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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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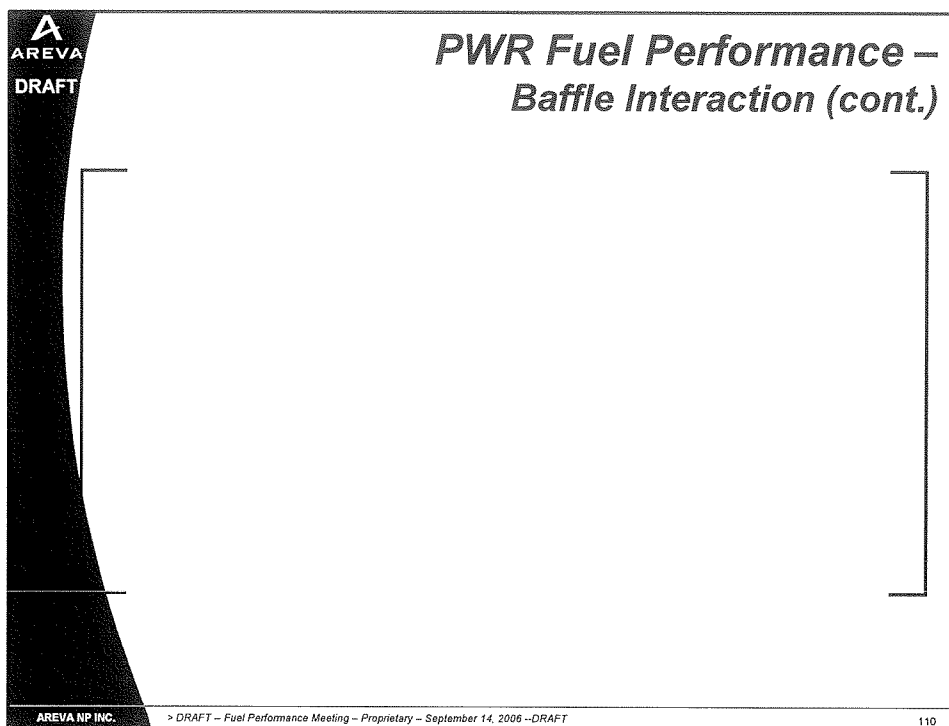
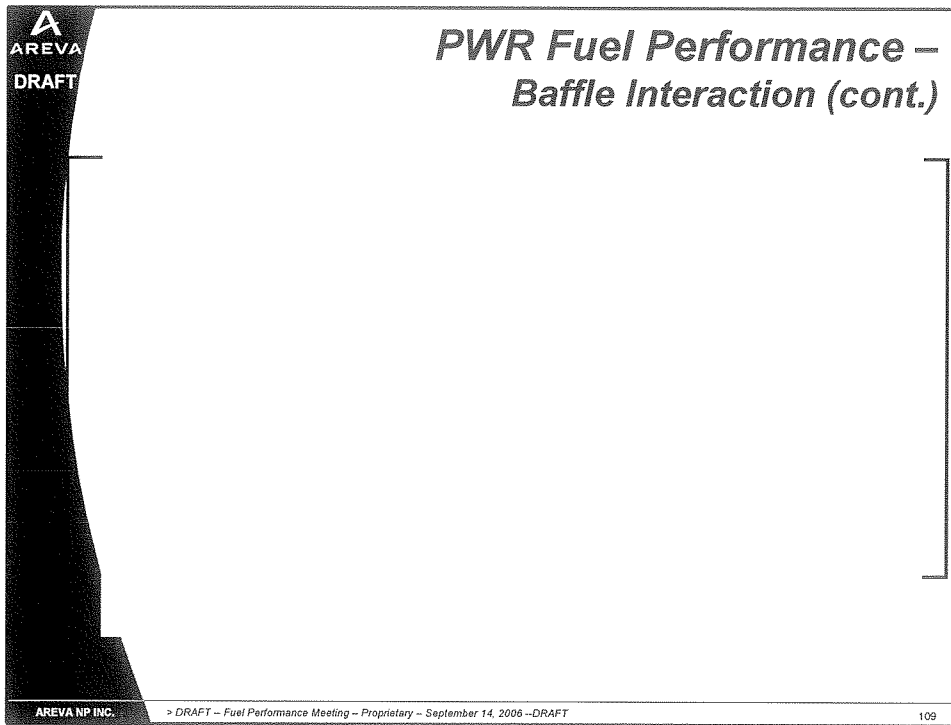
  
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# PWR Fuel Performance – Baffle Interaction (cont.)

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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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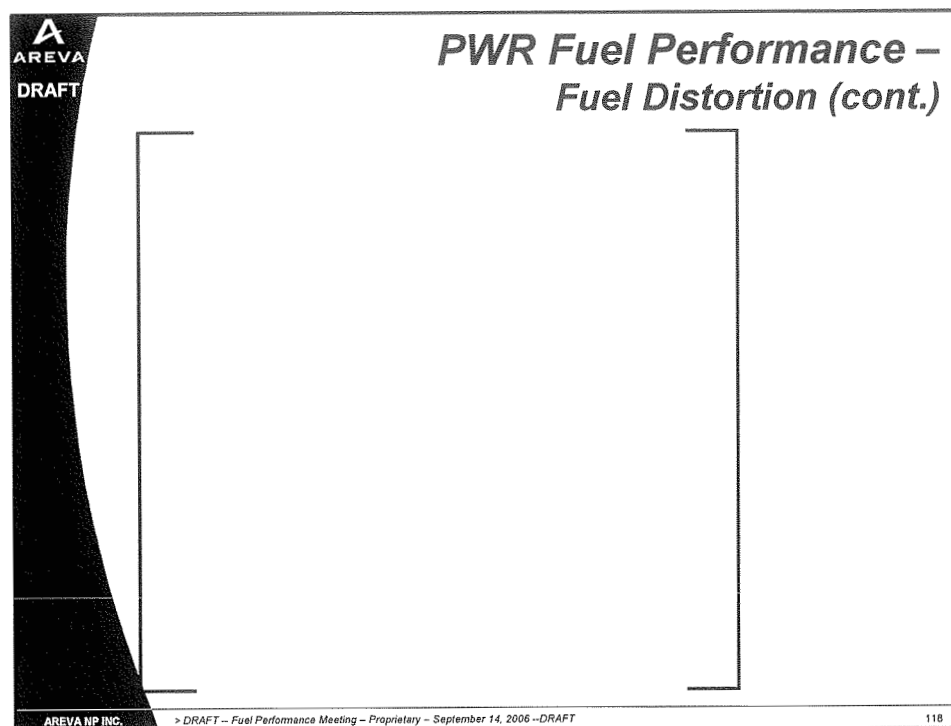
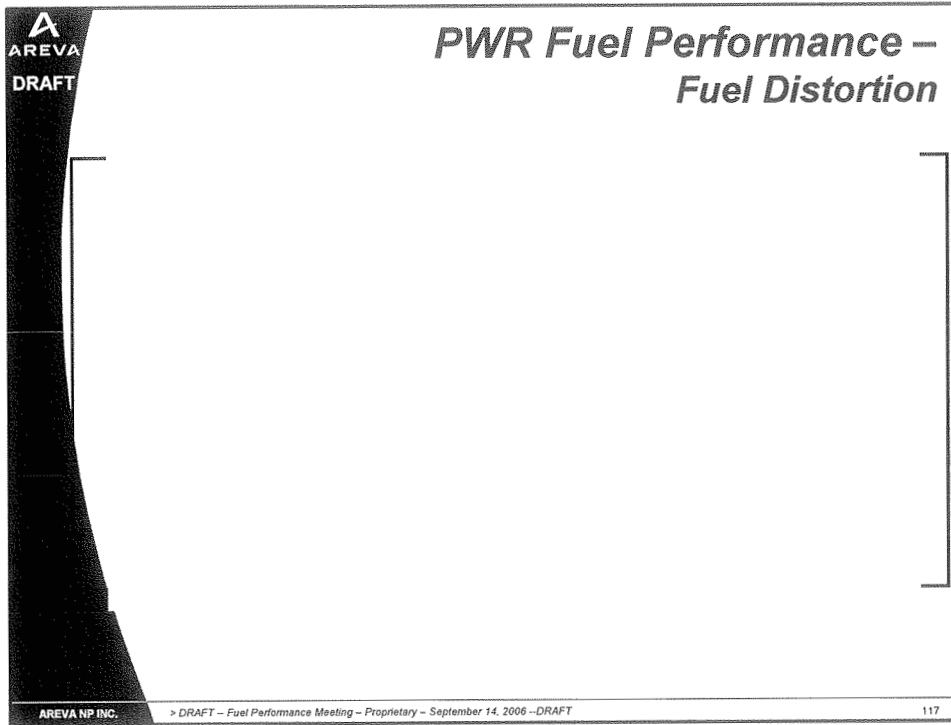
  
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# *PWR Fuel Performance – Baffle Interaction (cont.)*

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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)*




  
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# Water/Gas Sipping Description (BWR/PWR)

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# 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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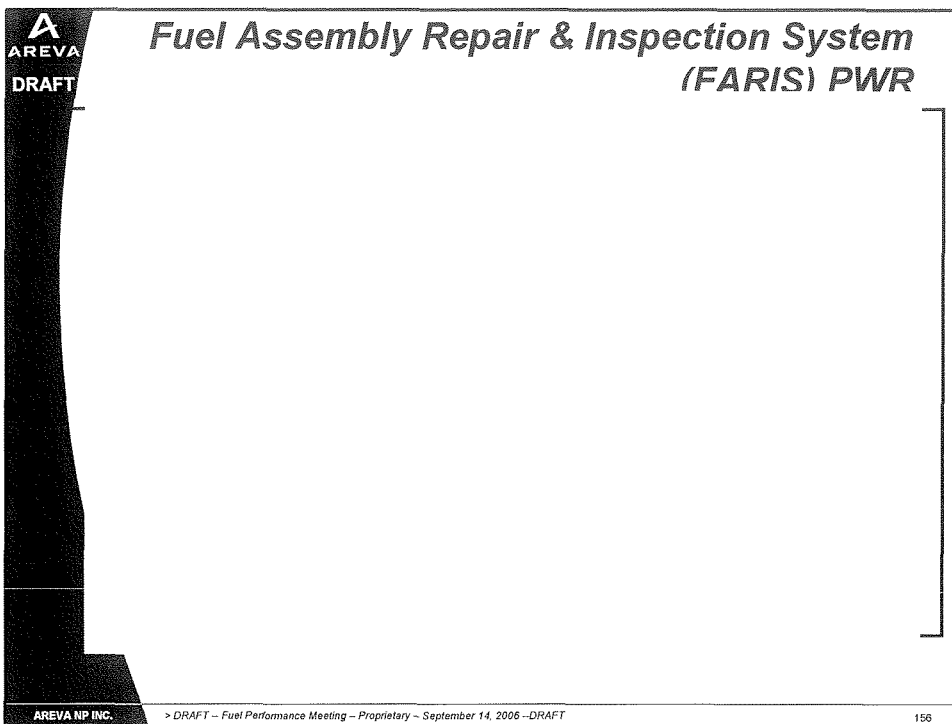
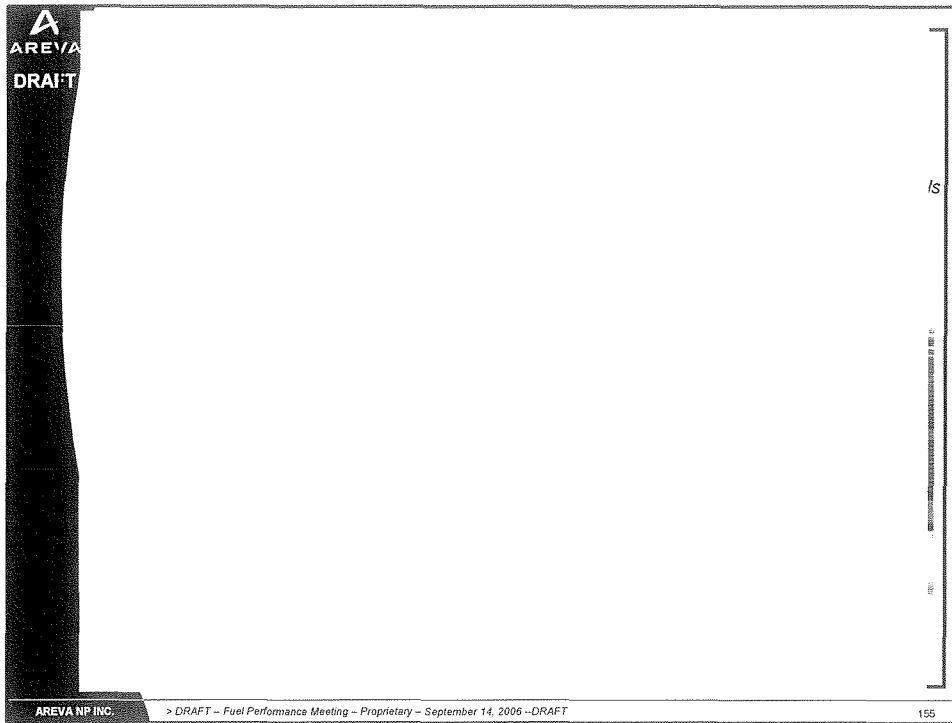
  
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# *Fuel Reconstitution and Recage*

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# Post-Irradiation Examination System

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# Post-Irradiation Examination System

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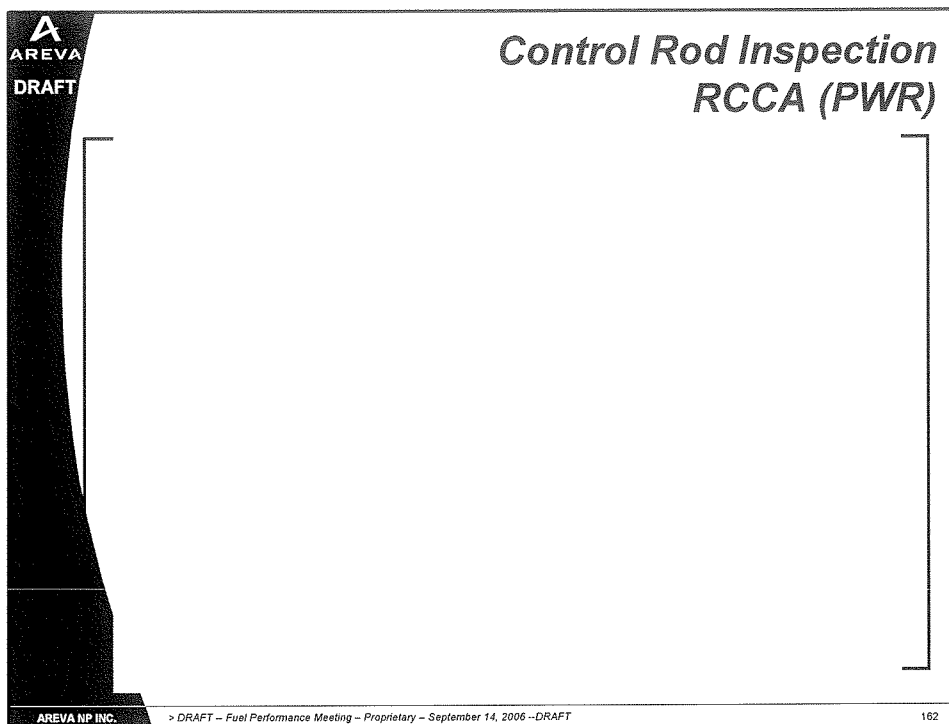
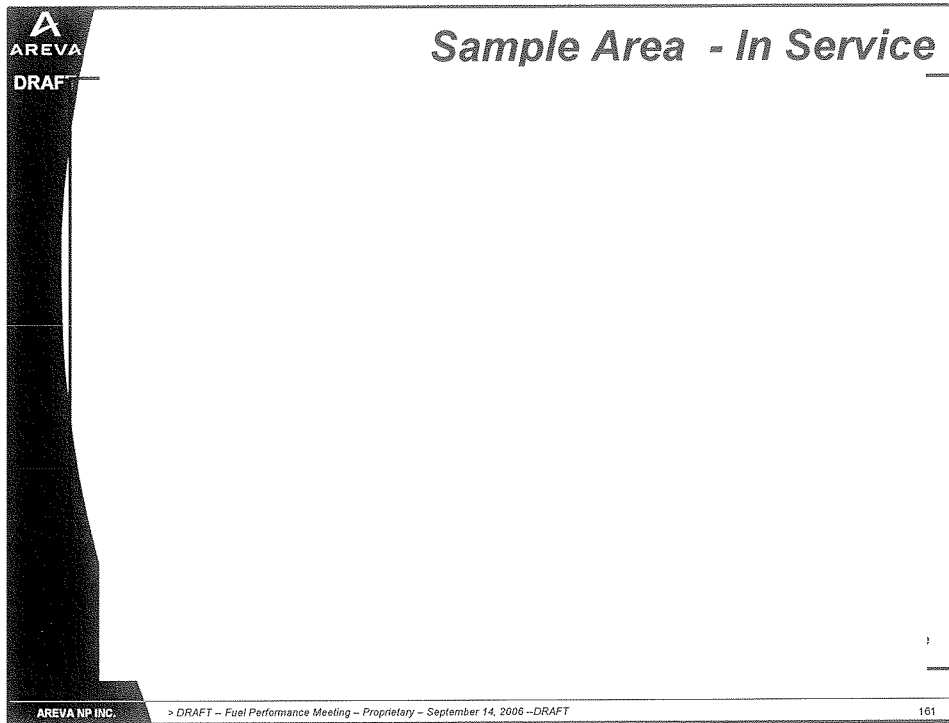
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## *Fuel Rod Gamma Scan System*

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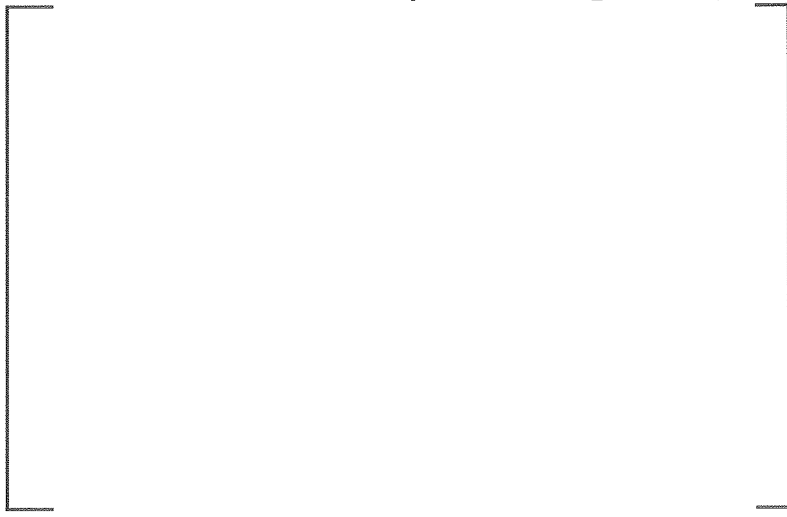
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*Specialty Tools*  
*Fuel Handling – In-Core Alignment Tool*  
*Top Nozzle Alignment (PWR)*




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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

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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  
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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.)***

## ***Summary of U.S. M5 Experience***






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

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# M5 Cladding Exhibits the Best Corrosion Behavior in PWRs

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# M5 Cladding Corrosion Database is Consistent Worldwide

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# M5 Fuel Rod Growth

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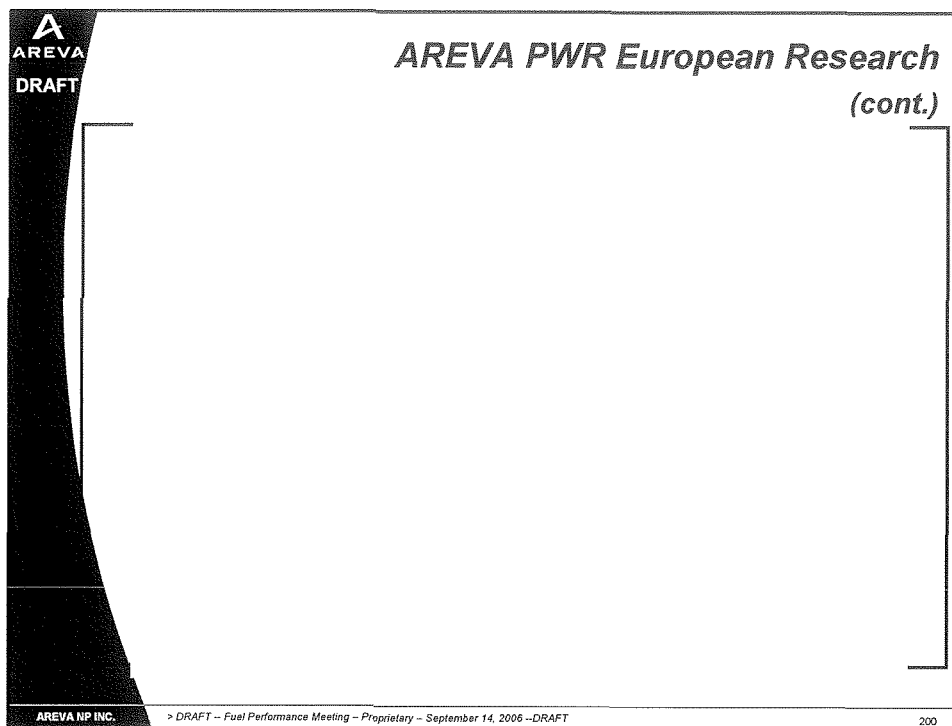
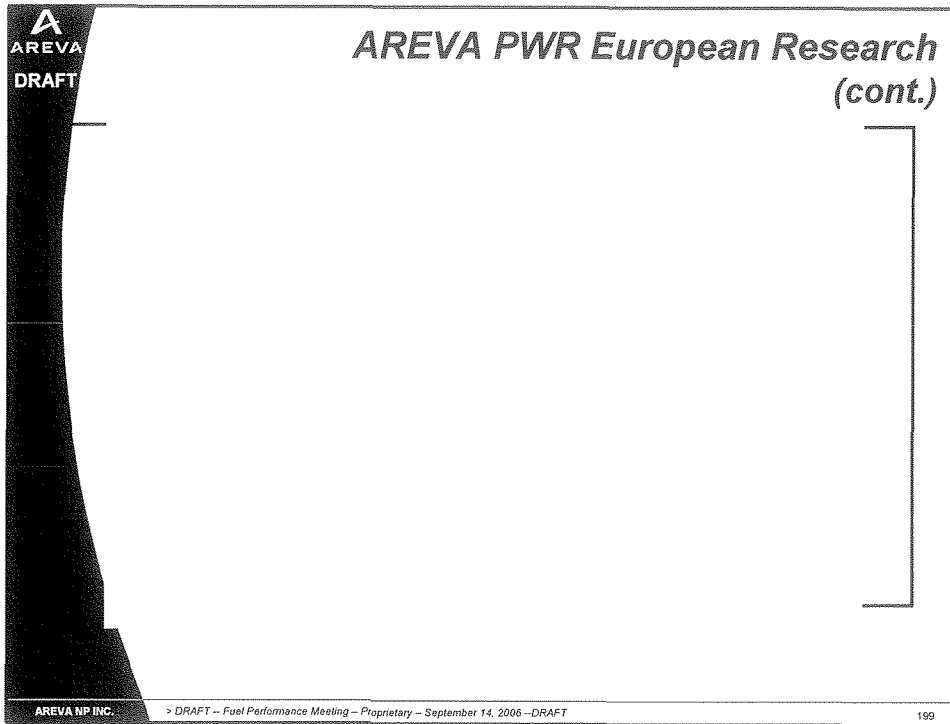
  
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(cont.)

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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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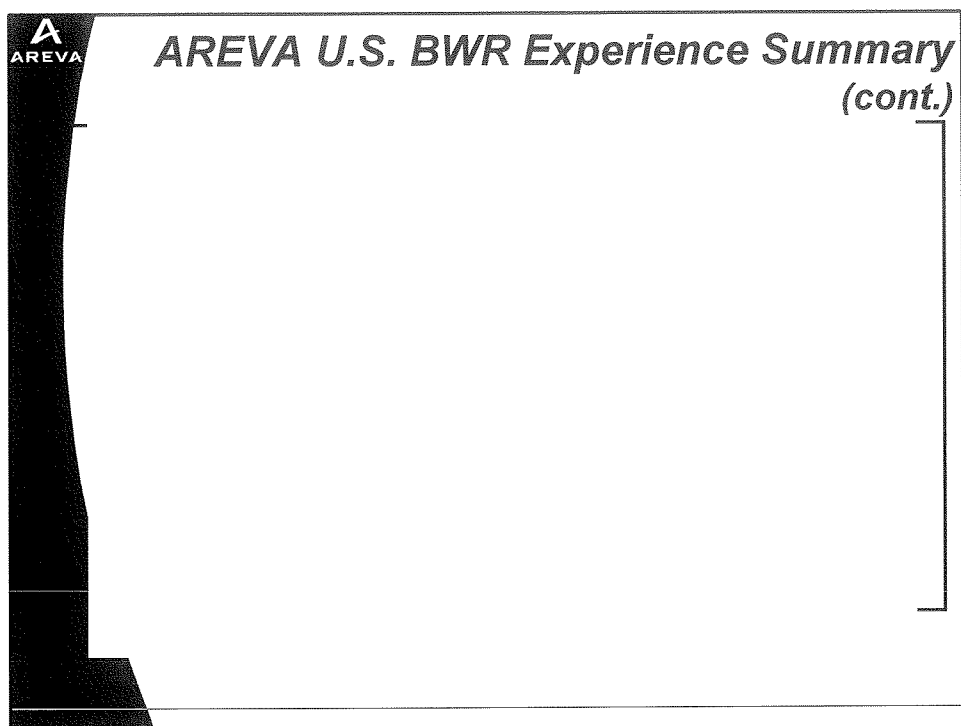
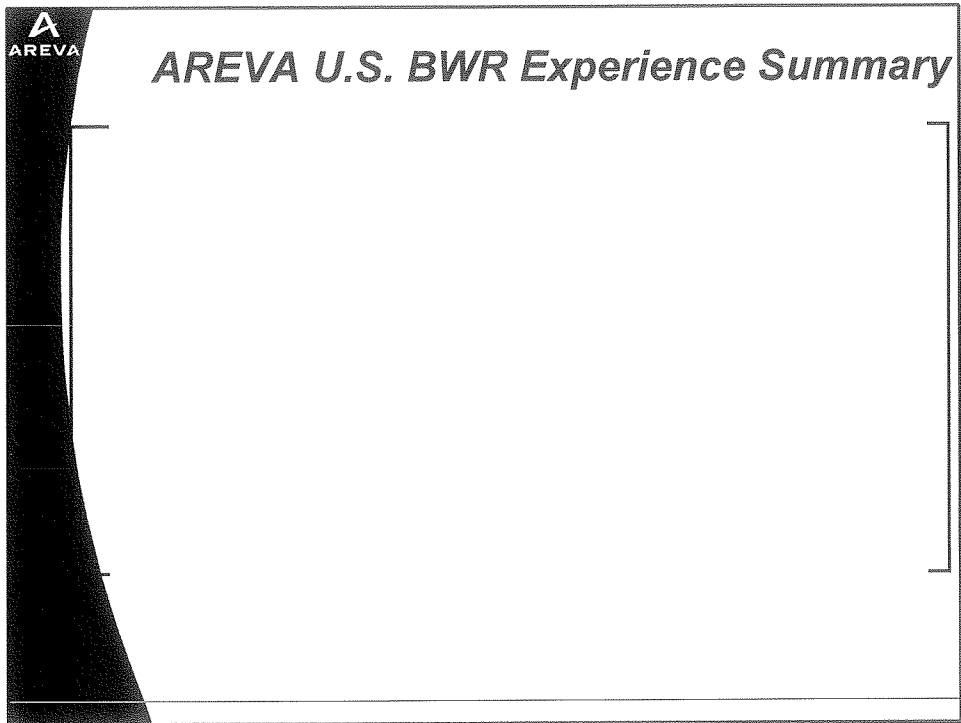
  
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# BWR High Burnup Support (cont.)

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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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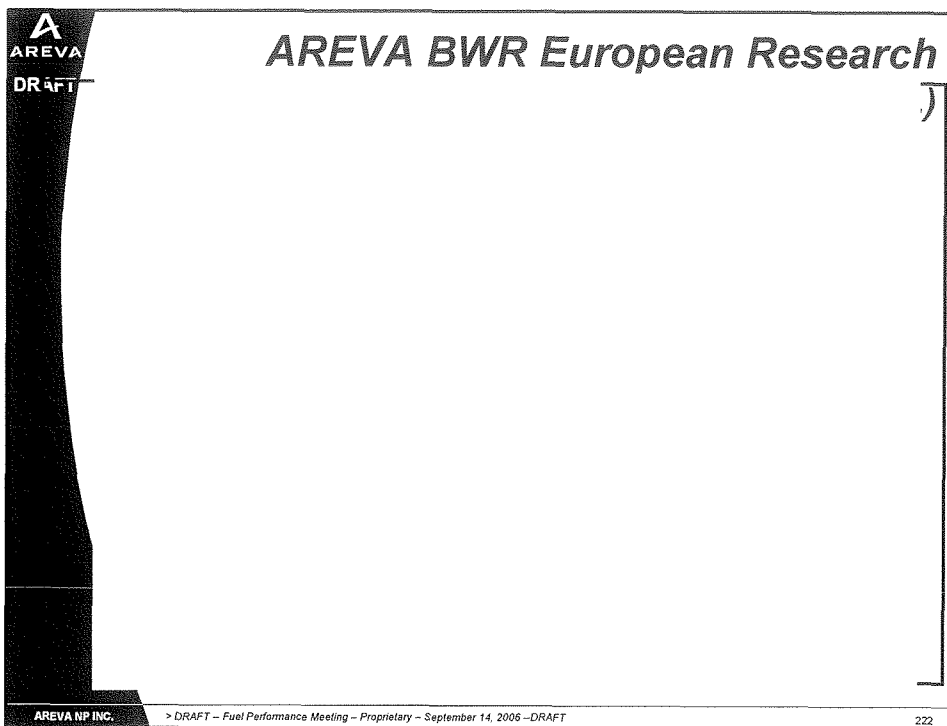
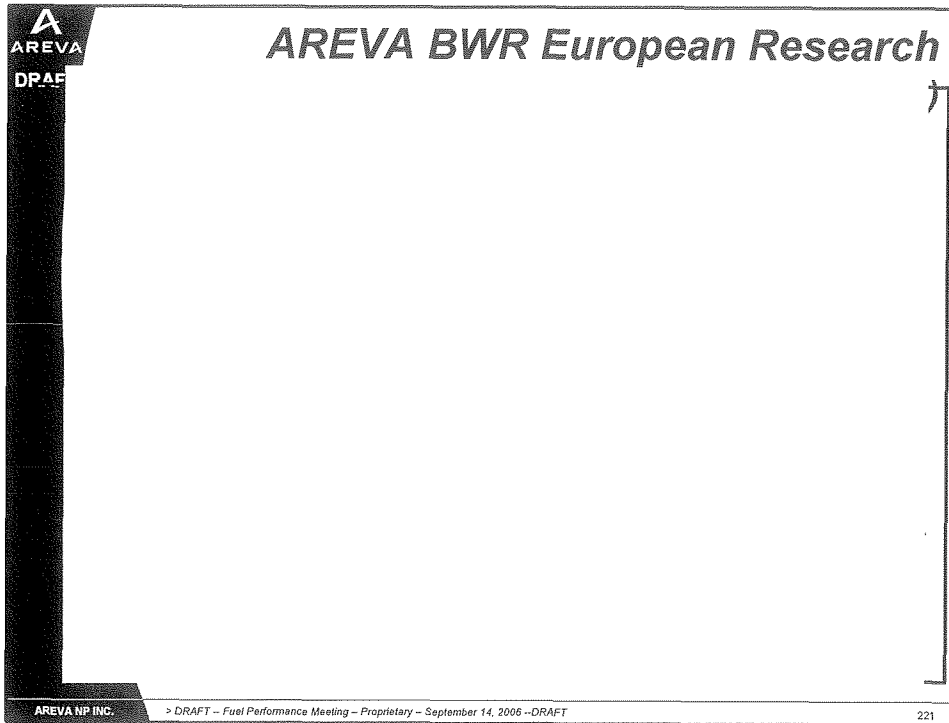
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# ***AREVA BWR European Research (cont.)***

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## ***AREVA BWR European Research (cont.)***

## ***AREVA BWR European Research (cont.)***



## ***AREVA BWR European Research (cont.)***