"Westinghouse Presentation on Westinghouse Fuel Performance Update Meeting" (Slide Presentations of February 20-21, 2008) and Associated Material (Non-Proprietary)

Westinghouse Electric Company
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355

Westinghouse/NRC
Fuel Performance Update Meeting

Columbia, SC
Feb 20-21, 2008

Westinghouse Electric Company LLC
4350 Northern Pike
Monroeville, PA 15146-2886

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Westinghouse Fuel Performance Update
Feb. 19-21, 2008
Columbia, SC

Wednesday, February 20		Tab
8:00 am - 8:15 am	Introductions and Welcome	
8:15 am - 10:30 am	Fuel Performance Update	1
10:30 am - 10:45 am	Break	
10:45 am - 11:45 am	Optima3	2
11:45 am - 12:15 pm	Spent Fuel Pool Criticality	3
12:15 pm - 1:00 pm	Lunch/Informal Discussion between NRC, Customers and Westinghouse	
1:00 pm - 2:30 pm	High Burnup and New Alloy Strategies LTA Programs High Burnup	4
2:30 pm - 3:15 pm	CE 16 NGF &	5
	New ZIRLO Corrosion Model	6
3:15 pm - 3:30 pm	Foxfire	7
3:30 pm - 3:45 pm	Break	
3:45 pm - 4:30 pm	New Reactor Fuel	8
4:30 pm - 4:50 pm	BEACON Sentinel	9
4:50 pm - 5:10 pm	Wrap-Up	

Thursday, February 21	**Licensing Review (Westinghouse & NRC)**	
9:00 am - 9:15 am	Current Programs	10
9:15 am - 9:30 am	PWR/BWR Topicals and Schedule	11
9:30 am - 11:30 am	General Licensing Topics	12
11:30 am - 12:30 pm	Lunch/Informal Discussion between NRC & Westinghouse & Wrap-Up	

Dress is Business Casual

Fuel Performance Update & Westinghouse Flawless Fuel Program

Westinghouse/NRC Fuel Update Meeting
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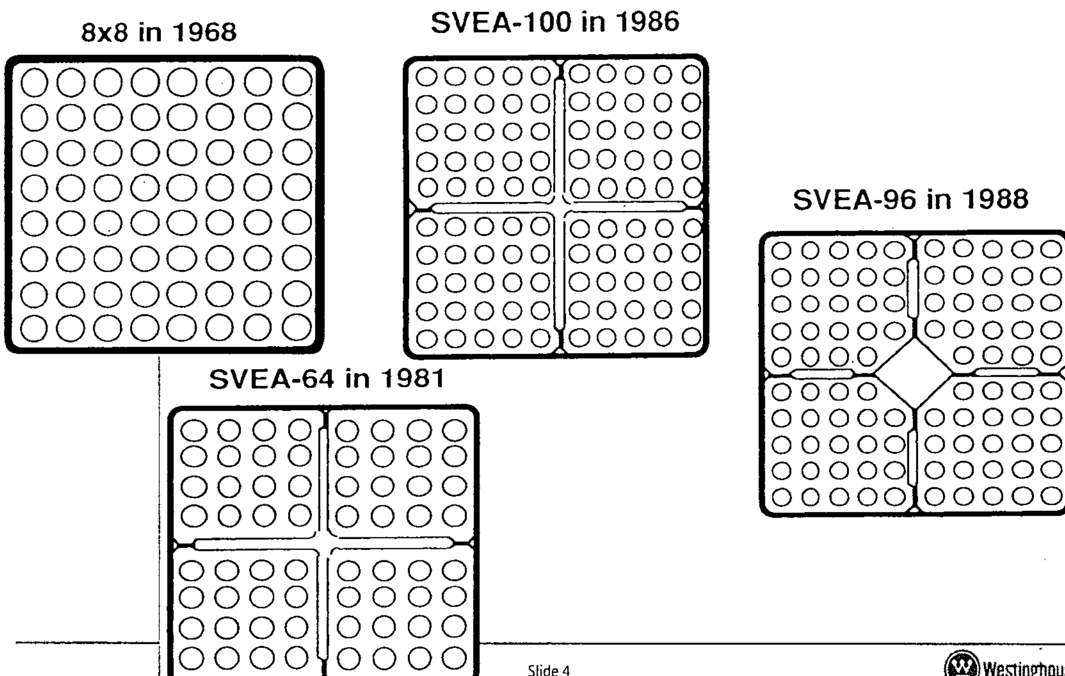
Current Westinghouse LWR Product Lines (Worldwide)

a, c

Topics

- BWR Fuel Performance Summary
- PWR Fuel Performance Summary
- Post Irradiation Exam Summary
- Westinghouse Flawless Fuel Program
- Key Design & Manufacturing Improvements

BWR Fuel Lattices
Westinghouse Fuel Design Evolution



Leaking Fuel Mechanisms (Primary) – Worldwide BWR Fuel Rods

a, c

BWR Leaking Fuel Rods by Year

a, b, c

BWR Leaking Fuel Summary

a, c

LK3 Cladding – In-Reactor Burnup Experience

a, b, c

Two-Life Rods [ ][a, c]

[ ][a, b, c]

Two-Life Rods Power History

[ ][a, b, c]

Cladding Corrosion - Mid-span Oxide Thickness by Cladding Type

[ ] a, b, c

Rod Growth By Cladding Type

[ ] a, b, c

BWR Fuel Performance Channel

a, c

Channel Corrosion

a, b, c

Channel Hydrogen Pick-Up

[ ] a, b, c

Channel Bow & Irradiation Induced Growth

[ ] a, c

Channel Growth

a, b, c

Channel Bow in Asymmetric Lattice

a, b, c

Channel Bow in Symmetric Lattice

[ ]a, b, c

Topics

- BWR Fuel Performance Summary
- PWR Fuel Performance Summary
- Post Irradiation Exam Highlights
- Westinghouse Flawless Fuel Program
- Key Design & Manufacturing Improvements

Leaking Fuel Mechanisms – Worldwide PWR Fuel Rods (1995 – 2007)

[ ]a, c

Leaking Rods – Global Performance, PWR & BWR

[ ]a, c

Leaking Rods – Global Performance, PWR & BWR

a, c

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PWR Fuel Performance

a, c

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Westinghouse "OFA" Grid Designs

a, c

Westinghouse-NSSS 15, 17 Low Pressure Drop Grid Designs

a, c

CE-NSSS14x14 & 16x16 Grid Support Evolution

a,c

Debris Performance

- Three Debris mitigation systems are used as a result of product evolution in different organizations.
- Westinghouse NSSS
  - –Debris Filter Nozzle (DFBN) + Low Profile Debris catching grid (P-Grid) below the bottom inconel grid + long end plug
  - –Pre-oxidized cladding offered as an option
- CE-NSSS
  - –High profile bottom grid attached to bottom nozzle.
  - –Long end plugs
- BWR-NSSS
  - –Debris filter nozzle (Triple Wave) – chevron fins; no line of sight through nozzle

Westinghouse-NSSS Debris Mitigation System – DFBN, P-Grid and Coated Cladding

a, c

CE-NSSS Debris Mitigation System – Guardian Grid and Long End Plug

a, b, c

BWR-NSSS Debris Mitigation System – Triple Wave

[ ] a, b, c

Field Performance of Debris Mitigation Systems

[ ] a, b, c

Topics

- BWR Fuel Performance Summary
- PWR Fuel Performance Summary
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Summary of Fretting Related Exam Results

a, c

CE-NSSS – 14x14 TURBO Product

a, c

UT Results

a, c

14x14 TURBO RCA Results

a, c

Westinghouse-NSSS -17x17 RFA leaking rods

a, c

17 RFA Debris Leaker

a, c

Westinghouse

17 RFA Debris Leaker

a, c

Westinghouse

17 RFA Assembly

a, c

Westinghouse-NSSS 15x15 V5H, OFA

a, b, c

Assembly HH83 G-5

a, c

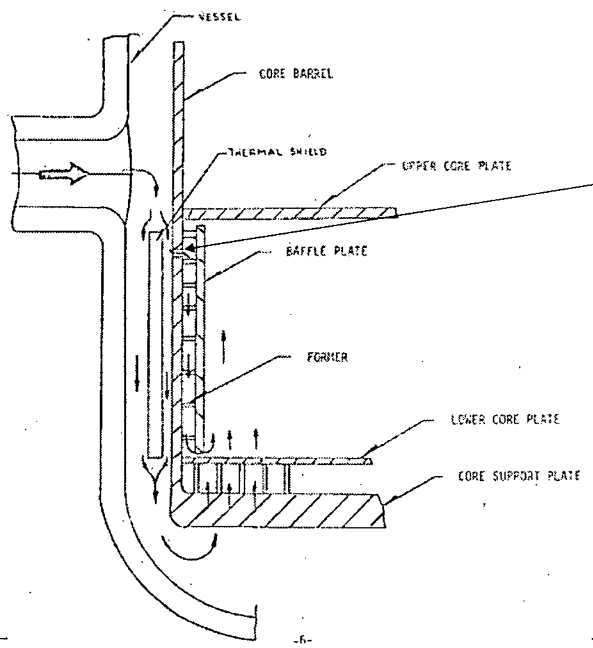
Assembly HH83 G-6

a, c

Assembly HH83

a, b, c

Downflow Baffle Cooling

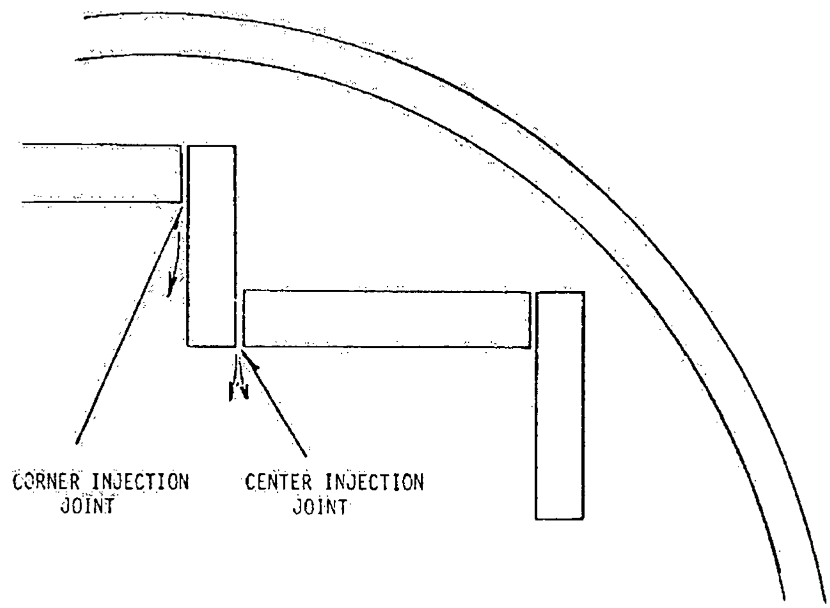


-6-

Coolant enters at the top of the baffle region and exits at the bottom

Pressure difference between baffle region and core can result in water jets if gaps exist between baffle plates

Baffle Joint Configurations



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17 NGF LTA Inspection Campaigns

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17 NGF Product Features

a, b, c

[ ]

Catawba 1 NGF Examination Results

a, b, c

[ ]

Millstone 3 NGF Examination Results

a, b, c

Catawba 1 and Millstone 3 NGF Examination Results – Fuel Assembly Growth

a, b, c

Catawba 1 and Millstone 3 NGF Examination Results – Fuel Rod Growth

a, b, c

Millstone 3 NGF Examination Results Fuel Assembly Bow

a, b, c

Topics

- BWR Fuel Performance Summary
- PWR Fuel Performance Summary
- Post Irradiation Exam Highlights
- Westinghouse Flawless Fuel Program
- Key Design & Manufacturing Improvements

Westinghouse Flawless Fuel Program

a, b, c

Westinghouse Flawless Fuel Program – A Systematic Approach to Get to Zero Defects

a, c

Westinghouse Flawless Fuel Program – A Systematic Approach to Get to Zero Defects (cont'd)

a, c

Topics

- BWR Fuel Performance Summary
- PWR Fuel Performance Summary
- Post Irradiation Exam Highlights
- Westinghouse Flawless Fuel Program
- Key Design & Manufacturing Improvements

Debris Fretting Improvement Projects

a,c

Original vs. Alternate P-Grid

a,c

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Preventing Future Crud/Corrosion Failures

a, c

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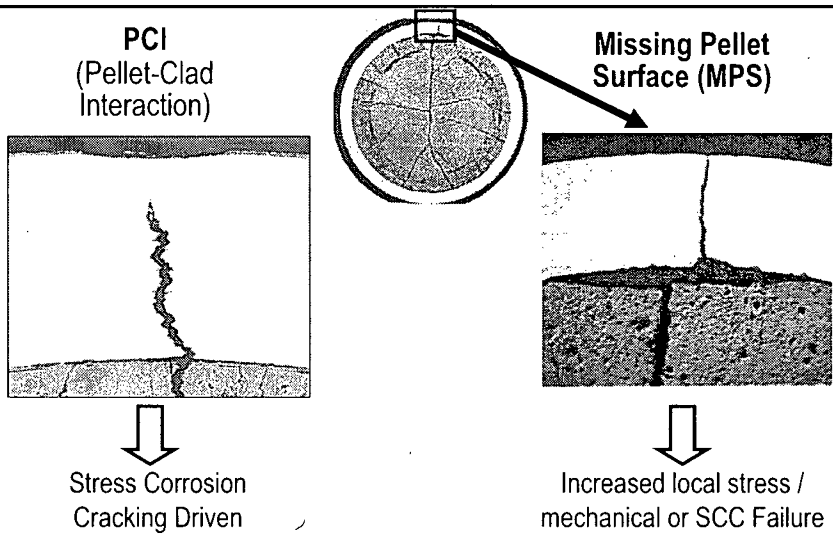
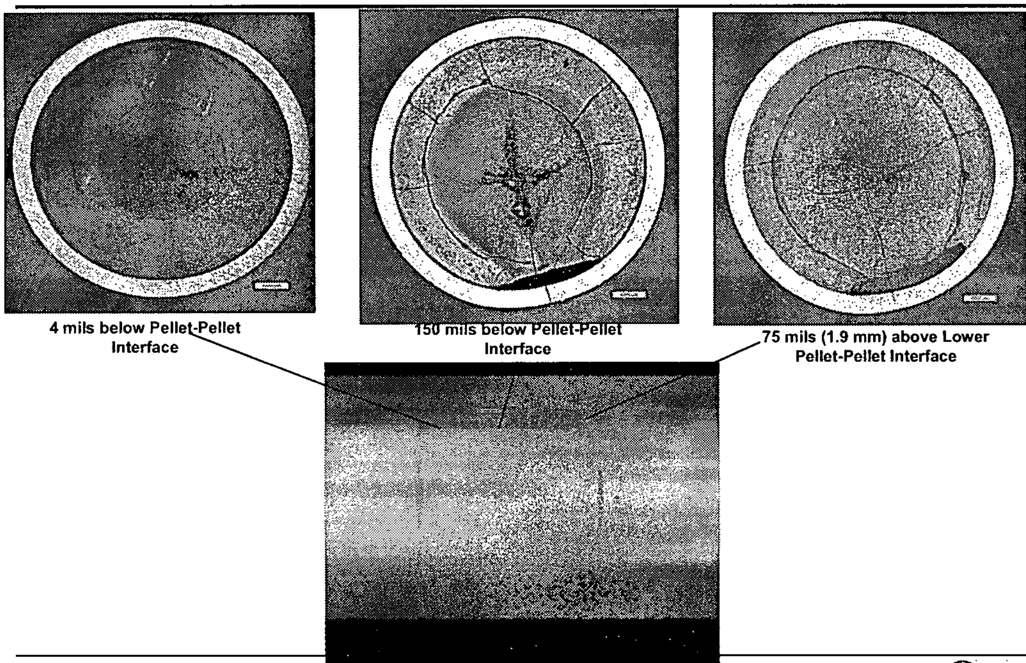
CFD Calculations Show Local Areas of Reduced Heat Transfer that Could Result in Crud Deposition

a, b, c

PCI/MPS Failures



Westinghouse PWR Rod - Missing Pellet Surface and Crack at 119.2-120.0 cm (46.9 inches)



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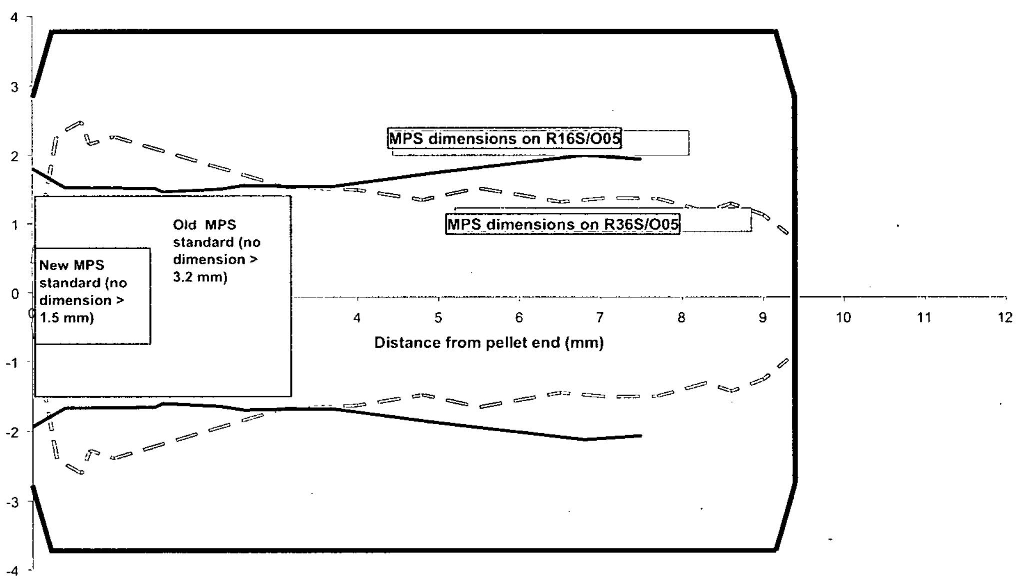
Pellet MPS Standards Much Smaller than MPS in Leaking Rods



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PCI Analysis Result Example

a, b, c

Integrated Pellet Quality Improvement Plan

a,
c

Summary & Conclusions

- Significant improvements in grid to rod fretting performance are being realized as new fretting resistant designs are replacing old products
- Debris induced leakers are being addressed by product improvements where possible and increased focus on FME control by sites as part of the "0 By 10" initiative
- New tools enable core designers to more accurately assess risk of crud formation in core loading pattern decision making process
- Major capital investments have been made and are underway to achieve the quality levels required to support leaker free fuel operation

Questions?

Optima3

Westinghouse/NRC Fuel Update Meeting
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Feb 20, 2008

Presentation Overview

- SVEA-96 Optima2
  - Performance
- SVEA-96 Optima3
  - Key features and Components
  - Verification
  - Introduction
- Conclusions

10x10 SVEA Design Evolution

<u>28 years SVEA Design Evolution</u>

- SVEA-96 Optima2 - 2 PLR Sizes — SVEA-96 Optima2
- Eighth Spacer - 1998 — SVEA-96 Optima
- SVEA-96 Optima Partial Length Rods - 1998 — SVEA-96+
- SVEA-96+/96S - Seventh Spacer - 1994 — SVEA-96S*
- SVEA-96 - 96 Rods Central Diamond Channel - 1988 — SVEA-96
- SVEA-100 10x10 Rod Array - 1986 — SVEA-100*
- Watercross Design - 1981 — SVEA-64

*For W-Atom Designed Reactors

BWR Fuel Deliveries

a, b, c

BWR Fuel Burnup Experience, 2007

a, b, c

SVEA-96 Optima2 Deliveries

a, c

Debris fretting mitigation
Debris filter - TripleWave

a, b, c

Implementation of TripleWave

a, c

TripleWave performance Statistics

a, b, c

SVEA-96 Optima2 - Summary

- SVEA-96 Optima2 is an excellent base for
  - high power density/power uprates
  - long and flexible cycles
  - high burnup
- SVEA-96 Optima2 became Westinghouse standard BWR fuel very quickly
  - 4045 assemblies has been delivered
  - Full cores are in operation, KKL and O3
  - Full burnup has been achieved (peak assembly average 60 MWd/kgU)

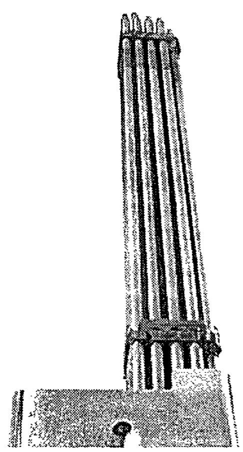
SVEA-96 Optima3 Product

a, c

SVEA-96 Optima3

SVEA-96 Optima3 provides

- Improved reliability
- Increased thermal margins
- More U
- Lower pressure drop
- Less parasitic absorption



SVEA-96 Optima3

a, c

SVEA-96 Optima3 - Spacer cell

a, c

SVEA-96 Optima3
Spacer with Mixing Vanes

a, c

SVEA-96 Optima3 Spacer w/o vanes

a, c

SVEA-96 Optima3
Sub-bundle Bottom End

a, c

SVEA-96 Optima3
Sub-bundle Top End

a, c

SVEA-96 Optima3
Plenum Volume

a, c

SVEA-96 Optima3 – Assembly Design

a, c

SVEA-96 Optima3
Thermal Hydraulic Performance

a, c

SVEA-96 Optima3 - Verification

a, c

ADOPT
Advanced Doped Pellet Technology

[ ] a, b, c

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ADOPT – Objectives

1. Higher density

2. Reduced fission gas release
   - Demonstrated by two independent [ ] a, c tests
   - Gamma measurements in [ ] a, c
   - On-line test in [ ] a, c /evaluation ongoing

3. Increased PCI threshold
   - Positive indications from a [ ] a, c ramp test
   - Creep test at [ ] a, c

4. Improved secondary degradation behavior
   - Autoclave corrosion tests
   - [ ] a, c in-reactor washout test

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Fission Gas Release – Gamma Scan at [ ] a,c

[ ] a, b, c

ADOPT Verification

[ ] a, c

Debris Fretting Mitigation Improvements

a, c

Debris fretting mitigation
Catching tests with spacers

a, b, c

Debris fretting mitigation
Combination of spacer and filter

a, b, c

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ZIRLO for BWR Fuel Channels

a, c

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SVEA-96 Optima3 - Summary

a, c

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US Applications

a, c

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Conclusions

– SVEA-96 Optima2 is a well proven design for US BWRs

– Further enhancements with SVEA-96 Optima3
  - An evolutionary design
  - Key proven components of SVEA-96 Optima2 maintained
  - All loop test completed successfully

– SVEA-96 Optima3 components in verification since 2003
  - Inspections 2004 and 2005 showed good behavior
  - Full burnup inspection in 2008 outage

– SVEA-96 Optima3 reload readiness from 2010
  - US introduction program to be decided

Questions?

Spent Fuel Pool Criticality Safety

Westinghouse/NRC Fuel Update Meeting
Columbia, SC
Feb 20, 2008

Spent Fuel Pool Criticality
Past Submittals

- [ ]a,c 12/2000, ML003761578
- [ ]a,c 9/2002, ML022610080
- [ ]a,c 04/2003, ML030910485
- [ ]a,c 09/2005, ML052420110
- [ ]a,c 09/2005, ML052420110
- [

  ]a,c 02/2006, ML060250208

Spent Fuel Pool Criticality Current and Future Efforts

- [

  ]a,c
- [

  ]a,c directed to withdraw – will be resubmitted in the near future
- [ ]a,c directed to withdraw and fix – will be resubmitted in the near future
- [ ]a,c directed to separate from uprate package or delay the uprate (chose to separate and pursue in parallel to the uprate licensing)
- [ ]a,c awaiting review
- [ ]a,c will be submitted in 2nd Qtr '08.
- The analyses to be submitted or resubmitted will incorporate additions based on the [ ]a,c experience

High Burnup and New Alloy Strategies

Westinghouse/NRC Fuel Update Meeting
Columbia SC
February 20, 2008

Strategy

- Alloys:
  - Past: Zr-4
  - Current: ZIRLO™
  - Near-term future: Optimized ZIRLO™
  - Future: AXIOM™ and advanced alloys

[ ] a, c

Subject Areas

- LTA Programs
- High-Temperature Oxidation Tests
- Optimized ZIRLO™
- AXIOM™
- Status of [ ]a,c Creep & Growth Specimens
- High Burnup Data Needs

LTA Programs

Westinghouse High Burnup ZIRLO™ LTA Summary

a, b, c

STD ZIRLO™ (SRA) Hotcell Exams

a, b, c

Summary of LTA Programs

[ ] a, b, c

Breakaway Oxidation Tests

Breakaway Oxidation

- Defined as long-term exposure to medium LOCA temperatures such as occurs in a Small Break LOCA
- Temperature range of interest 650 to 1000 °C
- Concern raised due to E110 experience
  - Clarify requirements for "advanced alloy" evaluations

Breakaway oxidation tests

- ANL results showed breakaway oxidation was alloy-dependent
  - Break away defined as [H] level of 200 ppm
  - Time required to get to 200 ppm H varies by temperature; generally, increasing temperature decreases time required to achieve 200 ppm
- Westinghouse testing has shown:
  - Similar results to ANL for as-received ZIRLO™ cladding
  - Virtually identical performance for Zirc-4 and ZIRLO™
  - Thin oxide film equivalent to reactor heating up significantly increases breakaway time
  - Opt ZIRLO™ has longer breakaway time than ZIRLO™

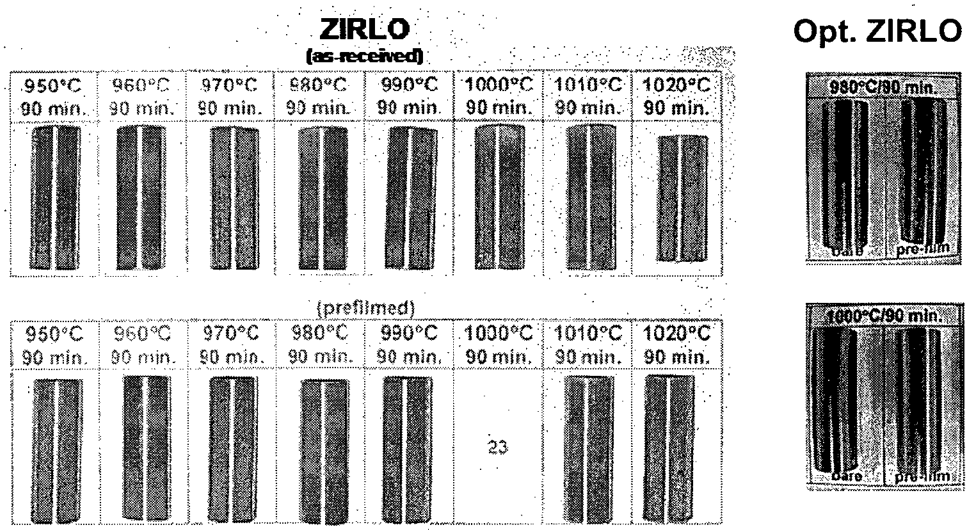
Background

- Oxidation tests performed at 970 °C in a flowing steam environment for 3000 – 5400 seconds
- ZIRLO™, Optimized ZIRLO™ and Zircaloy-4 claddings tested
- ZIRLO™ tested in both the as-received and pre-filmed condition
- ZIRLO™ tested with and without scratches
- STC facility also conducted long term oxidation testing ZIRLO™ and Zircaloy-4 claddings over a temperature range from 950 °C to 1020 °C (90-minute hold) to determine a minimum time to breakaway oxidation.

Results – Columbia Testing

a, b, c

ZIRLO™ Cladding Samples



ZIRLO™ cladding samples following exposure to high-temperature steam in the temperature range of 950 °C to 1020 °C for 90 minutes.

Observations

- Pre-filmed ZIRLO™ (thin oxides < 1 μm) shows significant resistance to hydrogen pickup for times up to at least 90 minutes
  - Pre-filming which simulates the first few days of in-core residency provides significant margin to breakaway oxidation
- As-received Optimized ZIRLO™ without pre-film shows no H pickup after 50 minutes.
- As-received ZIRLO™ absorbs ~200 ppm H after 3000 seconds at 970 °C
- As-received Zircaloy-4 picked up similar H (~95 ppm for a single data point) after 50 minutes at 970 °C
- Pre-filming protects scratches

Breakaway Testing at STC

- Most of the ZIRLO™ samples exhibited black adherent oxide over the entire sample.
- Tan oxide (when present) was associated with the ends of the samples and is not interpreted as the onset of breakaway oxidation. The tan oxide formed at the geometrical discontinuity of the cut end.
- Pre-filmed ZIRLO™ samples (360 °C/72 hours) exhibited less tan oxide at the ends but were not immune from formation of tan oxide
- Optimized ZIRLO™ behaved better

Breakaway Testing at STC (Cont'd)

- The Zircaloy-4 samples exhibited significantly higher weight gains than ZIRLO™ at temperatures above 980 °C
- Zircaloy-4 samples were more prone to forming a gray (non-protective) oxide than ZIRLO™ were to forming a tan (non-protective) oxide
- The temperature/time associated with the largest amount of tan/gray oxide was 1000 °C/90 minutes suggesting that this temperature/time combination would be associated with a minimum time to breakaway oxidation.

Breakaway Oxidation Tests - Summary

- Westinghouse believes that breakaway test results are highly dependent on test setup and not representative of in-core performance
- Test results should be able to be replicated
- Rulemaking needs to allow for completion of testing and reporting of results – current RES interpretation of ANL data is overly restrictive and not phenomenologically related to reactor operating conditions.

Optimized ZIRLO™

Status of Optimized ZIRLO™ LTA Programs

a, b, c

Optimized ZIRLO™ High Burn-Up Plans

a, b, c

Optimized ZIRLO™ High BU Plan Overview

a, c

Optimized ZIRLO™ Cladding Corrosion

a, b, c

Results of Optimized ZIRLO™ PIEs

a, c

Summary of Current Optimized ZIRLO™ Performance

- Optimized ZIRLO cladding has experience in 13 reactors
- Optimized ZIRLO cladding normally will have a PRXA structure with thermal creep rates equivalent to standard ZIRLO
- Creep is within current model bounds
- Corrosion results indicate significant corrosion improvements (> 30% reductions)
- Fuel rod growth is equivalent to standard ZIRLO
- First commercial batches in 2008

AXIOM™

Westinghouse

AXIOM™ LTAs

a, b, c

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Nominal Alloy Compositions for the AXIOM™ Alloys

[ ] a, b,

AXIOM™ Corrosion Performance

[ ] a, c

Current AXIOM™ LTA Plans

a, b, c

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Unfueled Cladding Creep and Growth Tests

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Status of [ ]a,c Creep and Growth Specimens

a, b, c

Status of [ ]a,c Creep and Growth Specimens

a, c

Irradiation Schedule

a, c

What Has Been Learned

a, c

[

] a, c

a, b, c

[

] a, c

a, b, c

[

] a, c

a, b, c

High Burnup Data Needs

a, c

CE 16x16 NGF Update

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Feb 20, 2008

Outline

- NGF Region Implementation in [ ]a, c
- NGF Region Implementation in [ ]a, c

NGF Region Implementation in [ ]a, c

- NGF fuel delivered to [ ]a, c (88 assys) 2/18/08
- NGF fuel being delivered to [ ]a, c (100 assys) 4/9/08
- Reload Analysis Reports completed
- Licensing:
  - All NGF topicals approved
    - DNB Correlation topical
    - 16x16 NGF Core Reference Report
    - LOCA Supplement on Grid Heat Transfer Model
    - Optimized ZIRLO™ topical
  - Provided Rev. 1 of Optimized ZIRLO™ Data Package to NRC, Answered all questions on LARs & Clad Exemption for [ ]a, c (waiting for SERs)
  - NRC will audit [ ]a, c setpoint analyses for partial DNB credit
  - Additional guide tube growth data to be provided this year

NGF Region Implementation in [ ]a, c

- CE 16x NGF design selected to support uprate in 2012
- NGF design similar to [ ]a, c design except assembly is shorter (active core is 136.7" vs 150")
- Licensing:
  - Will reference approved NGF topicals
  - LAR and Clad Exemption needed for full region

New ZIRLO™ Corrosion Model

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Feb 20, 2008

Outline

- Background
- Status on New ZIRLO™ Corrosion Model
- Topical Preparation
- Timeline
- Eliminate FDI Restriction for ZIRLO™ in CE NSSS Plants

Background

- Westinghouse has accumulated a significant amount of ZIRLO™ and Optimized ZIRLO™ data
  - More than 50,000 data points
- The current corrosion model is being updated to use all available data to make corrosion predictions in reload design analyses

Westinghouse ZIRLO™ Database

a, b, c

Status on New ZIRLO™ Corrosion Model

- A new model was developed and reviewed based on ZIRLO™ and Optimized ZIRLO™ corrosion data from Westinghouse plants
- Additional ZIRLO™ corrosion data is now available from CE type plants
- The new corrosion model is currently being validated for the CE ZIRLO™ data

Topical Preparation

- Prepare Addendum to ZIRLO™ /Opt. ZIRLO™ Topical WCAP-12610-P-A/CENPD-404-P-A to license new ZIRLO™ Corrosion Model
- Describe new ZIRLO™ corrosion model, supporting database and criteria
- Describe Hydrogen model, supporting data and criteria
- Summarize typical plant assessments
- See attached Draft Table of Contents

Topical Outline

1.0 Introduction
- 1.1 Purpose
- 1.2 Review Scope
- 1.3 Applicability to WCAP-12610-P-A and CENPD-404-P-A

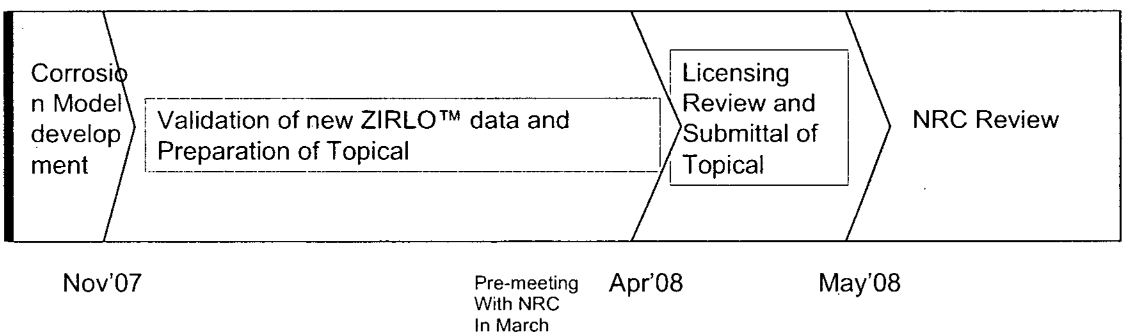
2.0 Corrosion Model and Design Methodology
- 2.1 Model Development Overview
- 2.2 Corrosion Database
- 2.3 Supporting Models
  - Hydrogen Pickup
  - Variable O/M
- 2.4 Model Form
- 2.5 Model Development
  - Sn Effect Calibration
- 2.6 Model Predictions of Calibration Data
  - Including Crud Li and Zinc Effects
- 2.7 Model Residuals
- 2.8 Model Uncertainties
- 2.9 Model Validation
- 2.10 Model Summary

3.0 Corrosion Model Criteria and Design Methodology
- 3.1. Fuel Performance
- 3.2 ECCS

4.0 Plant Assessments
- Calculations
- Text

5.0 References

Project Timeline



Anticipated submittal of New ZIRLO™ Corrosion topical: May 2008

Eliminate FDI Restriction for ZIRLO™ in CE NSSS Plants

- A Fuel Duty Index (FDI) restriction was imposed by NRC to licensees for implementing ZIRLO™ cladding in CE plants since no ZIRLO™ corrosion data was available in CE plants
- This restriction can be eliminated after enough ZIRLO™ data is accumulated from CE plants (14x and 16x) and corrosion behavior of the data is similar to Westinghouse ZIRLO™ database
- A generic letter will be prepared for licensees to submit to NRC

Foxfire

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What is Foxfire?

a, c

What is Foxfire?

a, c

Slide 3

Westinghouse

Key Model Upgrade/Addition Relative to PAD

a, c

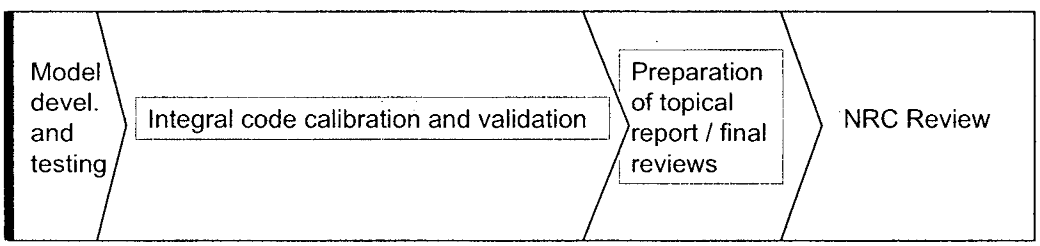
Slide 4

Westinghouse

Key Model Upgrade/Addition Relative to PAD

a, c

Project Timeline



1st quarter 2008 3rd quarter 2008 1st quarter 2009

Anticipated submittal of Foxfire topical: 1st quarter 2009

AP1000 Fuel Update

Westinghouse/NRC Fuel Update Meeting
Columbia, SC
Feb 20, 2008

Agenda

- Westinghouse Fuels approach to initial core load for AP1000
- The Core Reference Report
- Overview of other Fuel and Core Components
- Gray Rod Enhancement (GRCA)

Westinghouse Approach to Initial Core Load

The AP1000 fuel, core components and core design are being developed in three distinct stages:

1. Reference Design ⇨ defined by the DCD (rev 15)
2. Licensed Design ⇨ defined by the DCD (rev 16) ⇨ COL
   - For Fuels: DCD (Rev 15) + TR 18 = DCD (Rev 16)
3. Final Design ⇨ defined by the COL + Core Reference Report ⇨ Initial Plant Start-up

A 3 step process allows the use of the best fuel product, core components and core design at the time of initial plant start-up consistent with the ongoing advancements we are seeing today.

Approach to Initial Core Load (continued)

- Reference Design ⇨ defined by the DCD Rev 15
  - Purpose to provide a reference design on which to base plant certification completed (circa 1990s)
  - Establishes the AP1000 plant requirements
- Licensed Design ⇨ DCD Rev 16 [defined by the DCD + Technical Reports] ⇨ COL
  - Provides the licensed design in support of the COL application
  - Establishes a process for making changes and enhancements to the Fuel, Core Components and Core Design prior to initial start-up and for subsequent reloads
  - COL's submitted fall 2007 ⇨ Initial plant operations ~2014

Approach to Initial Core Load (continued)

- Final Design ⇨ COL + Core Reference Report
  - Submitted after the initial COL is issued but prior to initial fuel load with sufficient time for NRC review and approval.
  - A core reference report submitted to the NRC for review and approval (consistent with the requirements to address Tier 2* items)
    - Addresses enhancements to fuel assembly and core components design
    - Addresses initial fuel loading pattern, control rod designations and associated core physics parameters
  - Standardized Core Reference Report for the AP1000 fleet would be incorporated into the New Plant License following the standard license amendment process (10 CFR50.92)
  - Provides for NRC review & approval of initial core

The AP1000 Core Reference Report

AP1000 Core Reference Report

- The AP1000 Core Reference Report once reviewed and approved by the NRC would address any final changes to the fuel assembly design, methods and requirements prior to initial core load.

- The report presents the COL holder's actual initial core (cycle 1) fuel loading pattern, control rod designation (both RCCAs and GRCA) and associated core physics parameters at the time of initial start-up.

Core Reference Report

Examples of Fuel and Core Design evolutions that will be addressed in the Core Reference Report:

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Core Reference Report will be submitted to the NRC for review and approval and there will be no change to the Chapter 15 conclusions.

Approach to Initial Core Load

- Basic Ground Rules for the Initial Core
  - Tier 2 * changes must be NRC Reviewed and Approved
  - "DCD Design Criteria" is defined as the Principal Design Requirements
    - Section 4.1.1 defines the Principal Design Requirements
    - Conclusions of the Chapter 15 Safety Analyses remain valid
  - Actual fuel and core component designs (including RCCAs and GRCAs), loading pattern, control rod designations and core physics changes from the design in the DCD will be submitted to the NRC for review and approval (Core Reference Report) prior to initial fuel load .

Next step for Initial Core Load

- AP1000 Core Reference Report
  - Reviewed and approved by the NRC via LAR process
  - Addresses final changes to the methods, core, fuel and core components design prior to initial core load
- Core Reference Report to be submitted to the NRC consistent with construction schedule to maximize opportunity to incorporate fuel and core design evolutions.
  - Allow sufficient time for NRC review
  - Follow Topical/LAR Process

Status of Fuel Licensing Activities

- Technical Report (TR-18) submitted Oct 31,2006
  - COL Information Item Addressed
  - Limited design changes to reflect enhancements or address inconsistencies
  - Provided the basis for the changes in DCD Rev 16 currently under review
- Responded to all RAIs by Sept 30, 2007

Overview of other Fuel Assembly and Core Components

- Fuel Assembly
  - Base design is Westinghouse Robust Fuel Assembly (RFA)
  - 14 foot active fuel length (South Texas, EDF, and Doel 4 use the 14', RFA design)
  - Features adapted to AP1000 requirements (i.e., Top Mounted Instrumentation)
- Core Components
  - Core components are based on standard designs
  - GRCAs have been adapted from RCCAs to enable utilization of MSHIM control strategy
  - Core components and top nozzle have been adapted to allow top mounted in-core instrumentation

AP1000 Fuel Design Based on RFA

- AP1000 basic fuel assembly design is derived from the Westinghouse 17X17 Robust Fuel Assembly (RFA) XL design
- Westinghouse has significant experience with the RFA design

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- Detailed AP1000 fuel dimensions defined to meet specific AP1000 design requirements

AP1000 Fuel Features

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GRCA use in MSHIM Operation

- AP1000 uses MSHIM control strategy for reactivity changes associated with power level, power distribution and temperature control.
- MSHIM operation allows significant simplification in CVCS by eliminating previous requirements for boron change associated with power change.
- Operational boron change requirements with MSHIM are limited to startup, shutdown and fuel depletion.
- MSHIM control strategy fully automated in AP1000 power control system at power levels [ ]a,c

Controls Rods (RCCAs) are different from Gray Rods (GRCA)

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GRCA Design Evolution

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Advanced GRCA Design

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Summary

- AP1000 Core Reference Report
  - Reviewed and approved by the NRC via LAR process
  - Addresses final changes to the methods, core, fuel and core components design prior to initial core load
- DCD 12 is the current GRCA Design
  - Westinghouse is developing an advanced GRCA design utilizing [ ]a,c as a gray material
  - NRC's timely review and approval of the Enhanced GRCA Rodlet Design Topical needed for the introduction of this enhanced GRCA rodlet into the initial core for AP1000

Questions?

Overview of BEACON™ Sentinel™
(BEACON™ Fixed Incore Protection System)

Westinghouse/NRC Fuel Update Meeting
Columbia, SC
Feb 20, 2008

BEACON™ Sentinel™ Outline

- New innovative WEC technology for Future
- Background
- CPCS™ Overview
- BEACON™ Sentinel™ Summary
- Innovative BEACON™ Sentinel™ Concepts
- Questions and Comments?

New innovative WEC technology for Future

- Purpose
  - Make Safety Decisions based upon better knowledge
    - Use Incore information
  - Present
    - Conservative using ex-core data and offline radial peaking factors
  - Future
    - More accurate (3-D information) using information from inside reactor
- Goals
  - State of the Art Protection System applicable to all PWRs
  - Improved accuracy can provide support
    - for power uprates,
    - capacity factor improvements
    - other operational benefits
  - Improved Algorithms simplify analysis requirements

Background

- Core Protection Calculator System (CPCS™)
  - Most advanced operating PWR protection system in the world
  - Developed in 1970s to work on 1970s era computer hardware
  - Currently operating at 7 plants in US and 8 plants in Korea
  - No significant functional design improvements since 1986
  - Several plants operating with recent upgrade to "Common Q" hardware with essentially same functional design
- Current System Detector Information
  - Protection System uses Excore Information
  - Monitoring System uses Incore Information

Background – cont'd

- BEACON™
  - State of the Art Monitoring System for PWRs
  - Licensed and Marketed to all PWRs
- COLSS™
  - Digital on-line monitoring system used at plants with CPCS™
- BEACON - COLSS™
  - Licensed state-of-the-art monitoring system that combines the best modules of BEACON™ and COLSS™
- Basis for BEACON™ -Sentinel™
  - Builds on advanced concepts - CPCS™, BEACON™ and BEACON-COLSS™
  - Better computer hardware/software technology today
  - Advanced nuclear design tool

CPCS™ Overview

- 4 channel system
  - 2 channels to trip with 1 channel allowed to be in bypass
- Each channel calculates reactor power & axial power shape
  - based on input from single 3-level excore detector
- Each channel calculates radial peaking factor
  - based on pre-calculated look-up table and target rod positions
- On-line DNBR calculation
- Uncertainty analysis conservatively compensates for power distribution & TH algorithm simplifications

BEACON™ - Sentinel™ Overview

- Same 4 channel system as CPCS™
- Same protection functions & transient response as CPCS™
- Being developed to work on modern computer hardware with modern software technology
- Applies BEACON-COLSS™ concepts to safety grade protection system
- Uses Incore Information for Protection System

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Innovative BEACON™ Sentinel™ Concepts

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BEACON™ Sentinel™ Summary

- Present
  - Developed Functional Requirements document
  - Patent application submitted
  - Detailed slides provided at the May 2007 meeting
- Future
  - Continued development
  - Pre-submittal Meeting Spring 2009
  - License submittal Spring 2010
  - First Implementation 2011
- Questions or Comments?

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Westinghouse Organization

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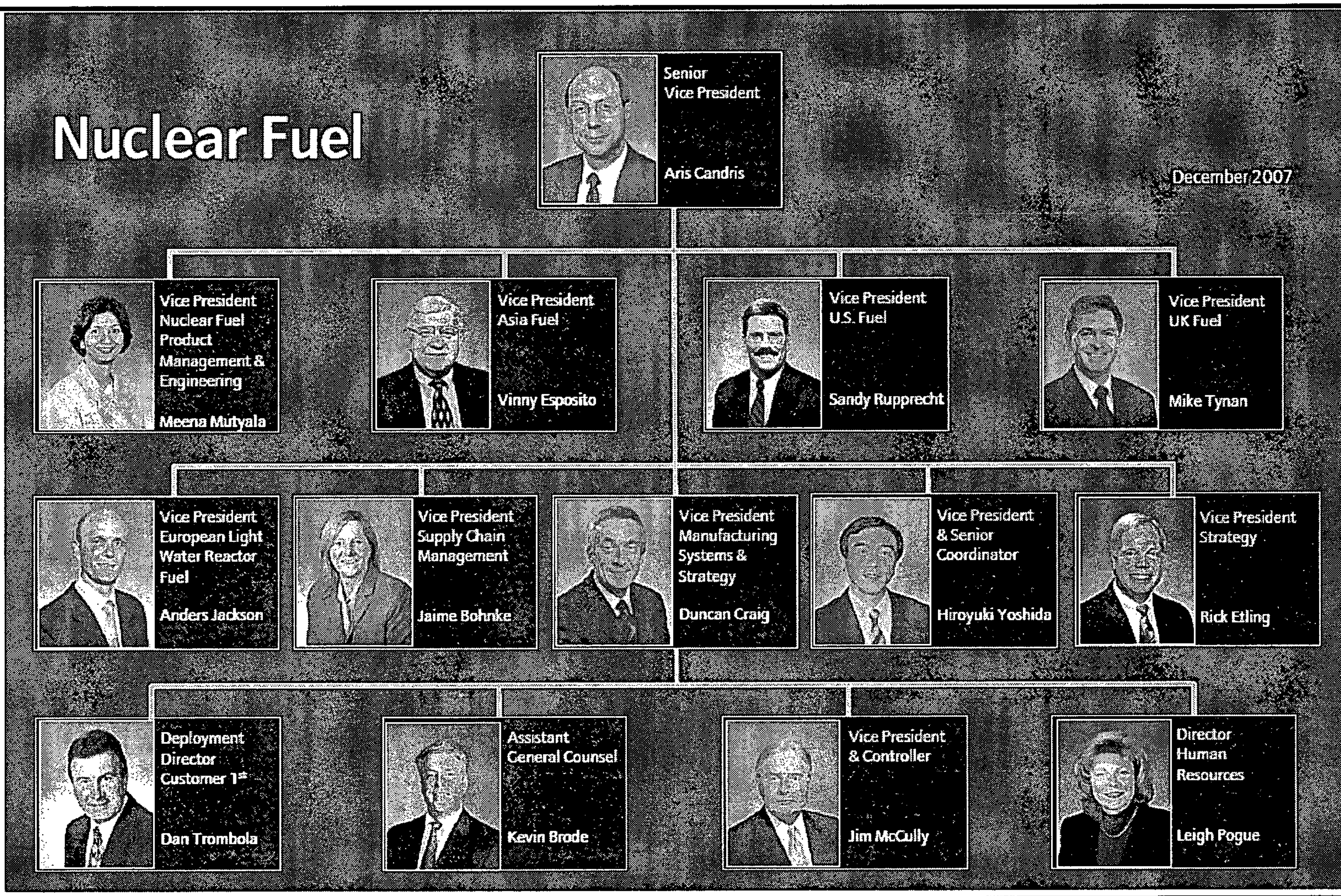
Feb 21, 2008

Current Westinghouse Nuclear Fuel Organization



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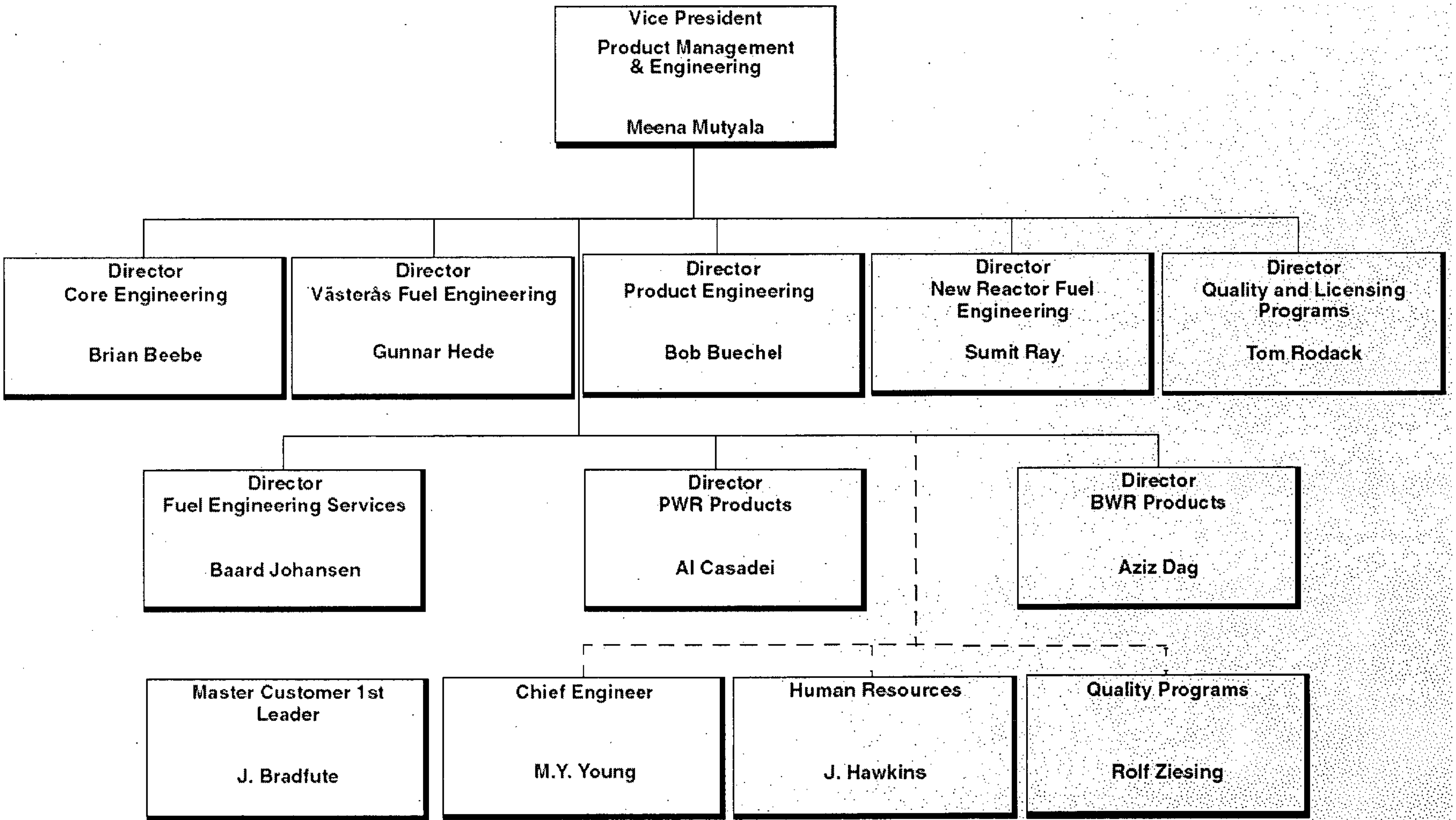
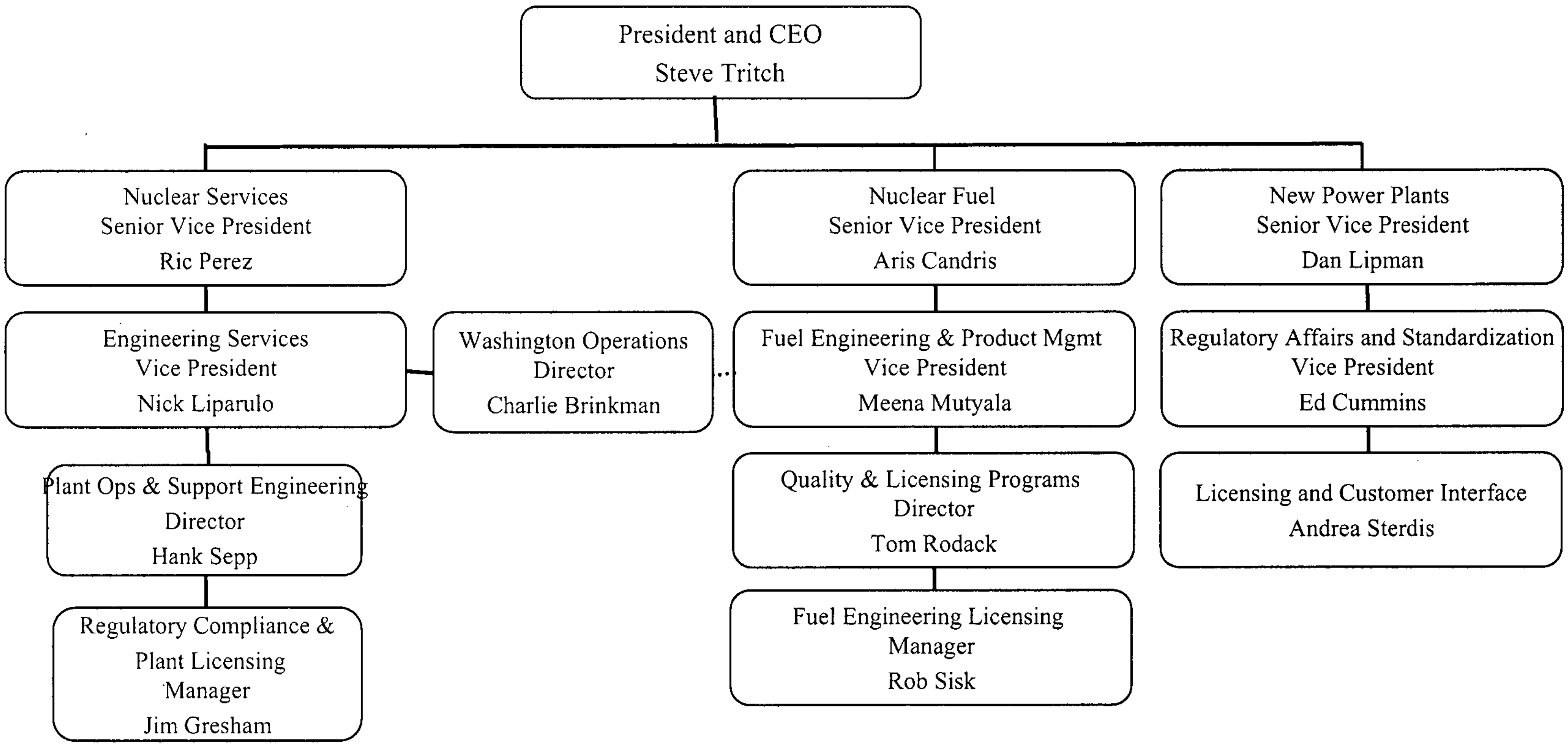
Current Westinghouse Product Management and Engineering Organization



Current Westinghouse Licensing Organization (s) (NRC Interface)



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Current Programs

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Current Programs

- Foxfire
- 17x17 NGF
- Optima3
- High Burnup
- Axiom
- AP1000
- Spent Fuel Pool Criticality

Topical Report Schedules

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PWR & AP1000 Topical Report Schedules

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BWR Topical Report Schedules

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General Licensing Topics

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Agenda

- Interpretation of 10 CFR 50.59
- Reviewer Qualification and Training
- Integrated Reviews
- The Role of Metrics at the NRC
- The Role of Precedents
- Level of Detail Required to Support Reviews
- LTA Testing Program
- AP1000 Fuel Licensing Process