

# **NUCLEAR FUEL PERFORMANCE INTRODUCTION / OVERVIEW**

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**President & CEO, STPNOC**  
**Chairman, FRP Executive Committee**

# OUTLINE

- **Materials Initiative Overview**
- **Fuel Reliability Program**
- **Fuel Performance Trends**
- **Industry Focus Areas**
- **Overall Impact and Assessment**

# ACRONYMS

- AOA - Axial offset anomaly**
- APSR - Axial Power Shaping Rods**
- CNO - Chief Nuclear Officer**
- EPRI - Electric Power Research Institute**
- FMEA - Failure Modes and Effects Analysis**
- FRED - Fuel Reliability Data Base**
- FRP - Fuel Reliability Program**
- GWe - Gigawatt electric**
- MRP - PWR Materials Reliability Program**
- NDE - Nondestructive Examination**
- NEI - Nuclear Energy Institute**
- PCI - Pellet-Clad Interaction**
- SGMP - Steam Generator Management Program**

# **MATERIALS INITIATIVE OVERVIEW**

- **In 2003, industry recognized need for united effort on materials issues**
- **CNOs endorsed NEI 03-08**
- **> \$59.5M industry-sponsored R&D**
  - **\$10M for EPRI FRP**

# **INITIATIVE (cont'd)**

- **Purpose is to provide**
  - **Consistent management process**
  - **Materials issues prioritization**
  - **Proactive, integrated, coordinated approaches**
  - **Implementation oversight**

# **INITIATIVE (cont'd)**

- **NEI 03-08 committed licensees to**
  - **Fund materials programs**
  - **Supply talent**
  - **Act in united manner**
- **Management structure created**

# NEI 03-08 STRUCTURE

**Nuclear Strategic Issues Advisory Committee  
(All CNOs)**

**Materials Executive Oversight Group  
(Selected CNOs)**

**Materials Technical Advisory Group  
(Issue Program Chairs, etc.)**

**Issue Programs (MRP, SGMP, etc.), Owners Groups,  
Fuel Reliability Program**

# **ISSUE PROGRAMS**

- **BWR Vessel & Internals Program**
- **PWR Materials Reliability Program**
- **Steam Generator Management Program**



# **PROGRAMS (cont'd)**

- **Fuel Reliability Program**
- **NSSS Owners Groups (materials programs)**
- **Chemistry, Corrosion, NDE**

# **FUEL RELIABILITY PROGRAM**

- **1998 - Robust Fuel Program focused on fuel design and performance**
- **2003 - Fuel Reliability Program refocused on fuel reliability to support Materials Initiative**
- **Objective is highly reliable fuel with zero defects**

# FRP (cont'd)

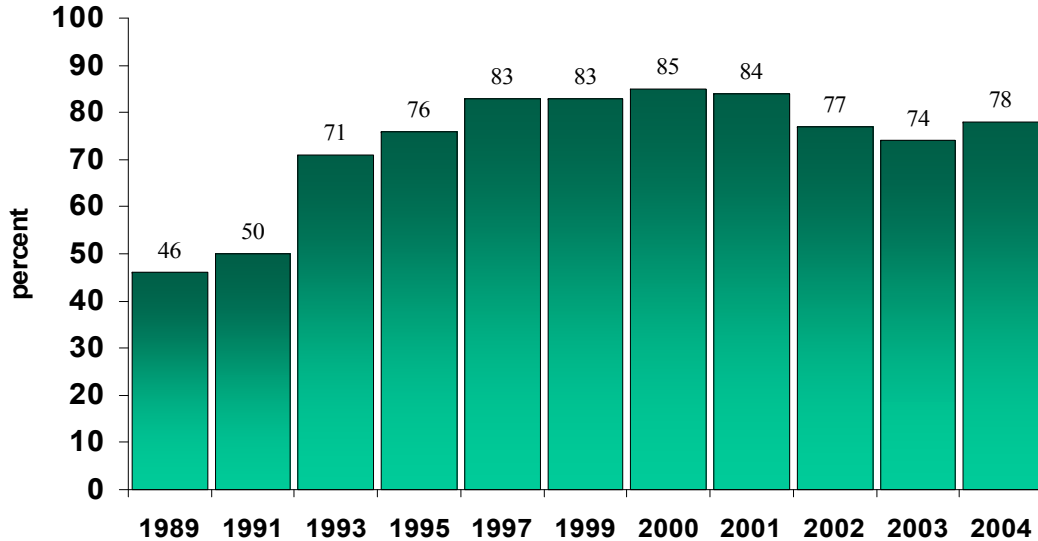
- **Four specific focus areas**
  - **Root cause investigations of failures**
  - **BWR crud and water chemistry**
  - **PWR crud and water chemistry**
  - **Regulatory interface**

# FUEL PERFORMANCE TRENDS

- **Several US plants still experiencing fuel defects**
- **Number of assemblies with fuel defects declined in 2004**
- **Objective is highly reliable fuel with zero defects**

# Fuel Reliability

## Percentage of Units Reporting Zero Defects



# 2004 FAILURE MECHANISMS

<b>BWR - PCI/suspect</b>	<b>7</b>
<b>- Debris</b>	<b>3</b>
<b>- Unknown/not inspected</b>	<b>5</b>
<b>PWR - Fretting</b>	<b>22</b>
<b>- Unknown/not inspected</b>	<b>13</b>

# FUEL RELIABILITY DATA BASE

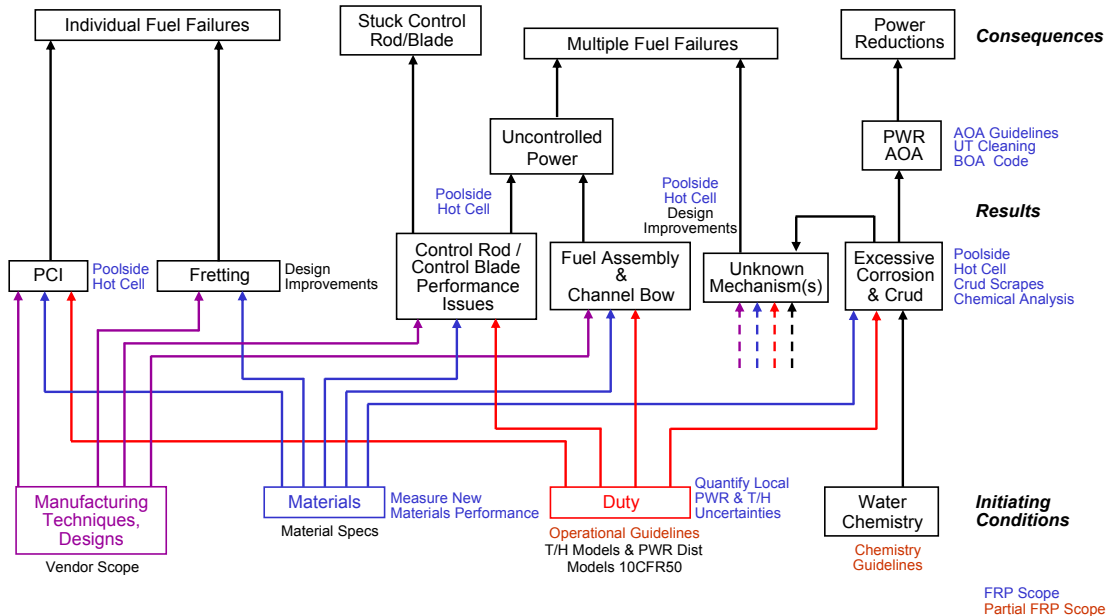
- **FRED now contains complete fuel performance and failure trends**
- **All US nuclear plants will have access to facilitate mandatory data entry**
- **International FRP members in Feb 2005**
- **Access for fuel vendors in 2005 Q1**

# **INDUSTRY FOCUS AREAS**

- **Manufacturing techniques, design**
- **Materials**
- **Duty**
- **Water chemistry**



# FMEA



# **OVERALL IMPACT AND ASSESSMENT**

- **FRP and industry efforts are starting to have positive effect on overall reliability**
- **Most fuel defects represent a very small fraction of limits that could affect offsite doses**

# **ASSESSMENT (cont'd)**

- **Licensees and vendors are taking aggressive action to correct issues**
- **Fuel defects cause operational issues and have economic consequences**
- **Overall objective is highly reliable fuel that operates defect free**

# **FUEL RELIABILITY PROGRAM**

**Rosa Yang**  
**Technical Executive - EPRI**

# INTRODUCTION

- **EPRI provides technical expertise, project management for FRP**
- **EPRI focus is R&D to support FRP objectives**

# FUEL DEFECT INVESTIGATIONS

- **Key aspects**
  - **Confirm performance margins**
  - **Support fuel defect root cause investigations**
- **Performed in cooperation with licensee and fuel vendor**

# **INVESTIGATIONS (cont'd)**

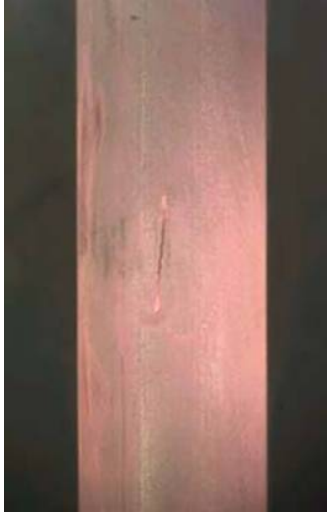
- **Focus on poolside inspections and hot cell examinations**
- **Plant performance results entered in FRED**

# **HOT CELL INVESTIGATIONS**

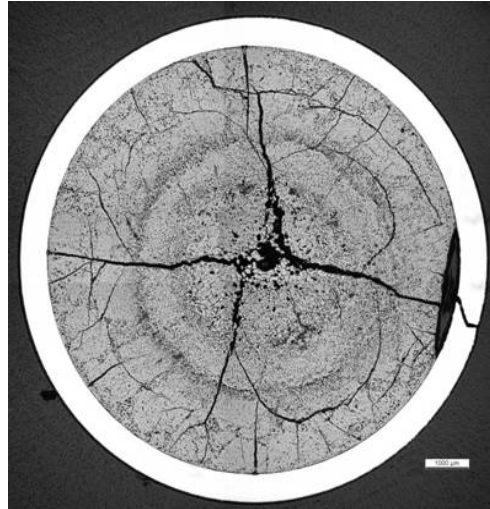
- **Most definitive, but most costly and time consuming**
- **Can provide very illuminating results**



# BWR PCI FAILURE



**Short Axial Crack**

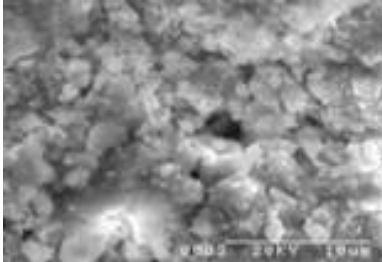


**Metallographic Cross Section at  
Short Axial Crack**

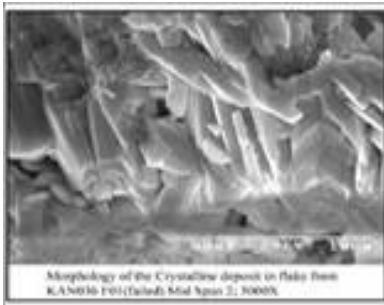
# **POOLSIDE EXAMINATIONS**

- **Faster; less expensive; can be performed more frequently than hot cell investigations**
- **EPRI developing better poolside techniques; early results are promising**

# CRUD CROSS SECTIONS



**Steam chimney on  
water side**



**Crystals containing  
Si, Zn, Al on fuel  
side near failure**

# SUMMARY

- **Only a brief snapshot of some EPRI activities**
- **Projects yielding results; performance improving**
- **Close licensee and vendor involvement has been critical to success**

# **FUEL VENDOR'S PERSPECTIVE**

**John Matheson**

**Senior VP, Nuclear Fuel - AREVA**

# **FUEL VENDOR'S PERSPECTIVE**

**Jack Fuller**

**CEO - Global Nuclear Fuels**

# **FUEL VENDOR'S PERSPECTIVE**

**Mike Saunders**

**Senior VP, Nuclear Fuel - Westinghouse**

# **LICENSEE'S PERSPECTIVE**

**Jim Malone**  
**VP, Nuclear Fuels -**  
**Exelon Generation Company, LLC**

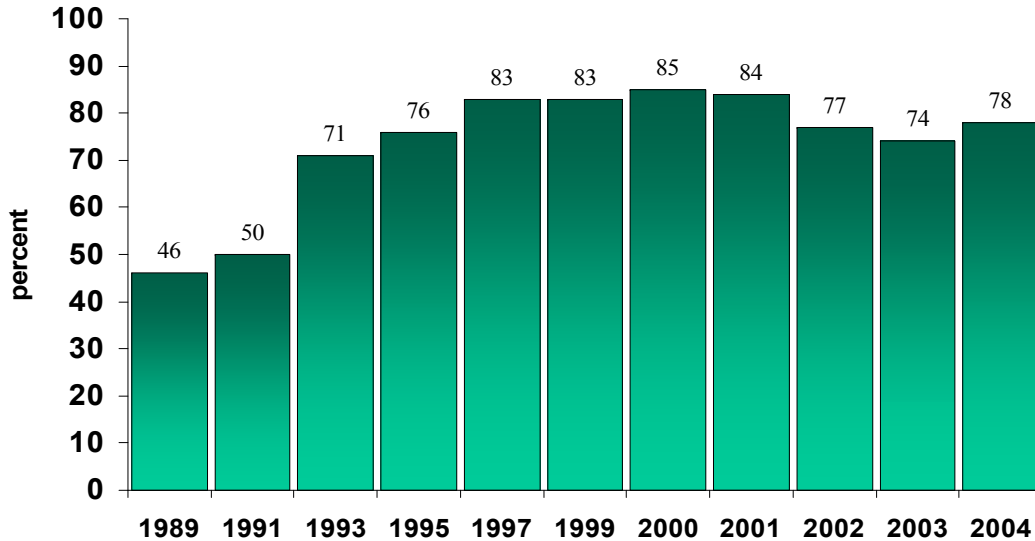


# PROBLEM STATEMENT

**We experienced an unacceptable number of fuel defects in Exelon units. Although Exelon performance is consistent with industry trends in the past three years, our goal is zero defects.**

# Fuel Reliability

## Percentage of Units Reporting Zero Defects



# **2004 FUEL FAILURE MODES**

**Braidwood – flaw assisted PCI**

**Dresden - foreign material or PCI**

**LaSalle - foreign material and flaw  
assisted PCI**

**Limerick - undetermined**

# **FAILURE MODES (cont'd)**

**Quad Cities 1 - 2 PCI, 1 undetermined**

**Quad Cities 2 - PCI**

**Three Mile - likely PCI**

# **ACTIONS TAKEN**

- **LaSalle 1&2 - removed leaking fuel**
- **Placed previous fuel design in low duty locations**
- **Quad Cities 1 - replaced 233 fuel assemblies susceptible to failure**
- **Instituted ramp rate controls**

# **ACTIONS (cont'd)**

- **Performed hot cell investigation of LaSalle failures**
- **Employed conservative management of BWR defects**
- **Strengthened vendor oversight**
- **Increased involvement with industry**

# **FUEL DEFECT IMPACTS**

- **Dose increases not significant**
- **No significant changes in radiation levels**
  - **Surveillances continued on schedule**
  - **Maintenance conducted per template**

# **IMPACTS (cont'd)**

- **Sites met or exceeded online corrective maintenance goals**
- **Utilized FRP results to support dose reduction efforts**
  - **Zinc addition**
  - **Ultrasonic fuel cleaning**



# **SUMMARY**

- **Fuel defects are unacceptable**
- **Actively managed defects and vigorously pursued root cause**
- **Dose increase not significant**
- **No delays or elimination of any surveillances or maintenance**