



**EPRI**

ELECTRIC POWER  
RESEARCH INSTITUTE

## **EPRI's R&D Programs on Materials Degradation in LWR's**

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Materials Degradation

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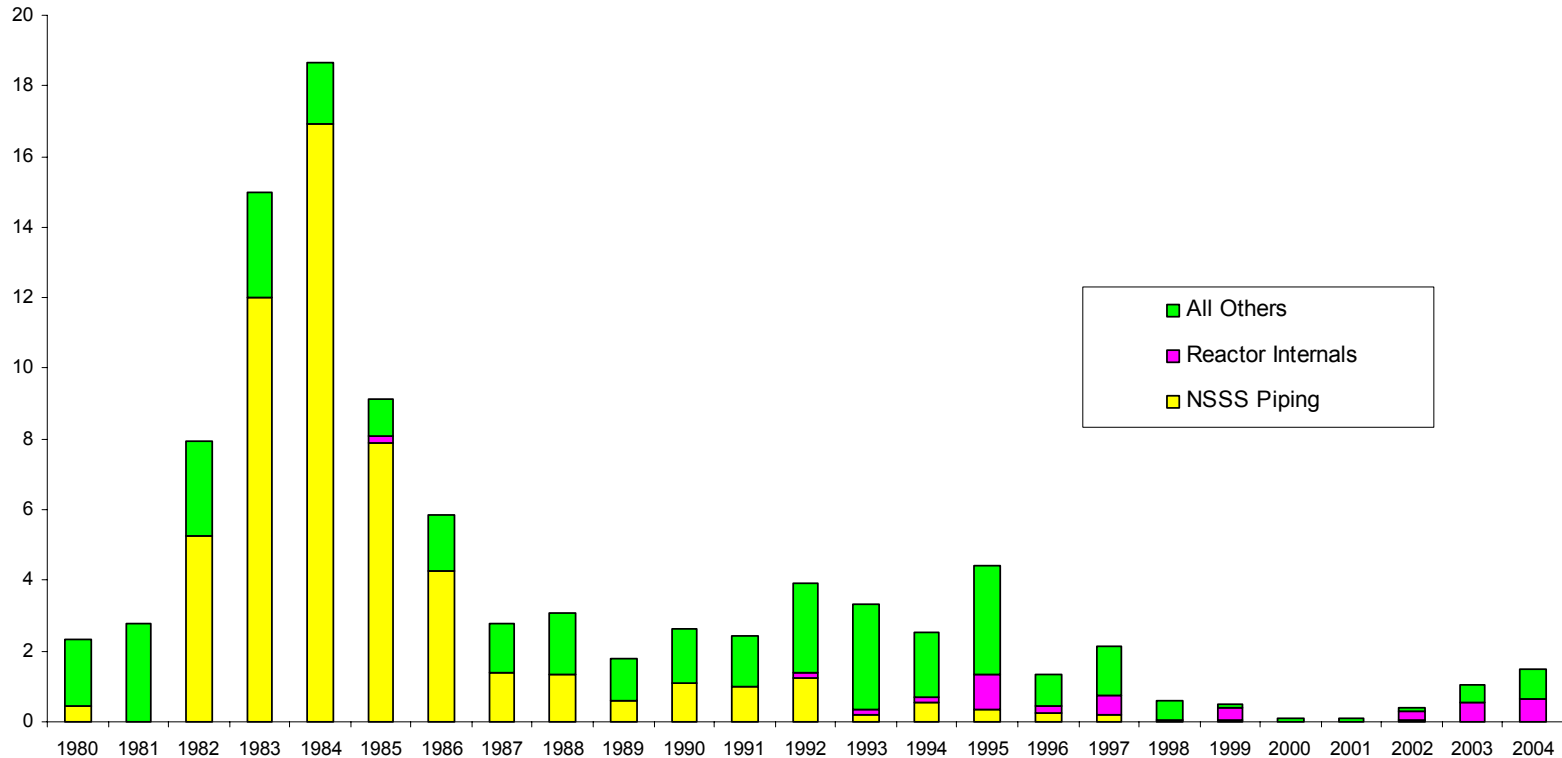
# The Industry Materials Initiative

- In May 2003, the U.S. Chief Nuclear Officers unanimously approved the “Industry Initiative on Management of Materials Issues” and the associated “Guideline for the Management of Materials Issues”, NEI 03-08.
- The purpose of the Initiative is to assure the safe, reliable and efficient operation of U.S. nuclear power plants by providing for:
  - Consistent materials degradation issue management processes across the industry
  - Prioritization of materials degradation issues
  - Proactive, integrated and coordinated approaches to issue resolution

# Capacity Factor Losses Due to Corrosion-Related Damage in BWRs

Through December 31, 2004

Capacity Factor Loss (%)



# EPRI's Nuclear Materials R&D Programs

- Seven EPRI R&D programs are governed by the Materials Initiative:
  - BWR Vessel and Internals Program (BWRVIP)
  - Materials Reliability Program (MRP)
  - Steam Generator Management Program (SGMP)
  - Fuel Reliability Program (FRP)
  - Non-Destructive Examination Program and Performance Demonstration Initiative (NDE, PDI)
  - Water Chemistry Control Program
  - Primary System Corrosion Research Program

# Licensees Participating in BWRVIP

## **U. S.** (13 utilities, 34 units)

- **Constellation Nuclear, Nine Mile Point LLC**
- **DTE Energy**
- **Energy Northwest**
- **Entergy**
- **Exelon**
- **FirstEnergy**
- **Nebraska Public Power District**
- **Nuclear Management Co.**
- **PPL Susquehanna, LLC**
- **Progress Energy**
- **PSEG Nuclear**
- **Southern Nuclear Company**
- **Tennessee Valley Authority**

## **International** (12 utilities, 44 units)

- **BKW FMB Energie AG – Switzerland**
- **Chubu Electric Power Company - Japan**
- **Chugoku Electric Power Company - Japan**
- **Comision Federal de Electricidad - Mexico**
- **Forsmarks Kraftgrupp AB - Sweden**
- **Iberdrola Generation - Spain**
- **Japan Atomic Power Company – Japan**
- **Kernkraftwerk Leibstadt – Switzerland**
- **OKG Aktiebolag - Sweden**
- **Taiwan Power Company - Taiwan**
- **Tohoku Electric Power Company - Japan**
- **Tokyo Electric Power Company - Japan**

# The Integrated Strategic Plan

- The Plan defines a systematic approach to managing materials degradation issues:
  - Identify component vulnerabilities
  - Assess condition (inspect & evaluate)
  - Mitigate initiation and propagation of degradation
  - Repair or replace component as required
- Implementing the Plan involves the identification and prioritization of knowledge gaps
  - Issue Management Tables (IMTs)
  - Materials Degradation Matrix (MDM)

# IMT Format

•Section X — Issue Management Table for YYYYYYY

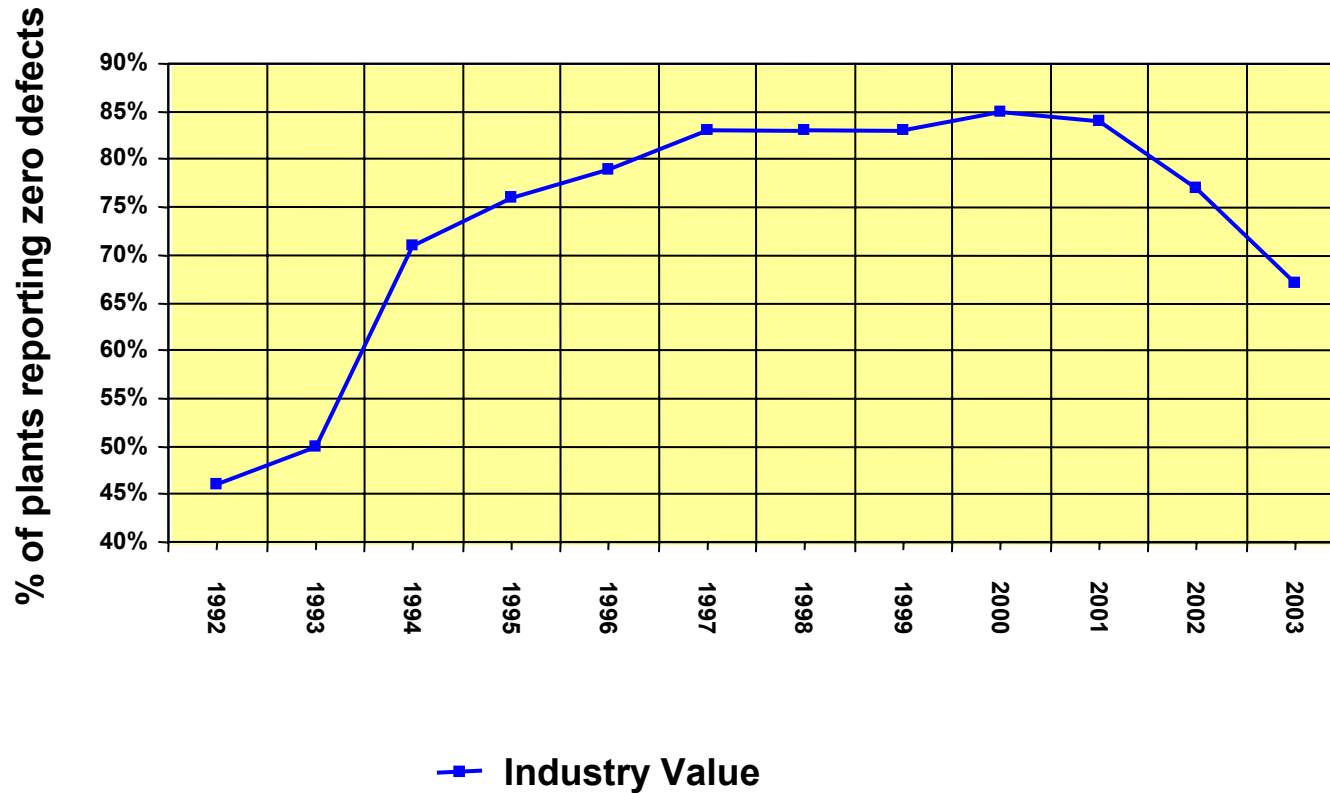
<u>Component</u>	<u>Material</u>	<u>Degradation Mechanism</u>	<u>Consequences of Failure</u>	<u>Mitigation Options</u>	<u>Repair / Replace Options</u>	<u>I &amp; E Guidance</u>	<u>Gaps, Priority &amp; Basis</u>	<u>Lead Responsibility</u>

# Strategic Plan Issues of Concern

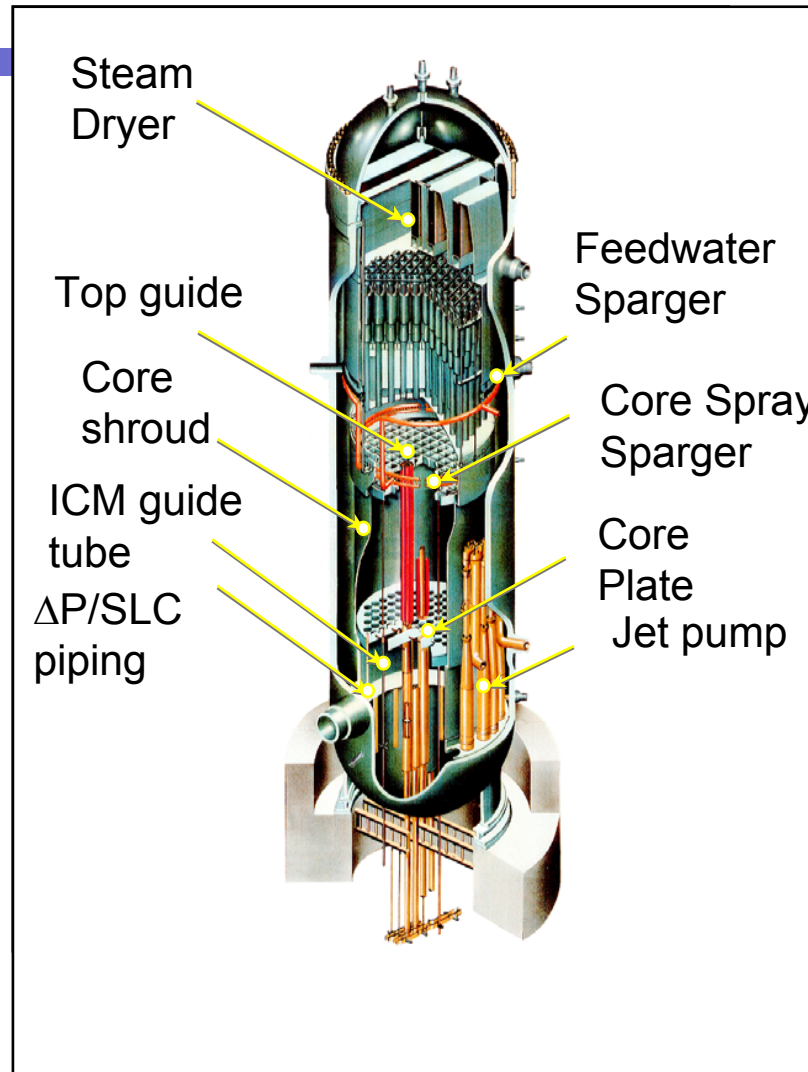
- Rev. 1 of the “Integrated Materials Issues Strategic Plan”, which was issued in April, 2005, identified four important materials degradation issues for which there were knowledge gaps of particularly high priority:
  - Fuel cladding degradation in both BWRs and PWRs
  - Degradation of BWR internals at high fluences
  - SCC of Alloy 690 steam generator tubes in PWRs
  - PWSCC of Alloy 600/82/182 RCS components in PWRs



# Fuel Reliability Trends (From INPO)

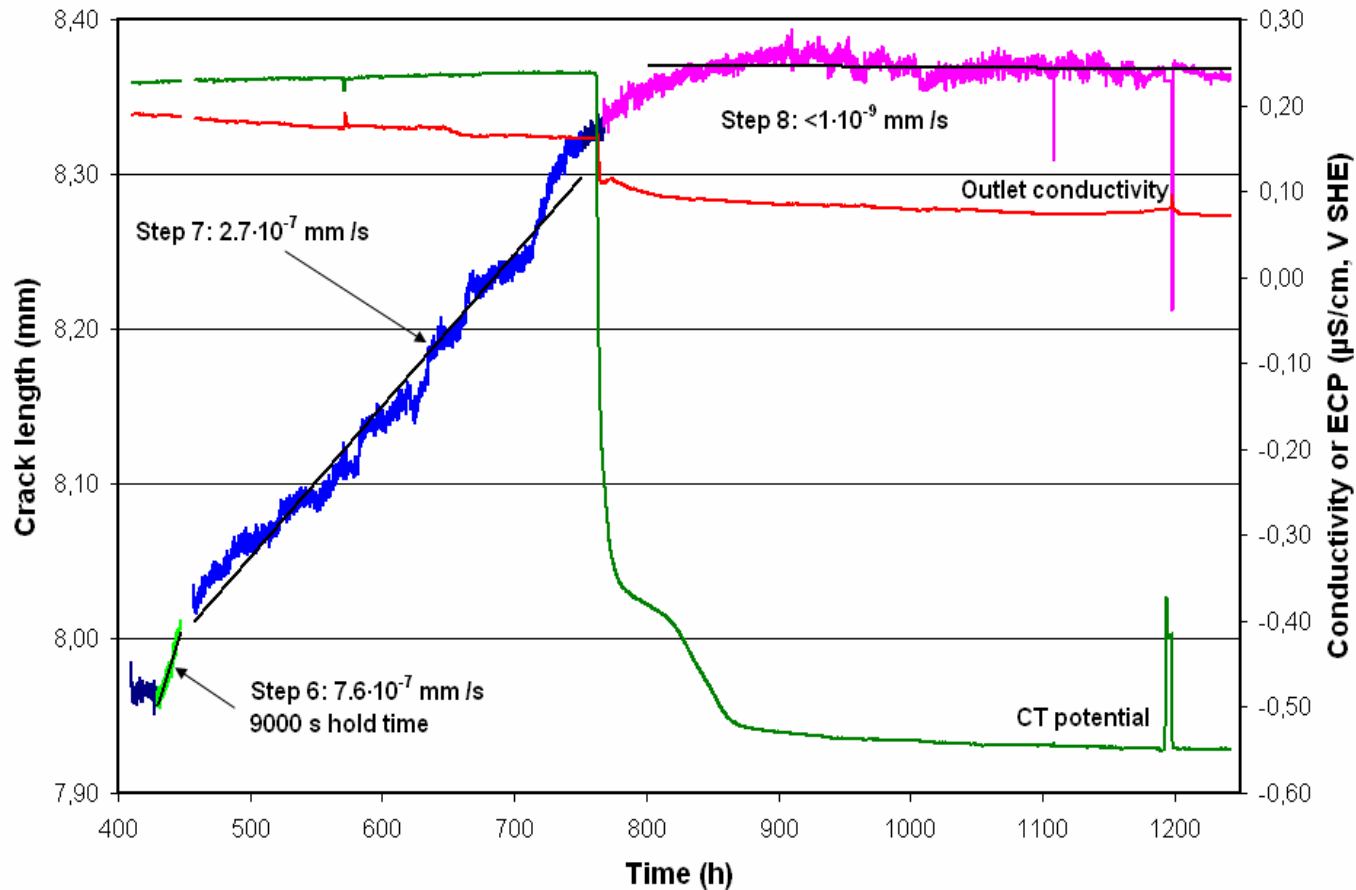


# Major BWR RPV Internal Components



# HWC mitigation of IASCC: 304L at 10.2 dpa

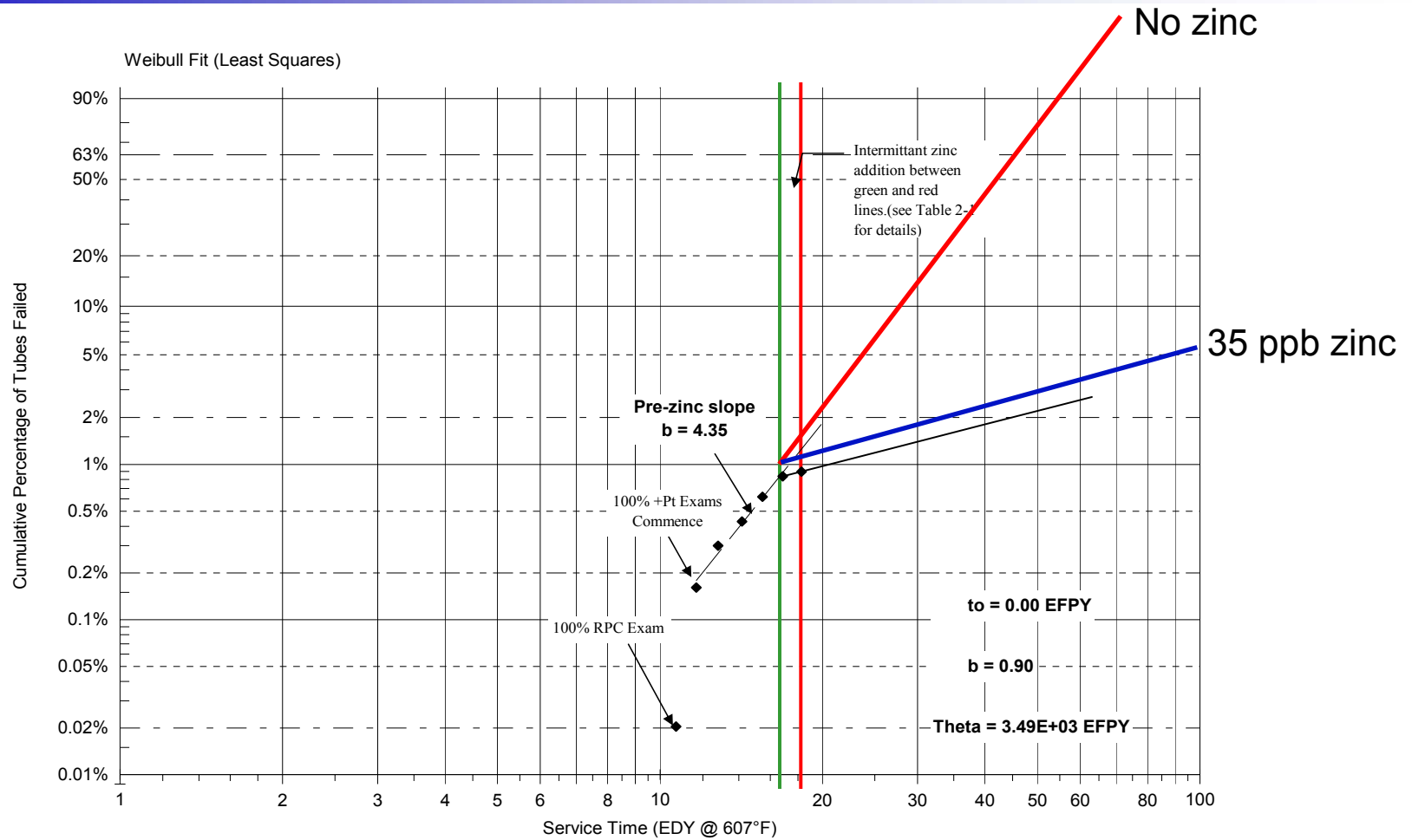
- Step 6:  $K_{\max} = 11 \text{ MPa}\sqrt{\text{m}}$ ,  $R=0.6$ ,  $f=0.001 \text{ Hz}$  + 9000 s hold
- Steps 7 & 8: Constant  $K_{\max} = 11 \text{ MPa}\sqrt{\text{m}}$



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# Example of Benefit of Zn Injection Observed for Steam Generator Tubes



# Summary

- The U.S. licensees have embarked on an ambitious Industry Initiative to minimize the future impact of materials degradation on their plants
- Seven EPRI programs representing about 50% of EPRI's spending on nuclear R&D are involved in the Industry Initiative
- An effort to identify and prioritize materials degradation knowledge gaps in PWRs and BWRs is nearing completion and is expected to define a substantial body of work that is needed to close knowledge gaps and minimize the impact of materials degradation and aging phenomena in both existing and new LWRs