NRC PWSCC Research Program

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Introduction

Primary Water Stress Corrosion Cracking

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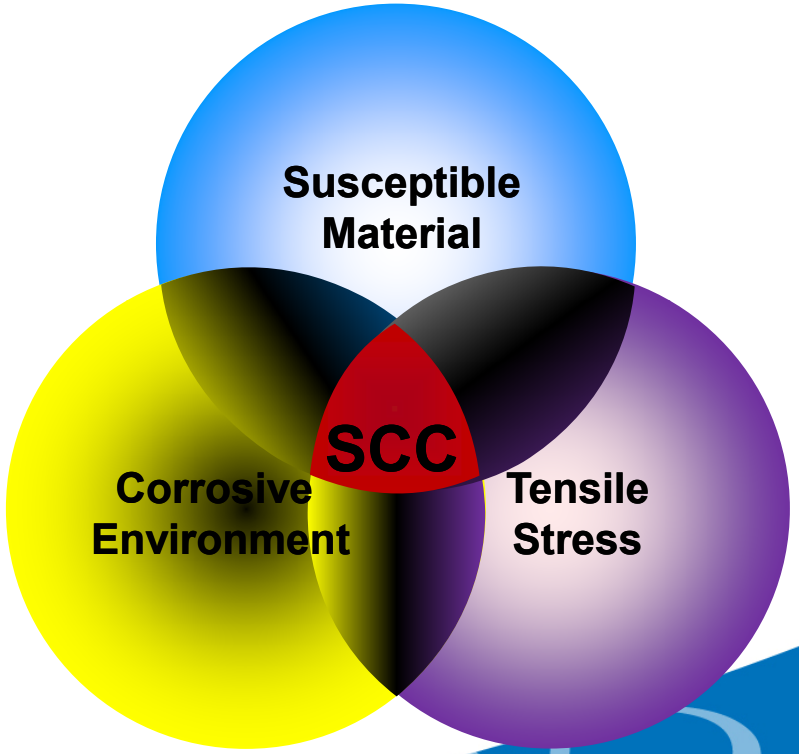
- 3 Necessary conditions must exist simultaneously:
  - Susceptible Material
  - Corrosive Environment
  - Tensile Stress
- SCC typically occurs at or near welds or other high tensile stress locations
- 3 Sources of tensile stress:
  - Fabrication (fit-up/welding/CW)
  - Primary stresses (applied)
  - Secondary stresses (thermal)



NRC Materials Research

General Overview

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- Materials research conducted by two branches:
  - RES/DE/CIB: Component Integrity Branch
    - NDE, RPV Embrittlement, Fracture Mechanics, Fatigue, PWSCC Safety Assessments, HDPE, LBB, and xLPR
  - RES/DE/CMB: Corrosion & Metallurgy Branch
    - Corrosion, SCC, Metallurgy, Steam Generator Research Program, Internals, LB60, PMMD, and Advanced Reactors
- Research related to needs of other NRC offices
  - User Need Request (UNR) & Expedited Needs
  - Staff Requirements Memorandum from Commission
  - ACRS letter for residual stress research program
  - RES Long-term Research Plan

PWSCC Regulatory Issues

Supporting NRR UNR 2005-011 & 2006-006

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- Purpose:
  - Support NRR in considering appropriate regulatory requirements to address PWSCC for Alloy 600/82/182 CRDM nozzles and J-groove welds and DMWs in Leak-Before-Break piping systems
- Objectives:
  - Short Term: evaluate the near-term adequacy of industry's PWSCC mitigation technologies and assess NDE capabilities
  - Long Term: Develop, verify, and validate a modular probabilistic code that explicitly models environmental degradation to assess compliance with 10 CFR 50 Appendix A GDC-4 by evaluating primary piping system leakage and rupture probabilities (xLPR).
- Accomplishments:
  - Mitigation research complete: MSIP, FSWOL, OWOL, and Inlay
  - NRC/EPRI xLPR & WRS MOUs in place and progressing well

NRC Piping Research

Supporting NRR UNR 2005-011 & 2006-006

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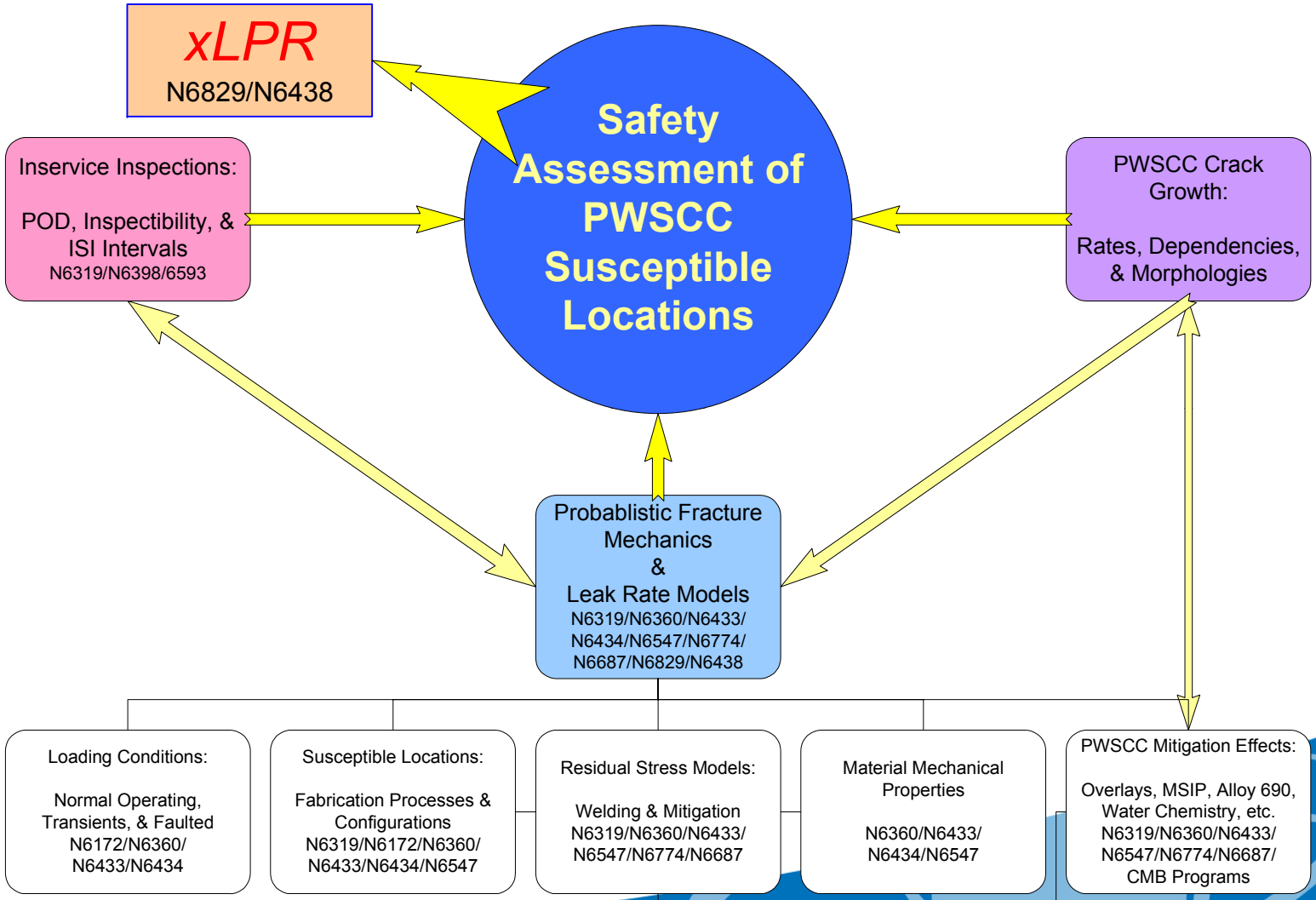

NRC Piping Research

Supporting NRR UNR 2005-011 & 2006-006

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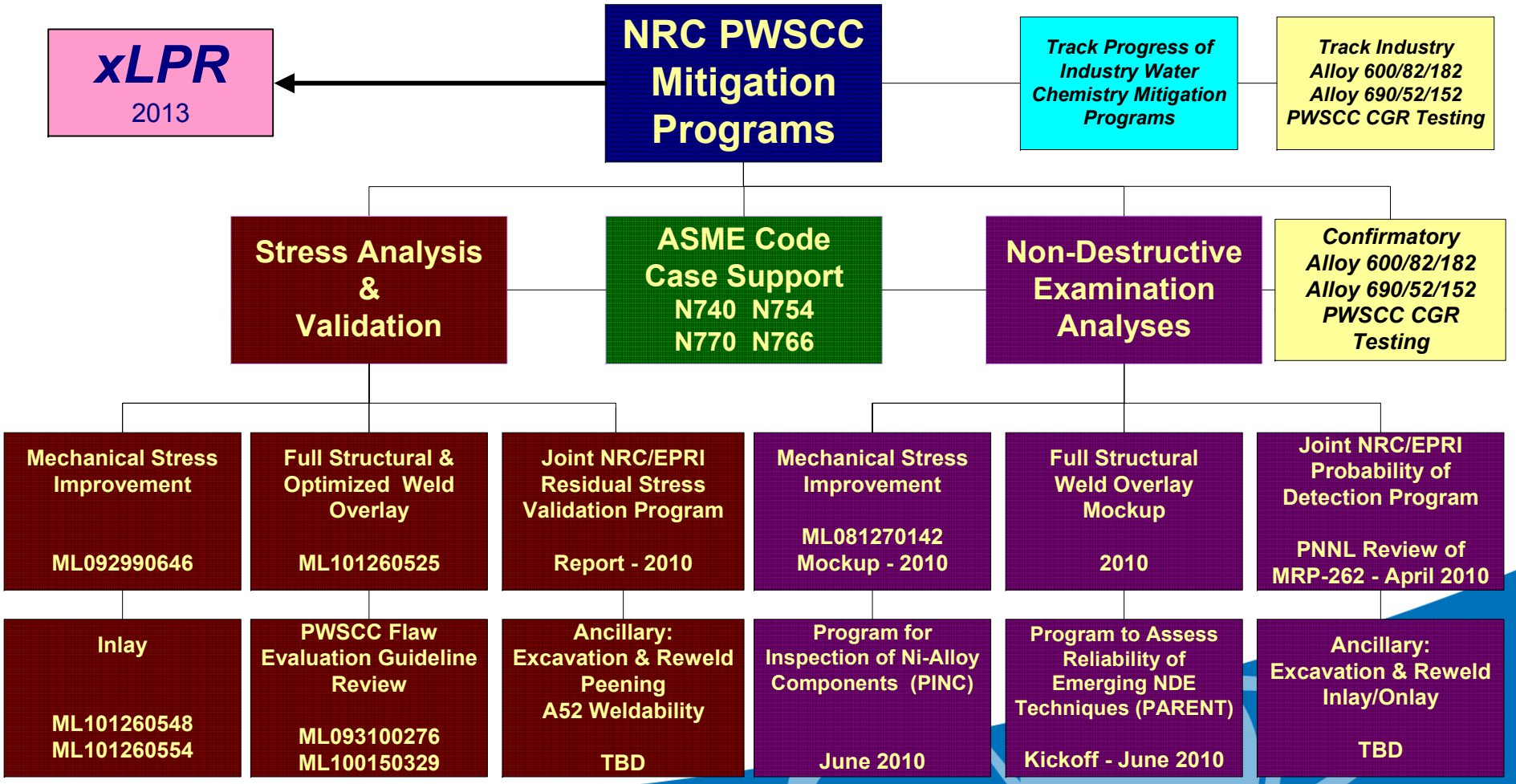

PWSCC Public Meeting

PWSCC Mitigation & Alloy 690 Meetings

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- **Date:** July 13-15, 2010
- **Location:** Legacy Hotel
- **Agenda:**
  - PWSCC Mitigation (July 13-14):
    - EWR, OWOL, xLPR, Alloy 52 Weldability, Peening, Water Chemistry, and WRS Validation Program
  - Alloy 690 PWSCC Research (July 14-15):
    - Working Group Status and Updates, Alloy 690/52/152 CGR results, and test matrix review

NRC/EPRI Research Programs

WRS Model Development & Validation Program

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- Background:
  - Component integrity analyses for PWSCC in DM welds showed that the results were highly dependent upon WRS profiles
  - ACRS letter dated 10/19/07 supported further WRS research
- Purpose:
  - Refine WRS FEA model development for 82/182 DM welds through sequential development from Phase I to IV
  - Develop reasonable assurance that WRS FEA models are defensible through a blind validation using well controlled mockups to various WRS measurement testing techniques
- Expected Outcome:
  - Blind validation of WRS FEA models using well controlled mockups focusing on through-wall axial & hoop stresses
  - Develop uncertainty distributions in WRS modeling

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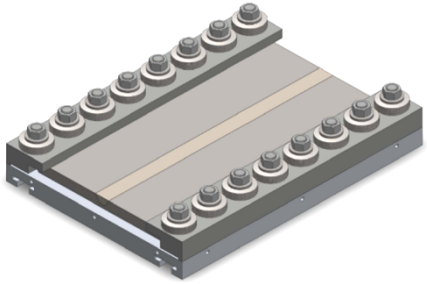
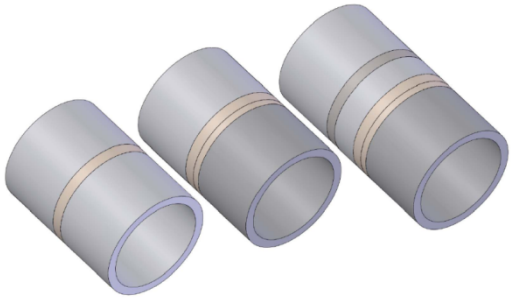
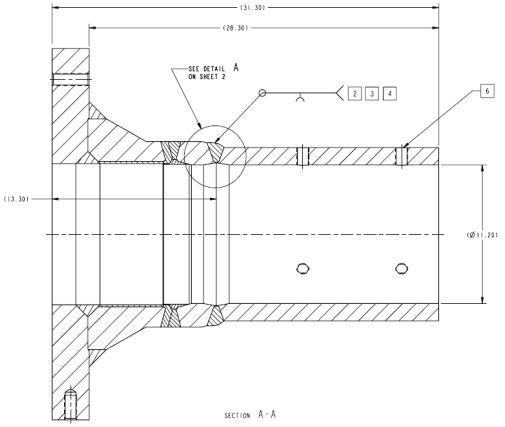
WRS Model Development & Validation Program

- Phase 1: Plates & Cylinders (EPRI–led)
  - Purpose: Refine WRS FEA model development by varying welding parameters and validate models to ND and DHD techniques





- Phase 2: PZR Surge Mockups (NRC-led, International WRS)
  - Purpose: Blind validation of mockups to XRD, ICHD, DHD, and ND



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WRS Model Development & Validation Program

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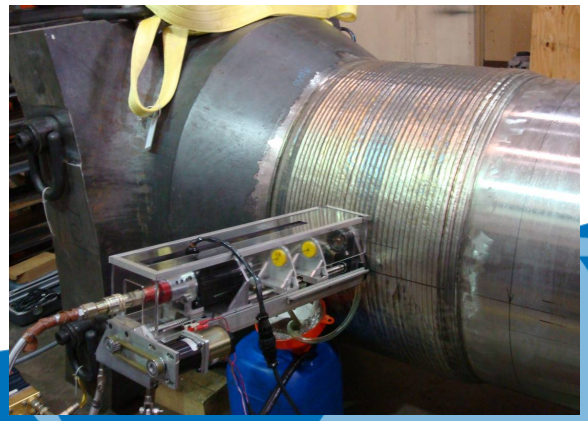
- Phase 3: PZR Safety & Relief Nozzles (EPRI-led)
  - Purpose: Blind validation of real components to XRD, ICHD, & DHD

- Phase 4: Cold Leg OWOL Validation (EPRI-led) ***Complete***
  - Purpose: Blind validation of OWOL process to XRD, ICHD, and DHD



NRC/EPRI Research Programs

xLPR Development, Verification, and Validation

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- Objectives:
  - Develop a probabilistic assessment tool to assess compliance with the requirements of 10 CFR 50 Appendix A GDC-4.
  - Develop, verify, and validate a modular probabilistic computer code that explicitly models environmental degradation to evaluate primary piping system leakage, LOCA, and rupture probabilities.
- Approach:
  - Model environmental degradation such as stress corrosion cracking with current management strategies; e.g. NRC approved in-service inspection protocols and mitigation technologies.
- NRC/EPRI MOU Addendum:
  - Existing xLPR addendum valid through December 31, 2012
  - Allows cooperative development of the xLPR probabilistic software tool benefiting both NRC and industry.

NRC/EPRI Research Programs

xLPR Development, Verification, and Validation

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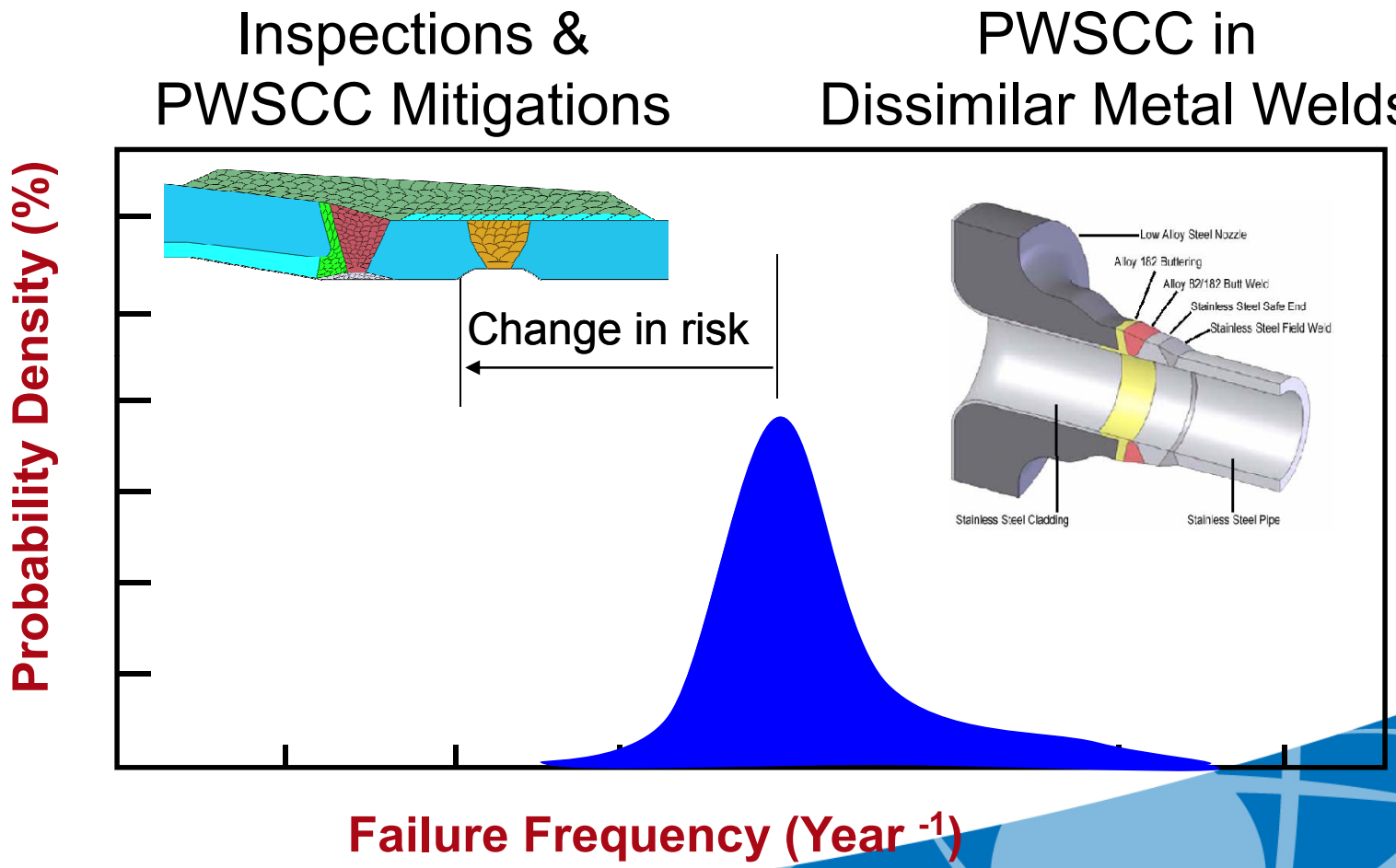

NRC/EPRI Research Programs

xLPR Development, Verification, and Validation

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- Pilot Study Code:
  - Final Version Completion: 3rd Quarter 2010
- Pilot Study Report
  - Draft Final Completion: End of 2010
- xLPR Completion: 2012/2013

Summary

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- Materials research conducted by two branches:
  - RES/DE/CIB: Component Integrity Branch
  - RES/DE/CMB: Corrosion & Metallurgy Branch
- PWSCC Research progressing well
- Cooperative Research through MOU beneficial:
  - Increased communications/openness
  - Increased efficiency
  - Less duplication of efforts
- Two additional MOU addenda proposed