Extremely Low Probability of Rupture (xLPR) Project

Background

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RES/DE/CIB

xLPR External Review Board Meeting

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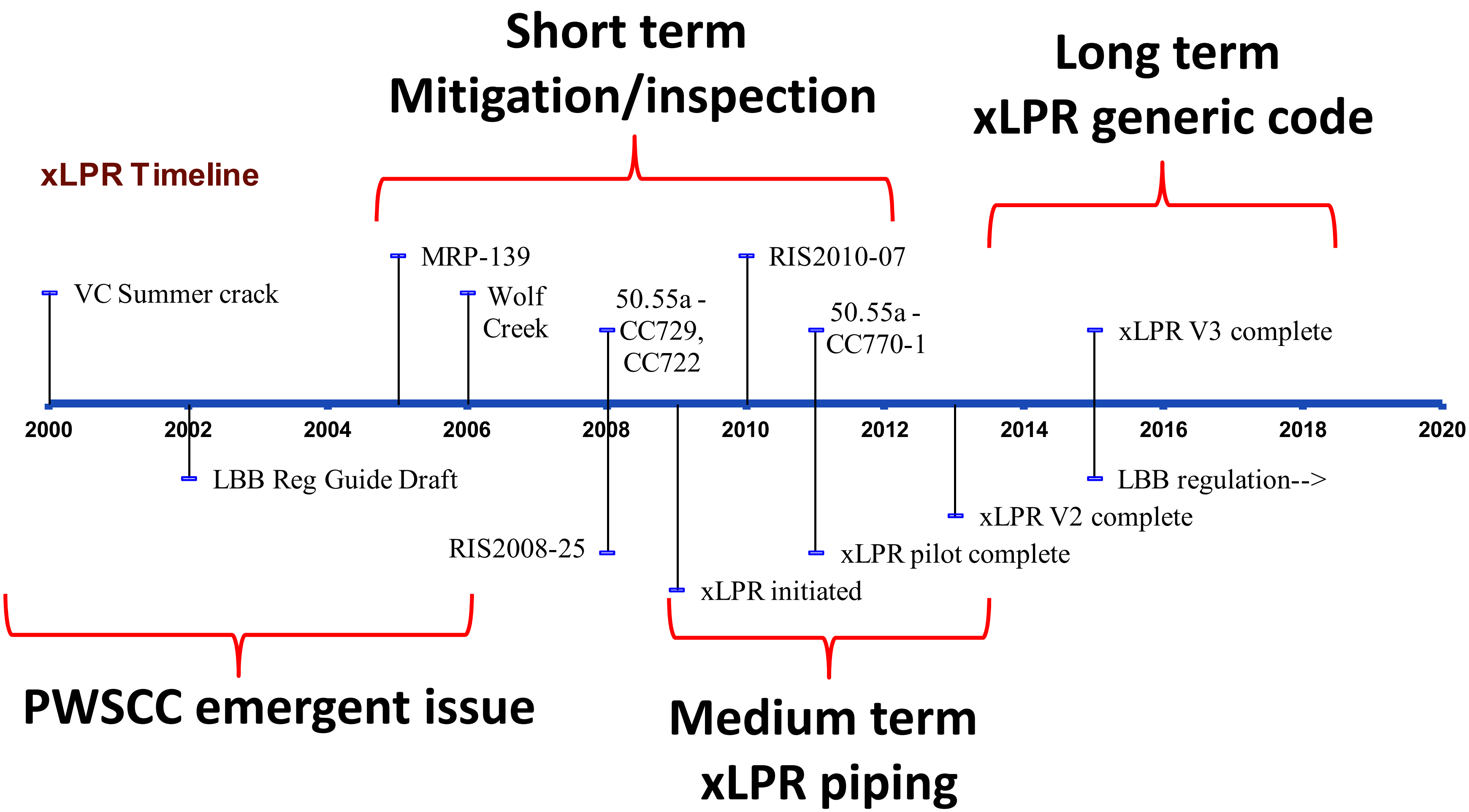
GDC-4 and LBB

- 10CFR50 Appendix A GDC-4 allows local dynamic effects of pipe ruptures to be excluded from design basis if pipe ruptures have extremely low probability of occurrence
- Local dynamic effects include pipe whipping and discharging fluids. Effect is to eliminate need for whip restraints and jet impingement shields
- Conservative flaw tolerance analyses developed and incorporated in SRP3.6.3 to demonstrate leak-before-break (LBB) and satisfy GDC-4
- SRP 3.6.3 stipulates no active degradation. However, PWSCC is active in LBB approved lines.

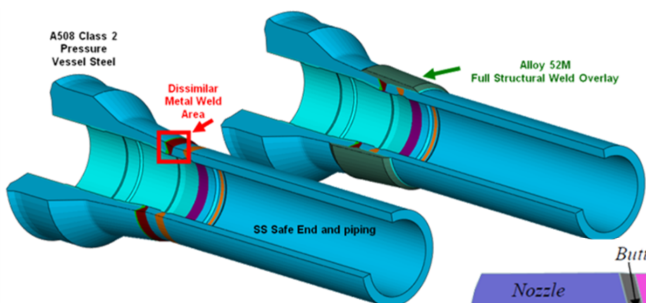
xLPR Timeline

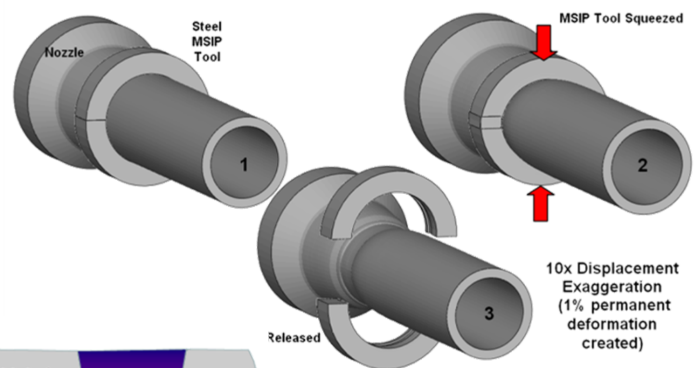


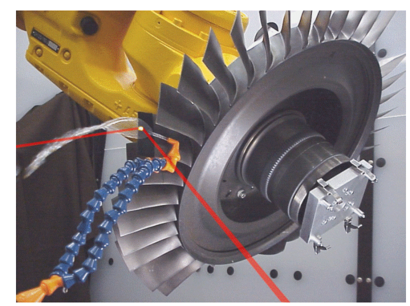
Short Term - Mitigation

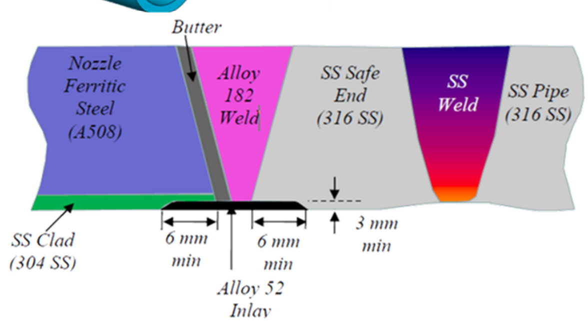
- Stress and Material Mitigations
  - Full Structural Weld Overlay (FSWOL)
  - Optimized Weld Overlay (OWOL)
  - Mechanical Stress Improvement Process (MSIP)
  - Inlay/Onlay

- Chemical and Surface Stress Modification Techniques
  - Hydrogen Optimization (Crack Growth Rate)
  - Zinc Application (Initiation Delay)
  - Water Jet Peening (WJP)
  - Fiber LASER Peening (FLP)









<u>Not all mitigation strategies are current approved by NRC</u>

Short Term - Inspection

- MRP-139 identified butt weld locations susceptible to PWSCC and developed approaches for inspection, reinspection, mitigation, and flaw evaluation.

- Approach incorporated in ASME Section XI Code Case N770

- N770-1 incorporated into 10CFR50.55a (with conditions)

Longer Term

- Develop a ***probabilistic*** assessment tool that can be used to ***directly*** assess compliance with 10CFR50App-A GDC-4

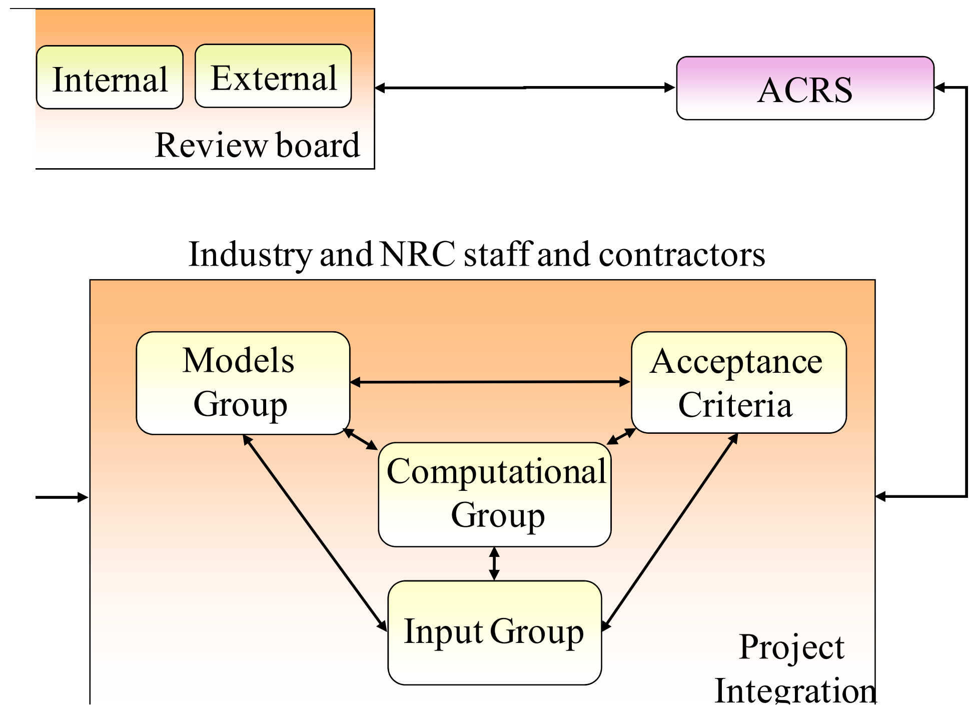
- Tool will be
  - **Comprehensive with respect to known challenges and loadings**
  - **Vetted with respect to scientific adequacy of models and inputs**
  - **Flexible to permit analysis of a variety of in service situations**
  - **Adaptable – able to accommodate**
    - evolving / improving knowledge
    - new damage mechanisms

xLPR Development

- **NRC goal to develop "modular" code for evaluating the risk of pressure boundary integrity failure**

- **Currently focusing on piping issues**
  - LBB
  - May be applicable to other needs

- **Working cooperatively with EPRI through MOU addendum**



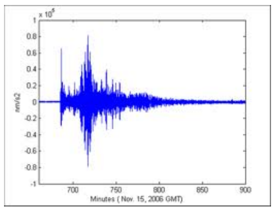
- **Initial pilot study to assess effectiveness of approach**

Why Cooperative Development?

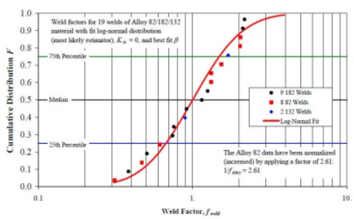
- **It's efficient, economical, leveraged, and legal**
  - **The NRC and the nuclear power industry (through EPRI) each conduct independent research on nuclear reactor safety**
  - **While the research efforts of the NRC and EPRI may be conducted for different purposes, the results obtained have common value to both the NRC and EPRI**
  - **To conserve resources and to avoid unnecessary duplication of effort, the NRC and EPRI cooperate through a Memorandum of Understanding to share information and/or costs whenever such cooperation and cost sharing is appropriate and mutually beneficial**

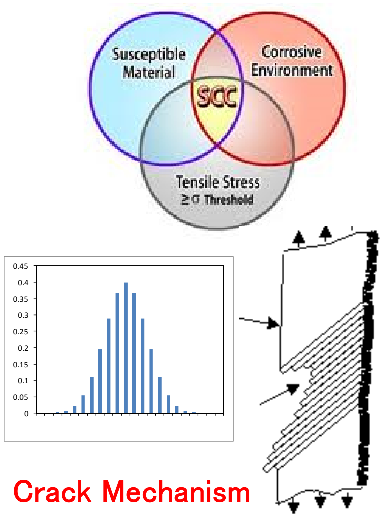
PFM Technical Flow

Loads

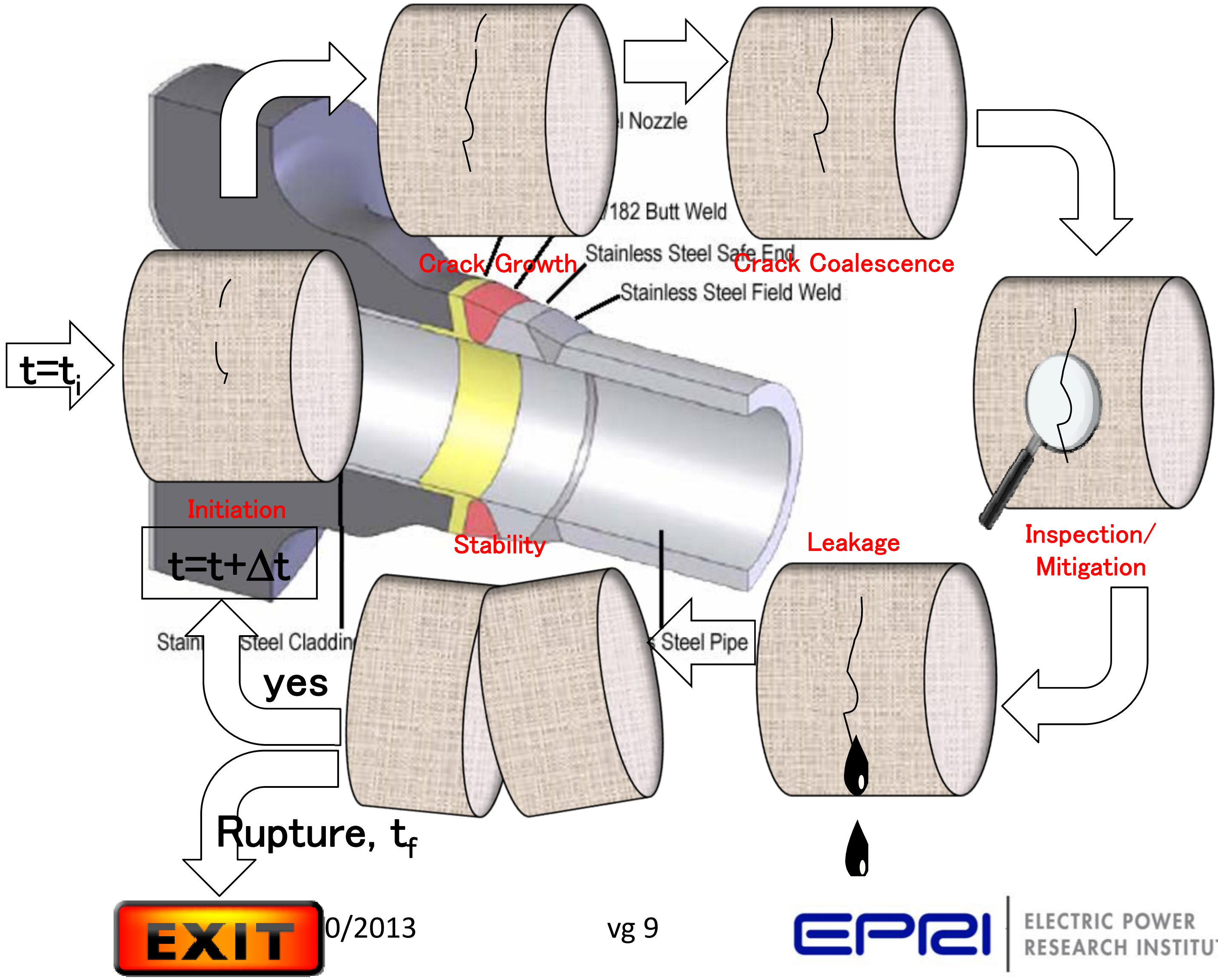


Material Properties





Crack Mechanism



Using xLPR – an Example

A. Conduct analyses with typical parameters

B. Conduct analyses with typical parameters and overlay