

xLPR Code Status and Plans

Industry / U.S. NRC Materials Programs
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Outline

- Project Background
- xLPR Code Overview
- Completed Work
- Current Work
- Future Work

Regulatory Framework

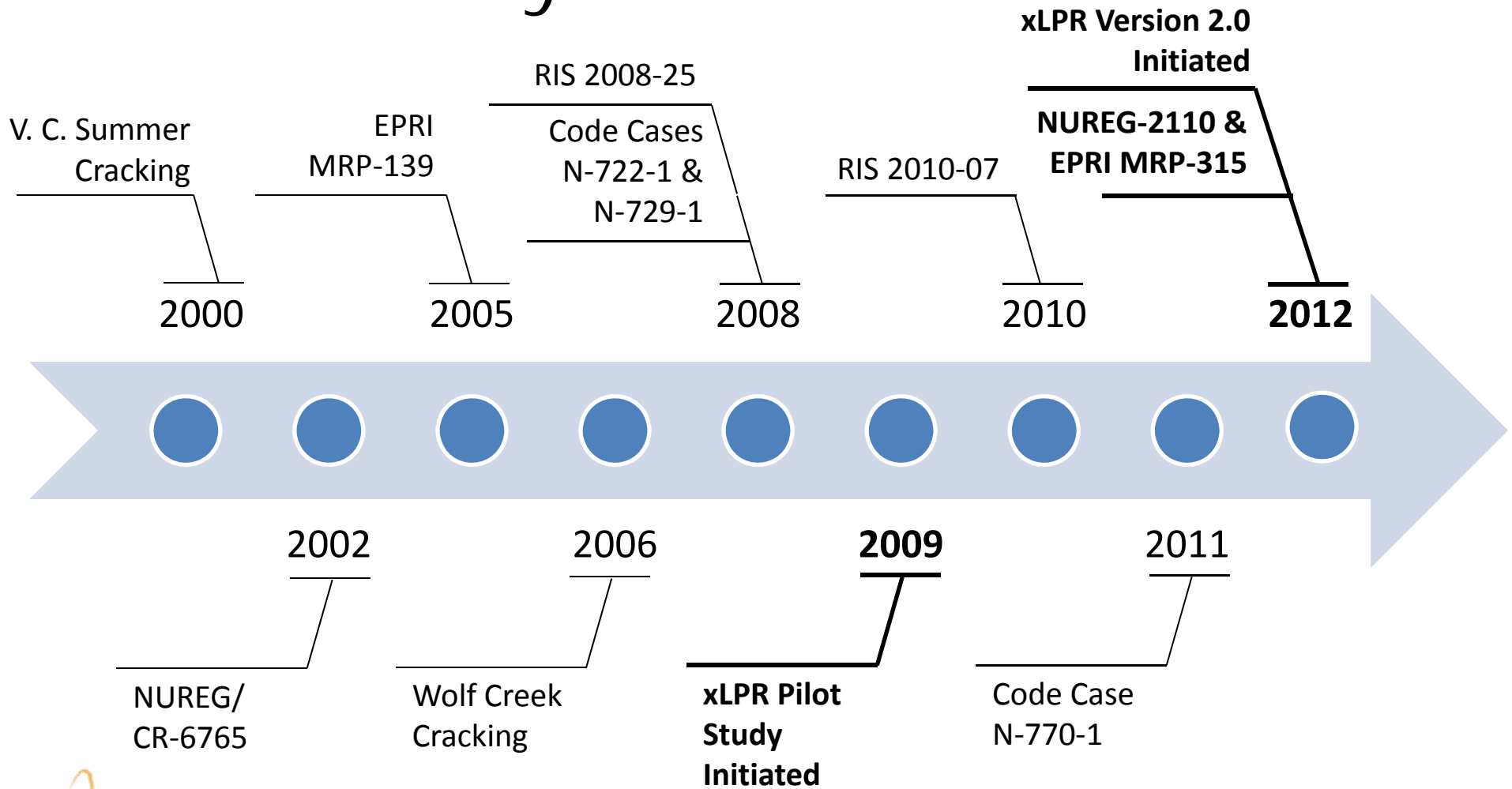
- 10 CFR Part 50, Appendix A, General Design Criterion 4

“ ... dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low ... ”

- NUREG-0800 Section 3.6.3, “Leak-Before-Break Evaluation Procedures”

“ ... demonstrate that PWSCC [primary water stress corrosion cracking] is not a potential source of pipe rupture.”

Noteworthy Events



xLPR Code

- Extremely Low Probability of Rupture
- Modular-based probabilistic fracture mechanics computer code developed under a strict quality assurance program
- First application will permit quantitative assessments of licensee compliance with General Design Criterion 4

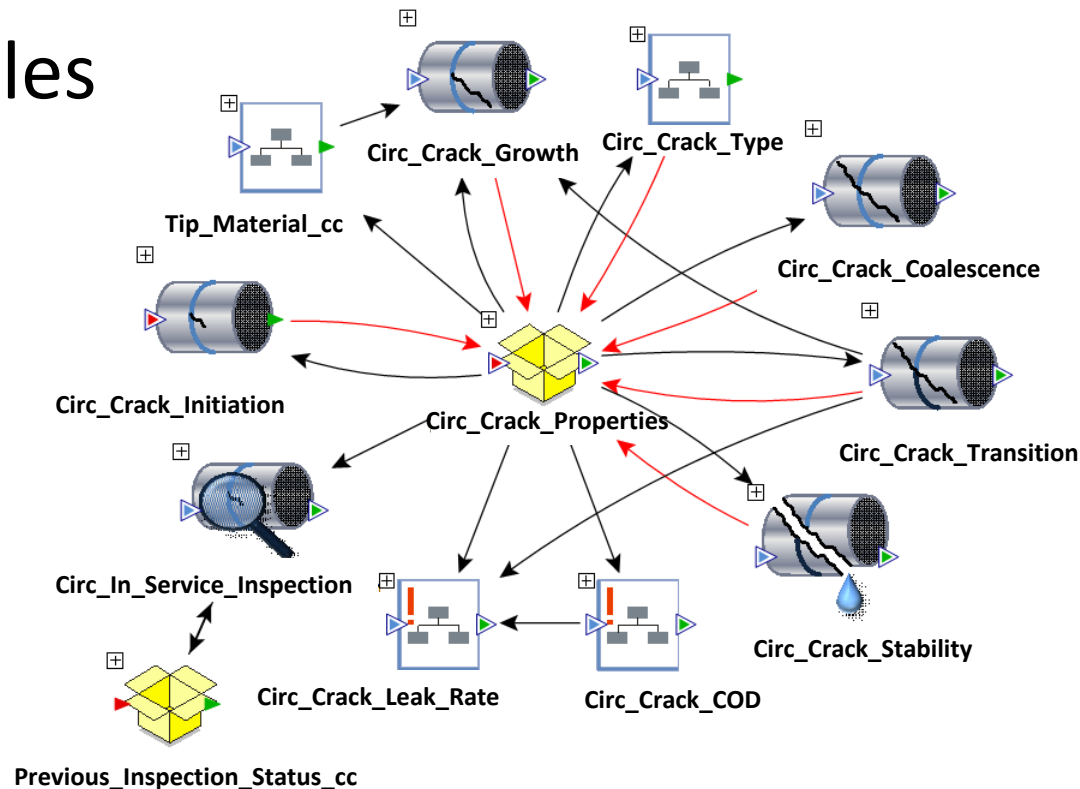
Code Development

- Cooperative effort between NRC and EPRI under a memorandum of understanding
- Supporting organizations



Code Framework

- GoldSim Monte Carlo simulation software
- Modules



Completed Work

- xLPR Version 1.0 (pilot study)
 - Objectives
 - Develop project management structure
 - Assess technical feasibility
 - Determine appropriate probabilistic framework
 - Final reports
 - NUREG-2110 – May 2012
 - EPRI 1022860 – June 2012
- xLPR Version 2.0
 - Released internally for initial testing – December 2014

Current Work

- xLPR Version 2.0
 - Ongoing activities
 - Verification and validation – Began April 2015
 - Completing documentation and quality assurance activities
 - Final release – Planned August 2015

Current Work Continued

- Acceptance criteria under development
 - xLPR acceptance group to make recommendation to NRC Office of Nuclear Reactor Regulation for consideration
 - All loss of coolant accident break sizes may result in dynamic effects
 - Proposed criteria
 - Failure definition: fast forming leak that exceeds charging pump capacity
 - Acceptable failure frequency: below 10^{-6} /year for each plant

Future Work

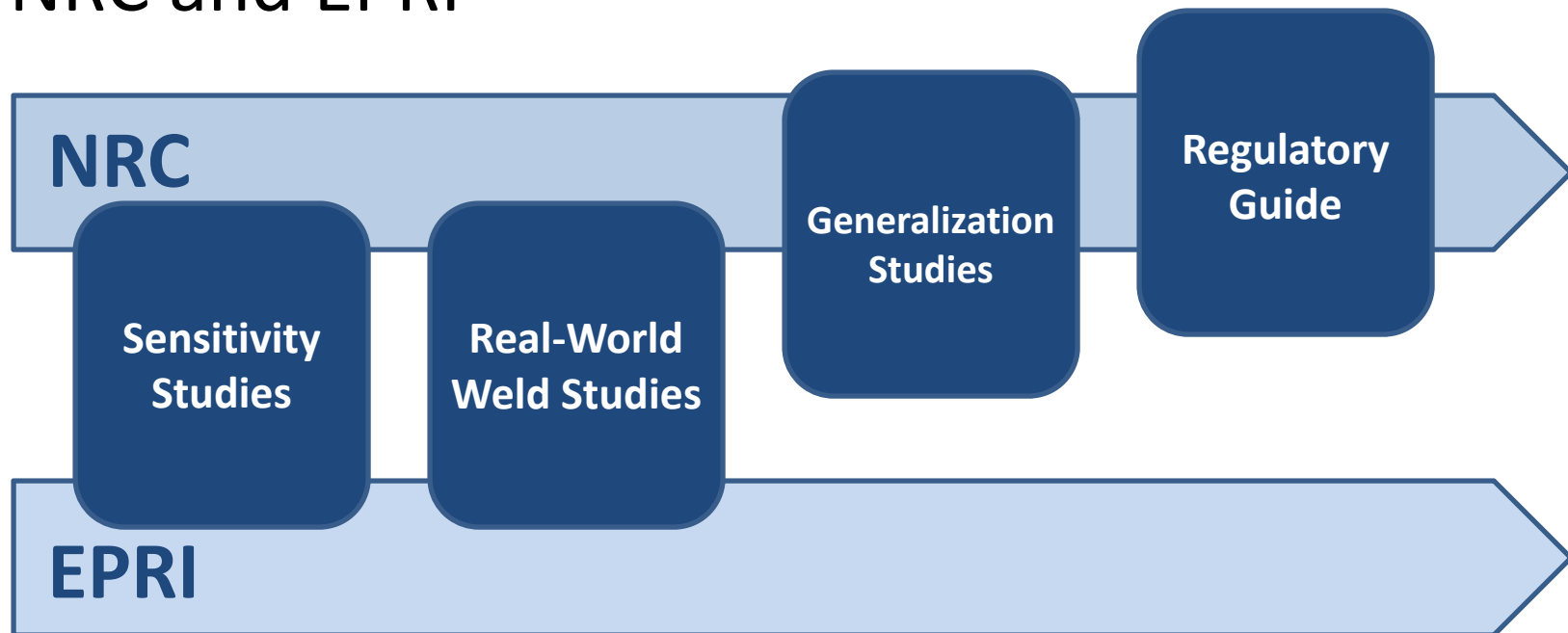
- Focus on application of xLPR to leak-before-break analyses
- Sensitivity studies
 - Determine drivers to rupture probability and uncertainty in results
 - Develop procedures for correctly running the code and interpreting outputs
 - Develop procedures for translating outputs to plant failure frequencies

Future Work Continued

- Real-world weld studies
- Generalization studies
- Regulatory guide

Future Work Continued

- New memorandum of understanding between NRC and EPRI



Questions?

References

NUREG/CR-6765, "Development of Technical Basis for Leak-Before-Break Evaluation Procedures," dated May 2002 (ML021720594)

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-722-1, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials Section XI, Division 1," dated July 5, 2005

EPRI Technical Report 1010087, "Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guidelines (MRP-139)," dated August 2005

ASME Boiler and Pressure Vessel Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1," dated March 28, 2006

NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 3.6.3, "Leak-Before-Break Evaluation Procedures," Revision 1, dated March 2007 (ML063600396)



References Continued

NRC Regulatory Issue Summary (RIS) 2008-25, “Regulatory Approach for Primary Water Stress Corrosion Cracking of Dissimilar Metal Butt Welds in Pressurized Water Reactor Primary Coolant System Piping,” dated October 22, 2008 (ML081890403)

ASME Boiler and Pressure Vessel Code Case N-770-1, “Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities Section XI, Division 1,” dated December 25, 2009

NRC RIS 2010-07, “Regulatory Requirements for Application of Weld Overlays and other Mitigation Techniques in Piping Systems Approved for Leak-Before-Break,” dated June 8, 2010 (ML101380231)

NUREG-2110, “xLPR Pilot Study Report,” dated May 2012 (ML12145A470)

EPRI Technical Report 1022860, “xLPR Pilot Study Report (MRP-315),” dated June 2012