United States Nuclear Regulatory Commission
Protecting People and the Environment

Probabilistic Evaluation of Normal Operations
Cooldown, Heatup, and Leak Tests

28th August 2012
Meeting at NRC-HQ, Washington, DC, USA

Meeting Objectives

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- Have a ***brief*** review of the technical presentation associated with normal heatup, cooldown, and leak test limits presented at ASME Section XI Working Group on Operating Plant Criteria
  - Washington DC Meeting
  - 14th August 2012
- Discuss and define next steps / actions
  - Who will do what, and by when?

Background

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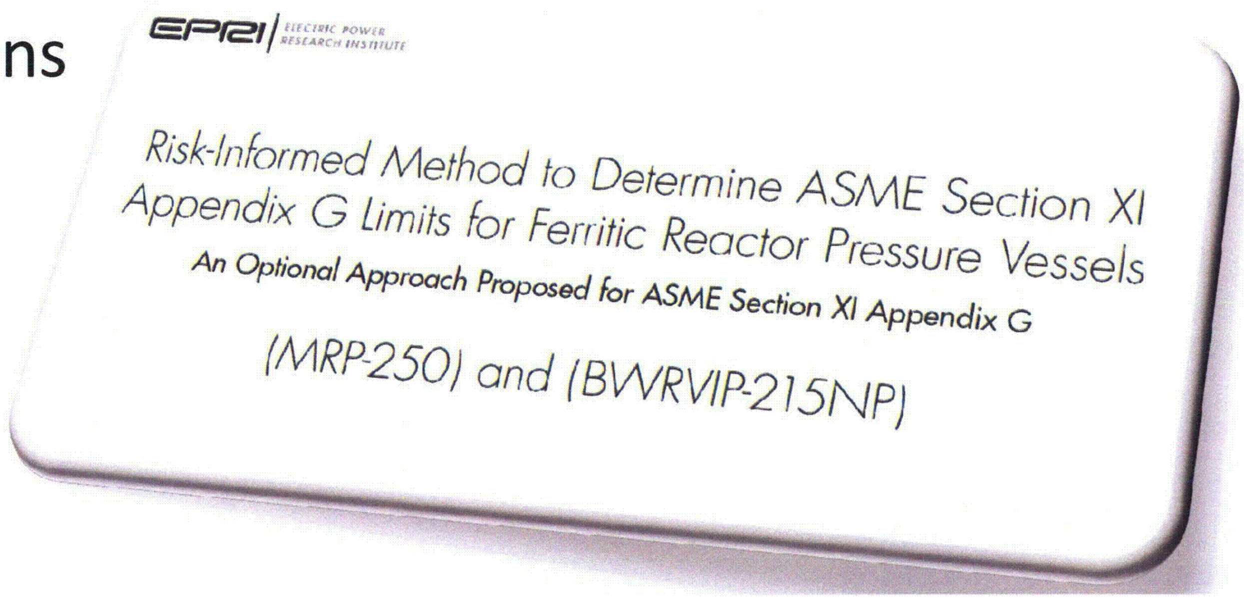
- **2009**: EPRI report providing technical basis for alternative cooldown, heatup, and leak test limits
- **2011**: These recommendations adopted by ASME Code (2011 Addenda)
- **Now**: NRC staff evaluation of the proposed alternative


EPRI ELECTRIC POWER RESEARCH INSTITUTE

Risk-Informed Method to Determine ASME Section XI Appendix G Limits for Ferritic Reactor Pressure Vessels

An Optional Approach Proposed for ASME Section XI Appendix G

(MRP-250) and (BWRVIP-215NP)

List of Major Findings

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1. **Concerning postulated transients following risk informed *vs.* allowed P-T limits**
   a. R-I lowers CPF for cooldown (relative to current procedures)
   b. R-I often increases CPF for heatup (relative to current procedures)
   c. R-I increases CPF for leak tests (relative to current procedures)

2. **Concerning postulated transients following allowed P-T limits**
   a. Can produce CPF > 10^{-6}
   b. The ¼T flaw does not produce the highest risk for cooldown, shallow flaws do
   c. Leak tests are permitted at temperatures close to RT_{NDT} in BWRs
   d. Actual transients (usually) have < CPF than idealized transients
      - Other P-T limits would produce different results

Today's focus

(2a) Postulated transients following allowed P-T limits can produce CPF > 10^{-6}

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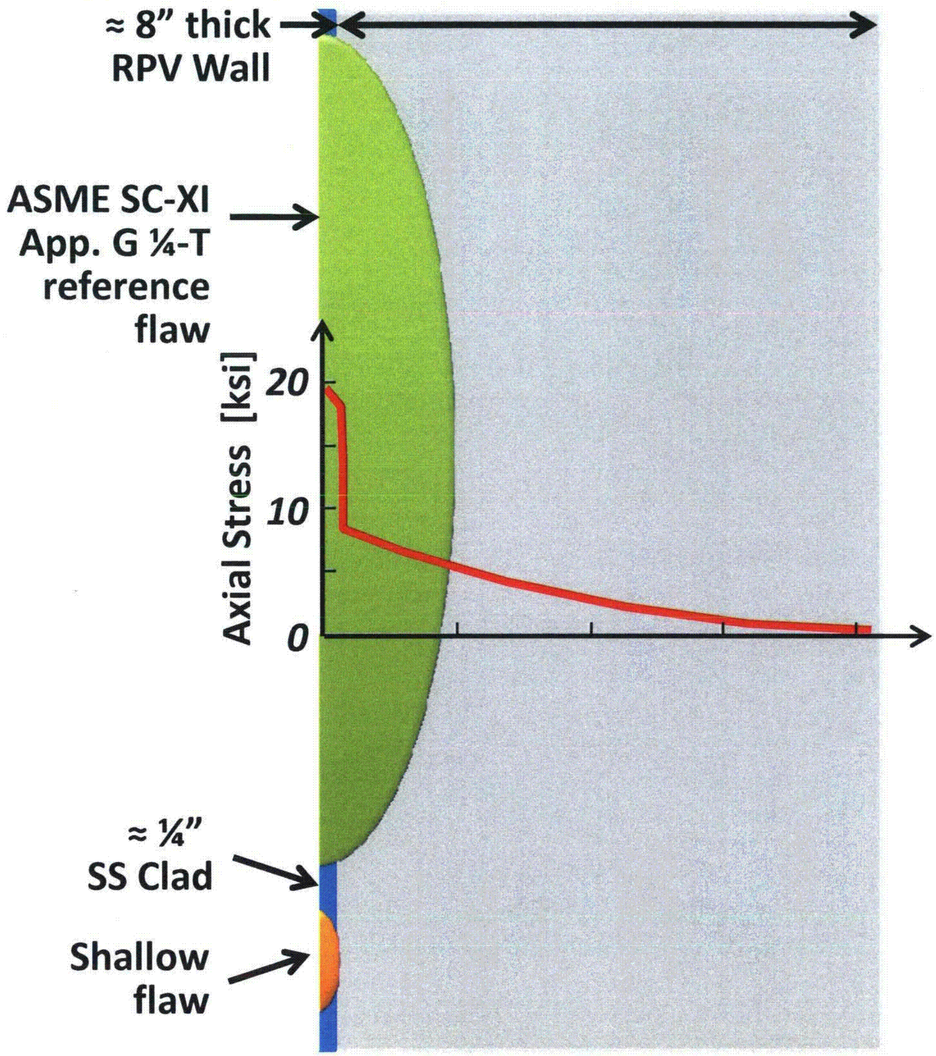
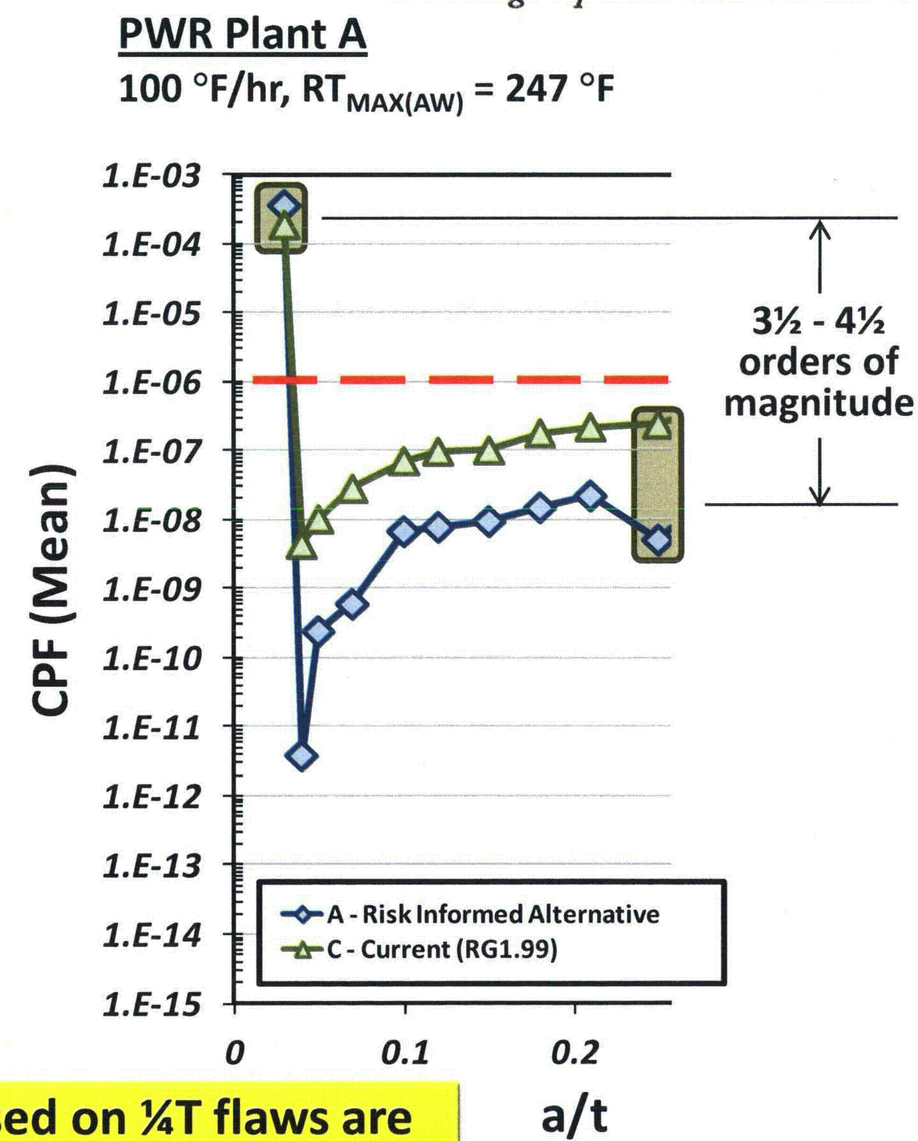
Loading Condition	Flaws for which where Current Pressure Limits Produce CPF > 10^{-6}	CPF Range
Cooldown	Embedded	Slightly above 10^{-6} if $RT_{MAX(AW)}$ > 247 °F
	Shallow surface breaking	10^{-4} to 10^{-2} across a wide range of RT_{NDT}
	Deep surface breaking	Up to 5×10^{-5} if $RT_{MAX(AW)}$ > 247 °F
Heatup	Deep surface breaking	10^{-4} to 10^{-2} above a/t = 0.2
Leak Test*	Any surface breaking	10^{-4} to 10^{-2} across a wide range of RT_{NDT}

* Leak test temperature can be close to, or below, RT_{NDT} depending on margin & vessel geometry

(2b) The ¼T flaw does not produce the highest risk for cooldown, shallow flaws do





Implication: PT curves based on ¼T flaws are not conservative for all conditions

(2c) Leak Tests are permitted at temperatures close to RT_{NDT} in BWRs

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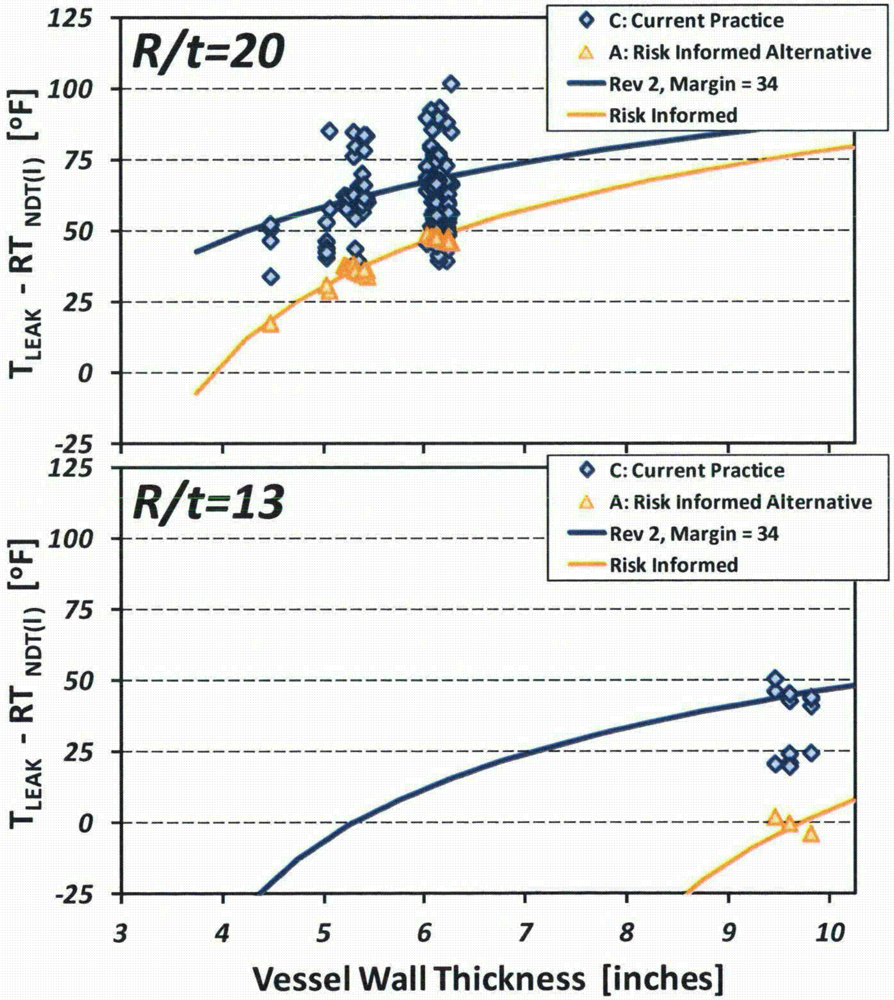
- **Reasons**
  - T_{LEAK}-$RT_{NDT(I)}$ controlled by
    - Geometry
    - Margin
  - Thick & low-R/t BWRs can have T_{LEAK} close to, or below, RT_{NDT}
- **Implications**
  - If fracture occurs, it will be non-ductile at temperatures near RT_{NDT}



$$T_{LEAK} - RT_{NDT(I)} = Margin + \beta + \frac{1}{0.02} \times ln\left\{\frac{F_2 \times Rate \times t^{2.5} + \dfrac{\alpha \times F_1 \times P_{OPER} \times R_i}{\sqrt{t}} - 33.2}{20.734}\right\}$$

Next Steps

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- **NRC documentation**
  - Description of current analysis and current results
  - FAVOR 12.0
    - To be released by 10/31/2012
  - NRR LIC-504 document – risk analysis based on currently available information
- **Further Analysis**
  - System constraint transients
    - Need information on how these are specified, generic or plant specific, etc.
  - Analysis of actual normal operating transients
    - Need data on these transients
  - Refined risk assessment
    - Need data on event frequency
  - Other ????
- **Questions**
  - Do other actions need to be added above?
  - Who will be doing what, and by when?