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Pressurized Thermal Shock: Current Regulations and Revision Status

R.L. Tregoning
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

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Current Regulations

- Governing regulations
  - 10 CFR 50.61 (PTS Rule) requires plants to monitor reactor pressure vessel (RPV) embrittlement
  - Appendix H to 10 CFR Part 50 contains requirements for qualifying a RPV material surveillance program for monitoring embrittlement
- Appendix H qualified surveillance results used in 10 CFR 50.61
  - Estimate fracture toughness transition temperature (RT_{NDT}) of the vessel's beltline steels
  - Estimate RT_{NDT} increase from irradiation damage over the vessel's life
- 10 CFR 50.61 provides requirements for estimating RT_{NDT} at end of the plant's operating license (RT_{PTS})
- 10 CFR 50.61 screening limits restricts RT_{PTS}
  - +270°F (132°C) for axial welds, plates, and forgings
  - +300°F (149°C) for circumferential welds
- Screening limits selected to limit through-wall cracking frequency to 5×10^{-6} events per year (Regulatory Guide 1.154)

Current Regulations, cont.

- 10 CFR 50.61 requires plants to ensure safe operation if RT_{PTS} exceeds screening limits
  - Implement "reasonably practicable" flux reductions to reduce the embrittlement rate
  - Anneal the RPV (RG 1.162)
  - Perform a plant-specific analyses to demonstrate that operating the plant does not pose an undue risk to the public (RG 1.154).
- No US PWR has an RT_{PTS} value that is projected to exceed the 10 CFR 50.61 screening limits before end of license
  - Several plants are close to limit (3 are within 2°F, while 10 are within 20°F)
  - Those plants will likely exceed screening limits during the 20-year license renewal period
- Some plants maintain RT_{PTS} values below screening limits by implementing flux reductions (e.g., low-leakage cores, ultra-low-leakage cores) that are not economically optimal.

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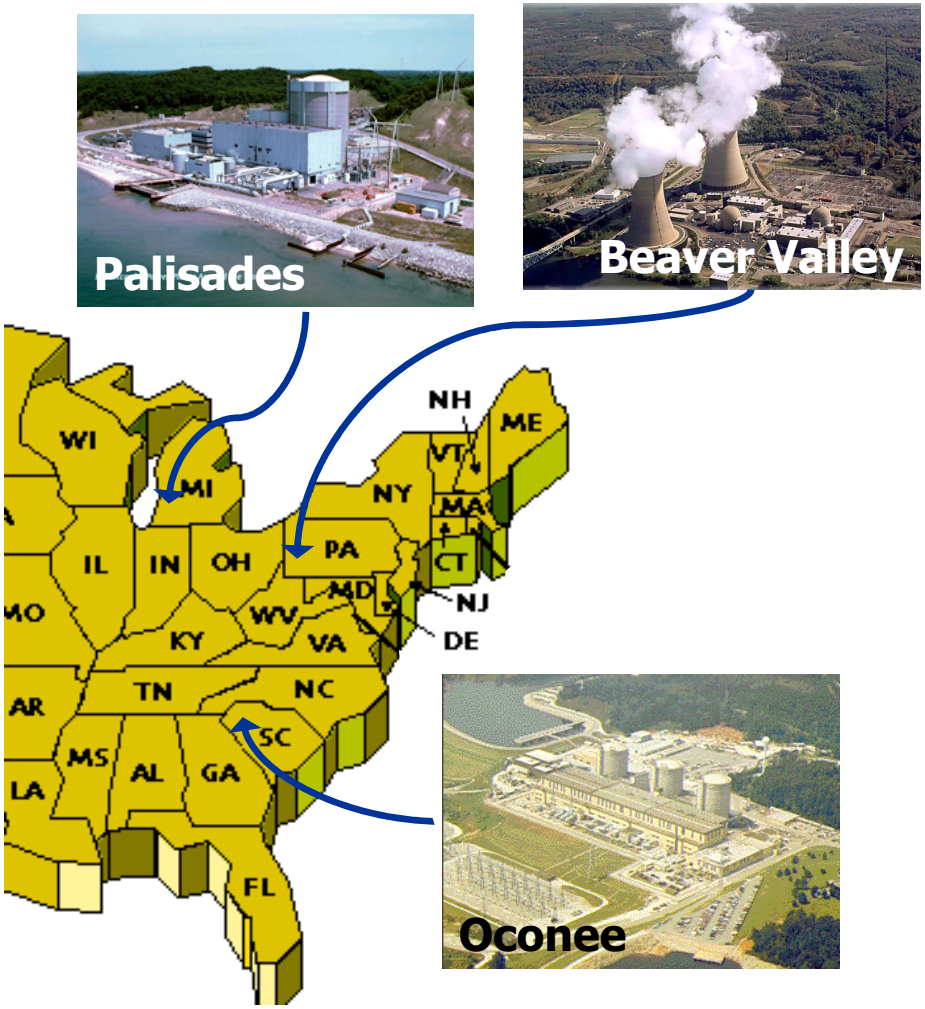

- **Risk-Informed Revision of 10 CFR 50.61**
  - **Technical advances (state of knowledge, data) suggest many conservatisms implicit to existing (RT_{PTS}) limits**
  - **Existing RT_{PTS} limits create artificial impediment to reactor life extension**
    - ✓ **Creates unnecessary work for NRC and industry**
    - ✓ **Does not necessarily enhance safety**
- **Approach**
  - **Features an explicit treatment of uncertainties**
  - **Includes detailed studies of three plants**
  - **Assessed generic applicability of these results to all domestic PWRs**

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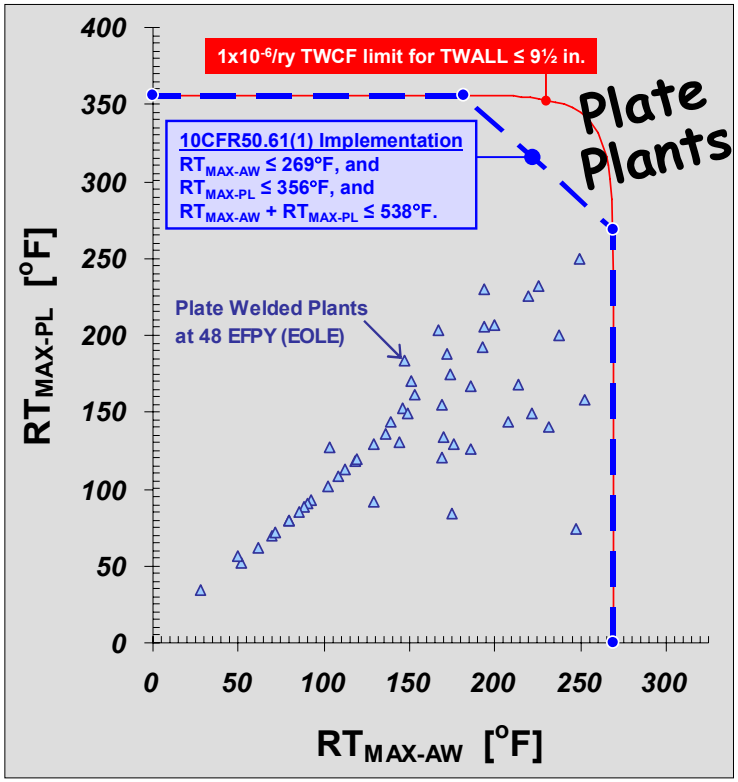
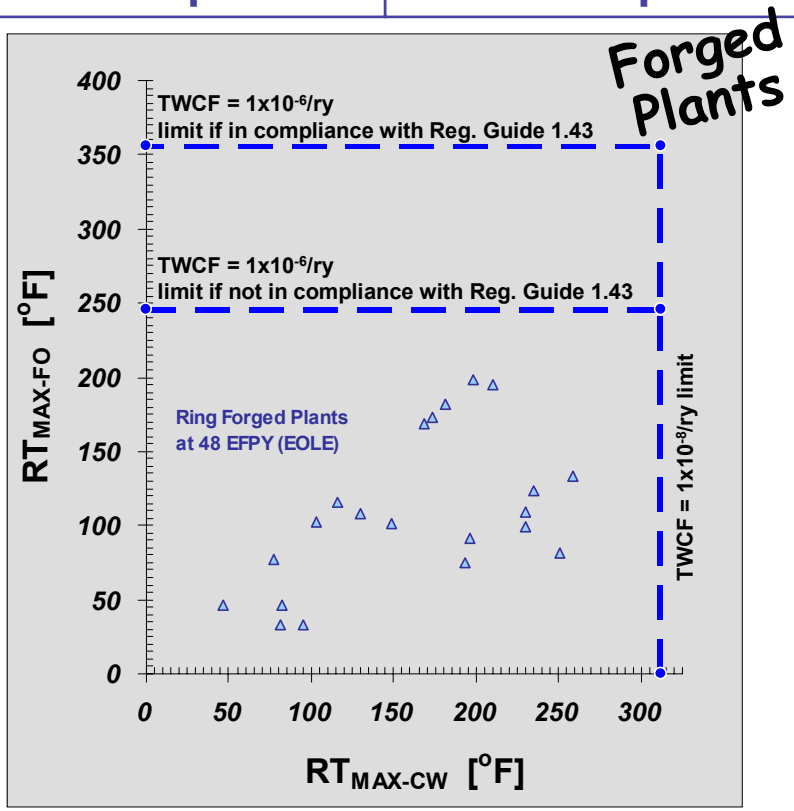
PTS Results

- **Proposed screening limits applicable to all US PWRs**
- **All plants below 1x10^{-6} limit after license renewal period ends**



Risk Dominant Factors	Much Less Important Factors
Primary Side Breaks	Secondary Side Breaks
Plate & Axial Weld Properties	Circumferential Weld Properties



- **Rulemaking underway**
  - **Public comment: Autumn 07**
  - **New rule: Autumn 08**

Reactor Vessel Integrity:

Status of Applicable Regulations

- Pressurized Thermal Shock (10 CFR 50.61)
  - Draft rule issued for public comment 2007
  - Rule proposed as a voluntary alternative to 10 CFR 50.61
  - Extensive public comments received
  - Currently addressing public comments
- Appendix G – Prevention of Brittle Fracture
  - Developing technical basis for revising Appendix G
  - Expect to complete technical basis in late 2008
- Appendix H – Reactor Vessel Surveillance Programs
  - Technical basis for revision drafted in 2007
  - Will complete technical basis in 2008
- Regulatory Guide 1.99 – Estimation of Embrittlement
  - Technical basis to be published in 2008
  - Changes to be made coincident with Appendix G