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Regulation of Pressurized Thermal Shock in the United States

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History and Background

- Pressurized Thermal Shock (PTS) was recognized as a potential challenge to pressurized water reactor (PWR) reactor pressure vessel (RPV) integrity in the 1970s
- PTS is important because it has the potential to result in a beyond design basis failure of a PWR's reactor coolant system, core damage, and release of radioactive material to the environment

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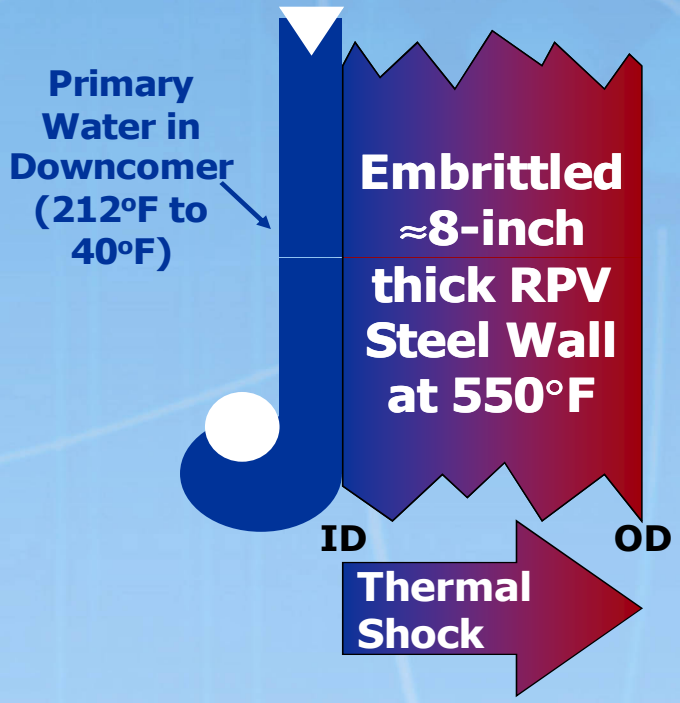
History and Background

- What is PTS?
  - An event that produces rapid cooldown from operating temperature, resulting in cold vessel temperatures with or without repressurization
  - Combined thermal and pressure stresses could induce fracture of the vessel if the vessel is radiation embrittled



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History and Background

- The current PTS Rule (10 CFR 50.61) was promulgated in 1983 and last amended in 1996
- 10 CFR 50.61 is fundamentally based on 1980s technology and information related to RPV integrity
- 10 CFR 50.61 is risk-informed inasmuch as the screening criteria (or acceptance criteria) in the rule are related to limiting the probability of PWR RPV failure to 5×10^{-6} per reactor-year

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History and Background

- 10 CFR 50.61 requires U.S. PWR licensees to:
  - Demonstrate that their RPV materials will have adequate fracture toughness to meet the screening criteria in the rule through the end of their operating license
  - Evaluate RPV surveillance data as part of the process of demonstrating compliance with the rule
  - Take actions specified by the rule if the licensee cannot demonstrate the their plant's RPV will meet the requirements of the rule throughout its licensed operating lifetime

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Motivation for Recent Activities

- 10 CFR 50.61 is recognized to be very conservative relative to what is known today about RPV integrity
- 10 CFR 50.61 creates unnecessary regulatory burden on U.S. PWR licensees and could cause some plants to shut down prematurely
- Therefore, the NRC developed a technical basis for a new PTS rule, 10 CFR 50.61a, which uses current technology to address these issues

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The New PTS Rule – 10 CFR 50.61a

- The NRC began work on the technical basis for 10 CFR 50.61a in the late 1990s

- Incorporates state-of-the-art understanding in the wide variety of technical areas affecting PTS evaluation:

  - Neutron fluence calculations
  - RPV steel embrittlement due to radiation
  - Flaw distributions in RPV plates, forgings, and welds
  - Fracture mechanics of RPV steels
  - Thermal-hydraulics
  - Probabilistic risk assessment / PTS transient frequencies
  - Uncertainty analysis in risk-informed applications

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The New PTS Rule – 10 CFR 50.61a

- 10 CFR 50.61a is structured similarly to 10 CFR 50.61
- 10 CFR 50.61a provides less conservative screening criteria (although these criteria are now related to a RPV failure frequency of 1×10^{-6} per reactor-year) for demonstrating RPV materials have adequate fracture toughness to ensure protection from PTS events
- However, 10 CFR 50.61a requires additional licensee action to demonstrate that the characteristics of their plant's RPV are consistent with the technical basis for 10 CFR 50.61a

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The New PTS Rule – 10 CFR 50.61a

- The NRC expects to complete 10 CFR 50.61a in 2009
- It is anticipated that several U.S. licensees will apply to use 10 CFR 50.61a shortly after it is issued
- Potential new U.S. reactors are not covered under 10 CFR 50.61a as PTS transient frequencies, in particular for advanced passive PWR designs, were not evaluated in the 10 CFR 50.61a technical basis