PWR Large Break LOCA Analyses And Their Application To New Reactor Licensing Process

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Status of New Reactor Licensing In U.S

- A total number of 18 applications with 28 units
- Reactor Design Types:

  Pressurized Water Reactors:

Westinghouse	AP1000
AREVA	U.S EPR
Mitsubishi	U.S APWR

  Boiling Water Reactors:

General Electric	ABWR, ESBWR

  Advanced Reactor Under Consideration

  B&W mPower, NuScale, IRIS, 4S

  PRISM, HTGR

Licensing Review Process

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Component 1. Design Certification Review

Component 2. Early Site Permit Review

Component 3. Combined Construction & Operating (COL) License Review

Design Certification Review

- As an important part of design certification and COL review, Emergency Core Cooling System (ECCS) needs to be evaluated according to Federal Regulation 10CFR 50.46 or Appendix K to 10CFR Part 50

- NRC reviews applicants' submittal which usually contains testing or analyses results about ECCS performance during Large Break Loss of Coolant Accident

PWR ECCS LBLOCA Evaluation And Confirmatory Analysis

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- Staff's review of the submittal is normally supported by performing confirmatory analysis using NRC independent safety analysis codes, e.g, RELAP5, TRACE FRAPCON and FRAPTRAN, MELCOR, etc.

- PWR LBLOCA confirmatory analyses usually consist of the following phases of analyses:

    1. System Model Development
    2. System Initial Condition Development
    3. Analysis Results Evaluation

- Outcome of the confirmatory analysis results

    Requests for Additional Information (RAI)

- Demonstration of a sample 4 loop PWR LBLOCA simulation

Significant Common Safety Issue

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Initial Core Stored Energy Calculation

- Initial core stored energy has a significant impact on peak cladding temperature during LBLOCA, especially for reactors with the reflood peak well into the LBLOCA accident

- Legacy fuel performance codes have been used to provide initial core temperature distribution according to power distribution and burn-up

- Some legacy fuel performance codes have been found to be under-predicting the fuel conductivity degradation due to burn-up

Regulatory Action

Information Notice 2009-23 titled “Nuclear Fuel Thermal Conductivity Degradation” was issued to all operating reactor licensees, new reactor applicants and nuclear fuel storage and transportation licensees to inform them the potential impact of the legacy fuel performance codes

Future Analysis Improvement For Consideration - Decay Heat Sampling

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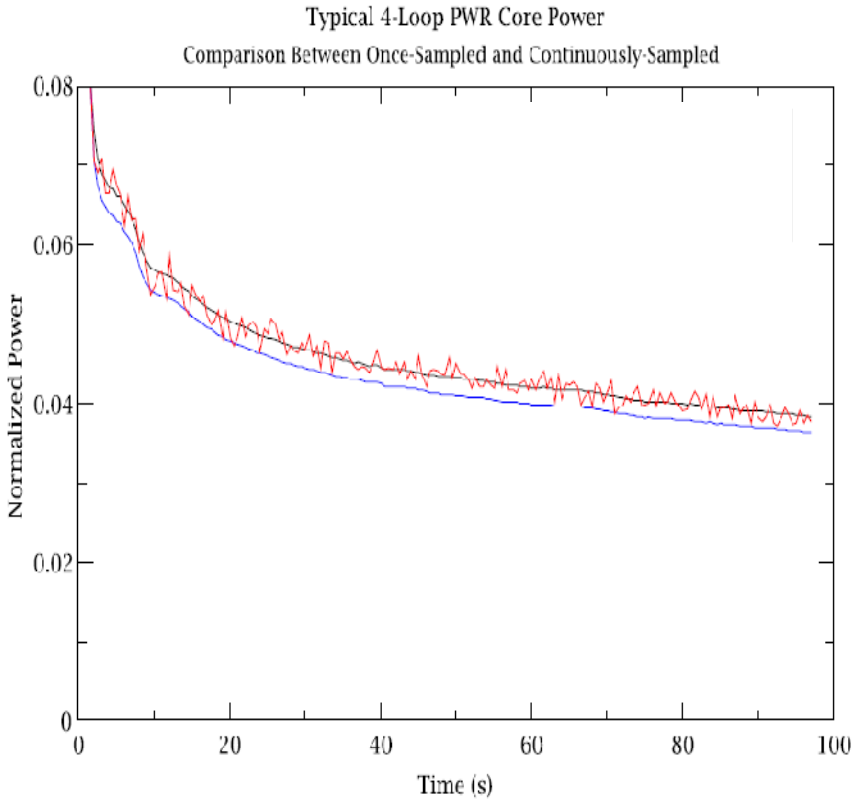

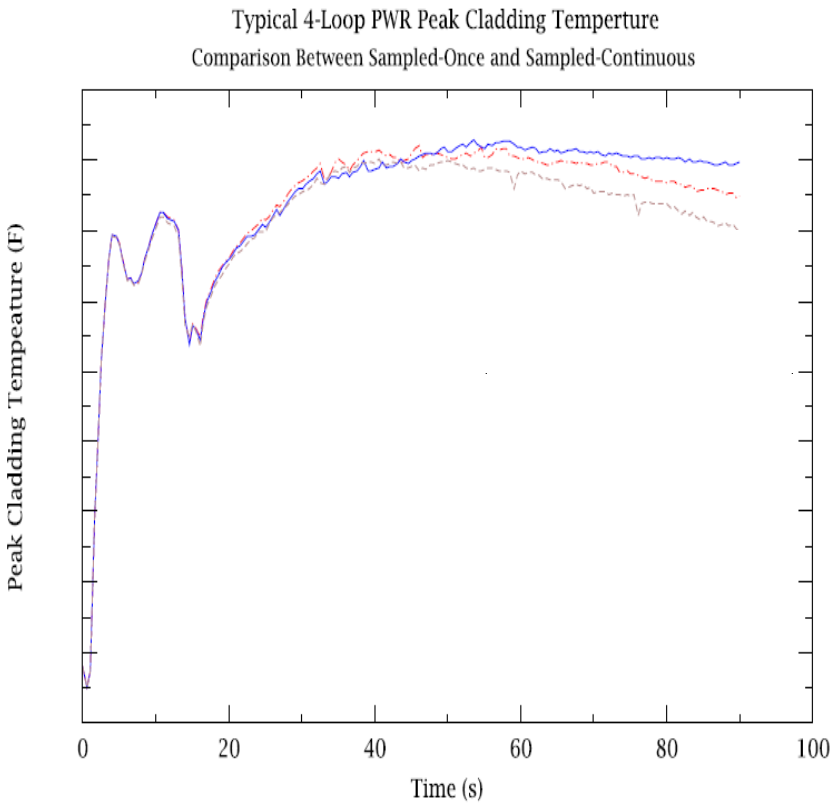

- Sampling once at the beginning of the LOCA transient has been commonly used
- More frequent sampling at 1/10 of fuel conduction time constant may reduce uncertainty of PCT

Conclusion

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- Confirmatory analysis has been used to support U.S. NRC's new reactor licensing process
- The evaluation of the PWR LOCA analysis revealed the potential underprediction of initial core stored energy. Information Notice has been issued to inform the industry