GE Hitachi Nuclear Energy

BWR LOCA
Long-Term Cooling Aspects

Public Meeting on 10CFR50.46c Proposed Rule

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Outline

- Summary of 5 LOCA Criteria
- Long-Term Cooling per 10CFR50.46
  - Jet-Pump Plants
  - External Pump Plants
- Debris Blockage Considerations
  - Current Status

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The Five Criteria for ECCS Acceptance

10CFR50.46 lists the following as the Emergency Core Cooling System (ECCS) evaluation acceptance criteria:

Peak Cladding Temperature < 2200 °F

Maximum Local Oxidation < 17%

Hydrogen generation, hence core-wide oxidation < 1%

Coolable geometry: core remains amenable to cooling

Long-Term Cooling: After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

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Compliance with Long-Term Cooling

- Compliance with LTC requirement is documented in NEDE-20566-P-A, for both jet pump and external pump designs.

- Integral and separate effect tests on the core spray sparger designs of the BWRs were verified by means of full-scale mock-ups tested in air at various flow conditions. Steam environment effects are also addressed in NEDO-20566-3.

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Compliance with Long-Term Cooling

- Pipe Breaks Other Than Recirculation System:
  The reactor vessel re-floods for all pipe breaks other than in the recirculation system, and the fuel cladding quickly cools to saturation temperature.
  No further perforation nor metal-water reaction will result.
- Recirculation Line Breaks in Non-Jet Pump BWRs:
  As demonstrated in NEDE-20566-P-A, the fuel rods will be wetted by the core spray in a matter of minutes following the accident. The cladding surface area will return quickly to saturation temperature.
  No further perforation nor metal-water reaction will result.

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Compliance with Long-Term Cooling

- Recirculation Line Breaks in Jet Pump BWRs:
  When the core re-floods shortly following the postulated LOCA, the fuel rods will return quickly to saturation temperature over their entire length.
  When at least one spray system is available long-term, the upper third of the core will remain wetted by the core spray water as in non-jet pump BWRs, and there will be no further perforation or metal-water reaction.

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Adequacy of Long-Term Cooling

- Adequacy of LTC requirements was further investigated for top peaked axial power shapes and newer core loading patterns. The applicability was confirmed.
- As decay heat falls off, the heat flux in the core will be too small to cause two-phase level above the top of active fuel. This occurs in ~10 minutes for the low-powered peripheral channels and about 30 hours for high-powered bundles.
- There is at least one core spray system available long-term and the upper third of the core will remain wetted and cooled by the spray water as in non-jet pump BWRs.

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Debris Blockage Considerations

- Current Status:

  BWROG is supporting responses to NRC questions and proposing additional tests to demonstrate that:

  There is no debris blockage impact on initial quench and PCT

  There is sufficient fuel channel inlet flow with potential blockage.

- Additional tests for long-term to assess how long it would take the fuel inlet blockage, if any, is planned.
- In the 50.46c rulemaking, timeline aspects must be considered in coordination with BWR debris blockage issue resolution.

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