



GSI-191 Resolution Status Meeting February 7, 2007

In-Vessel Downstream Effects

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Purpose of Presentation

- Respond to PWROG letter on Long-Term Cooling
- Emphasize some items that need to be addressed in the upcoming Topical Report on In-Vessel Downstream Effects



Owners Group Position on Long-Term Cooling

Cladding Embrittlement:

- PWROG position: Maximum allowable cladding temperature 800°F for 30 days with no significant impact on mechanical properties, corrosion, or hydrogen pickup
- References “Long-term autoclave testing”

PWROG needs to provide test results for NRC staff to review

Should demonstrate test results are applicable to all commercial cladding materials



Topical Report Methodology

Methodology should account for differences in PWR RCS and ECCS designs

Examples:

- CE plants with smaller recirculation flows (core boiling long after hot leg injection initiation may impact concentration of debris in core, plate-out, etc...)
- Use of pressurizer spray nozzles for hot-leg injection evaluated for the potential to be clogged with debris
- Upper Plenum Injection plants with no cold leg recirculation flow may have no means of flushing the core following a large hot leg LOCA



Topical Report Methodology

Need to account for additional debris trapped/hot spots due to swelled and ruptured cladding

- Debris may collect in the restricted channels caused by clad swelling, and at the rough edges at rupture locations
- FLECHT tests have shown that swelled and ruptured cladding will affect the cladding temperature profile. FLECHT tests did not include post-LOCA debris



Topical Report Methodology

Should account for long-term boiling effects on debris and chemical concentrations in the core

- Similar to post-LOCA boric acid precipitation evaluation
- Account for change in water volume available to mix with constituents concentrated by the core
- Partial blockage of the core creates alternate circulation patterns within the reactor vessel and will affect the concentration analysis
- Will the solubility limits be exceeded for any of the material dissolved in the coolant that is being concentrated by boiling in the core?

Topical Report Methodology

Should evaluate how spacer grids might trap debris and chemicals and potentially affect heat transfer from the fuel rods

- Analyses show that a partially filled spacer grid produces only a moderate cladding temperature increase even if only axial conduction down the cladding is considered
- Similar analyses show that a blocked spacer grid with only axial conduction will result in unacceptable temperatures
- Need to provide a basis for the extent that the spacer grids can trap debris, and for the ability for the debris to block flow
- Evaluation needs to include potential for issues identified in previous slides may negatively impact this concern

Topical Report Methodology

Consideration for plating out of debris and/or chemicals on the fuel rods during long-term boiling

- Long-term boiling in the core following a large LOCA may last for several weeks for some designs depending on the ECCS flow and core inlet temperature
- Should determine the concentration of materials in the core, and the potential for plate out on the fuel rods from this material (boiler scale)
- When the composition and thickness of the boiler scale has been determined, the effect on fuel rod heat transfer can be evaluated

Topical Report Methodology

Need to address whether high concentrations of debris and chemicals in the core from long-term boiling can affect long-term cooling

- For a large cold leg break, the density difference between the core and the downcomer determines the hydrostatic driving head and subsequent flowrate into the core
- Debris blockage of the core inlet will reduce the flow of water into the core
- As the boiling rate decreases, the high concentration of debris and chemicals in the core will increase the coolant density in the core and reduce the flow into the core region
- Voiding within the core will decrease the coolant density relative to the downcomer and increase the flow of water into the core (recognized counter-active effect)