



Overview of NRC-Sponsored Research Supporting GSI-191 Resolution

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General Research Philosophy

- **Motivation:** Recognized that research was necessary in some key technical areas to ensure adequate resolution of GSI-191
- **Broad Objectives**
 - Focus on technical areas having highest uncertainty (ACRS, staff, industry) and where generic evaluation provides the most impact
 - Conduct parametric and/or scoping studies to evaluate important variables over ranges of representative conditions
 - Interact with regulatory staff and industry to inform testing approach & conditions
- **Goals**
 - **Integrated Chemical Effects Testing (ICET) Program:** Provide basic technical knowledge to industry and staff on formation of chemical byproducts
 - **Other Programs**
 - Conduct confirmatory research for staff use in conducting an independent review and assessment of licensee GL 2004-02 evaluations
 - Make important results publicly available to inform ongoing industry activities



Technical Areas of Study

- **Chemical effects:** Determine potential for chemical by-product formation within containment pool environments. Characterize and predict by-products that form.
 - ICET: Los Alamos National Laboratory (LANL)
 - Chemical Speciation Prediction: Center for Nuclear Waste Regulatory Analyses (CNWRA) @ Southwest Research Institute
- **Head loss:** Confirmatory research on head losses associated with PWR containment materials with and without chemical effects
 - Chemical Effects Head Loss Testing: Argonne National Laboratory (ANL)
 - Particulate Head Loss Testing: Pacific Northwest National Laboratory (PNNL)
- **Downstream effects:** Confirmatory research on the effect of injected debris on surrogate high pressure safety injection (HPSI) throttle valve performance, LANL
- **Coatings transport:** Confirmatory research on the transportability of coating chips to the sump screen, Naval Surface Warfare Center (NSWC)

Important Research Results: Chemical Effects



- Chemical products can form in representative sump environments which may contribute to degraded Emergency Core Cooling System (ECCS) performance.
- Relatively small variations in post-LOCA containment pool environmental variables and interactions among containment pool materials can result in significantly different concentrations and types of chemical by-products.
- Prediction of chemical by-product concentrations and species is most accurate when analytical models are properly benchmarked by experimental data.
- Calcium phosphate can form in trisodium phosphate-buffered environments. Calcium phosphate has relatively slow settling rates and provides greater contributions to the pressure drop across a test sump screen than corresponding amounts of calcium silicate insulation.

Important Research Results: Other Research Areas



- Fibrous insulation was more likely than either calcium silicate or reflective metal insulation to create blockage within surrogate HPSI throttle valves.
- Under test conditions, HPSI throttle valve blockage could increase due to ingested debris accumulation, but the blockages were often unstable.
- Chip shape and density appear to most strongly influence transportability of coating materials.
- Debris arrival sequence strongly influenced the pressure drop across test sump screens. The creation of an initial fibrous debris bed followed by particulate loading resulted in the largest pressure drops.
- Significantly greater pressure drops occurred in tests when the fibrous debris bed became saturated with either particulate or chemical product loading. Saturation may occur either uniformly or within a thin region.



Research Status and Schedule

- Chemical effects
 - ICET
 - All testing is complete and test data reports are publicly available.
 - NUREG/CR report to be published by June 2006.
 - Chemical Speciation Prediction
 - Initial analyses have been completed. Follow on analyses are underway.
 - Analyses and NUREG report will be completed by June 2006.
- Head loss testing
 - Chemical Effects Head Loss Testing
 - Testing will be completed in April 2006.
 - NUREG/CR report to be published by August 2006.
 - Particulate Head Loss Testing
 - Testing will be completed by April 2006.
 - NUREG/CR report to be published by August 2006.



Research Status and Schedule

- Downstream effects
 - HPSI throttle valve testing is complete.
 - NUREG/CR report will be published in March 2006.
- Coatings transport
 - Initial testing phase is complete.
 - Final testing and analysis will be completed in March 2006.
 - NUREG/CR report will be published in Fall 2006.

Results and Information



- Over the last year, RES has produced five NUREG/CR reports, seven technical reports which have been publicly released, and provided research summaries on the NRC's PWR sump performance website.
- NUREG Reports
 - NUREG/CR-6868, Small-Scale Experiments: Effects of Chemical Reactions on Debris-Bed Head Loss, March 2005
 - NUREG/CR-6874, GSI-191: Experimental Studies of Loss-of-Coolant-Accident-Generated Debris Accumulation and Head Loss with Emphasis on the Effects of Calcium Silicate Insulation, May 2005
 - NUREG/CR-6877, Characterization and Head-Loss Testing of Latent Debris from Pressurized-Water-Reactor Containment Buildings, July 2005
 - NUREG/CR-6885, Screen Penetration Test Report, October 2005
 - NUREG/CR-6873, Corrosion Rate Measurements and Chemical Speciation of Corrosion Products Using Thermodynamic Modeling of Debris Components to Support GSI-191, April 2005

Results and Information



- ICET Data Reports
 - Integrated Chemical Effects Test Project: Test #1 Data Report, July 2005
 - Integrated Chemical Effects Test Project: Test #2 Data Report, October 2005
 - Integrated Chemical Effects Test Project: Test #3 Data Report, October 2005
 - Integrated Chemical Effects Test Project: Test #4 Data Report, November 2005
 - Integrated Chemical Effects Test Project: Test #5 Data Report, January 2006
 - Memorandum from M. Evans to J. Hannon, on Final Transmittal of Information Summarizing Integrated Chemical Effects Results and Implications, October 2005

- ANL Quick Look Reports
 - Chemical Effects/Head-Loss Testing Quick Look Report, Tests 1 & 2, September 16, 2005
 - Chemical Effects/Head-Loss Testing Quick Look Report, Tests ICET-3-4 to 11, January 20, 2005



More Detailed Information

- Poster on Emergency Core Cooling System Sump Research located in the concourse contains additional information on these research activities.
 - Detailed overview of each test program
 - Test videos
 - Handouts
 - Discussion with each NRC program manager

- Visit the NRC's sump performance website for obtaining publicly available reports and information related to these research programs: <http://www.nrc.gov/reactors/operating/ops-experience/pwr-sump-performance/tech-references.html>