Calvert Cliffs GSI-191 Program

Thermal Hydraulic Analysis of Containment Response and Acceptable Head Loss Test Selection

October 25, 2016

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Agenda

- Introductions
- Objectives for Meeting
  - Thermal Hydraulic Analysis of Containment
    - Demonstrate that one CS pump will be secured prior to the onset of chemical precipitation
    - Containment pressure reduces to 2.8 psig prior to containment pool reducing to 140°F
  - Acceptable Strainer Head Loss Test
    - Identify chemical effects head loss test applicable simplified risk-informed approach
- Staff Questions & Concerns
- Schedule for Future Periodic Meetings

CCNPP Attendees

- Jake Smith – Director Site Engineering
- John Haydin – M&CU Engineering Manager
- Andre Drake – Lead Responsible Engineer GSI-191
- Craig Sellers – Project Manager GSI-191
- Eric Federline – Project Support

Thermal Hydraulic Analysis of Containment

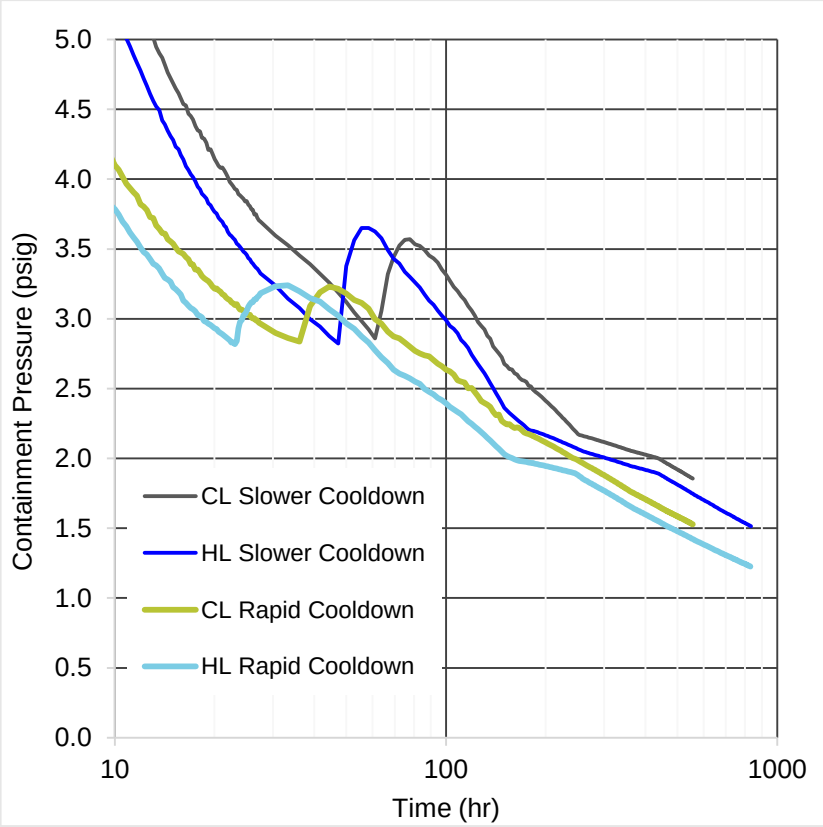
- Investigate Sump Temperature and Containment Pressure
  - Large Break LOCA Events
  - Cooldown Scenarios
    - 2 Containment Spray Pump + 2 Containment Air Coolers – Slower Cooldown
    - 2 Containment Spray Pumps + 4 Containment Air Coolers – Rapid Cooldown
- In all cases, pool temperature > 140°F when containment pressure reduces to 2.8 psig
  - One Containment Spray Pump secured at containment pressure < 2.8 psig
  - Chemical precipitants remain soluble until pool temperature reduces to 140°F
  - Cold Leg Break, Max SI, Max Instrument Uncertainty, pool = 138.8°F @ 2.48 psig
    - Cold Leg Break produces 10% to 20% less precipitate

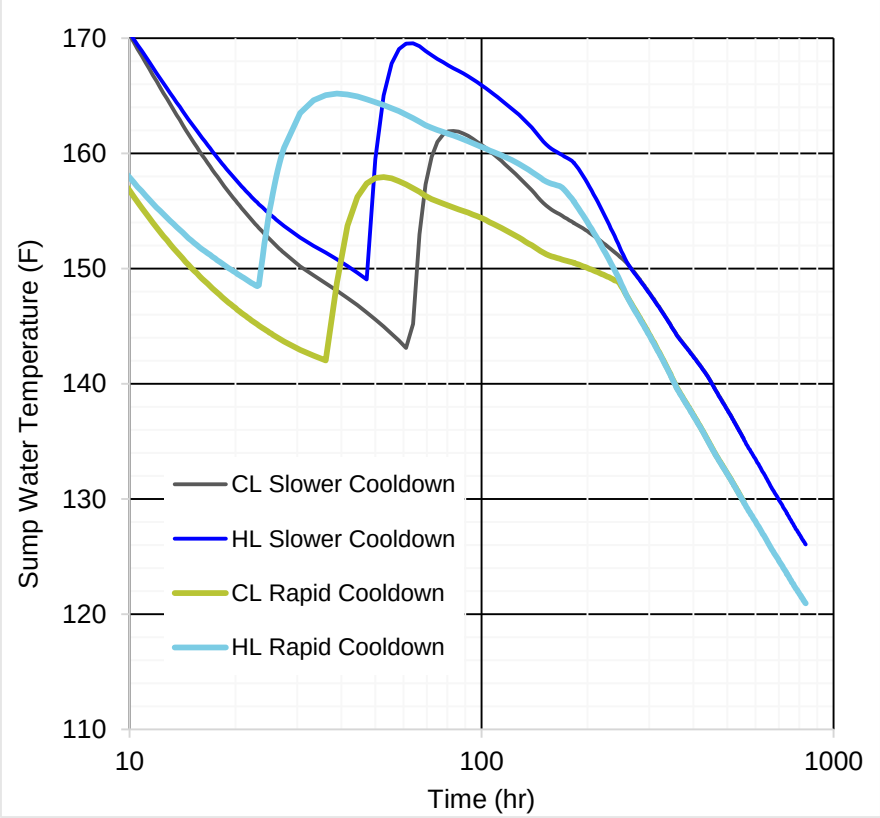
Thermal Hydraulic Analysis Results

- 2 CS pumps + 2 CACs
  - Hot Leg Break
    - Time to 140°F = 108.3 hours
    - Time to 2.8 psig = 47.2 hours
    - Time to secure pump = 61.1 hours
    - Pressure @ 140°F = 1.98 psig
  - Cold Leg Break
    - Time to 140°F = 77.8 hours
    - Time to 2.8 psig = 63.9 hours
    - Time to secure pump = 13.9 hours
    - Pressure @ 140°F = 2.58 psig
- 2 CS pumps + 4 CACs
  - Hot Leg Break
    - Time to 140°F = 86.1 hours
    - Time to 2.8 psig = 23.6 hours
    - Time to secure pump = 62.5 hours
    - Pressure @ 140°F = 1.95 psig
  - Cold Leg Break
    - Time to 140°F = 50.0 hours
    - Time to 2.8 psig = 38.9 hours
    - Time to secure pump = 11.1 hours
    - Pressure @ 140°F = 2.63 psig

Thermal Hydraulic Response After CS Pump Trip

- Containment Spray primary heat removal for containment pool
- Pressure and Temperature increase after pump trip
- Pressure increase can auto restart CS pump
- EOPs being revised to prevent auto restart of CS pump





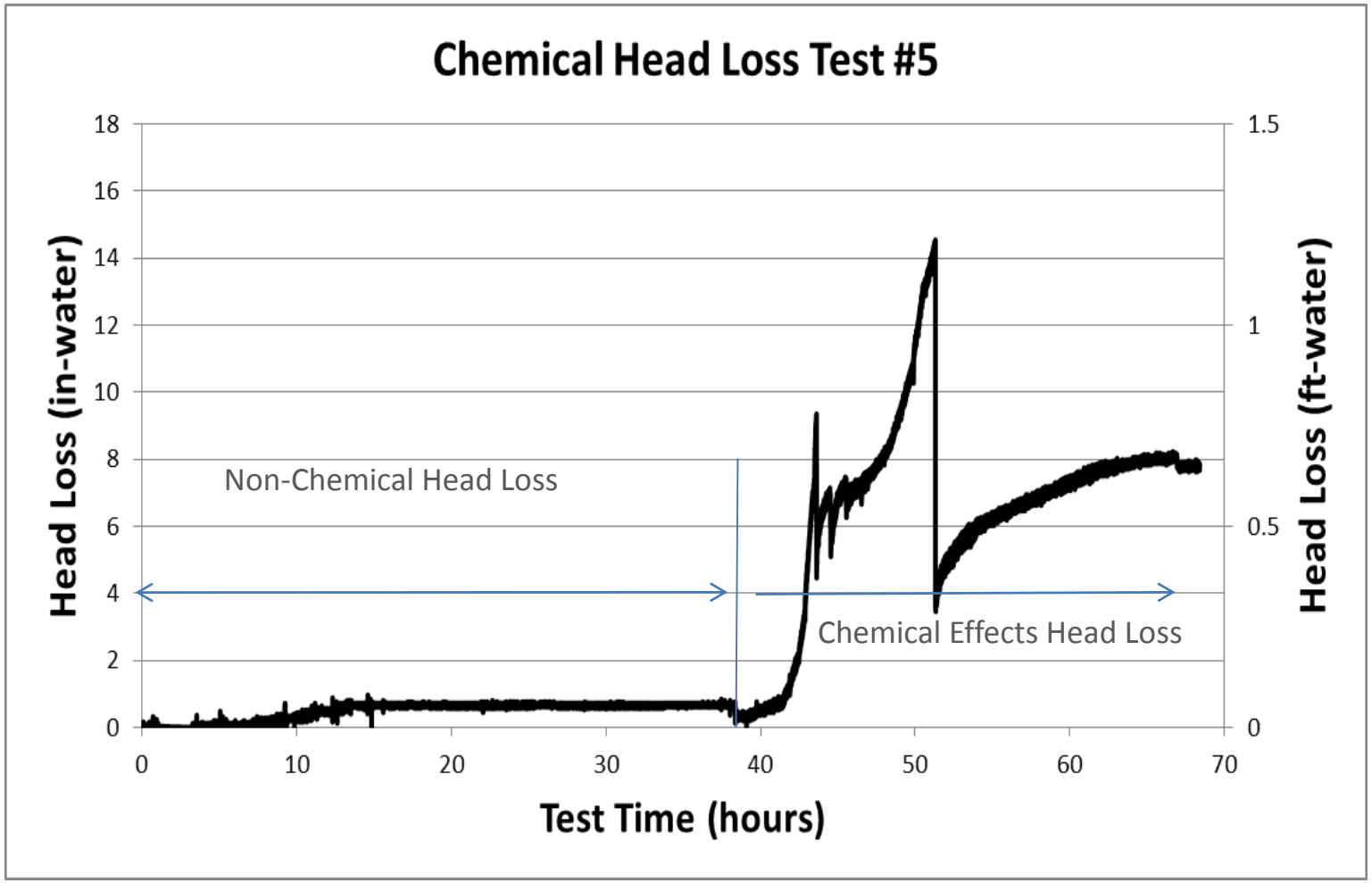
2010 Head Loss Testing – Test 5

- CCNPP performed a sequence of strainer head loss tests in 2010 with varying, scaled debris loads

- Test 5 is most appropriate test to use to define critical break size
  - Largest amount of fiber fines with maximum head loss below acceptance criteria of 1.99 ft H_20 when chemical precipitates form

- Test 5 Corresponding Plant Quantity Debris Loads
  - 211 lbs NUKON Fines
  - 542 lbs Thermal Wrap Fines
  - 29 lbs Generic Fiberglass
  - 43 lbs Temp-Mat
  - 206 lbs Epoxy Chips
  - 2269 lbs Particulate (modeled using silicon carbide)
  - 54.1 lbs of WCAP-16530 $NaAlSi_3O_8$

Head Loss Plot – Test 5



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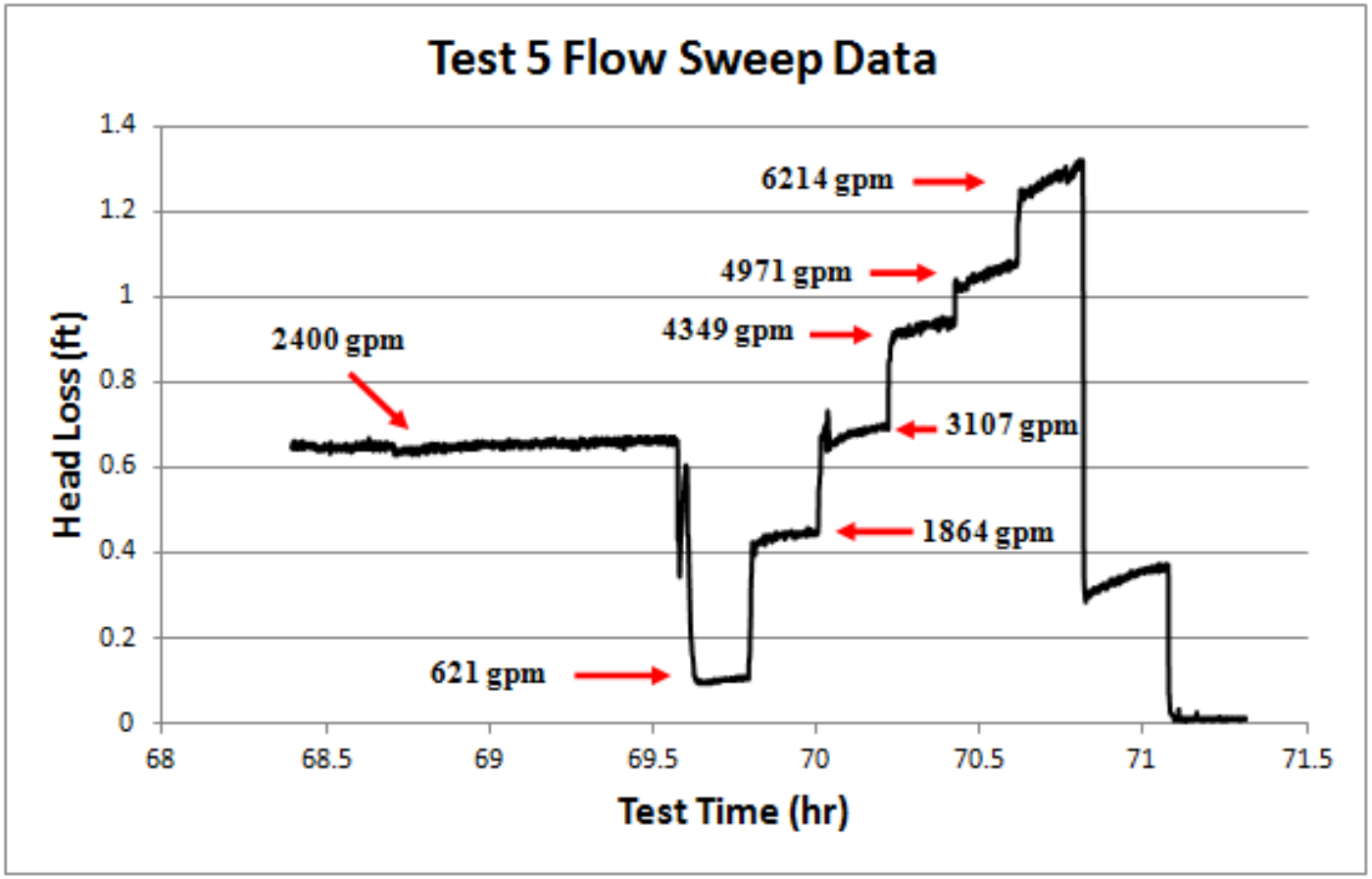
2010 Testing Flow Rates

- 2010 testing program added fibrous, particulate, and coating chip debris at scaled design plant flow rate of 5000 gpm
- During and after addition of chemical precipitates, flow was lowered to scaled flow rate of 2400 gpm (assumed 1 CS pump and 1 HPSI pump)
- Maximum recirculation flow rate at on-set of chemical effects could be as high as 2900 gpm (1 CS pump and 2 HPSI pumps)
- Flow sweeps performed at the end of each test
  - Test flow rate varied from scaled plant values of ~600 gpm to ~6000 gpm, holding for 10 minutes at various increments

2010 Test 5 Flow Sweep Data



Note – Plot Shows Corresponding Plant Flow Rates used in Test

Scaling Test 5 Head Loss Using Flow Sweep Data - Preliminary

- During test, break-through occurred in debris bed as chemical precipitates were introduced
- Increase maximum head loss recorded in Test 5 (1.21 feet) by ratio of flow rate increase from 2400 gpm to 2900 gpm
- This is more conservative the scaling using ration of head loss increase from flow sweeps

Test 5 Flow Sweep Results - Preliminary

- Linearly interpolate head loss
  – 2900 gpm / 2400 gpm = 21% increase

- Maximum total head loss including clean strainer head loss:
  (1.21 ft * 1.21) + 0.288 ft = 1.75 ft

- Below acceptance criteria of 1.99 ft (limiting failure mode of CCNPP strainer is dearation)

Questions/Concerns

- Jointly Review Issues, Questions, and Concerns for Future Communication

Next Steps

- Finalize Update of Calculations
- Present Formal Risk-Informed GSI-191 Analysis and Results
- Desire Next Meeting – 4Q 2016